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Ameren Missouri Program Year 2019 Annual EM&V Report

Volume 4: Demand Response Portfolio Report

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Figure 4-6. Residential DR Program – Summary of Program Impacts

		Nest	ecobee	Emerson	Total
Event Season Demand Impacts	Number of Events	4	4	1	4
	Average Number of Participating Devices	8,034	686	557	9,276
	Per Device kW Impact	1.10	1.33	1.25	1.12
	Total MW Impact	8.81	0.92	0.70	10.43
	% of Cooling Load Reduced	72%	84%	83%	74%
Weather Normalized Resource Capability Estimates	Total Number of Enrolled Devices	10,132	935	911	11,977
	Per Device kW Impact	1.27	2.15	2.15	1.41
	Total MW Impact	12.90	2.01	1.96	16.86
	% of Cooling Load Reduced	65%	91%	91%	69%
Energy Optimization Savings	Total Number of Participating Devices	4,845	836	-	5,681
	Per Device kWh Impact	37.94	160.44	-	55.97
	Total MWh Impact	183.84	134.13	-	317.97
	% of Baseline Energy Usage Reduced	3%	15%	-	5%
Event Day Energy Savings	Total Number of Participating Devices	7,910	662	557	9,129
	Per Device kWh Impact	10.12	9.94	2.00	9.62
	Total MWh Impact	80.08	6.58	1.12	87.78
	% of Baseline Energy Usage Reduced	10%	8%	7%	9%

1. Glossary of Terms Acronyms and Abbreviations

This section contains definitions of the key terms used throughout this report.

Active days – days during which energy optimization actively runs.

Bring your own thermostat (BYOT) – program enrollment channel that engages customers with existing and already installed devices.

Capacity – amount of electric load available for reduction.

Cumulative DR Capability – a metric based upon the resource capability used to determine earnings opportunity award for DR programs to provide incentives for peak demand savings as well as retention of the DR capability over the implementation period.

Device – smart thermostat in the context of the Residential DR Program.

Emergency event – a dispatch of participants in the program as issued by MISO to manage system emergencies.

Energy optimization – proprietary algorithms that optimize thermostat setpoints to achieve HVAC system runtime.

Event day – 24 hours during which an event, either test or peak shaving, is dispatched.

Learning days – days free of energy optimization.

Load curtailment – reduction of electricity usage for a period of time.

Marketplace – program enrolment channel that engages customers who purchase qualifying devices through Ameren Missouri Online Marketplace program.

Missouri Energy Efficiency Investment Act (MEEIA) goal – three-year savings target approved by the Missouri Public Service Commission for a given program.

NERC holidays – holidays set forth by the North American Reliability Corporation (NERC) and include days on which the following holidays are observed: New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day and Christmas Day.

Nominated capacity – event hour demand reduction goal set for each participating account. This value represents the maximum amount for customer incentive payment purposes.

Non-event day – 24 hours during which no event, either test or peak shaving is dispatched.

Peak demand – the highest electrical demand during any one-hour interval during a designated period of time.

Peak shaving event – a dispatch of participants in the program to reduce Ameren Missouri's distribution system peak demand.

Resource capability – event performance under typical weather conditions reflecting total demand under control by the programs at program year-end and available to be called under conditions consistent with Ameren Missouri's peak forecasting weather assumptions.

Test event – a dispatch of participants in the program to test the performance of the DR Program.

2. Executive Summary

This volume of the PY2019 Annual Report presents evaluation results from the Ameren Missouri PY2019 portfolio of demand response (DR) programs, as described in Ameren Missouri's 2019-21 Missouri Energy Efficiency Investment Act (MEEIA) Energy Efficiency Plan. In this document, the evaluation team provides portfolio-level results for PY2019, as well as detailed findings for each program. Results for the business and residential portfolios are provided in separate volumes.

For the demand response portfolio, Ameren Missouri prioritized capturing demand impacts to meet capacity reserve requirements, while also incorporating energy efficiency (EE) savings within the design strategy through smart thermostat optimization. In 2019, Ameren Missouri launched two new DR Programs:

- Residential DR Program (also referred to as Peak Time Savings program)
- Business DR Program

This evaluation summarizes key lessons learned regarding data capture, customer experience, and program impacts. The evaluation team conducted a variety of evaluation activities, including customer interviews and surveys to understand customer experience and satisfaction, as well as impact analyses leveraging robust baseline estimation processes. Importantly, this evaluation also assessed resource capability, which is the degree to which Ameren Missouri can reliably capture demand impacts in PY2020 based on a forecast of program enrollment and demand impacts estimated in PY2019.

The following sections present overarching key evaluation findings and recommendations for the demand response portfolio. The remainder of this volume is organized as follows:

- Chapter 3 presents the general evaluation approach for the demand response programs, including overarching evaluation objectives and an overview of the PY2019 evaluation activities and methodologies.
- Chapters 4 and 5 present evaluation results for the two DR programs.

2.1 Portfolio Summary

The DR portfolio is comprised of two programs: one residential and one commercial. For the residential program, Ameren Missouri launched an innovative 'intentionally' integrated DR and EE Peak Time Savings (PTS) thermostat program. A relatively new program design, Ameren Missouri worked with a team of partners to capture the co-benefits of both EE and DR. The Residential DR Program is designed to control cooling load with the help of smart thermostats to achieve peak demand savings and energy savings. Eligible customers include Ameren Missouri electric customers with central air conditioning systems, including heat pumps, and a program-qualifying smart thermostat. Qualifying smart thermostats in PY2019 include ecobee®, Nest®, and Emerson™ devices. Customers either enroll existing devices (bring your own thermostat or BYOT channel) or purchase and install qualifying devices through the Ameren Missouri Online Marketplace (Marketplace channel). Franklin Energy administered the program, and Uplight delivered the program.

In addition to launching the Residential DR Program, Ameren Missouri worked with Enel X to offer a business aggregator DR Program. The program is designed to reduce load during periods of peak demand. Enel X is the program aggregator, responsible for recruiting and enrolling customers, developing customized load reduction nominations and load curtailment strategies, dispatching demand response events and maintaining customer relationships with participating businesses. Eligible business customers can participate in DR events through

a variety of strategies, including direct load control and manual response. Each enrolled facility receives a customized load curtailment strategy, focusing on a variety of energy loads such as lighting, HVAC, chillers, motors, and processing equipment.

Figure 2-1 provides a summary of the DR portfolio program designs.

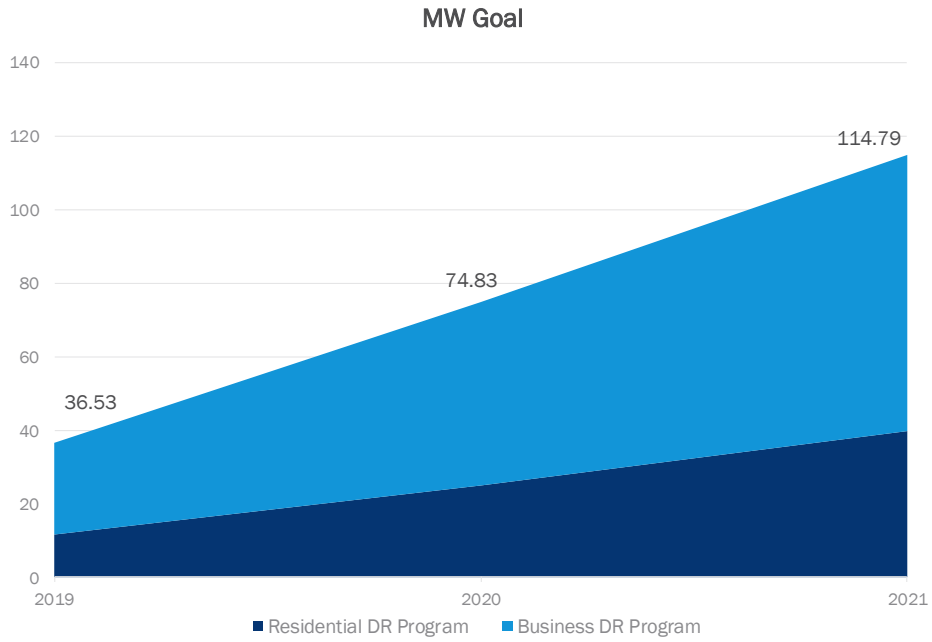
Figure 2-1. Summary of DR Portfolio of Programs

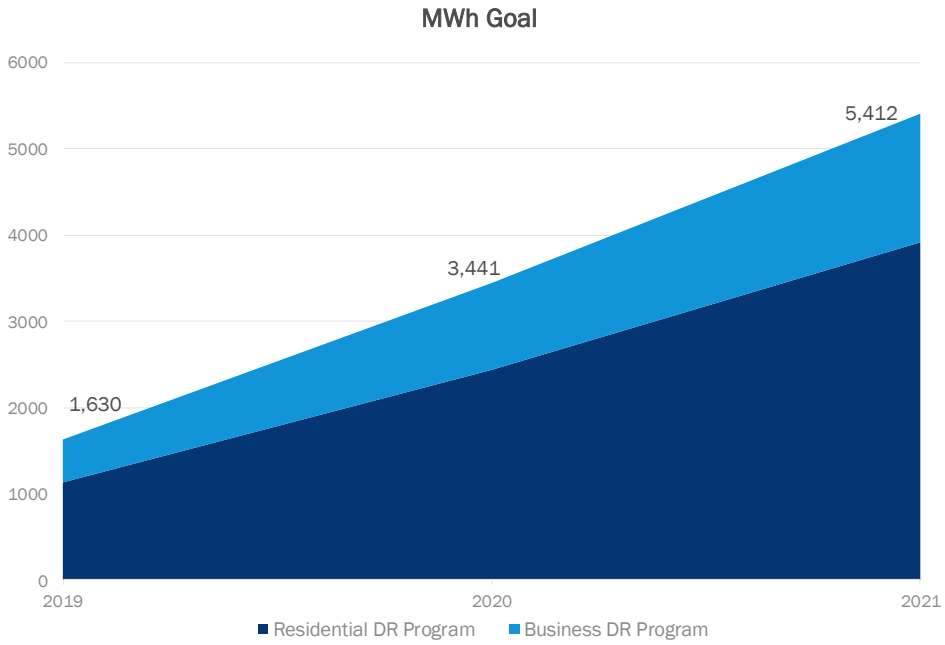
Program	Residential DR Program	Business DR Program
Eligible Customers	Residential electric customers with individual central air conditioning systems	Business customers
Eligible measures	Nest, ecobee and Emerson smart thermostats	Measure agnostic
Number of 2019 Events	4 three-hour test events	2 one-hour test events
Participation Incentive	$50 sign up; $25 participation	Custom incentive
Program Implementers	Franklin Energy, Uplight	Enel X

*Note that for the Business DR program, in addition to the two one-hour test events dispatched during the event season, an additional test event was dispatched in December 2019.

The DR portfolio MEEIA III demand reduction and energy savings goals for the three-year cycle aim to achieve 114.79 MW in demand savings and 5,412 MWh in energy savings across the Residential and Business DR Programs. The Business DR Program is expected to contribute the majority of the portfolio's demand savings (65%), while the Residential DR Program is expected to deliver 72% of the portfolio's energy savings goal. Figure 2-2 summarizes the DR portfolio goals by program.

Figure 2-2. Summary of Cumulative DR Portfolio Goals for the Planning Cycle





2.2 Portfolio Impact Results

At the end of the PY2019 season, the demand response portfolio achieved 32.82 MW in average load reduction as well as 499.89 MWh in energy savings. Milder than normal temperatures during the PY2019 event season resulted in dispatching only test events and were one of the driving factors behind the savings. For the Business DR Program specifically, there was a high degree of variability in facility-level impacts for Business DR Program participants.

Table 2-1. 2019 Event Season Performance Summary

Program	Participants	Event Season MW Performance	Event Season MWH Performance
Residential DR Program	9,276	10.43	405.75
Business DR Program	53	22.39	94.14
Total DR Portfolio	**9,329**	**32.82**	**499.89**

To compare the DR portfolio performance against the MEEIA III MW goals, Opinion Dynamics calculated weather normalized resource capability estimates. Resource capability reflects total demand under control by the programs at program year-end and available to be called under conditions consistent with Ameren Missouri's peak forecasting weather assumption.**Error! Reference source not found.** Figure 2-3 summarizes portfolio performance toward MEEIA III cumulative goals, for both demand and energy. As can be seen in the figure, the programs exceeded the demand goal of 36.53 MW by 30.26 MW for a total of 66.79 MW, achieving 183% of the goal, but fell short of the energy savings goals, achieving 499.89 MWH of the 1,630 MWH (31%).

Figure 2-3. DR Portfolio Performance Against MEEIA III Cumulative Goals

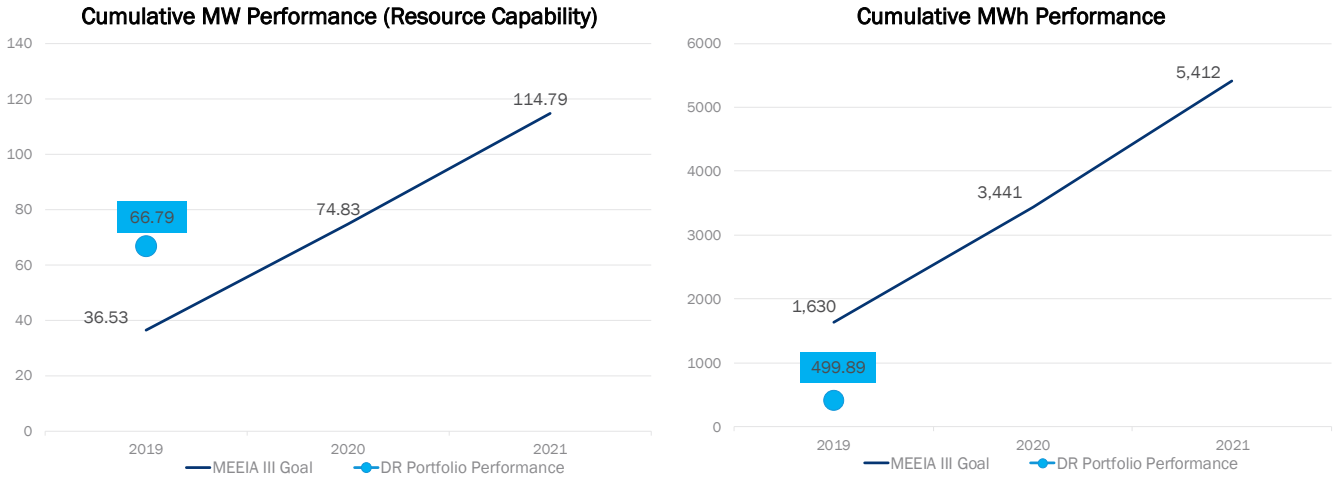


Table 2-2 provides a detailed summary of each program's performance against MEEIA III goals, including participation goals. As can be seen in the table, both programs exceeded goals in terms of customer enrollment. As of the end of PY2019, the Residential DR Program achieved 183% of its enrollment goal, while the Business DR program achieved 298% of the enrollment goal. From a resource capability perspective, both programs had a strong performance, which positions them well for the years ahead. More specifically, the Residential DR Program achieved 16.86 MW and 147% of its goal, while the Business DR Program achieved 49.99 MW and 200% of its goal. Both programs underperformed against the energy savings goal (36% and 19% for the Residential and Business DR programs, respectively). Energy savings for both programs are

calculated based on event day impacts. In addition, energy savings for the Residential DR Program include energy optimization savings during the cooling season. Across the portfolio, lower than planned energy savings are due to fewer than expected events dispatched in PY2019 due to milder than normal weather. For the Residential DR Program, the late start of the energy optimization component for most of the enrolled devices (Nest's) was another factor driving the energy savings results.

Table 2-2. DR Portfolio Performance Against MEEIA III

Program	2019 MEEIA III Goal	PY2019 Performance	Goal Achieved (%)
Participation as of the End of PY2019 (Participants)			
Residential DR Program	6,533	11,977	183%
Business DR Program	50	149	298%
Total DR Portfolio	**6,583**	**12,126**	**184%**
Resource Capability (MW)			
Residential DR Program	11.50	16.86	147%
Business DR Program	25.00	49.99	200%
Total DR Portfolio	**36.50**	**66.79**	**183%**
Energy Savings (MWH)			
Residential DR Program	1,130.00	405.75	36%
Business DR Program	500.00	94.14	19%
Total DR Portfolio	**1,630.00**	**499.89**	**31%**

In addition to the event season performance and resource capability performance, we also calculated cumulative DR capability. Cumulative DR capability is calculated to support the earnings opportunity metric for Ameren Missouri's DR programs. For the Residential DR Program, the cumulative DR capability mirrors the resource capability, whereas for the Business DR Program, per the MEEIA III Plan,[1] the cumulative DR capability is based on the performance of only tested participants, as opposed to all participants enrolled in the program at year-end.[2] Cumulative DR capability estimates for the two programs were considerably higher than the target, reaching 49.96 MW and representing 137% of the target.

Table 2-3. DR Portfolio Summary of Resource Capability Estimate Impacts by Program

Program	Target (MW)	PY2019 Performance (MW)	% of Target Achieved
Residential DR Program	11.50	16.86	147%
Business DR Program	25.00	33.10	132%
Total DR Portfolio	**36.50**	**49.96**	**137%**

2.3 Portfolio Process Findings and Recommendations

In PY2019, Ameren Missouri launched a new demand response portfolio working closely with an array of implementation partners across both programs, including Enel X, Franklin Energy, and Uplight. As such, PY2019 was a touchstone year for the portfolio, in which Ameren Missouri offered an integrated Residential

1 Ameren Missouri 2019-21 MEEIA Energy Efficiency Plan.
https://efis.psc.mo.gov/mpsc/commoncomponents/viewdocument.asp?DocId=936195031
2 Including event season DR or Test events as well as winter Test event.

DR Program that balances an array of smart thermostats, market channels, and energy intervention strategies, as well as a Business DR Program designed to bid into the Midcontinent Independent System Operator, Inc. (MISO) market in future years.

The demand response portfolio overachieved in terms of customer enrollment, suggesting an interest in the market for these programs as well as strong implementer performance in recruiting customers. Both programs resulted in high levels of customer satisfaction and, as a result, high likelihood of recommending the programs to others.

Looking forward, Ameren Missouri should continue to focus on continued engagement of enrolled participants as well as targeted enrollment of future participants to achieve portfolio goals. More specifically, key considerations include ensuring continued persistence in delivery of load impacts, mitigation of event overrides, as well as ensuring consistency in commercial load impacts for participants through continuous education and feedback.

Further, Ameren Missouri should continue to work with their implementation partners to recruit customers with potential for delivering load impacts. Educating customers on the program participation process, emphasizing the voluntary nature of the programs, and ensuring customer ability to regain control will be key to addressing these barriers to enrollment. Additionally, the evaluation team presents the following key program-specific findings and recommendations:

Residential DR Program

- Program planning assumptions of per-participant demand impacts are higher than what the program delivered in PY2019. Moving forward, the program will need to enroll more participants than planned, or achieve greater per-device impacts, to achieve demand impact goals. More specifically, the PY2019 evaluation results, under historically normal weather conditions, suggest that the program is estimated to deliver 1.69 kW in per-participant[3] load impacts, which is lower than the MEEIA planned value (1.76 for PY2019 kW).[4]
  - **Recommendation:** Program staff should balance participant enrollment targets with consideration of both resource capability and event season demand impacts to optimize the program's performance against its demand goal.
- PY2019 event impacts may not reflect future impacts. In PY2019, events were called for cooler temperatures (90°F on average during event hours across all four events) than typical peak (99 °F) with temperatures rarely rising above 95°F during the event season. As a result, the program called fewer than planned events, with four test events being dispatched. Given the cooler than anticipated weather, the program's event season demand impacts were lower than the demand impacts anticipated under historical peak weather conditions for the same number of participants (1.12 kW vs. 1.41 kW). Weather conditions (including temperature and humidity), however, are directly tied to customer experiences and behaviors during the event season, including comfort during events, frequency of overrides and event opt-out, satisfaction with overall program experiences, and ultimately customer de-enrollment from the program. During the PY2019 event season, customers were content with the number of events, event duration, and generally remained comfortable during the course of the events, though temperature differences were certainly noticeable.

[3] Based on 1.41 kW performance per-device and 1.2 devices per participant.
[4] This value is based on MEEIA III PY2019 enrollment goal of 6,533 participants and 11.50 MW in demand savings.

- **Recommendation:** Based on the resource capability estimates, the evaluation results suggest that a hotter event season and dispatching more events will likely result in an increase in total and per-participants demand impacts, should participant experiences with the events remain comfortable. As a result, program staff should balance the number of events and event duration with consideration of overrides and de-enrollment in future years. Working to collect participant feedback on their experiences during events will help gather early feedback and make any necessary adjustments to messaging or make any other feasible mid-course corrections. Providing additional prompts to participants in event notification e-mails encouraging them to resist overriding temperatures during the events and emphasizing environmental benefits and lower energy costs for the community (which resonate with participants and for many were core motivators to participation) can help ensure persistence of event temperature setpoints and ensure continued participation. Deploying behavioral encouragement mechanisms such as comparison to neighbors and competition, among others, via comparing participant performance over the course of the season to that of other

- The Residential DR Program did not achieve MEEIA III energy savings goals. More specifically, evaluated event season savings represented 36% of the goal, with the energy optimization algorithms accounting for more than three-quarters of energy savings (78%). The success of the program performance against its energy savings goals will continue to rely on the optimization component. Energy optimization performance was largely due to delays in launch and variations in impacts across the devices. Ecobee's deployment of aggressive energy optimization adjustments delivered deeper savings, but ecobees represent a smaller share of program participants. Nest's energy optimization algorithm delivered per-device savings nearly five times lower than ecobee, but accounted for the vast majority of the participating devices. On a per-participant basis across the event day and optimization components ecobee devices achieved 204 kWh in energy impacts, which is much higher than the PY2019 planned value of 173 kWh, whereas Nest devices achieved 58 kWh in energy impacts, which is much lower than the planned value. Notably, Nest optimization algorithms ran during the second half of the event season only and are less aggressive than the Orchestrated Energy optimization algorithms that ran on the ecobee devices. Deployment of the optimization component over the course of the entire event season as well as harvesting energy savings from a larger number of events will likely narrow the gap for Nest devices.

  - **Recommendation:** Deploy energy optimization algorithms as early in the event season as possible to increase total energy savings.

- Despite substantial enrollment through the BYOT channel in PY2019, continued participant enrollment through the BYOT channel will need to rely on new market entrants, given current smart thermostat market penetration and participant enrollment achieved through the channel. In addition, 15% of eligible Ameren Missouri discounted thermostat sales through the Marketplace program were converted into the Residential DR Program, suggesting opportunities to understand barriers to program enrollment and optimize thermostat enrollment. Furthermore, device manufacturers currently eligible for the program do not capture all of the potentially eligible customers.

  - **Recommendation:** The program should continue to diversify enrollment channels as a way to meet MEEIA III enrollment goals. Continued expansion of eligible devices and channels, planned by the implementation team for PY2020, will allow the program to tap into the previously untouched customer market. It is also important to understand the reasons for participant non-enrollment in the Program through the Marketplace channel. In PY2020,

survey research with customers who purchased but did not enroll in the program through the Marketplace channel would be useful to better understand barriers to program conversion and strategies for a more effective enrollment.

- The current Residential DR Program participants (who currently represent early adopters of the smart thermostat technology) skew toward higher levels of income and educational attainment. As smart thermostat adoption enters the mainstream market, and more market channels are adopted, the Residential DR Program participant composition may change, with potential implications on energy consumption patterns associated with the size of the home as well as participant presence at home during various times of the day. This changing participant composition may lead to future program engagement, and associated demand savings opportunities, that is different from current results.

  - **Recommendation:** As the program matures, program staff should identify factors driving program performance, e.g., high cooling load, engagement with devices, square footage of homes. Over time, we recommend monitoring participant composition across salient features and consider any need to align program goals with anticipated program performance, as well as any changes with targeting future high-value customers in the population.

- According to research conducted with program eligible Ameren Missouri's customers, there are a number of barriers to customer enrollment in Central AC DR Programs, including concerns about allowing the utility to control thermostats, potential negative impact on comfort, data security, and knowledge of the participation process. While none of them emerge as extreme barriers, comfort is the most commonly referenced barrier.

  - **Recommendation:** Educating customers on the program strategies (such as precooling) that increase the comfort of the home, as well as providing assurances of customers' ability to regain control of their devices easily will help mitigate barriers to engagement.

- The evaluation team identified a number of inconsistencies and limitations in the available data that limited the ability to link participant with telemetry and usage data necessitating changes in the planned approach to estimate energy and demand impacts. While the evaluation team was able to estimate demand and energy impacts, these changes in approach reduced the rigor of the evaluated results and our ability to provide more granular results or insight into customer behavior and engagement with the program to inform future planning.

  - **Recommendation:** Ameren Missouri and program staff should consider further discussing the possibility of obtaining data linkages with Nest. Obtaining participant consent to data sharing as part of program participation provision can be used as an alternative pathway to obtaining the desired data linkages.

Business DR Program

- Based on the program resource capability estimate, the program is well-positioned to achieve PY2020 goals with currently enrolled participants. However, the customers enrolled after the event season differ in terms of business segment profiles, thus presenting uncertainty around their future program performance.

  - **Recommendation:** Enel X should monitor those facilities closely during the PY2020 event season, as their load shaving behavior during the event season may be different than what was observed for facilities during the PY2019 event season.

- In PY2019, nominated capacity did not align with event performance, and in some cases, represented more than the entire facility load. A number of factors are driving this misalignment, including aggressive nominations, limited pre-event period interval data to support nomination development, customers with limited DR experience or insight into facility load profiles, a variety of diverse customer segments, and a mild PY2019 event season.
  - **Recommendation:** It is important for Enel X to continue monitoring customer performance against nominated capacities over the course of the PY2020 event season and adjust nominations to align them with actual customer potential based both on what customers can and are willing to achieve.
- Participants requested more, and more timely information to understand their program performance and progress toward the nomination goal to adjust their load reduction strategies as needed to achieve their load reduction commitment
  - **Recommendation:** Enel X should work to ensure timely communication with participants on event performance and assess opportunities to support participants in locating and achieving further load reductions.
- According to research conducted with program eligible Ameren Missouri customers, customers are concerned with a negative impact on comfort and facility operations. Lack of understanding of the program participation process is another likely barrier to customer engagement with the program.
  - **Recommendation:** When marketing the program to prospective customers, Enel X should consider addressing customer concerns of negative impact on comfort and facility operations through education and discussion of developing custom load curtailment strategies supported through highlighting implementer support and voluntary nature of the program. Providing additional customer education on the process of program participation will likely help increase customer comfort level with the process and further reduce customer uncertainty about participating in the program.

2.4 Cost-Effectiveness Results

Cost-effectiveness analysis compares the benefits of an energy efficiency or demand response program with the cost of delivering it, expressed as the ratio of the net present value (NPV) of lifetime benefits to the costs. A cost-effectiveness ratio of greater than 1.0 means that the benefits generated by the program exceeded its costs. Cost-effectiveness can be assessed from several different "perspectives," using different tests, with each test including a slightly different set of benefits and costs.

The evaluation team assessed the cost-effectiveness of both Demand Response programs, using five costs-effectiveness tests recommended by the California Standard Practice Manual[5] and used in prior evaluations:

- **Total Resource Cost (TRC) Test:** Perspective of all utility customers (participants and nonparticipants) in the utility service territory;
- **Utility Cost Test (UCT):** Perspective of utility, government agency, or third-party program implementer;
- **Ratepayer Impact Measure (RIM) Test:** Impact of efficiency measure on nonparticipating ratepayers overall;

[5] California Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects. October 2001.

- **Participant Cost Test (PCT):** Perspective of the customers installing the measures; and
- **Societal Cost Test (SCT):** Perspective of all utility customers (participants and nonparticipants) in the utility service territory.[6]

Table 2-4 summarizes the cost-effectiveness results for both DR programs. Both programs screen cost-effective under the TRC test.

Table 2-4. Summary of Demand Response Cost-Effectiveness Results

Program	TRC	UCT	RIM	PCT
Residential Demand Response [A]	1.11	1.11	0.98	n/a
Business Demand Response [A]	3.34	3.34	3.25	n/a

[A] Includes the lifetime costs and benefits of Demand Response programs over a 10-year effective useful life.

For portfolio-level cost-effectiveness testing, the Residential DR Program and the Business DR Program are included in the Residential Portfolio and the Business Portfolio, respectively. Portfolio-level results are presented in Volume 1.

[6] Although we developed SCT results as a part of our evaluation, this section does not show the results because they are equivalent to TRC results due to two factors: (1) Ameren Missouri does not include non-energy impacts in cost-effectiveness testing, and (2) Ameren Missouri uses the same planning assumptions for both tests, including the discount rate.

3. Evaluation Approach

This volume presents the evaluation results of the Ameren Missouri PY2019 portfolio of demand response programs, as described in Ameren Missouri's 2019-21 Missouri Energy Efficiency Investment Act (MEEIA) Energy Efficiency Plan. The following programs comprise the demand response portfolio:

- Residential DR Program (Peak Time Savings)
- Commercial aggregator Business DR Program

The Evaluation Team assessed each program separately, and the results of each program-level evaluation are presented individually in subsequent sections of this volume. However, the research objectives generally applied to all the demand response programs, and many of the evaluation activities were conducted across all the programs. The remainder of this chapter discusses the research objectives common to all business program evaluations. It presents an overview of the evaluation approach and the activities conducted to address the research objectives. Where additional detail is needed to describe specific activities (mostly program-specific data collection activities), they are discussed in the individual program chapters.

3.1 Research Objectives

The demand response portfolio evaluation was designed to address numerous process and impact objectives. An additional objective is also included focused on responding to the five key research questions stipulated in 4 CSR 240-22.070(8). The research objectives addressed by the PY2019 demand response portfolio evaluations are described in greater detail below.

Process Objectives

Process-related interviews with program participants to better understand the type of customers targeted for these programs and any opportunities or challenges these customers may face regarding participating in DR events. In addition, the process evaluation will draw on the initial activities described above. The key objectives of the process evaluation include:

- Assess how well customers understand event participation and identify barriers to participation;
- Assess how well customers understand the energy optimization platform (for residential customers);
- Measure customer satisfaction, with program processes and motivations for participating;
- Identify opportunities for improvement in customer experience; and
- Provide evaluation results that can be used to improve the design and implementation of the Program.

Impact Objectives

Across the DR portfolio, we estimated ex post demand response event load reduction and energy savings. In addition, we calculated the anticipated resource capability for the following year. Finally, for the residential thermostat program, we also calculated thermostat optimization energy savings impacts. Research objectives are as follows:

- What are the estimated ex post demand response event impacts?
- What are the anticipated resource capability estimates?
- What are the event energy savings impacts?
- What are the thermostat optimization energy savings impacts, where relevant?

Cost Effectiveness Objectives

- Assess the cost-effectiveness of each demand response program and the demand response portfolio as a whole using industry-standard cost-effectiveness tests
- Ensure alignment of cost-effectiveness testing assumptions and parameters with the PY2019 demand response evaluation results, Ameren Missouri's TRM Revisions 2.0, and industry best practices.
- Provide total program benefits, costs, net benefits, and cost-effectiveness testing results.

CSR Mandated Research Objectives (4 CSR 240-22.070(8))

- What are the primary market imperfections that are common to the target market segment?
- Is the target market segment appropriately defined, or should it be further subdivided or merged with other market segments?
- Does the mix of enduse measures included in the program appropriately reflect the diversity of enduse energy service needs and existing enduse technologies within the target market segment?
- Are the communication channels and delivery mechanisms appropriate for the target market segment?
- What can be done to more effectively overcome the identified market imperfections and to increase the rate of customer acceptance and implementation for select enduses/measure groups included in the Program?

3.2 Evaluation Activities and Methodologies

The combination of research activities used to examine each program varied, largely dictated by the data available, as well as an analytical approach to estimating impacts for each program. Table 3-1 shows the research activities included in each of the evaluations. Program-specific details are included in each program chapter where relevant.

Table 3-1. Research Activities by Program

Research Activity	Residential DR Program	Business DR Program
Program Manager and Implementer Interviews	√	√
Program Material Review	√	√
Tracking System Review	√	√
Participant and Market Actor Research		
Participant Survey	-	√

Research Activity	Residential DR Program	Business DR Program
Participant In-Depth Interviews	√	-
Market Partner Survey	-	-
Trade Ally/Service Provider In-Depth Interviews	-	-
Participating Developer & Designer Interviews	-	-
Gross Impact Analysis		
Database Review	√	√
Ex Post Event DR Impacts	√	√
Ex Post Event Energy Impacts	√	√
Resource Capability Assessment	√	√
Energy Optimization Impacts	√	-
Attribution/Net Impact Analysis		
Free-ridership	-	-
Participant Spillover	-	-
Market Partner Spillover	-	-

Program Manager and Implementer Interviews

To support evaluation planning, we conducted in-person interviews with program implementation staff in early 2019. In these interviews, we explored details of the design and planned implementation for each program, as well as program staff's evaluation priorities.

The Evaluation Team conducted an additional interview with the program and implementation staff throughout 2019 related to program evaluability, data access, and methodological considerations. The goals of these interviews were to clarify any outstanding questions about program design and implementation and to gain an understanding of planned changes for PY2020.

Program Material Review

We conducted a comprehensive review of all available program materials, including program tracking data, implementation strategies, and load curtailment plans. This review served to familiarize the Team with details of program design and implementation.

Tracking System Review

In February 2019, the Evaluation Team conducted a review of all available data tracking systems across Franklin Energy, Uplight, Nest, ecobee, as well as Enel X. The goal of our review was to ensure the databases contained the data necessary to complete our evaluation accurately. We developed a memo summarizing our findings of the review and recommended the additional fields be tracked.[7]

[7] Memo titled *Program Tracking Data Review – Business Energy Efficiency Programs*, dated February 28, 2019.

Participant Research

For the business DR Programs, the Evaluation Team conducted data collection with program participants through in-depth interviews. For the residential DR Programs, given the substantial number of participants, we captured data through a quantitative survey.

The **participant research** consisted of quantitative online surveys or qualitative telephone interviews conducted with Ameren Missouri demand response customers who had participated in a DR Program during PY2019. The number of participants determined whether we used a survey or interview approach: For programs with a large number of participants, we used surveys; for programs with few participants, we used interviews. The general topics covered across the business programs included:

- Satisfaction with the program overall and different components of the program
- Barriers to enrolling in the programs
- Barriers to participating in Ameren Missouri DR events
- Recommendations for program improvement

With surveys, we used simple random sampling or, in some instances. With interviews, we sampled purposively to ensure we captured respondents with desired characteristics. Details of the individual data collection activities, including population sizes, sampling approaches, response rates, and achieved levels of confidence/relative precision are discussed in the individual program chapters.

Gross Impact Analysis

The PY2019 impact analyses for the Ameren Missouri demand response programs included review of the program-tracking database, statistical analysis, and calculated baseline load (CBL) approach. Our team estimated energy and demand impacts associated with demand response events (i.e., event day impacts) as well as energy savings associated with the energy optimization platform (i.e., non-event day impacts). We outline these below.

Key objectives of the PY2019 gross impact analysis include:

- Characterize program participation with respect to event participation, and other relevant characteristics;
- Estimate the first-year ex-post gross energy (kWh) and demand (kW) savings and
- Determine weather-normalized DR capability for all participants enrolled throughout PY2019.

Database Review

We reviewed the program-tracking database to check that the databases contained all needed information to estimate program impacts.

Event Day Impacts

To calculate event day impacts, we use two distinct approaches for the residential and business DR Programs. For the evaluation of the Residential DR Program, we determined annual demand and event day energy

impacts, including assessment of event participation using statistical analysis of event day demand and associated energy savings.

- Assess Uplight's randomized control trial through the assignment of participants into treatment and control groups as well as days into treatment and control days for ecobee devices.
- Assess event participation, including failures and opt-outs.
- Conduct event regression modeling to estimate hourly and average event run-time, kW, and kWh impacts.
- Assess average event kW impacts under normalized weather conditions for all participants enrolled in PY2019.
- Conduct regression modeling to estimate non-event day kWh impacts for cooling season.

For the Business DR Program, we verified event performance using the aggregator's established baseline method. We used facility interval data provided by Ameren Missouri to conduct the analysis. Using the established baseline, the evaluation team measured event performance as the difference between actual metered demand on an hourly basis during the event season and the final baseline.

- Use aggregator's established baseline method to estimate hourly and average event kW and kWh savings impacts.
- Calculate average demand savings across all peak shaving events throughout the summer event season.

Event Day Conservation Impacts

To calculate energy savings on an event day, we sum the impacts for all hours incorporated within the regression analysis or algorithm (e.g., all 24 hours) depending on the program. The kWh savings calculation will include increased loads (often pre-cooling and snapback) that occur in the hours around the event as well as decreased loads during the event.

For the Residential DR Program, the evaluation of non-event day conservation impacts includes an estimate of the cooling season, non-event day net energy impacts using a statistical analysis of customer run-time data and weather data, as well as average HVAC equipment capacity assumptions to convert run-time to energy impacts.

Resource Capability

Because DR is a resource used to meet future peak demand needs during system peak events on Ameren Missouri's system, we also report its capabilities under conditions that are consistent with how Ameren Missouri forecasts peak demand and performs its long-term planning analyses. The total annual resource capability reflects impacts from participants in the Test Events (estimated in the event impact analysis above) as well as potential impacts from participants who enrolled in the program after the event season (but before the end of the program year).

For the Residential DR Program, participants demand reductions are weather-sensitive, unlike enrolled business DR customers. As a result, we weather-normalized residential DR impacts, using Ameren Missouri system peak weather, to determine DR capability for use in integrated resource planning. For the Business DR Program, we estimated hourly, and average demand impacts for facility-specific test events called for each

facility and applied a participation rate to those who enrolled after the summer event season and before the end of PY2019.

Cumulative DR Capability

Cumulative DR capability is a performance metric used in the assessment of the earnings opportunity award for the DR programs. The cumulative DR capability was calculated consistent with the MEEIA III Plan. For the Residential DR Program, the cumulative DR capability calculation mirrored the resource capability calculation described above and reflected event-season impacts normalized to Ameren Missouri system peak weather and extrapolated to all participants enrolled as of the end of PY2019. For the Business DR Program, the cumulative DR capability calculation is based on evaluated impacts from event season participants and impacts from tested participants who enrolled after the event season but before the end of PY2019. Cumulative DR capability for the Business DR Program therefore excludes anticipated demand impacts from participants who enrolled after the end of the event season and before PY2019 but were not tested. As such, it is lower than the resource capability.

Non-Event Day Energy Optimization Impacts

During the summer of 2019, Ameren Missouri, with Uplight as the implementer, ran a thermostat optimization program to reduce HVAC electricity consumption as part of the Peak Time Savings Program. The program operated in two different ways, depending on the thermostat device manufacturer. Google controlled Nest devices as part of a program they call "Seasonal Savings," while Uplight controlled ecobee devices as a part of "Orchestrated Energy (OE)." These programs were designed and operated very differently, requiring different approaches to calculating energy savings. We used a statistical analysis to estimate impacts, separately for each optimization program.

Attribution/Net Impact Analysis

Per industry-standard practices, we assume a net-to-gross ratio of 1.0 for impacts from DR events, i.e., there is no free ridership or spillover. Our estimate of non-event day energy impacts incorporates Uplight and Nest's randomized controlled trial, producing net energy impacts adjusted for free-ridership and participant spillover.

CSR Mandated Research Objectives

We address the CSR Mandated research objectives in each program-specific chapter. These questions were answered through leveraging participant research, database review, impact analyses, and baseline research.

4. Residential Demand Response Program

This chapter summarizes the PY2019 evaluation methodology and results for the Residential Demand-Response (DR) Program (also referred to as the Peak Time Savings program).

4.1 Evaluation Summary

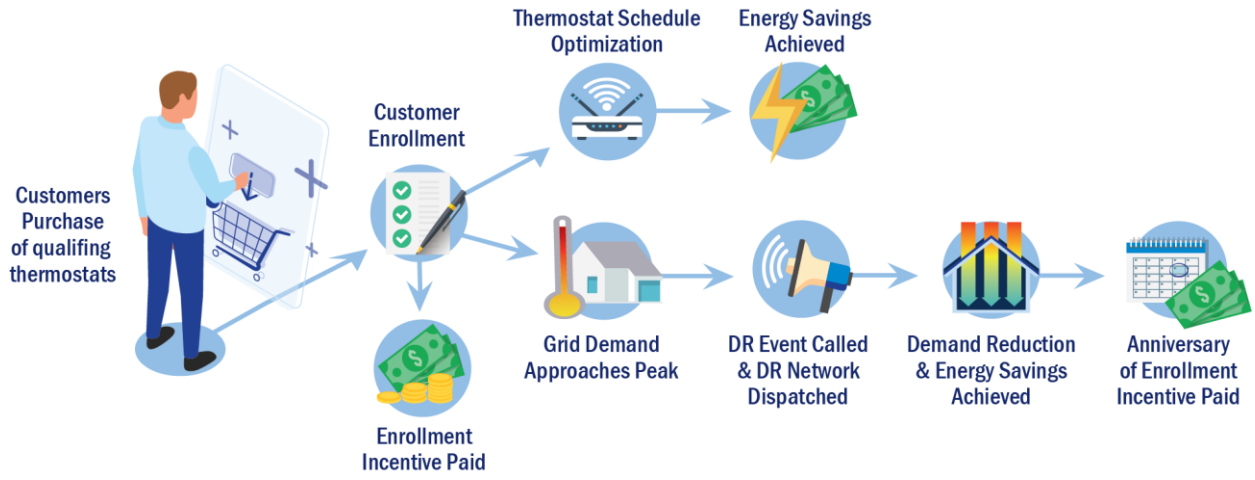
4.1.1 Program Description

The Residential Demand Response (DR) Program was new in PY2019. The program was designed to control the cooling load with the help of smart thermostats to achieve peak demand savings and energy savings. Eligible customers included Ameren Missouri electric customers with central air conditioning systems[8] who either had or were ready to purchase and enroll in the program an eligible smart thermostat. Qualifying smart thermostats in PY2019 included ecobee, Nest, and Emerson devices[9]. Customers could either enroll their existing devices (BYOT channel) or purchase, install, and enroll qualifying devices through the Ameren Missouri Online Marketplace (Marketplace channel) in the DR Program.[10] Customers could enroll up to two devices in the program and received a $50 sign up bonus for enrolling their device(s) in the program and $25 for each year of remaining in the program. The program was administered by Franklin Energy and delivered by Uplight. Uplight was responsible for customer engagement, enrollment, event dispatch, and overall program delivery and customer communications. Franklin Energy is the overall residential portfolio implementation contractor and was responsible for coordinating the overall management and data systems for the residential portfolio.

Figure 4-1 provides an overview of the customer journey from device purchase through event participation and payment. From a customer perspective, the design of this program motivates not only device purchase, but also continuous engagement over many years, with the Demand Response and Energy Optimization interventions. This varies from traditional energy efficiency programs that focus on enrollment and equipment purchase behaviors, incorporating ongoing customer engagement over multiple years and at different times within a program year. This innovative approach, integrating energy optimization and demand response, conceptually benefit the customer through a unified effort.

[8] Including heat pumps.
[9] Note that Emerson devices were added to the program part-way through the summer event season.
[10] Devices could be self-installed or professionally installed.

Figure 4-1 Summary of Customer Journey in the Residential DR Program



As illustrated above, the program design included two distinct components – demand response and energy optimization. Given that three distinct device manufacturers were participating in the program as well as two intervention strategies (e.g., EE and DR), our evaluation results highlight the variation in specific DR and energy optimization control strategies as well as the variability in implementation (e.g., which devices participate) in each intervention strategy by device manufacturer.

Demand Response

The primary focus of this program is to achieve demand reductions during summer peak periods. This program component achieves demand reduction through reductions in participant cooling runtime during hours of peak demand (demand response events). Uplight achieves demand reductions by increasing device temperature setpoints during DR events.[11] Participants receive advance notifications of the events via e-mail, device app, or on their device[12]. Participants receive notifications of the upcoming events the day of the event. Event notifications provide detailed descriptions of what to expect prior to or during the event. Participant homes are usually pre-cooled prior to the event start to maximize participant comfort during the event.

Energy Optimization

The energy optimization component (also known as Orchestrated Energy for ecobee and Emerson devices[13] and Seasonal Savings for Nest devices) includes an adaptive and customer-specific algorithm that modifies, throughout the event season, device setpoints to reduce cooling runtime and therefore saving energy. Notably, Uplight initially intended to run Orchestrated Energy on all program eligible devices, but later revised its approach to allow Nest/Google to run their own Seasonal Savings optimization algorithms. Orchestrated Energy is known to be more aggressive in terms optimization and energy savings as a result.

Program delivery in PY2019 varied by the device manufacturer, as documented below:

- Nest - demand response events were called among all participants on each event day. Participants were assigned in the treatment and control group for the energy optimization component using a random encouragement design. Optimization was running continuously upon customer enrollment,

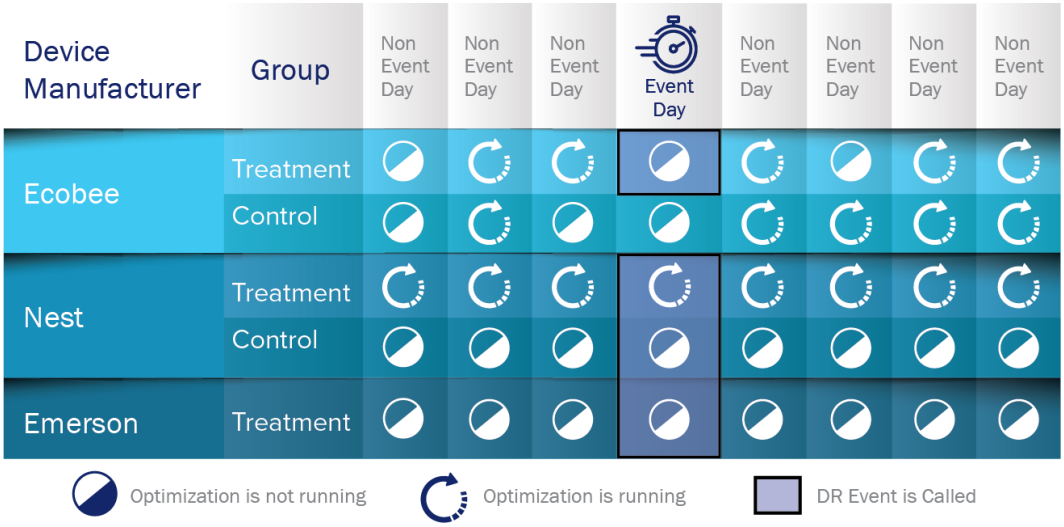
[11] For Nest devices, Google dispatches events through the Rush Hour Rewards (RHR) program.
[12] Note that ecobee and Emerson participants received advanced notifications via e-mail only in PY2019.
[13] Orchestrated Energy was designed and implemented by Uplight.

including during demand response events. Participants could not de-enroll from the optimization component without de-enrolling from the demand response component.

- Ecobee – Ecobee designed a randomized control trial design to estimate demand response and energy optimization impacts. For DR events, participants were randomly assigned in the treatment and control group for demand response events for each event. In other words, demand response events were called only among the treatment group, except during the system-wide event. All devices were enrolled in the energy optimization component, but days on which optimization runs are randomly assigned (learning days are control days, active days are treatment days). Energy optimization was not running during the demand response events. Participants could not de-enroll from the optimization component without de-enrolling from the demand response component.
- Emerson – Devices participated in one event, which was called among all participants. No optimization was deployed in the PY2019 event season.

Figure 4-2 provides a visual representation of the program design by the device manufacturer.

Figure 4-2. Residential DR Program – Schematic Representation of the Demand Response Program Design



Program marketing and enrollment included a variety of outreach strategies, including direct mail and e-mail communications from Ameren Missouri or Ameren Missouri with device manufacturers, notifications on customer devices or device apps, and advertising on Ameren Missouri's website.

Program participation processes varied by the device manufacturer and channel but generally included eligibility check based on HVAC equipment, verification of customer account information, and confirmation that enrolled customers are Ameren Missouri electric customers, and customer review and acceptance of terms and conditions. Notably, Nest conducted verification and customer enrollment for all Nest devices and coordinated the customer enrollment process with Uplight and Franklin Energy, whereas enrollment of all ecobee and Emerson devices was handled by Uplight and Franklin Energy.

4.1.2 Participation Summary

Figure 4-3 presents participation in the Residential DR Program during PY2019 and compares participation against the MEEIA III participation goal. As can be seen in the figure, Uplight enrolled 9,180 customers in the

program as of the end of the season, representing 140% of the participation goal, and additional 1,458 customers enrolled post-event season, reaching 162% of the goal.

Figure 4-3. Residential DR Program – PY2019 Program Participation Summary (Customers)

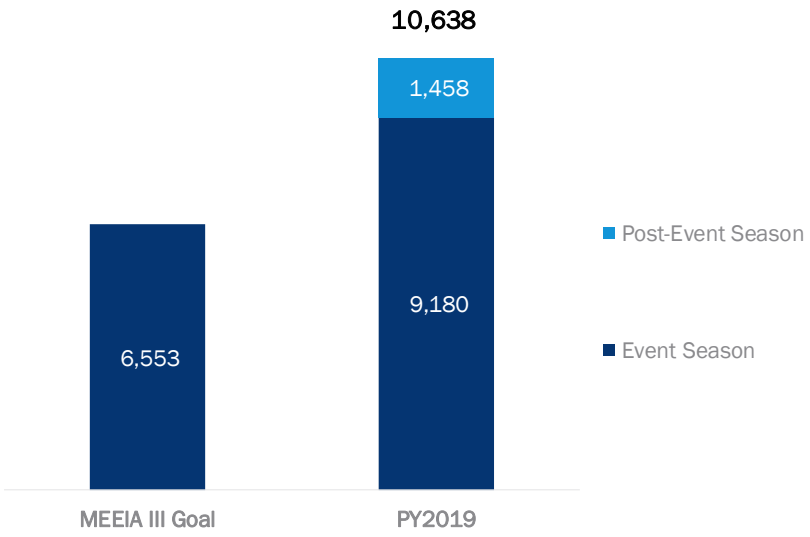


Table 4-1 compares participation against Uplight device enrollment goals by channel. Uplight started enrolling devices in the program in April 2019. As of the end of the season, Uplight enrolled a total of 10,668 devices in the program. As of the end of the year, Uplight enrolled an additional 1,679 devices, to a total of 12,347 devices. Most devices (88%) entered the program through the BYOT channel, which is considerably higher than the planned composition by channel. Notably, a larger share of ecobees enrolled in the program through the Marketplace channel as compared to the other device manufacturers.

Table 4-1. DR Program – PY2019 Demand Response Program Participation Summary (Devices)

Program Channel	Uplight Enrollment Goal		Enrollment as of the End of the 2019 Event Season		Enrollment as of the End of 2019	
	Devices	% of Devices	Devices	% of Devices	Devices	% of Devices
BYOT channel	3,510	42%	9,523	89%	10,926	88%
Marketplace channel	4,803	58%	856	8%	1,124	9%
Unknown channel	0	0%	289	3%	297	2%
Total	**8,313**	**100%**	**10,668**	**100%**	**12,347**	**100%**

On average, customers enrolled 1.2 devices in the program, with little difference by the manufacturer. Overall, 15% of participating customers enrolled multiple devices in the program (Table 4-2).

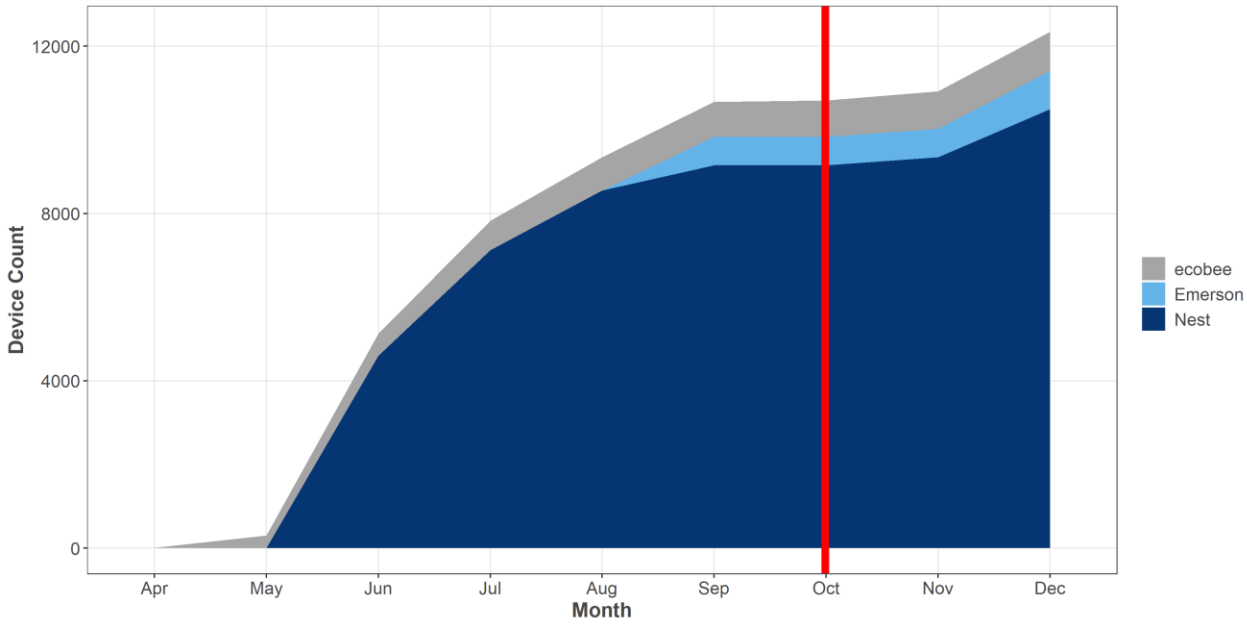
Table 4-2. Residential DR Program – Summary of Devices Enrolled Per Customer as of the End of PY2019

Device Manufacturer	Devices	Customers	Devices Per Customer
Nest	10,495	9,039	1.2
Ecobee	941	817	1.2
Emerson	911	798	1.1
Total	**12,347**	**10,638***	**1.2**

*Note that the total does not equal the sum of the customers across device manufacturers because a single customer could have devices from multiple manufacturers participating in the event season.

Figure 4-4 summarizes device enrollment trends throughout the event season. The red vertical line on the graph marks the end of the event season. Nest represented most of the enrolled devices (85%) as of the end of the PY2019 year. Ecobee devices accounted for another 8%. Uplight introduced Emerson devices to the program mid-way through the event season. As of the end of the year, a total of 911 Emerson devices were enrolled in the program, representing 7% of all devices enrolled as of the end of the season.

Figure 4-4. Residential DR Program – Device Enrollment Over Time by Device Manufacturer



Over the course of the event season, Ameren Missouri called a total of four demand response events. Due to mild summer in PY2019, no load-shaving events were triggered, and only test events were called, including one system reliability test event. Figure 4-5 documents event days and times alongside average temperature during the event dispatch hours.

Figure 4-5. Residential DR Program – Event Days with Average Maximum Temperatures and Event Hours

Uplight started running optimization of the ecobee devices at the beginning of the summer season (May 2019). Nest launched Seasonal Savings in early August 2019. Uplight did not run optimization on Emerson devices during the PY2019 event season.

4.1.3 Key Impact Results

At the end of the event season, the Residential DR program had 10,638 participants and achieved 10.43 MW in average demand savings. Milder than normal temperatures during the event season along with lower than planned per-participant demand impacts were key contributing factors to program performance. Across the event day and energy optimization components, the program achieved 406 MWh in energy savings. Energy savings from the energy optimization component accounted for 78% of all energy savings, while event day energy savings accounted for the remaining 22%. A late start to the optimization of the Nest devices, along with Uplight's inability to deploy more aggressive optimization algorithms on the Nest devices were the key contributing factors to program underperformance.

Table 4-3. Residential DR Program – Summary of Event Season Performance

Metric	Performance
Participant count	10,638
Demand impact (MW)	10.43
Energy impact (MWH)	405.75

Table 4-14 presents the 2019 resource capability estimate. Resource capability reflects weather normalized demand impacts applied to the population of devices enrolled as of the end of PY2019.[14] As can be seen in the table, the program's resource capability estimate is 16.86 MW, which represents 147% of the PY2019 MEEIA III goal. Given these results, combined with participation enrollment achievements to-date, the program is well-positioned to achieve its PY2020 goal. Notably, even under normal weather conditions, per participant and per-device planning values are higher than the estimated program performance.

Table 4-4. Residential DR Program – Comparison of Resource Capability Impacts to Goal

Metric	MEEIA III Goal
Resource capability (MW)	16.86
PY2019 MEEIA III goal (MW)	11.50
Percent of PY2019 goal	147%

Table 4-5 presents the PY2019 cumulative DR capability. For the Residential DR program for PY2019 cumulative DR capability is equivalent to the resource capability.

Table 4-5. Residential DR Program – Cumulative DR Capability

Metric	Result
Cumulative DR capability (MW)	16.86
PY2019 target (MW)	11.50
Percent of PY2019 target	147%

Nest devices accounted for the largest share of demand and energy impacts, primarily due to the share of total devices enrolled in the program. Nest per-device impacts, both demand, and energy, however, were lower than ecobee's and Emerson's. Nest demand impacts are lower likely to a higher percent of setpoint overrides during the events. Less aggressive optimization algorithms, along with energy optimization running only part of the season are the two core factors contributing to the difference in the energy savings from the energy optimization component between Nest and ecobee devices. Figure 4-6 summarizes event season impact across core impact

[14] The impact estimates are inclusive of de-enrollments and device overrides/event opt-outs.

categories overall and by device manufacturer. As can be seen in the figure, per-device event season demand impacts were the highest for ecobee devices at 1.33 kW and lowest for Nest devices at 1.10 kW. Ecobee and Emerson devices reduced a higher share of cooling load than the Nest devices.

Figure 4-6. Residential DR Program – Summary of Program Impacts

		Nest	ecobee	Emerson	Total
Event Season Demand Impacts	Number of Events	4	4	1	4
	Average Number of Participating Devices	8,034	686	557	9,276
	Per Device kW Impact	1.10	1.33	1.25	1.12
	Total MW Impact	8.81	0.92	0.70	10.43
	% of Cooling Load Reduced	72%	84%	83%	74%
Weather Normalized Resource Capability Estimates	Total Number of Enrolled Devices	10,132	935	911	11,977
	Per Device kW Impact	1.27	2.15	2.15	1.41
	Total MW Impact	12.90	2.01	1.96	16.86
	% of Cooling Load Reduced	65%	91%	91%	69%
Energy Optimization Savings	Total Number of Participating Devices	4,845	836	-	5,681
	Per Device kWh Impact	37.94	160.44	-	55.97
	Total MWh Impact	183.84	134.13	-	317.97
	% of Baseline Energy Usage Reduced	3%	15%	-	5%
Event Day Energy Savings	Total Number of Participating Devices	7,910	662	557	9,129
	Per Device kWh Impact	10.12	9.94	2.00	9.62
	Total MWh Impact	80.08	6.58	1.12	87.78
	% of Baseline Energy Usage Reduced	10%	8%	7%	9%

4.1.4 Key Process Findings

As of the end of the PY2019 event season, the Residential DR Program enrolled 10,668 devices across 9,180 participants, averaging 1.2 participating devices per customer. The program exceeded its customer enrollment goals. Nest devices represented 85% of all devices enrolled. Emerson device enrollment in the program started in the second half of the event season. As a result, Emerson owners participated in only one event in PY2019.

Most participants entered the program through the BYOT channel. In fact, the share of participants enrolled through that channel was much greater than the planned share by Uplight and Franklin Energy (88% vs. 42%). Based on the estimate of eligible smart thermostat penetration in Ameren Missouri's service territory from the 2019 Residential Baseline study, opportunities to tap into the existing inventory of smart thermostats are limited, and future enrollment through the BYOT channel will have to rely on the recently purchased devices and new market entrants.

As of the end of PY2019, 5,831 customers purchased smart thermostats through the Marketplace channel, and 986 of those (16%) enrolled in the Residential DR Program. Reasons for non-enrollment in the Program were not explored through this evaluation and are unknown. Exploring them, however, can help glean insight into ways to maximize program enrollment through the Marketplace channel.

Program participants were diverse in their sociodemographic composition but were skewing toward higher income and higher levels of educational attainment, which is not surprising given that smart thermostats are still in the early adoption phase and higher income levels, as well as higher levels of education, are consistent with the early adopter characteristics. Future program participants can be different in terms of these core demographics and may respond to events differently.

E-mails from either Ameren Missouri or both Ameren Missouri and device manufacturers were the most common sources of program awareness. Customers were driven to enroll devices and participate in the program by a range of factors, including sign-up bonuses, energy savings, environmental benefits, and lower energy costs for the community. Sign up bonus, however, was the most frequently mentioned motivator to program enrollment.

Despite multiple eligibility checks and verification steps, virtually all participants found the process of enrollment and registering their device either very or somewhat easy.

PY2019 event season was cooler than typical Missouri summer, and participant experiences during events as well when the optimization algorithms were running are likely influenced by the weather. Though, the program caps the number of events called per season at ten, Uplight called just four test events in PY2019. Participants are generally satisfied with the number of events they participated in, with most rating the number of events to be just right. In fact, 46% of Emerson owners, who participated in just one event, wished they participated in more events. Over a quarter (26%) of Nest owners and 18% of ecobee owners also wish they participated in more events. These findings suggest that dispatching additional events will likely not have a negative impact on participant experiences with the program. All events called in PY2019 lasted four hours, and participants are happy with that duration.

Most participants were home during events and therefore experienced increased temperatures, which were 5°F or 6°F degrees higher than participant typical comfort temperature, as reported by participants in the survey. Over half of those participants found the changes in temperature quite noticeable.[15] Although

[15] Includes ratings of very and somewhat noticeable.

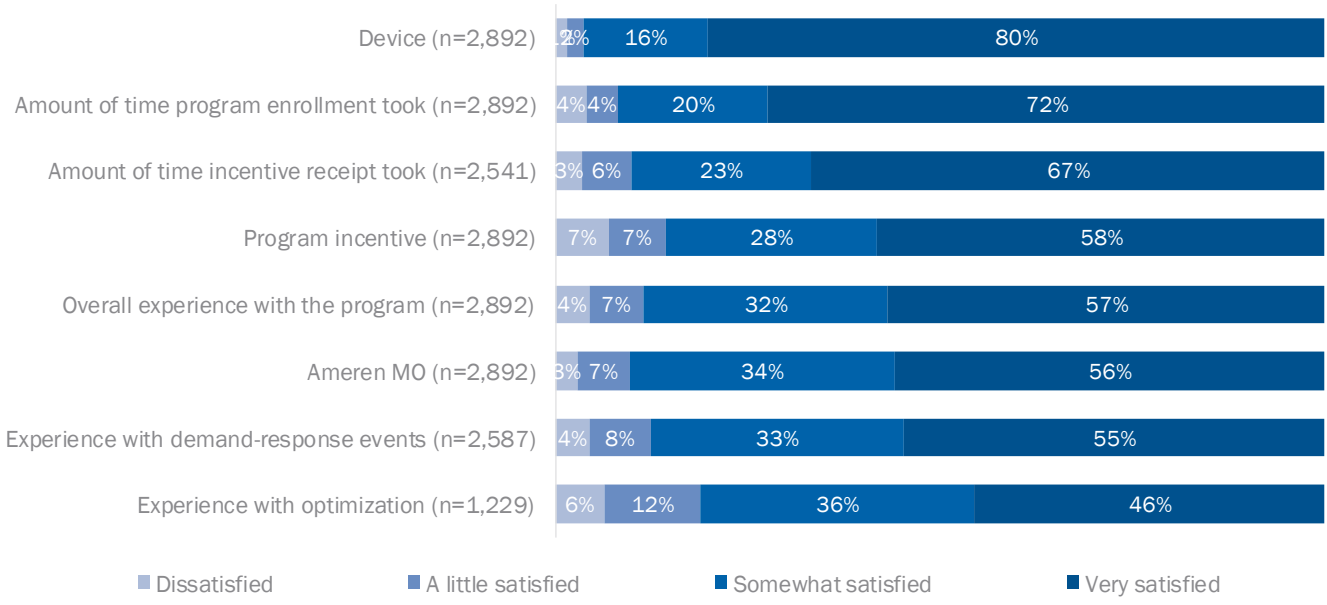
participants noticed a temperature increase, most remained generally comfortable. Around a third of the participants report overriding temperature settings during events.

Participants received notifications of upcoming events as well as post-event summaries. Participants were satisfied with the mode of event notifications (e-mail for ecobee and Emerson owners and a combination of e-mail, device, or device app for Nest owners), the timing of the notifications, as well as with the clarity of the information contained in the notifications and summaries.

Energy optimization algorithms ran on participant devices during the PY2019 event season. Ecobee optimization algorithms made more aggressive temperature adjustments than the Nest algorithms. No all participants enrolled in the energy optimization component were aware of the optimization algorithms running on their devices (40% were not aware). Ecobee owners were significantly more likely to report noticing temperature changes, as compared to Nest owners, which is supported by more aggressive ecobee algorithms. As a result, Nest owners report much higher comfort levels than ecobee owners during the times when the optimization algorithms were running.

Participants report high satisfaction ratings across most program components – from program enrollment to satisfaction with their devices. Participants are least satisfied with their experiences with demand-response events and experiences during days when optimization algorithms were running on their devices. Dissatisfied participants cite high temperatures as the key reason for their dissatisfaction. Likely as a result of high satisfaction levels, participants are likely to recommend the program to others. In fact, nearly a quarter of participants have already recommended the program.

Figure 4-7. Residential DR Program – Participant Satisfaction Ratings



Only 2% of participants de-enrolled from the program in PY2019, yet the de-enrollment of ecobee devices was considerably higher than the program average (14%). Based on the limited insight into de-enrollment reasons through the participant survey, uncomfortable temperature settings, as well as relocation were cited as the key reasons.

Research with eligible customers completed as part of the 2019 Residential Baseline Study shows that core concerns that may prevent customer engagement with the program include concerns with comfort. Utility control of customer devices as well as general lack of knowledge of what the program participation process entails can also act as impediments to customer engagement with the program.

Data tracked as part of the program contained the necessary data fields to conduct a thoughtful and rigorous evaluation overall. The evaluation team, however, was unable to link Nest telemetry and device data to a master participant file maintained by Franklin Energy and Uplight. As such, we were not able to directly verify that devices provided in the Nest data are associated with Ameren Missouri participating accounts. The inability to link the data from the various sources also presented methodological challenges, resulting in imperfections in the evaluation approach and measurement.

Missouri Code of State Regulations (CSR) requires that demand-side programs, operating as part of a utility's preferred resource plan, are subject to ongoing process and impact evaluations that meet certain criteria. Table 4-6 summarizes responses to the CSR process evaluation requirements for the Residential DR Program.

Table 4-6. Residential DR Program – Summary of Responses to CSR Process Evaluation Requirements

CSR Required Process Evaluations Questions	Findings
What are the primary market imperfections that are common to the target market segment?	Smart thermostat penetration in Ameren Missouri services territory is relatively low still, with 8% of all thermostats being smart thermostats. Program participation goals for PY2020 will require the presence of a considerable number of devices available and eligible for program enrollment. Broadband internet access, which is presently at 85% in Ameren Missouri service territory limits the number of homes that can participate in the program. Customers have a variety of concerns about participating in the Central AC DR solution, including concerns about allowing the utility to control customer's thermostats, potential negative impact on comfort, data security, and knowledge of the participation process. While none of them emerge as extreme barriers, comfort is the one that worries customers the most.
Is the target market segment appropriately defined, or should it be further subdivided or merged with other market segments?	All residential customers with central air conditioning systems and a program supported smart thermostat are eligible to. Given the nature of the program design, which relies on smart thermostats to deliver demand impacts during demand response events, the target market is appropriately defined, and further market segmentation is not necessary.
Does the mix of enduse measures included in the program appropriately reflect the diversity of enduse energy service needs and existing enduse technologies within the target market segment?	Program eligible devices cover the most prominent device manufacturers – Nest, ecobee, and Emerson. However, other devices from other manufacturers can help increase program's reach. It is our understanding that Uplight and Franklin Energy are working on introducing those devices as part of the program in PY2020.
Are the communication channels and delivery mechanisms appropriate for the target market segment?	E-mail outreach along with outreach via devices and device apps are cost-effective and targeted given program design and the target market segment.
What can be done to more effectively overcome the identified market imperfections and to increase the rate of customer acceptance and implementation for select	Diversifying customer acquisition channels and introducing new device manufacturers into the program can help capture more customers thus ensuring achievement of participation goals for the MEEIA III cycle.

CSR Required Process Evaluations Questions	Findings
enduses/measure groups included in the Program?	Tailoring program messaging to emphasize program strategies that minimize participant discomfort during the events (precooling), communicating that customers can stay in control of their devices by way of temperature overrides, as well as actively providing information on what the participation process looks like will help mitigate known barriers to customer engagement with the Program.

4.1.5 Conclusions and Recommendations

The evaluation team offers the following conclusions and recommendations for the Residential DR Program:

- **Conclusion 1:** Program planning assumptions of per-participant demand impacts are higher than what the program delivered in PY2019. Moving forward, the program will need to enroll more participants than planned, or achieve greater per-device impacts, to achieve demand impact goals. More specifically, the PY2019 evaluation results, under historically normal weather conditions, suggest that the program is estimated to deliver 1.69 kW in per-participant[16] load impacts, which is lower than the MEEIA planned value (1.76 for PY2019 kW).[17] Should conditions similar to PY2019 continue, the program's per-device performance of 1.34 kW per-participant[18] will be 23% lower than the goal.
  - **Recommendation 1:** Program staff should balance participant enrollment targets with consideration of both resource capability and event season demand impacts to optimize the program's performance against its demand goal.
- **Conclusion 2:** PY2019 event impacts may not reflect future impacts. In PY2019, events were called for cooler temperatures (90°F on average during event hours across all four events) than typical peak (99 °F) with temperatures rarely rising above 95°F during the event season. As a result, the program called fewer than planned events, with four test events being dispatched. Given the cooler than anticipated weather, the program's event season demand impacts were lower than the demand impacts anticipated under historical peak weather conditions for the same number of participants (1.12 kW vs. 1.41 kW). Weather conditions (including temperature and humidity), however, are directly tied to customer experiences and behaviors during the event season, including comfort during events, frequency of overrides and event opt-out, satisfaction with overall program experiences, and ultimately customer de-enrollment from the program. During the PY2019 event season, customers were content with the number of events, event duration, and remained generally comfortable during the course of the events, though temperature differences were certainly noticeable.
  - **Recommendation 2:** Based on the resource capability estimates, the evaluation results suggest that a hotter event season and dispatching more events will likely increase total and per-participants demand impacts, should participant experiences with the events remain comfortable. As a result, program staff should balance the number of events and event duration with consideration of overrides and de-enrollment in future years. Working to collect participant feedback on their experiences during events will help gather early feedback and make any necessary adjustments to messaging or make any other feasible mid-course corrections. Providing additional prompts to participants in event notification e-mails encouraging them to

[16] Based on 1.41 kW performance per-device and 1.2 devices per participant.
[17] This value is based on MEEIA III PY2019 enrollment goal of 6,533 participants and 11.50 MW in demand savings.
[18] Based on 1.12 kW performance per-device and 1.2 devices per participant.

resist overriding temperatures during the events and emphasizing environmental benefits and lower energy costs for the community (which resonate with participants and for many were core motivators to participation) can help ensure persistence of event temperature setpoints and ensure continued participation. Deploying behavioral encouragement mechanisms such as comparison to neighbors and competition, among others, via comparing participant performance over the course of the season to that of other participants can also be effective in stimulating engagement and deeper savings.

- **Conclusion 3:** The Residential DR Program did not achieve MEEIA III energy savings goals. More specifically, evaluated event season savings represented 36% of the goal, with the energy optimization algorithms accounting for more than three-quarters of energy savings (78%). The success of the program performance against its energy savings goals will continue to rely on the optimization component. Energy optimization performance was largely due to delays in launch and variations in impacts across the devices. Ecobee's deployment of aggressive energy optimization adjustments delivered deeper savings, but ecobees represent a smaller share of program participants. Nest's energy optimization algorithm delivered per-device savings nearly five times lower than ecobee, but accounted for the vast majority of the participating devices. On a per-participant basis across the event day and optimization components, ecobee devices achieved 204 kWh in energy impacts, which is much higher than the PY2019 planned value of 173 kWh. In contrast, Nest devices achieved 58 kWh in energy impacts, which is much lower than the planned value. Notably, Nest optimization algorithms ran during the second half of the event season only and are less aggressive than the Orchestrated Energy optimization algorithms that ran on the ecobee devices. Deployment of the optimization component throughout the entire event season as well as harvesting energy savings from a larger number of events will likely narrow the gap for Nest devices.

  - **Recommendation 3:** Deploy energy optimization algorithms as early in the event season as possible to increase total energy savings.

- **Conclusion 4:** Despite substantial enrollment through the BYOT channel in PY2019, continued participant enrollment through the BYOT channel will need to rely on new market entrants, given current smart thermostat market penetration and participant enrollment achieved through the channel. In addition, 16% of eligible Ameren Missouri discounted thermostat sales through the Marketplace program were converted into the Residential DR Program, suggesting opportunities to understand barriers to program enrollment and optimize thermostat enrollment. Furthermore, device manufacturers currently eligible for the program do not capture all of the potentially eligible customers.

  - **Recommendation 4:** The program should continue to diversify enrollment channels as a way to meet MEEIA III enrollment goals. Continued expansion of eligible devices and channels, planned by the implementation team for PY2020, will allow the program to tap into the previously untouched customer markets. It is also important to understand the reasons for participant non-enrollment in the Program through the Marketplace channel. In PY2020, survey research with customers who purchased but did not enroll in the program through the Marketplace channel would be useful to better understand barriers to program conversion and strategies for a more effective enrollment.

- **Conclusion 5:** The current Residential DR Program participants (who currently represent early adopters of the smart thermostat technology) skew toward higher levels of income and educational attainment. As smart thermostat adoption enters the mainstream market, and more market channels are adopted, the Residential DR Program participant composition may change, with potential implications on energy consumption patterns associated with the size of the home as well as participant presence at home during various times of the day. This changing participant composition may lead to future program engagement, and associated demand savings opportunities, that is different from current results.
  - **Recommendation 5:** As the program matures, program staff identify factors driving program performance, e.g., high cooling load, engagement with devices, square footage of homes. Over time, we recommend monitoring participant composition across salient features and consider any need to align program goals with anticipated program performance, as well as any changes with targeting future high-value customers in the population.
- **Conclusion 6:** According to research conducted with program eligible Ameren Missouri's customers, there are a number of barriers to customer enrollment in Central AC DR Programs, including concerns about allowing the utility to control thermostats, potential negative impact on comfort, data security, and knowledge of the participation process. While none of them emerge as extreme barriers, comfort is the most commonly referenced barrier.
  - **Recommendation 6:** Educating customers on the program strategies (such as precooling) that increase the comfort of the home, as well as providing assurances of customers' ability to regain control of their devices easily will help mitigate barriers to engagement.
- **Conclusion 7:** The evaluation team identified a number of inconsistencies and limitations in the available data that limited the ability to link participant, with telemetry, and usage data necessitating changes in the planned approach to estimate energy and demand impacts. While the evaluation team was able to estimate demand and energy impacts, these changes in approach reduced the rigor of the evaluated results and our ability to provide more granular results or insight into customer behavior and engagement with the program to inform future planning.
  - **Recommendation 7:** Ameren Missouri and program staff should consider further discussing the possibility of obtaining data linkages with Nest. Obtaining participant consent to data sharing as part of program participation provision can be used as an alternative pathway to obtaining the desired data linkages.

4.2 Evaluation Methodology

The evaluation team performed both impact and process evaluation activities to assess the performance of the Residential DR Program in PY2019. The evaluation team explored the following research objectives:

- Characterize program participation concerning the devices selected, event participation, and other relevant characteristics;
- Estimate the first-year ex-post gross energy (kWh) and demand (kW) savings;
- Determine weather-normalized DR capability for all participants enrolled throughout PY2019;
- Assess how well the customers understand event participation and identify barriers to participation;

- Assess how well the customers understand the energy optimization component of the program;
- Measure customer satisfaction, with program processes and events, and motivations for participating;
- Identify opportunities for improvement in customer experience; and
- Provide evaluation results that can be used to improve the design and implementation of the program.

Table 4-7 provides an overview of the program evaluation activities. As with integrated programs, the evaluation team incorporated key considerations related to measurement strategy. More specifically, we developed appropriate baselines for load shaping as opposed to load shedding, requiring thoughtful consideration of data ingestion, cleaning, and analysis by device type. We document the key baseline considerations, by vendor, in the evaluation methods section below. Following the table, we outline program-specific aspects of key evaluation methodologies.

Table 4-7. Residential DR Program – PY2019 Evaluation Activities for the Demand Response Program

Evaluation Activity	Description
Program Manager and Implementer Interviews	▪ Conducted interviews (1) before program launch to inform evaluation planning and (2) towards the end of PY2019 to understand program staff's perspective on program performance.
Program Material Review	▪ Reviewed available program materials to inform evaluation activities.
Tracking System Review	▪ Reviewed implementer's tracking system to ensure that data required for the evaluation is being collected.
Participant Survey	▪ Surveyed with program participants to collect data to inform program participation and processes.
Gross Impact Analysis	▪ Conducted event regression modeling to estimate hourly and average event run-time and kW and kWh impacts. ▪ Assessed average event kW impacts under normalized weather conditions for all participants enrolled in PY2019. ▪ Assessed fidelity of the experimental assignment of customers and days for optimization purposes. ▪ Conducted regression modeling to estimate kWh impacts associated with the thermostat optimization component.

Post-Season Participant Survey

The evaluation team completed an online survey with a representative sample program participants at the end of the event season. The key goals of the survey were to gather information on customer experiences and preferences to identify opportunities for improving program design and implementation. To this end, the survey covered the following topics:

- Sources of program awareness and motivation for participation;
- Experiences with program enrollment and device registration;
- Satisfaction with various program processes, the program overall, and Ameren Missouri in general;

- Demand-response event participation (awareness, experience, and satisfaction);
- Participation in energy optimization component (awareness, experience, and satisfaction); and
- Sociodemographic and household characteristics

The evaluation team relied on the program tracking data extract[19] to draw a survey sample. We processed the data to remove duplicate records as well as records without the necessity for survey administration contact information. We fielded the survey online with all customers, thus attempting a census. Table 4-8 provides a summary of program participation as well as survey completes by the device manufacturer. We fielded the survey via the web between October 31 and November 17, 2019. Participants received e-mail invitations and up to three reminders to complete the survey. We completed a total of 2,892 surveys. This represents a yield rate of 32%.

Table 4-8. Residential DR Program – Participant Survey Sample Sizes and Number of Web Completes by Thermostat Type

Thermostat Type	Participant Population	Sample	Survey Completes
Nest	7,784	7,729	2,449
Ecobee	689	640	213
Emerson	590	590	230
Total	**9,063**	**8,959**	**2,892**

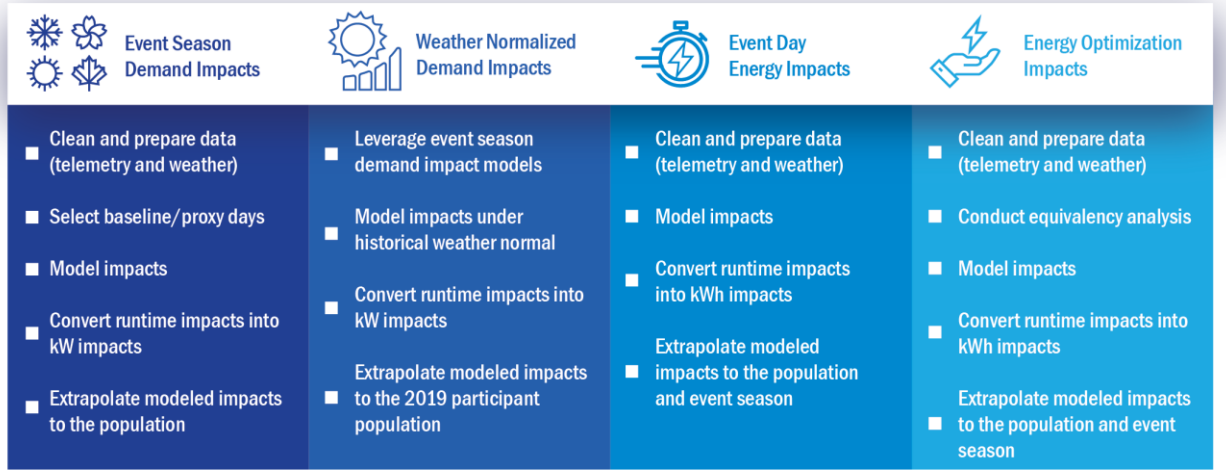
The survey sample resembled the participant population across a range of known participant characteristics; therefore, there was no need to apply post-stratification weights.

Impact Analysis

Impact analysis for the program consisted of several components, namely event season demand impacts, weather normalized resource capability impacts, event day energy impacts, and energy optimization impacts. Figure 4-8 provides an overview of the data cleaning and preparation steps associated with each impact analysis component. Following the figure, we detail data sources that the evaluation team leveraged to complete each analysis as well as summarize our approach. Figure 4-8 of this report contains further methodological details.

[19] Data reflected participation as of October 5, 2019.

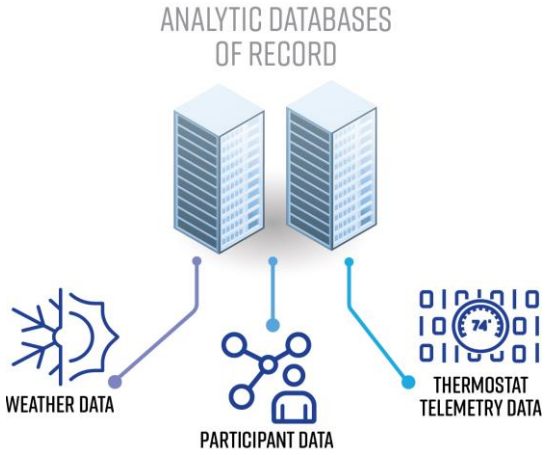
Figure 4-8. Residential DR Program – Gross Impact Analysis Overview



Data Cleaning and Preparation

We used data from several sources in support of the gross impact analysis, namely participation, weather, and device telemetry data. We processed data from each source separately before integrating in analytic databases to support gross impact analysis and modeling efforts. Figure 4-9 provides a visual representation of the various data sources that supported the gross impact analysis. Following the table, we provide detail on each source.

Figure 4-9. Residential DR Program – Overview of Data Sources



Weather Data

To ensure consistency with Ameren Missouri's weather used for planning purposes, we used weather data from St. Louis Lambert airport weather station across all impact analyses that required weather data. We gathered weather data from the National Oceanic and Atmospheric Administration's National Climatic Data Center, which houses the Integrated Surface Database of hourly weather measurements from thousands of locations across the country. We downloaded the hourly weather data from that station for 2019. As part of the data preparation, we calculated cooling degree hours with an outdoor base temperature of 75 degrees for use in the model. We chose 75 degrees as the base temperature because 75 degrees is approximately the point at which participants start using their central AC during summer afternoons.

Participant Data

We relied on participant data extracts provided separately by Uplight and Franklin Energy. We received participants who de-enrolled from the program as a separate extract from Uplight. As part of the data cleaning process, we reconciled participant counts, merged the separate data files, and addressed gaps and missing values where possible. We also conducted a careful review of accounts associated with participating devices and ensured that all participating devices were associated with Ameren Missouri electric accounts. Finally, we ensured the accuracy of the date of customer enrollment in the program. This date was essential for determining participant counts for the impact analysis.

Device Telemetry Data

We received device telemetry data from several distinct sources.

- We received ecobee and Emerson telemetry data from Uplight. The data included hourly runtime with associated setpoints and indoor temperatures. In addition, the data contained key device and participant information, and detail on day type (optimization treatment or control, demand-response, etc.), number of overrides per hour, and demand response event identifiers. The data contained unique identifiers that enabled the evaluation team to link the telemetry data to the participant data extracts and thus validate data contents and attach the telemetry data to participants. This data supported all impact analyses for these two device manufacturers.
- We received Nest telemetry data from Nest/Google via Uplight. We received two separate sets of data extracts.
  - Daily runtime data extract and associated device extract. Nest/Google provided this extract to support the analysis of energy optimization impacts. In addition to daily runtime data, the extract contained detail on dates of participating device assignment into treatment and control groups, participating device qualification, participant opt-in to the optimization component, and zip codes.
  - Hourly runtime data extract and associated device-level extract. Nest/Google provided this extract to support the analysis of the DR impacts. The data included hourly runtime with associated setpoints and indoor temperatures. In addition, the data contained key device and participant information, including anonymized device IDs, anonymized customer IDs, and zip codes.

Both sets of extracts provided by Nest/Google contained anonymized device data. Consistent with stated standard practice for Nest/Google, the provided data extracts included the zip code of the installed location for each enrolled device and no other information regarding program participants. In

cases where there were too few enrolled devices within a given zip code, device location was further obscured by listing the zip code for the nearest weather station for the installed location. Neither extract included unique identifiers to link the data sets together or to the implementer provided participant data extracts. Such anonymization presents challenges for successful validation of the telemetry data and introduces a certain degree of uncertainty to the analysis. However, our team validated the available data by comparing zip codes provided to us against the zip codes associated with Ameren Missouri service territory. We only included devices with valid Ameren Missouri zip codes in the modeling efforts. We also validated participant data by ensuring that each participating device had a valid Ameren Missouri account number and address associated with it. We used participant data to derive the final participant counts for impact aggregation purposes.

Event Season Demand Impacts

The event season demand response impact analysis resulted in event period demand impacts for devices in place and operational during the PY2019 event season. Below, we outline analytical activities that were a part of the analysis.

Clean and Prepare Data

We explored telemetry data for gaps, missing values, and out of range values. Because Nest telemetry data had a different structure, we cleaned and prepared it separately from the ecobee and Emerson data. Throughout the data cleaning process, however, we maintained as much consistency as possible across that data sets to ensure the comparability of results. For instance, Nest telemetry data did not contain clear identifiers of de-enrolled devices, devices opting out of events, as well as devices with connectivity issues or with the HVAC system in off/heating mode, whereas ecobee and Emerson data did. As such, we retained those devices in both data sets, and our impacts are inclusive of those devices. As part of the data cleaning process, we removed failed devices (devices with no runtime) from Nest, ecobee, and Emerson telemetry data. For Nest specifically, we removed devices with anonymized zip codes, as well as zip codes outside of Ameren Missouri service territory. We did so to ensure that the impact analysis leverages devices operating in Ameren Missouri service territory as much as possible.[20] Because we were able to match ecobee and Emerson telemetry data to participant electric accounts, we were able to validate all devices as associated with Ameren Missouri electric accounts. Overall, we removed 10% of Nest, 14% of ecobee, and 12% of Emerson devices for modeling purposes. Appendix A contains a detailed table of device drops that we performed as part of this step.

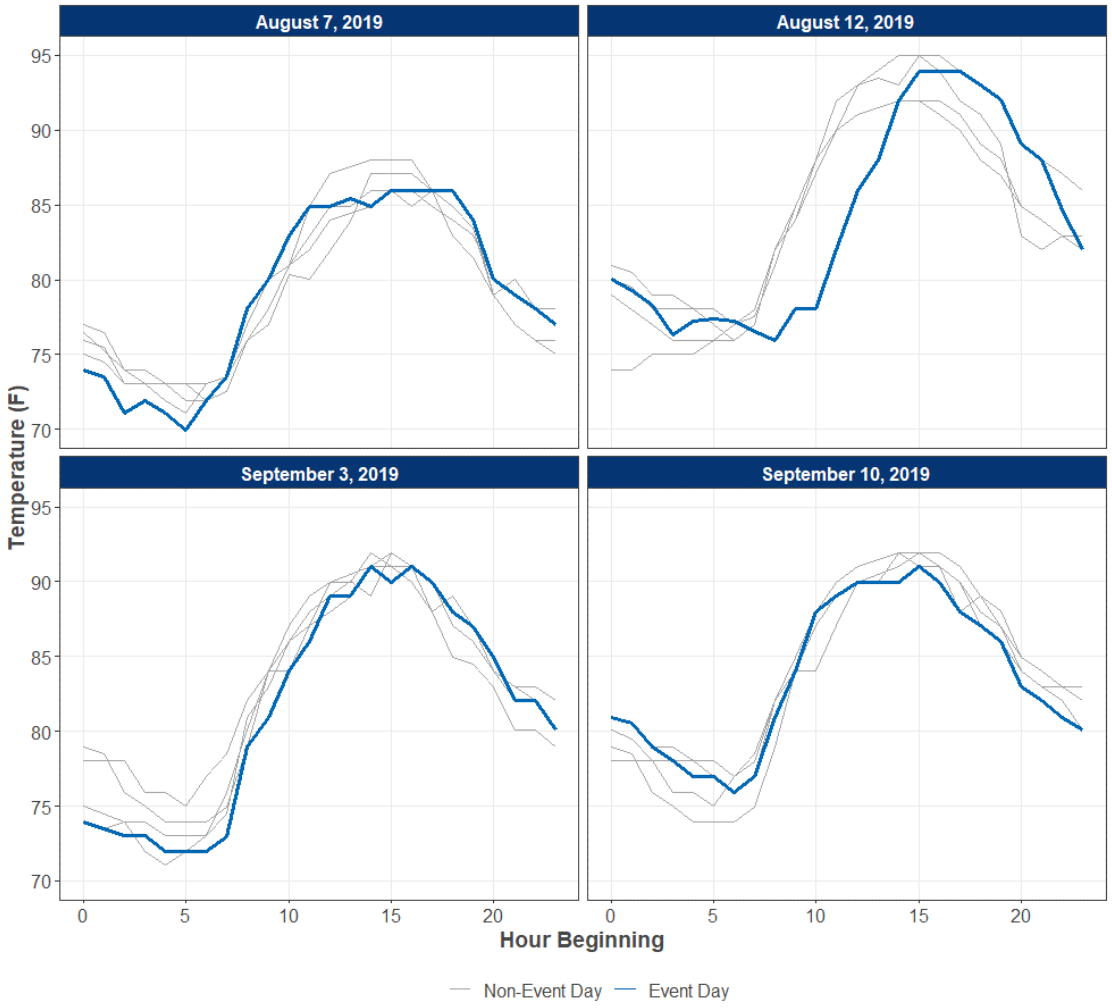
Select Baseline Days

While Uplight relied on the RCT design by randomly assigning participants to the treatment and control group for each event, Nest dispatched demand-response events across all participants. For consistency, we relied on a quasi-experimental design to evaluate and select proxy days to serve as the baseline. To develop matches, we used Euclidean distance matching to select four non-event days that were similar in weather profile for each event day. This method pairs event and non-event day hours by choosing pairs with the smallest overall distance between hourly weather profiles. Figure 4-10 shows the weather profiles for each event day and the proxy non-event days after matching. The blue lines in the figure represent the event days, and the gray lines represent the matched non-event days. As can be seen, average hourly temperature profiles match fairly well between the event and matched comparison days for all events but Event 2 (August 12, 2019). To minimize bias associated with the baseline for that event day, we removed the August 12 event from the estimation of event season demand impacts.

[20] We used participant data to extrapolate impact results to the population of devices.

We should note that for Nest, runtime on a subset of baseline days reflects active energy optimization algorithms on a subset of devices and is not truly representative of baseline conditions absent any program intervention. Because we could not match participant assignments to the treatment and control group for the energy optimization component to the demand response telemetry data, we could not isolate and remove devices with energy optimization algorithms running from the analysis, nor could we remove them from the DR events called in PY2019. This likely biases the baseline runtime and may affect the estimates of demand impacts.

Figure 4-10. Residential DR Program – Average Hourly Temperatures on Event Days and Matched Non-Event Days



Model Impacts

We used a linear fixed-effects regression modeling approach for the demand response impact analysis. The model estimates the hourly kW demand impacts on a per-device level. Event impacts are the mean difference between the modeled (predicted) baseline kW and the event kW over the event period[21]. The "fixed-effects" modeling approach allows us to control for the time-invariant device-level factors affecting demand (i.e., factors that do not change over the study period, such as square footage of home) without measuring those factors explicitly in the models.

As is standard practice for impact analysis, we tested many models. We selected the final models based on fit with actual runtime, especially during the hours leading up to the event. We judged the ultimately selected model fit primarily on replication of actual runtime during non-event hours, especially the hours before the event. To assess whether the models could accurately predict non-event runtime, the team used each model to predict runtime for an actual non-event day and compared the predicted runtime to the actual runtime. We ran models using runtime data before converting it to power by applying a connected load assumption. We modeled impacts separately for Nest's and ecobees. We modeled impacts for each event day. Due to the late entry of the Emerson devices in the program, we did not have sufficient runtime data for baseline weather days. As such, we did not model Emerson's impacts. Instead, we compared the non-event day runtime. Notably, to ensure that the baseline is not contaminated with energy optimization algorithms for ecobees, we only included devices that were in learning mode during the proxy weather days. Appendix A contains final model specification, model outputs, as well as comparison of ecobee and Emerson runtime showing similar runtime patterns.

Convert Runtime to kW

Because impact modeling leverages runtime data, it is necessary to convert runtime data to the cooling load. We relied on the HVAC capacity measurements collected as part of the 2019 baseline study to develop an estimate of the connected load. Appendix A contains further detail on the approach used to develop the connected load assumption. The resulting per-device connected load is 3.07 kW.

Extrapolate Modeled Impacts to Population

We calculated total impacts for each event by multiplying the per-device impacts by the number of participating devices during the event season by thermostat manufacturer. We determined the participating device counts for each event using the participant data extract. We used the participant data extract because it contained verifiable participant information. We adjusted participant counts in the participant extract by the expected device failure rate. We derived the failure rate from the telemetry data. Because all other device statuses (e.g., overrides) were included in the models, we did not need to make any additional adjustments to the participating device counts.

We calculated total event-season demand impacts as the weighted average of impacts across events by thermostat manufacturer, weighting by the number of participating devices in each event. We excluded the August 12, 2019 event from the total event-season demand impacts due to the baseline not matching optimally for that event day.

[21] The statistical regression model used to estimate the baseline hourly kW during event periods predicts what the kW would have been during the event, if no event had been called. We then compare this baseline kW to actual event day kW to establish demand impacts by hour for each event. We estimated a separate model for Nest and ecobee devices. However, because Emerson devices only participated in the last event, we applied the ecobee impacts from the last event to the Emerson devices given the consistency in run time between ecobee and Emerson devices

Ecobee and Emerson demand impacts reflect DR impact and exclude impacts from the energy optimization component. In contrast, Nest demand impacts are partially inclusive of the energy optimization component in the baseline and event day runtime.

Weather Normalized Resource Capability

An estimate of weather normalized resource capability reflects estimated demand impacts from devices enrolled as of the end of PY2019 under peak weather conditions.

Model Impacts Under Historic Weather Normals

To determine weather-normalized resource capability, we specified a separate set of models. The models incorporated event season demand impacts and historical weather from Ameren Missouri's Technical Reference Manual (TRM). We fit a series of random-effects models for each device manufacturer. We used a peak temperature of 99°F as specified in the Ameren Missouri's TRM. The random effects model is similar to the fixed effects model. The difference is that instead of removing the mean for each device and then modeling with the deviations, a random effects model simultaneously estimates individual means (the β_i intercept) assuming a normal distribution of means, and the remainder of the coefficients. Thus a random effects model allows us to estimate impacts for a different, future set of devices than the ones currently participating, with the assumption that devices participating in the PY2019 event season are representative of those enrolled after season-end.

We fit models using the hourly runtime data separately for Nest devices and for ecobee/Emerson devices. Upon fitting the models, we estimated the predicted event impact for the first event hour. We set the temperature for the prediction using a cooling degree hours (CDH) term. The predicted event impact is the predicted baseline demand minus the predicted event demand for the first event hour. This model includes estimates from all four events. However, the September 10 event was called several hours earlier than the other events. As a result, the model accounts for this difference by using a set of flexible event hour indicators rather than a single event indicator interacted with an hour as is customary when all events are called during the same set of hours. Appendix A contains the final model specification used to develop weather normalized resource capability, along with the graphical representation of the model fit.

Extrapolate Modeled Impacts to Population

We calculated total weather normalized resource capability by multiplying the weather normalized per-device impacts by the number of devices enrolled in the program as of the end of PY2019 by thermostat manufacturer. We used participant data extracts to derive the total number of devices. We adjusted the number of devices by device failure rate. We derived the failure rate from the telemetry data for devices participating in the PY2019 event season. The failure rate was the weighted average percentage of failed devices based on each event and thermostat manufacturer.

Cumulative DR Capability

Cumulative DR capability is a performance metric used to establish Ameren Missouri's earnings opportunity award. Opinion Dynamics calculated the cumulative DR capability consistently with the approach specified in the MEEIA III Plan. Per the plan, cumulative DR capability calculations mirror those for weather normalized resource capability.

Event Day Energy Impacts

In addition to estimating demand impacts for each event during the event hours, we also estimated energy savings achieved during event days. To estimate event day energy savings, we used a similar methodology as the event season demand impacts, but rather than comparing the baseline runtime from the model to actual event day runtime for only the event hours, we compared baseline runtime to actual event day runtime for all hours of the event day. Therefore, the event day runtime reduction is estimated as the difference between baseline and actual runtime for an average device based on the regression model outlined in the Event Season Demand Impacts section above. To calculate program-level energy savings, we multiplied the impacts for each event by the number of devices who participated in those events and then summed impacts across events. Please refer to the Event Season Demand Impacts section above for how we cleaned and prepared data, selected baseline days, converted run time to kW, and modeled impacts in order to estimate event day energy impacts.

Energy Optimization Impacts

The design of the energy optimization program component was unique for Nests and ecobees. Emerson devices had no energy optimization program components. As such, we tailored our evaluation approach to each manufacturer.

Nest devices are optimized using a proprietary algorithm designed to reduce energy consumption without excessive degradation of occupant comfort. They adjust temperature settings slowly, over a matter of weeks, and return the original settings at the end of the summer season. The program is run as a randomized encouragement design (RED) experiment, wherein participants are randomly assigned into treatment and control group. After random assignment, treatment group participants are prequalified based on device availability and other criteria and are invited to enroll in the optimization component. Participants can choose to enroll or not. The presence of participant pre-qualification step makes the evaluation of the program as a strict RED difficult. Information on device qualification is not available for the control group, thus presenting potential bias to the equivalency of the treatment and control groups. As such, we evaluated the impacts using the RCT design framework and difference-in-difference (DID) regression model.

Energy optimization design for ecobees, on the other hand, is structured as a simple crossover design, where devices are treated on most days, but have randomly assigned non-treatment days. We calculated savings from this type of experimental design as the simple difference between the mean runtime on non-treatment days minus mean run time on treatment days.

Clean and Prepare Data

Nest data cleaning and preparation included removing devices with missing zip codes, anonymized zip codes, and zip codes outside of Ameren Missouri service territory. We also removed a handful of devices that had corrupted device IDs and could not be matched between the device level extract, which contained experiment assignment, and telemetry data extract. We excluded 2% of Nest devices as part of data cleaning and preparation.

For ecobee devices, we leveraged the same runtime data that we used for the event season demand impact analysis. As part of the data cleaning process, we identified and removed devices that were not a part of the experimental design (3% of all ecobee devices). Appendix A contains detailed tables with device drops.

Conduct Equivalency Analysis

Before running the models, we performed an equivalency analysis to ensure that Nest treatment and control group and ecobee treatment and control days were equivalent in terms of run time. This check ensures the fidelity of the experimental design. The analysis confirmed equivalency. Appendix A contains detailed results from the equivalency analysis.

Model Impacts

For both Nest and ecobee devices, we relied on the control group (participants for Nest and days for ecobees) to establish the counterfactual, i.e., the baseline run time that participants likely would have used in the absence of the optimization intervention.

To estimate Nest optimization impacts, we fit a linear fixed effects regression model, which accounted for factors that are not expected to vary over time via the constant terms of the equation, such as square footage. This model accounted for differences in weather and pre-program run time between participants. To improve our estimate of what participants' runtime would have been absent from the program, we added dummy variables for each of the seven days of the week.[22] Including these variables in the model helped control for daily trends such as weekday versus weekend schedules and allowed for a more accurate estimate of pre- and post-program usage. The model included weather terms as well as interaction terms between weather and the post-participation period for the treatment group to account for differences in weather patterns across the summer season. We also included interaction terms to control for any differences in baseline usage between the treatment and control groups. We excluded demand response event days from impact modeling. Appendix A contains the final model specification and model outputs.

The impact analysis of ecobee devices was relatively straightforward because Uplight structured their program as a simple crossover design, where devices are treated on most days but have randomly assigned control days. As such, we calculated runtime reduction from this type of experimental design as the simple difference between mean run time on control days minus mean run time on non-control days. Non-control days included treatment days, days when devices were inoperative, as well as ineligible treatment days. Days with unknown treatment status we not included in the analysis. As such impacts reflect runtime not just on the days when the optimization algorithms were active, reflective the ITT approach. The analysis resulted in per-device daily minutes of runtime reduction.

We modeled impacts for both manufacturers using runtime data before converting them to power by applying connected load assumption. We later converted runtime impacts to energy impacts by applying the connected load assumption.

Extrapolate Modeled Impacts to Population and Event Season

For Nest devices, consistent with the intent to treat (ITT) approach, we used modeled estimates of average per-device daily runtime reduction. We extrapolated them for the months during which the Nest optimization algorithms were running (August 1, 2019, through September 30, 2019). We then multiplied runtime savings by the number of devices in the treatment group. We used participant data extract to determine the total number of devices enrolled in the program at the time of the optimization launch and adjusted the count by the percent of devices assigned to the treatment group. We derived that percent from the telemetry data.

For ecobee devices, we calculated average per-device total hours of runtime on non-control days. We then converted per-device daily minutes of runtime reduction to minutes per hour of runtime reduction. We then

[22] Dummy variables are binary terms for each day of the week, with "1" signifying that the observation occurred in that day.

multiplied minutes per hour of runtime reduction by the number of hours of runtime across non-control days to arrive at the per-device season total runtime reduction. We then multiplied per-device runtime reduction by the total number of participating devices. We derived the total number of devices from the participant data extract.

Convert Runtime Impacts to kWh Impacts

We used the connected load assumption of 3.07 per-device to convert the total runtime reduction to kWh savings.

4.3 Evaluation Results

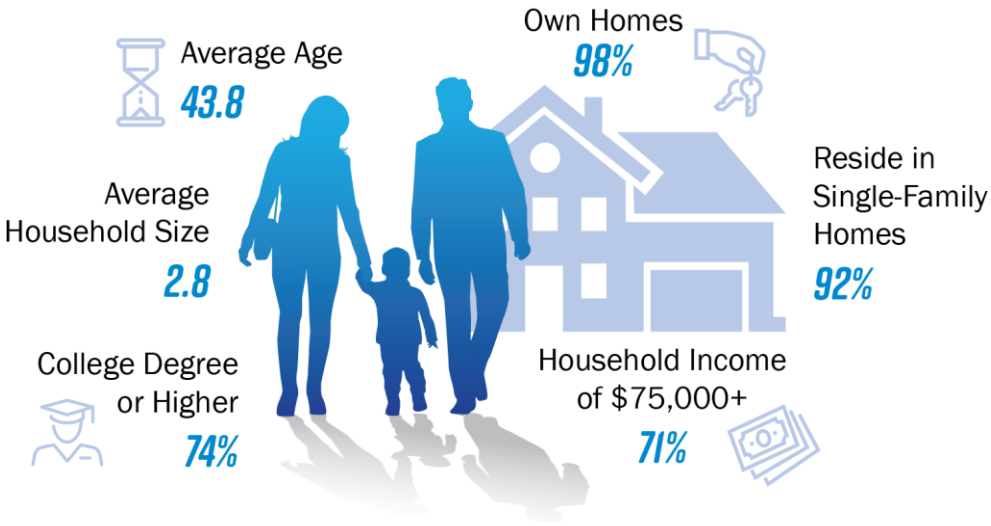
This section presents a detailed process and impact evaluation results for the Residential DR Program.

4.3.1 Process Results

Participation Summary

As of the end of the event season, 9,180 participants enrolled devices in the program. Participants were diverse in their sociodemographic composition, based on the participant survey results. However, program participants differ from Ameren Missouri's broader residential customer base. Program participants tend to be more affluent with higher levels of educational attainment. This customer composition is not surprising and is consistent with the early adopters of smart thermostats across the country. Emerson thermostat owners tend to skew older when compared to the ecobee and Nest thermostat owners. Figure 4-11 provides an overview of participants' key sociodemographic characteristics.

Figure 4-11. Residential DR Program – Participant Overview



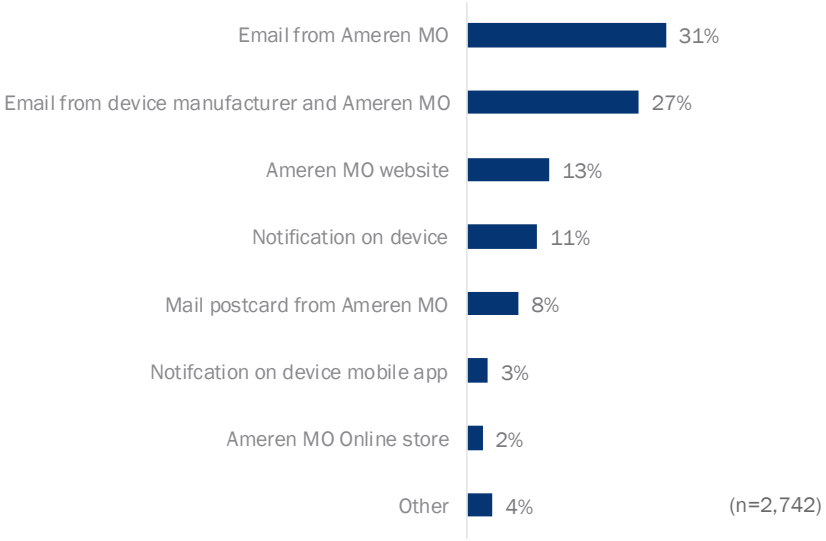
As smart thermostat adoption enters mainstream, participant composition may change, with potential implications on participation dynamics, including energy consumption patterns, which can be associated with the size of the home as well as participant presence at home during various times of the day.

Program Awareness and Motivation for Participation

Uplight relied on a range of marketing and outreach tactics to reach and engage participants with the Residential DR Program, including direct mail communications, e-mail outreach, outreach via devices and device apps, as well as Ameren Missouri website and Marketplace web page. Source of program awareness were consistent with the means of outreach. More specifically, based on the participant survey results, participants primarily learned about the program via e-mail outreach – over half (58%) report first learning about the program by either receiving an e-mail from Ameren Missouri or both Ameren Missouri and the device manufacturer. An additional 13% first learned about the program through the Ameren Missouri website, and 11% through notifications on their devices (Figure 4-12). Ecobee device owners are more likely to report

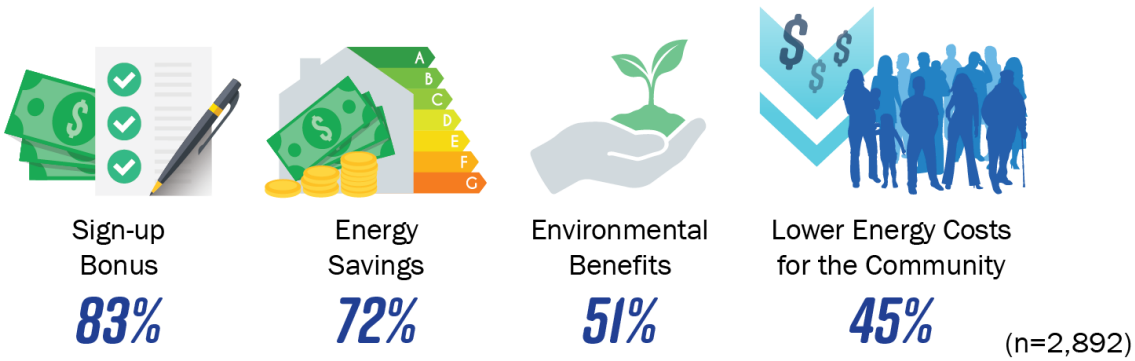
learning about the program through the Ameren Missouri website and mail postcards. Not surprisingly, participants who entered the program through the Marketplace channel are significantly more likely to report learning about the program through the Ameren Missouri and Marketplace website.

Figure 4-12. Residential DR Program – Sources of Program Awareness



Multiple factors motivate participation, but incentives in the form of a sign-up bonus and energy savings are the key motivators to participation. When probed specifically about the importance of energy savings on the decision to enroll in the program, 85% of participants rate energy savings as a very or somewhat important factor, with 45% rating it as a very important factor.

Figure 4-13. Residential DR Program – Motivators for Program Enrollment



Experiences with Program Enrollment

The process of program enrollment varied by device manufacturer and program channel and included multiple steps performed by several entities (Nest, Franklin Energy, Uplight), such as verification of eligibility at multiple junctures of the enrollment process, acceptance of terms and conditions, and new device registration. Despite multiple steps, participants find program enrollment to be easy. In fact, three-quarters of participants (75%)

rate the process of enrolling in the program as very easy, and another 22% rate the process as somewhat easy. Furthermore, when asked specifically about the ease of registering their device, 98% of participants rate the process as either somewhat or very easy.

The few participants who experienced difficulties enrolling in the program most commonly cited issues with the website working properly and needing to submit enrollment forms multiple times or rely on enrollment via phone. A small number of participants report being confused about whether they ultimately ended up enrolling and what the required next steps were. Fewer still rank the thermostat registration process as lengthy or overly complex.

Experiences with Events

Not all participants recalled participating in demand response events. More specifically, 11% of participants did not recall participating in Ameren Missouri's demand-response events. As part of the participant survey, we explored participant experiences with the various components of the demand-response events. More specifically, we explored participant presence in their homes during the events, participant reactions to the duration and total number of events they participated in, comfort level with the indoor temperature during the events, as well as resulting temperature overrides.

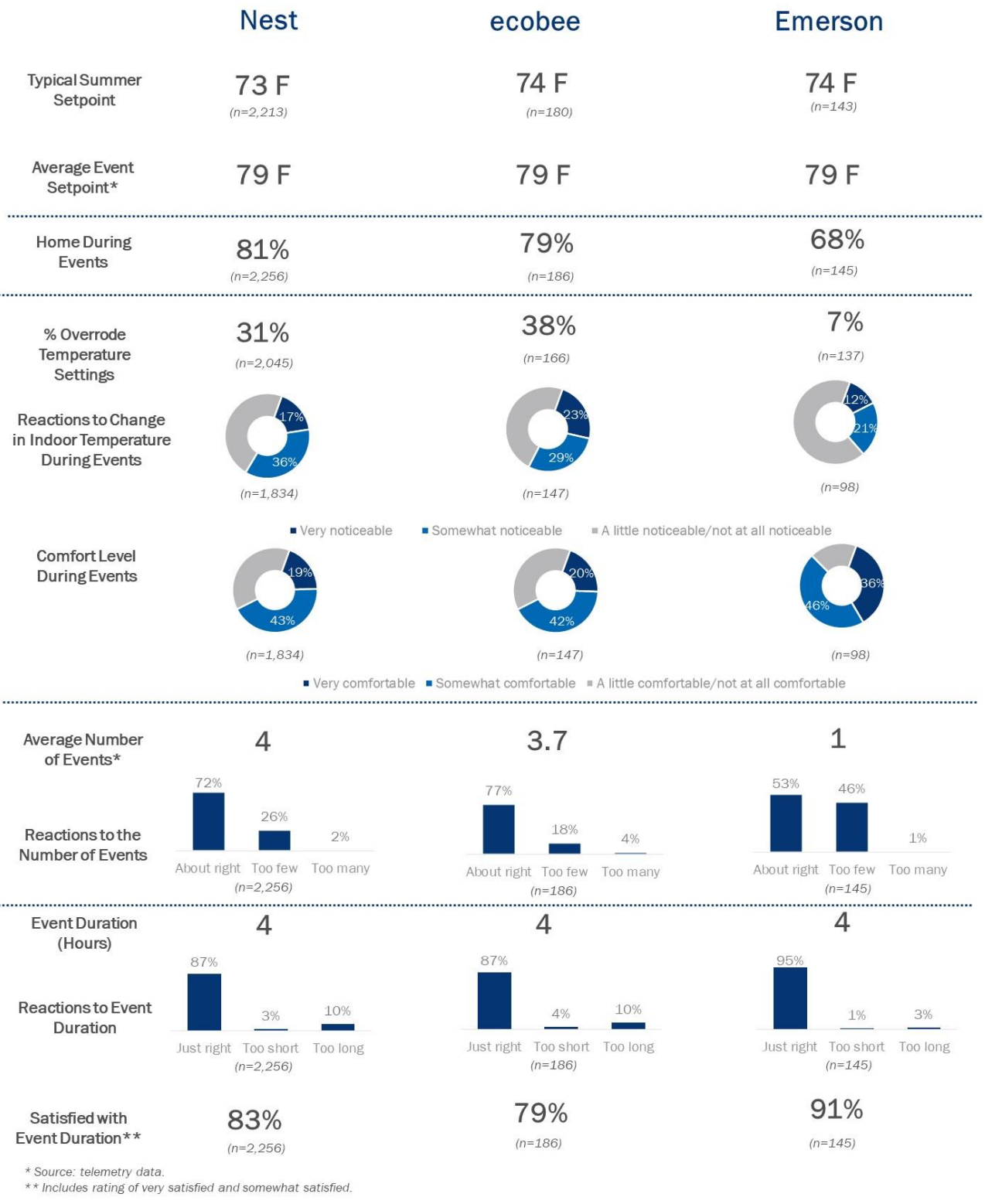
Figure 4-14 summarizes key findings related to the participant event experiences by device manufacturer. During events, Ameren Missouri adjusted device setpoints to 79°F, which is 5°F or 6°F degrees higher than participant typical comfort temperature, as reported by participants in the survey.[23] Participants were at home during events generally and noticed changes in temperature. More specifically, 53% of Nest owners, 52% of ecobee owners, and 33% of Emerson owners report changes in indoor temperature during the events to be very or somewhat noticeable. Despite the fact that participants noticed temperature increase, most remained generally comfortable. Namely, 62% of Nest and ecobee owners and 82% of Emerson owners who were home during events report feeling very or somewhat comfortable during the events. Some participants overrode adjusted temperature settings, primarily to stay comfortable. Just under a third of Nest owners (31%), 38% of ecobee owners, and 7% of Emerson owners reported doing so. Across the board, Emerson owners are less likely to report feeling uncomfortable during events and less likely to override device temperature settings. Emerson devices were controlled similarly as ecobee devices during events. Emerson participants, however, only participated in one event (as compared to four events for Nest participants and close to four events for ecobee participants[24]) that featured relatively mild temperature (90°F on average during the event). Those are likely the reasons explaining more positive customer experiences of events for Emerson device owners.

Participants are generally satisfied with the number of events they participated in, with 72% of Nest owners, 77% of ecobee owners, and 53% of Emerson owners rating the number of events to be just right. In fact, 46% of Emerson owners, who participated in just one event, wished they participated in more events. Over a quarter (26%) of Nest owners and 18% of ecobee owners also wish they participated in more events.

All events called in PY2019 lasted four hours. Participants are happy with that duration, with most rating it to be just right and reporting high levels of satisfaction with it. Only a small percent of participants (10% of Nest and ecobee owners, and 3% of Emerson owners) report that events lasted too long.

[23] We asked participants to report the temperature they generally keep their thermostat set on a hot summer day when at home. For ecobees, where we could link survey results to participant data, we verified the accuracy of the self-reported value.
[24] Not every device was selected to participate in each event due to the RCT design for assigning devices to events.

Figure 4-14. Residential DR Program – Summary of Participant Experiences During Events



* Source: telemetry data.
** Includes rating of very satisfied and somewhat satisfied.

Event Notifications and Post-Event Summaries

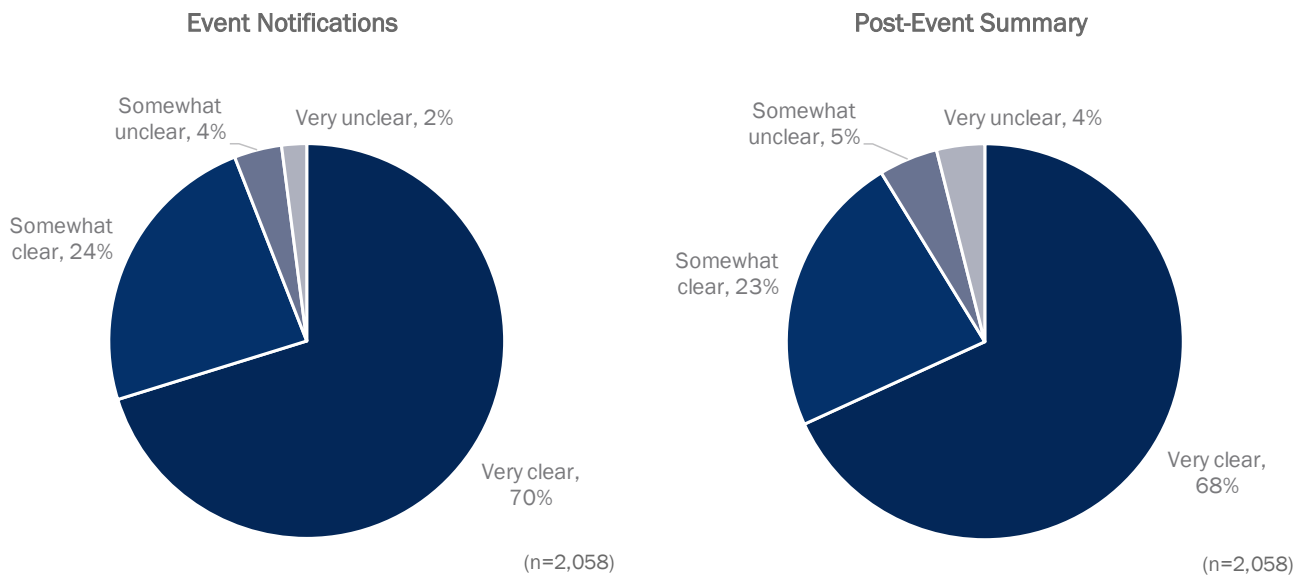
Ecobee and Emerson owners received notifications of upcoming events via e-mail only, while Nest owners could receive notifications via e-mail, on their device app, and on their device. Most (98%) recall notifications in advance of demand-response events, however, ecobee owners are significantly more likely not to recall receiving notifications than Nest owners (11% vs. 1%). Ecobee owners overwhelmingly prefer e-mail as a way of receiving notifications (92%). As for Nest owners, 62% prefer e-mail, 29% prefer their device app, and 7% prefer receiving notifications on their device.

We asked participants if the timing of event notifications allowed for enough advance notice before events or if they would have liked to have been notified earlier. Participants are overwhelmingly (86%) satisfied with the timing of event notifications. Only 14% would like to receive notifications sooner.

Participants find instructions contained in notifications on what to expect during an event to be clear and understandable. More specifically, 94% of participants rate the information very or somewhat clear.

Most participants (87%) recall receiving e-mails with post-event summaries. Similar to event notifications, participants find post-event summaries to be clear (91%).

Figure 4-15. Residential DR Program – Clarity of Information Provided in Event Notifications and Post-Event Summaries



Program De-Enrollment

Only 2% of devices de-enrolled from the program in PY2019 based on the participation data. However, ecobee participants were much more likely to de-enroll from the program. As part of the participant survey, we explored the reasons for de-enrollment among a small subset of participants who reported de-enrolling from the program (n=30). De-enrolled participants cite uncomfortable temperature settings as well as relocation as the key reasons for de-enrollment. De-enrolled participants find their de-enrollment experience generally easy.

Table 4-9. Residential DR Program – De-Enrollment Summary

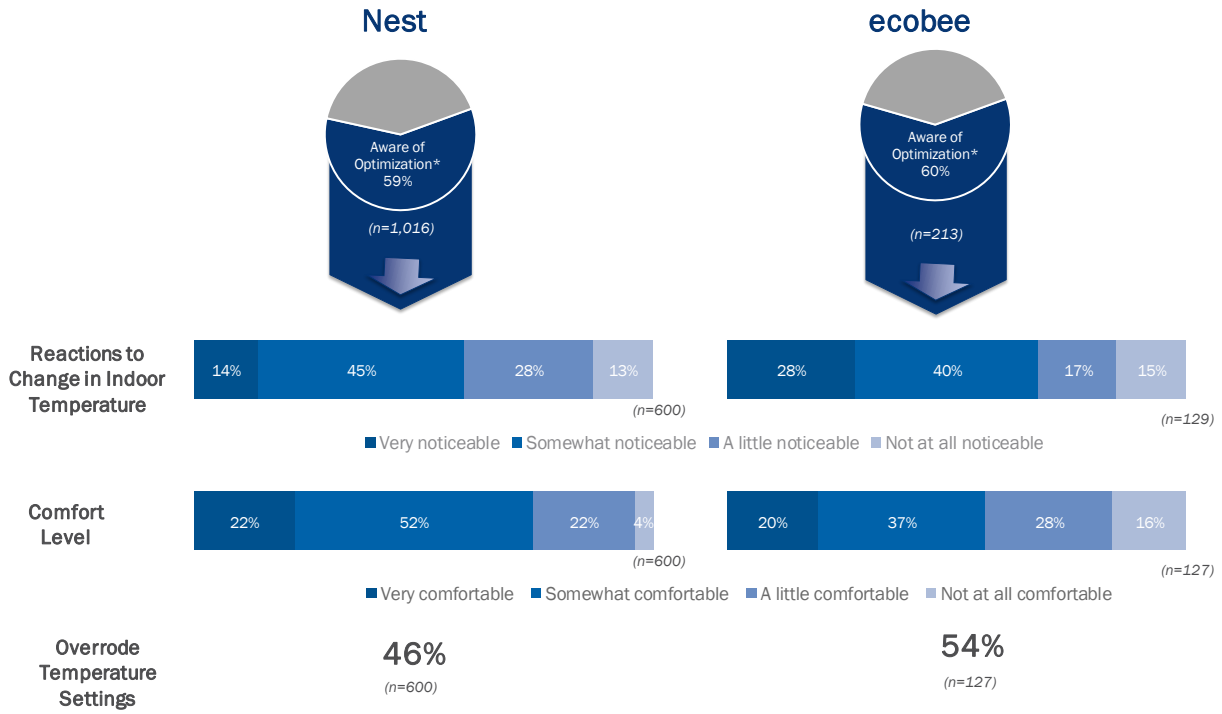
Device Manufacturer	Percent De-Enrolled
Nest	1%
Ecobee	14%
Emerson	1%
Total	**2%**

Experiences with Energy Optimization

Energy optimization was running on just Nest and ecobee devices in PY2019. All ecobee participants were enrolled in the energy optimization component, but only a subset of Nest participants were. As part of the survey, we asked participants about participant awareness and experience with the optimization component. Figure 4-16 summarizes participant experience with optimization.

Six in ten participants were aware of the optimization running in the summer of 2019. Six in ten of those participants noticed temperature changes. Ecobee owners are significantly more likely to report noticing temperature changes, as compared to Nest owners (68% vs. 59% respectively reported that temperature changes were very or somewhat noticeable). Nest owners report much higher comfort levels than ecobee owners during the times when the optimization algorithms were running. More specifically, 74% of Nest owners report feeling very or somewhat comfortable, and only 57% of ecobee owners report feeling the same way. It is our understanding that ecobee optimization algorithms adjust temperature settings more aggressively to achieve savings than Nest, which is a likely reason for differences in participant experiences.

Figure 4-16. Residential DR Program – Participant Experiences with Optimization

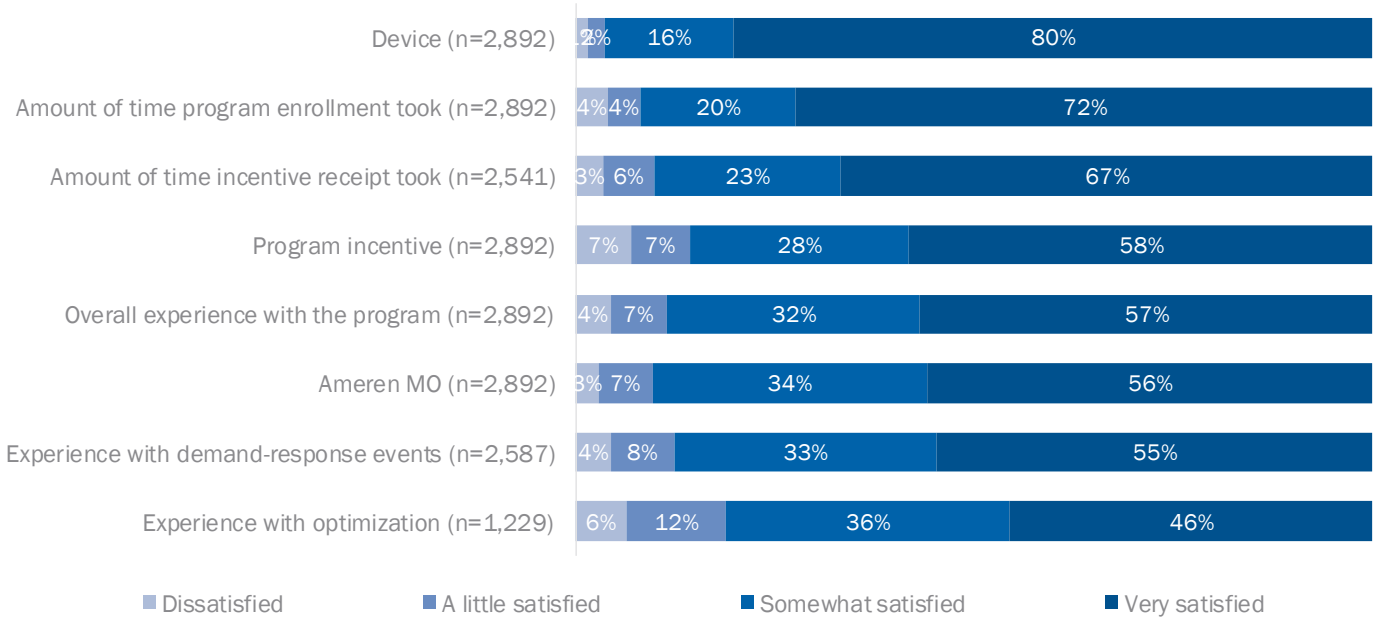


** Question asked of participants aware of their enrollment in the optimization component.*

Participant Satisfaction

Participants report high satisfaction ratings across most program components – from program enrollment to satisfaction with their devices (Figure 4-17). Participants are least satisfied with their experiences with demand-response events and experiences during days when optimization algorithms were running on their devices. Dissatisfied participants cite high temperatures as the key reason for their dissatisfaction. Overall, 90% of participants are satisfied with Ameren Missouri, and 64% report that their participation in the Residential DR Program has made them feel more favorable toward Ameren Missouri. Ecobee owners report lower satisfaction ratings consistently with such components of the program as overall program experience, experience with demand-response events, and optimization than Nest or Emerson participants. As a result, ecobee owners report lower levels of satisfaction with Ameren Missouri.

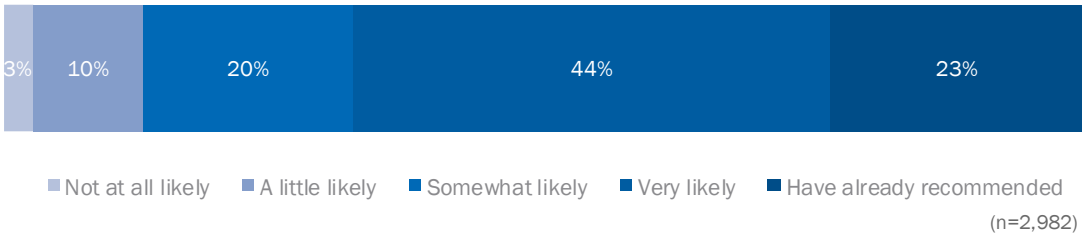
Figure 4-17. Residential DR Program – Participant Satisfaction Ratings



Few (5%) of participants contacted Ameren Missouri or program staff with questions or problems related to the program. Most frequently cited reasons for contact were questions about program rebates (44%), thermostat registration (26%), temperature adjustments (20%), and thermostat operation (13%). Most participants remained either very or somewhat satisfied with Ameren Missouri's ability to resolve questions (67%). Reasons for dissatisfaction include delayed incentives and questions about device registration and temperature adjustments remaining unresolved. A small number of participants note that customer service representatives were not sufficiently knowledgeable on the topic to resolve questions and issues effectively.

Likely as a result of high satisfaction levels, participants are likely to recommend the program to others. In fact, nearly a quarter of participants (23%) have already recommended the program, and an additional 64% are either very or somewhat likely to recommend the program (Figure 4-18). Ecobee owners are less likely than Nest and Emerson owners to report being likely to recommend the program.

Figure 4-18. Residential DR Program – Likelihood to Recommend



Program Barriers and Opportunities

Based on the results from the Residential baseline study conducted in PY2019, 8% of all thermostats in Ameren Missouri's service territory are smart thermostats. Not all of those devices, however, are eligible for the Residential DR Program. Based on our estimates, in PY2019, there were just over 71,000 eligible smart thermostats. The Residential DR Program enrolled 10,926 devices through the BYOT channel, which represents an enrollment rate of 15% of all eligible smart thermostat devices into the program in Ameren Missouri's service territory. Such an enrollment rate suggests that additional enrollment of eligible smart thermostats through the BYOT channel will be limited based on the **existing** device inventory and will need to rely on newly purchased devices, through the Ameren Missouri residential program portfolio or outside of it.

In PY2019, the Residential DR Program relied heavily on the BYOT channel, with that channel representing 88% of all enrolled devices. Continued reliance on the BYOT channel in PY2020 would require and enrollment of nearly 8,400 incremental devices through that channel to meet the 2020 MEEIA III incremental device participation goal.[25] Assuming the historical engagement rate of 15%[26], 55,000 eligible devices will need to be sold in Ameren Missouri's service territory, ideally before the start of the event season. While it is difficult to predict smart thermostat sales in any given year, selling 55,000 eligible devices will mean increasing device penetration by over 6%.[27] Continued heavy reliance on the BYOT channel to deliver incremental devices, therefore, presents a risk for the program. Diversifying device acquisition channels can offer a solution that ensures a pipeline of additional devices available and eligible for enrollment. Based on our discussions with Uplight and Franklin Energy, there are plans to expand those channels beyond the Marketplace channel. Uplight also plans to start enrolling Honeywell devices in the program in PY2020, thus expanding the field of eligible devices.

Uplight and Franklin Energy did not meet their planned device enrollment from the Marketplace channel, achieving an enrollment rate of 9% compared to planned 58% from that channel. As of the end of PY2019, 5,831 customers purchased smart thermostats through the Marketplace channel, and 986 of those (16%) enrolled in the Residential DR Program. Reasons for non-enrollment in the Program are unknown. Uplight and Franklin Energy's plan was to enroll three-quarters (76%) of incremental participants through the Marketplace channel in PY2020 and 90% in PY2021.

As part of the Residential Baseline study, we also captured the penetration of broadband internet needed for smart thermostat participation in the Residential DR Program. Based on the survey results, 15% of homes in

[25] We assumed BYOT channel representing 88% of enrollments and 1.2 devices per participant. The MEEIA 2020 incremental participation goal is 7,905 participants.
[26] We assume that all of the existing devices in Ameren Missouri territory were touched by program outreach.
[27] For the purposes of this calculation, we used a total household count of 935,186 and adjusted that by penetration of broadband required for smart thermostat installation, which is at 84.8% in Ameren Missouri's service territory.

Ameren Missouri's service territory did not have broadband access. This may also present a barrier to the adoption of smart thermostats and program participation.

Finally, as part of the Residential Baseline survey, we asked respondents about barriers to adoption of various DR solutions, namely Central AC Demand Response solution, through which Ameren Missouri would adjust thermostat settings to achieve peak period load reduction, and an electric water heater program, through which Ameren Missouri would remotely access and shut off water heater to reduce peak load. Notably, the Central AC Demand Response solution is consistent with the current Design of the Residential DR Program. Below, we present a summary of customer sentiments related to each solution, including barriers to adoption of specific DR solutions as well as self-reported likelihood to adopt at various incentive levels.

Central AC DR Solution

(Explored with homeowners with central air conditioning systems)

Customers have a variety of concerns about participating in the Central AC DR solution, including concerns about allowing the utility to control customer's thermostats, potential negative impact on comfort, data security, and knowledge of the participation process. While none of them emerge as extreme barriers, comfort is the one that worries customers the most. Overall, between 22% and 29% of respondents rate those barriers as extreme, and between 31% and 36% do not consider those to be barriers. The likelihood to adopt this solution is heavily dependent on the incentives offered, with 60% reporting being somewhat likely to participate in the solution at the annual incentive of $50. In contrast, 49% report the same for the $25 incentive. Notably, a considerable share (40%) are unlikely to adopt this solution no matter the incentive.

Consideration: Educating customers on the program strategies (such as precooling) that increase the comfort of the home, as well as providing assurances of customers' ability to regain control of their devices easily will help mitigate barriers to engagement.

Electric Water Heater DR Solution

(Explored with homeowners with electric water heaters)

Just over a third (35%) of Ameren Missouri customers primarily heat water with electricity. Customers' biggest concern with participating in the electric water heater DR solution is not having enough hot water when needed. Other concerns include allowing the utility to control their water, negative impact on comfort, as well as lack of knowledge of the program participation process, however, they are less prominent. Half of the customers would be likely to participate in this solution at the annual incentive of $50 compared to 35% reporting the same at

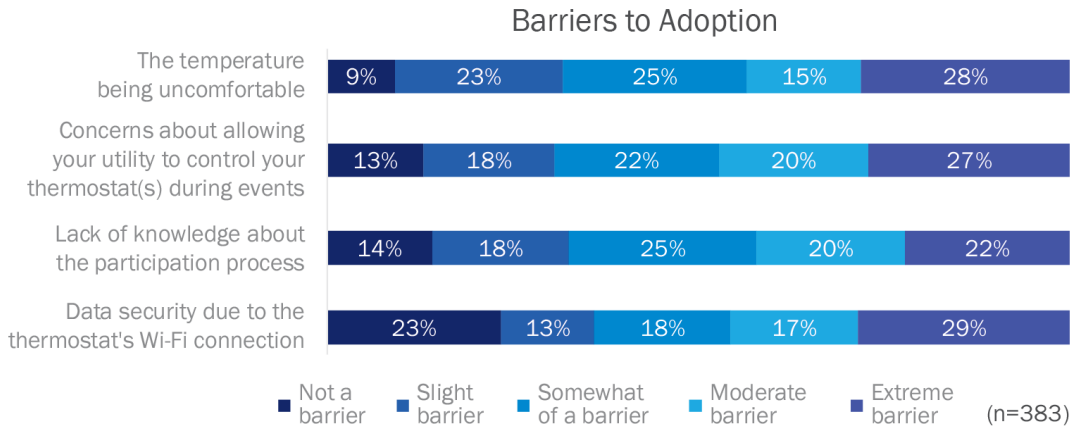
the annual incentive of $25. Notably, a considerable share of customers (36%) are unlikely to adopt this solution no matter the incentive.

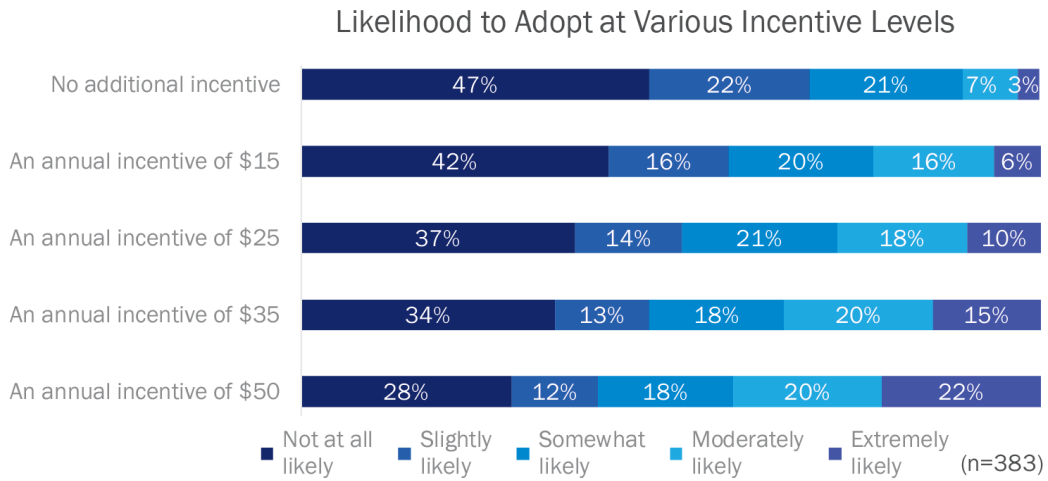
Consideration: Penetration of electric water heaters is a limiting factor to engaging customers, making this solution available to just over a third of homeowners. Mitigating customer concern of allowing utility to control water heater by emphasizing the fact that customers are ultimately in control of their equipment and can override temperature settings will help increase customer confidence of and consideration of the solution, as will additional customer education on the strategies that the program may undertake to address the concerns of not having hot water when needed. Providing additional customer education on the process of program participation can help increase customer comfort level with the process and further reduce customer uncertainty about participating in the solution. Special consideration needs to be given to incentive levels to provide sufficient impetus for customer interest and engagement

Figure 4-19. Residential DR Program – Centra AC Demand Response Solution

Central AC Demand Response Solution

Explored with homeowners with central air conditioning systems





40% would not participate no matter the incentive.

Reasons for non-participation include...

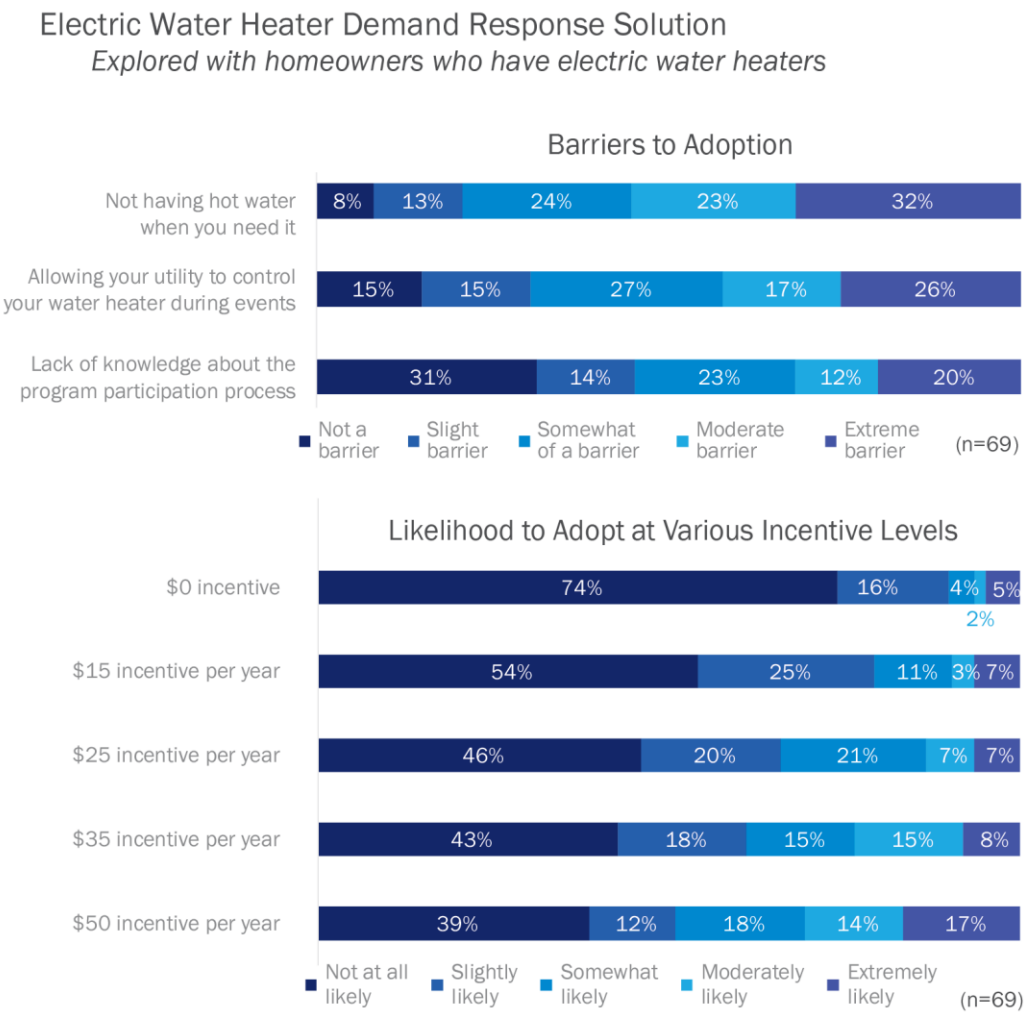
"Need to have more information to become more familiar and comfortable."

"We are elderly, temperature increases in summer time might be too uncomfortable."

"There is usually someone home at all times of the day"

10% would consider participating only if incentives were substantially higher ($100+)

Figure 4-20. Residential DR Program – Electric Water Heater Demand Response Solution



32% would not participate no matter the incentive.

Reasons for non-participation include...

"I don't want anyone controlling my appliances but me"

"Want my hot water when needed"

"I am not comfortable with someone else controlling when I can have hot water"

19% would consider participating only if incentives were substantially higher ($100+)

4.3.2 Impact Results

This section details demand and energy impact results from the Residential DR Program. We first discuss event season demand impacts, followed by impacts for resource capability purposes. We then detail event day energy impact results. Finally, we discuss impacts from the energy optimization algorithms.

Event Season Demand Impacts

The Residential DR Program achieved 10.43 MW in demand impacts across all participating devices. Table 4-10 provides event season demand impacts by event and device manufacturers. Event day demand impacts represent average impacts across all event hours. Appendix A contains detailed tables with hourly demand impacts by event and device manufacturer. Emerson devices only participated in the last event and were lacking runtime data to develop baseline load estimates. Due to a lack of runtime data and similarity of the runtime of Emerson and ecobee devices, we applied ecobee impacts for Emerson devices for that event. Per-device demand impacts are inclusive of de-enrolled participants, as well as devices that were overridden during the events.

Per device demand impacts range from 1.06 kW to 1.30 kW and are generally higher on hotter days. On average, per-device demand impacts during the August 12 event when average temperature during the event was the highest of the four events (94°F) were the highest at 1.30 kW. In contrast, during the August 7 event, when the temperature was lowest (86°F), demand impacts were the lowest (1.10 kW). Demand impacts for ecobee devices were considerably higher than for Nest devices across all events.

Table 4-10. Residential DR Program – Demand Impacts by Event and Device Manufacturer

Event	Manufacturer	Total Number of Devices Enrolled	Aggregate (MW)		Per Device (kW)		% Demand Impact	Average Event Temp. (F)
			Baseline Load	Demand Impact	Baseline Load	Demand Impact		
August 7, 2019	Nest	7,070	9.75	7.71	1.38	1.09	79%	86
	ecobee	607	0.86	0.74	1.42	1.22	86%	
	Total	**7,677**	**10.61**	**8.45**	**1.38**	**1.10**	**80%**	
August 12, 2019	Nest	7,660	15.69	9.72	2.05	1.27	62%	94
	ecobee	628	1.33	1.05	2.12	1.67	79%	
	Total	**8,288**	**17.02**	**10.76**	**2.05**	**1.30**	**63%**	
September 3, 2019	Nest	8,387	14.74	9.78	1.76	1.17	66%	90
	ecobee	666	1.25	1.03	1.87	1.54	82%	
	Total	**9,053**	**15.98**	**10.80**	**1.77**	**1.19**	**68%**	
September 10, 2019	Nest	8,645	12.23	8.96	1.42	1.04	73%	90
	ecobee	784	1.18	0.98	1.50	1.25	83%	
	Emerson	557	0.84	0.70	1.50	1.25	83%	
	Total	**9,986**	**14.24**	**10.63**	**1.43**	**1.06**	**75%**	

Table 4-11 provides a summary of average demand impacts by device manufacturers for the event season. Across the PY2019 event season events[28], the program achieved 1.12 kW in per-device demand impact. The average per event demand impact for the PY2019 event season is 10.43 MW. Ecobee devices achieved higher

[28] Note that we excluded the August 12 event due to baseline considerations.

per-device demand impacts than Nest devices (1.33 kW vs. 1.10 kW). Given the higher volume of Nest devices, these participants contributed 84% of the total load impact. Across all manufacturers, per-device impacts were lower than the planned value (1.47 kW)[29], indicating that even during a hotter event season, the program will likely come short of the planned value.

Table 4-11. Residential DR Program – Average Event Season Demand Impacts by Manufacturer

Manufacturer	Average Number of Devices Enrolled	Aggregate (MW)		Per Device (kW)		% Load Impact
		Baseline Load	Demand Impact	Baseline Load	Demand Impact	
Nest	8,034	12.24	8.81	1.52	1.10	72%
ecobee	686	1.10	0.92	1.60	1.33	84%
Emerson	557	0.84	0.70	1.50	1.25	83%
All	**9,276**	**14.17**	**10.43**	**1.53**	**1.12**	**74%**

Analysis of setpoints and per-device load by event hour across the events[30] for Nest and ecobee devices highlight differences in event hour setpoints and therefore load as the events progressed. More specifically, Nest setpoints decrease, and load increases as the event progresses, whereas ecobee devices hold consistent temperature setpoints. This, combined with a slightly higher modeled baseline load for ecobees, is a likely explanation for ecobee devices garnering higher per-device demand impacts.

Table 4-12. Residential DR Program – Average Hourly Setpoints and Device Load

Manufacturer	Day Type	Average Setpoint (F)*			Average Per Device Load (kW)*		
		Hour 1	Hour 2	Hour 3	Hour 1	Hour 2	Hour 3
Nest	Event	78	77	76	0.15	0.40	0.70
	Reference	75	75	75	1.29	1.52	1.74
	Difference	*3*	*2*	*1*	*-1.14*	*-1.12*	*-1.04*
ecobee	Event	78	78	78	0.13	0.21	0.45
	Reference	76	75	75	1.41	1.63	1.76
	Difference	*3*	*3*	*3*	*-1.28*	*-1.42*	*-1.31*

* Excludes August 12 event due to baseline considerations.

Appendix A contains detailed plots of per-device demand impacts by device manufacturer and event.

Resource Capability Estimates

Resource capability estimates reflect weather normalized demand impacts applied to the population of devices enrolled as of the end of PY2019. Table 4-13 details resource capability impacts by device as well as cumulatively across all enrolled devices. Final device counts used for resource capability estimates were adjusted to account for expected device failure, which reduced the total device count by 3% from 12,347 to 11,977.

As can be seen in the table, anticipated demand impacts from the 11,977 devices enrolled as of the end of PY2019, adjusting for failure, is 16.86 MW. Average per-device impacts under normal weather conditions are

[29] This value is based on MEEIA III PY2019 enrollment goal of 6,533 participants and 11.50 MW in demand savings and an assumption of 1.2 devices per participant. The most recent version of the Ameren MO TRM deems the demand savings at 1.53 kW per thermostat.
[30] We excluded setpoints and load during the August 12, 2019 event and associated baseline days due to baseline day equivalency.

estimated at 1.41 kW and are projected to be higher for ecobee and Emerson than for Nest devices (2.15 kW vs. 1.27 kW). Average demand impact of 1.41 is slightly lower than the deemed value of 1.53 kW in the Ameren Missouri TRM[31] or the per-device planned value of 1.47 kW[32], indicating that under normal weather conditions the program will likely fall short of the goal.

Table 4-13. Residential DR Program – Resource Capability Impacts

Manufacturer	Total Number of Devices Enrolled as of the End of PY2019 (Adjusted for Failure)	Aggregate (MW)		Per Device (kW)		% Load Impact
		Baseline Load	Demand Impact	Baseline Load	Demand Impact	
Nest	10,132	19.96	12.90	1.97	1.27	65%
ecobee	935	2.21	2.01	2.37	2.15	91%
Emerson	911	2.16	1.96	2.37	2.15	91%
All	**11,977**	**24.33**	**16.86**	**2.03**	**1.41**	**69%**

Table 4-14**Error! Reference source not found.** compares resource capability impacts to PY2019 MEEIA III goals. Weather normalized demand impact of 16.86 MW represents 147% of the PY2019.

Table 4-14. Residential DR Program – Comparison of Resource Capability Impacts to Goal

Metric	Result
Resource capability load impact (MW)	16.86
PY2019 MEEIA III goal (MW)	11.50
Percent of PY2019 goal	147%

Cumulative DR Capability

Cumulative DR capability for the Residential DR program mirrors resource capability and is presented in the table below. Cumulative DR capability represents a performance metric for the earnings opportunity award for the DR programs.

[31] 2019-24 MEEIA plan, Revision 1.0, Appendix I, Vol 3: Residential Measures.
[32] This value is based on MEEIA III PY2019 enrollment goal of 6,533 participants and 11.50 MW in demand savings and an assumption of 1.2 devices per participant.

Table 4-15. Residential DR Program – Comparison of Cumulative DR Capability to Target

Metric	Result
Cumulative DR capability (MW)	16.86
PY2019 target (MW)	11.50
Percent of PY2019 target	147%

Summary of Energy Impacts

Table 4-16**Error! Reference source not found.** compares total event season energy savings to the MEEIA III goal.[33] Energy savings in the table are inclusive of the savings achieved during demand response events, as well as savings achieved through the optimization component of the initiative. The Residential DR Program achieved 406 MWh out of target 1,130 MWh, which represents 36% of the MEEIA III goal. Energy savings from the energy optimization component accounted for 78% of all energy savings, while event day energy savings accounted for the remaining 22%. MEEIA goal assumed per-participant energy savings of 172 kWh in PY2019. On a per-participant basis across the event day and optimization components ecobee devices achieved 204 kWh in energy impacts, which is much higher than the planned value, whereas Nest devices achieved 58 kWh in energy impacts, which is much lower than the planned value. Notably, Nest optimization algorithms ran during the second half of the event season only and are less aggressive than the Orchestrated Energy optimization algorithms that ran on the ecobee devices. Deployment of the optimization component throughout the entire event season, as well as harvesting energy savings from a larger number of events will likely narrow the gap for Nest devices, but we anticipate that the gap will still remain.

Table 4-16. Residential DR Program – Comparison of PY2019 Event Season Energy Savings to Goal

Metric	Result (MWh)
Event season energy savings	405.75
Event day energy savings	*87.78*
Energy savings from the optimization component	*317.97*
PY2019 MEEIA III goal	1,130.00
Percent of goal	36%

Event Day Energy Impacts

In addition to demand reductions, demand response events resulted in moderate energy savings during event days. Achieving energy savings as a result of the demand response events is not the primary goal of the Demand Response programs.

Energy savings reflect cumulative reductions in energy over the 24 hours period, as compared to baseline days, across all four test events. Energy savings were generally consistent across events, ranging from 1.90 kWh to 2.93 kWh per-device. Despite more aggressive pre-cooling strategies deployed for the ecobee and Emerson devices, energy savings for those device manufacturers are not substantively different from Nest's across events. In fact, despite aggressive pre-cooling strategies, ecobee and Emerson devices achieved energy savings ranging from 7% to 12% of the baseline usage. Table 4-17 details event day per-device and total energy savings.

[33] Goals are based on the MEEIA III Plan filing for the Residential DR program.

Table 4-17. Residential DR Program – Event Day Energy Savings by Event and Device Manufacturer

Events	Manufacturer	Total Number of Devices Enrolled	Aggregate (MWh)		Per Device (kWh)		% Savings	Average Event Day Temp. (F)
			Baseline Usage	Energy Savings	Baseline Usage	Energy Savings		
August 7, 2019	Nest	7,070	164.54	17.54	23.27	2.48	11%	79
	ecobee	607	15.86	1.71	26.12	2.82	11%	
	Total	**7,677**	**180.40**	**19.25**	**23.50**	**2.51**	**11%**	
August 12, 2019	Nest	7,660	235.30	21.59	30.72	2.82	9%	84
	ecobee	628	21.83	1.81	34.75	2.89	8%	
	Total	**8,288**	**257.12**	**23.40**	**31.02**	**2.82**	**9%**	
September 3, 2019	Nest	8,387	205.33	24.57	24.48	2.93	12%	82
	ecobee	666	17.93	1.48	26.92	2.23	8%	
	Total	**9,053**	**223.25**	**26.05**	**24.66**	**2.88**	**12%**	
September 10, 2019	Nest	8,645	233.13	16.39	26.97	1.90	7%	84
	ecobee	784	23.63	1.57	30.15	2.00	7%	
	Emerson	557	16.79	1.12	30.15	2.00	7%	
	Total	**9,986**	**273.55**	**19.08**	**27.39**	**1.91**	**7%**	

Table 4-18 summarizes event day energy savings by device manufacturer across all events. As can be seen in the table, event day energy savings averaged 9.62 kWh per-device and represented 9% of the total baseline usage. Across the four demand response events dispatched in PY2019, the Residential DR Program achieved 87.78 MWh in energy savings. As with the demand savings, Nest contributed the most savings to the event season total (91%) due to the total number of devices enrolled.

Table 4-18. Residential DR Program – Event Day Energy Savings by Device Manufacturer

Manufacturer	Total Number of Devices Enrolled	Aggregate (MWh)		Per Device (kWh)		% Savings
		Baseline Usage	Energy Savings	Baseline Usage	Energy Savings	
Nest	7,910	837.23	80.08	105.44	10.12	10%
ecobee	662	79.17	6.58	117.94	9.94	8%
Emerson	557	16.79	1.12	30.15	2.00	7%
Total	**9,129**	**933.19**	**87.78**	**101.75**	**9.62**	**9%**

Impacts from Device Optimization

Table 4-19 summarizes energy savings from the device optimization component. Through running optimization algorithms on participating devices throughout the season, the program achieved 198.39 kWh in per-device savings and 317.97 MWh in total energy savings. The average savings rate is 5%. The Optimization of Nest devices resulted in much lower per-device savings than the optimization of the ecobee devices (37.94 kWh vs. 160.44 kWh). Overall, Nest devices achieved an average savings rate of 3%, and ecobee devices an average savings rate of 15%. Notably, while Nest devices accounted for 87% of savings due to a large number of participating devices, savings for this device manufacturer are reflective of the optimization algorithms running for a portion of the event season (August and September). They will likely be higher if deployed throughout the entire event season.

Table 4-19. Residential DR Program – Device Optimization Energy Savings Summary

Manufacturer	Total Number of Devices Enrolled	Aggregate (MWh)		Per Device (kWh/Event Season)		% Savings
		Baseline Usage	Energy Savings	Baseline Usage	Energy Savings	
Nest	4,845	5,837.05	183.84	1,204.76	37.94	3%
ecobee	836	919.52	134.13	1,099.90	160.44	15%
Total	**5,681**	**6,756.56**	**317.97**	**2,304.66**	**55.97**	**5%**

Appendix A contains graphs with runtime data comparisons for Nests and ecobees. The graphs help to visually explain the differences in energy optimization impacts between the two device manufacturers.

5. Business Demand Response Program

This section summarizes the PY2019 evaluation methodology and results for Ameren Missouri's Business Demand Response (DR) Program.

5.1 Evaluation Summary

5.1.1 Program Description

In 2019, Ameren Missouri launched the Business Demand Response (DR) Program. This program contributes the largest demand savings within the PY2019 business portfolio, accounting for 56% (or 25 MW) of planned demand savings, but only 1% (or 500 MWh) of planned energy savings. The program was designed to reduce load during periods of peak demand. Enel X acted as the program aggregator in PY2019, responsible for recruiting and enrolling customers, developing load reduction nominations, developing customized load curtailment strategies, dispatching demand response events, and maintaining customer relationships with participating businesses. Enel X engaged customers to participate in DR events through a variety of efforts, including direct load control, manual response, and behind the meter assets. Notably, there are no defined measures for this program as each participant is unique and may utilize a variety of mechanisms to reduce load during an event. Furthermore, the program is voluntary, and participants may choose not to participate in the events. In PY2019, leveraging behind the meter generation as part of the program was not permitted.

Each enrolled facility received a customized load curtailment strategy, focusing on a variety of energy loads such as lighting, HVAC, chillers, motors, and processing equipment. Participants received a custom capacity-based payment (based on the average MW performance across all events in a given program year), and an energy payment (based on each MWh of performance during events) developed and negotiated by Enel X. Participants were not subject to performance penalties.

Demand response events were called during the summer event season lasting from May 1 through September 30, 2019. Enel X could call up to five peak shaving events and up to two test events.[34] Both event types could last for up to four hours in duration. No more than two events could be called consecutively.

Figure 5-1 provides a visual overview of the event notification process that Enel X followed in PY2019 to prepare customers for events and communicate event start and end dates. As can be seen in the figure, a week before a DR event is likely to be called, Enel X sends participants an e-mail with advance notice for a likely event day. Participants also receive a reminder notification a few days before the event day. On the day of the event, Enel X issues a formal event notification several hours in advance with a start and end time of the event, as well as a link in an e-mail to confirm receipt. Non-responsive participants may receive a second alert. After the event ends, Enel X sends a final e-mail confirming the end of the DR event dispatch.

[34] Emergency demand response events were not planned for the 2019 event season.

Figure 5-1. Business DR Program – Event Notification Flow

The program does not have customer eligibility requirements – everyone who is interested in participating and has not opted out of MEEIA Programs can do so. However, Enel X focuses its outreach on larger customers (400 kW of peak demand or more) to ensure sufficient DR opportunities. Once a customer agrees to participate, Enel X installs its metering equipment to collect interval electric usage data.

Incentives to participants are based on their average performance during the events. Participants are not subject to penalties for non-performance or under-performance.

5.1.2 Participation Summary

Based on the MEEIA III filing, the program goal for PY2019 was 25 MW[35] of capacity reduction. In PY2020, Ameren Missouri will double its MEEIA III goal to 50 MW of capacity reduction. Enel X enrolled 53 customers[36] for the PY2019 event season with a total nominated capacity of 37.1 MW, which represents 148% of the PY2019 MEEIA III goal. Following the dispatch of the two summer season test events, Enel X adjusted the capacity nomination goals for select participants to better align with their ability to curtail load during the peak periods.

By the end of PY2019, Enel X had enrolled 149 accounts in the program for a total of 77.9 MW in nominated capacity, 56% more than the PY2020 MEEIA III goal.

Table 5-1. Business DR Program – Goals and Participation Summary

Metric	MEEIA III Goal	Enrollment	% of Goal
End of the PY2019 Event Season Enrollment Summary			
Accounts	50	53	106%
Nominated capacity (MW)	25.00	37.06	148%
Progress Towards PY2020 Cumulative Enrollment Goals			
Accounts	100	149	149%
Nominated capacity (MW)	50.00	77.90	156%

In PY2019, Ameren Missouri used the program for peak shaving purposes. However, the summer of 2019 was mild temperature-wise, and therefore Enel X was unable to call peak shaving events. To assess participant

[35] The 25 MW goal is from the MEEIA III Filing and is different than the goal specified in the Statement of Work between Enel X and Ameren Missouri, which references 35 MW goal.
[36] Defined as unique accounts.

performance, Enel X called two one-hour test events on August 16 and September 25. Figure 5-2 below provides details for each test event.

Figure 5-2. Business DR Program – Overview of PY2019 Events

*Number of customer accounts and nominated capacity represents those among whom the event was called.

Following the completion of the event season, Enel X dispatched a one-hour test event on December 12, 2019, to ascertain nominated capacity values for customers enrolled in the program after the end of the 2019 event season. The December test event was dispatched to a total of 19 newly enrolled customers representing 21.6 MW in nominated capacity.

Participating customers spanned a range of business types. In the 2019 event season, Enel X's primary customers were manufacturing plants, followed by business and consumer services and agriculture and mining operations.

5.1.3 Key Impact Results

Business DR Program achieved 22.39 MW in average demand savings during the PY2019 event season. PY2019 was a milder than normal summer, and participating facilities, based on Enel X's feedback, were new to the DR Program participation process. Furthermore, the lack of interval data prevented a more precise development of nominated capacities for program participants.

Program participants achieved 65% of the nominated capacity in the August 16 test event and 60% in the September 25 test event. The average event season performance across all accounts was 22.39 MW or 60% of the nominated capacity. Overall, 9% of all accounts met or exceeded the nominated capacity goal across both events (realization rate of 100% or higher). Enel X recognized that the nominated capacities for participating facilities were an overestimate driven by lack of participant experience with demand response programs and load reductions strategies as well as a lack of interval data to inform goal feasibility. Notably, Enel X is actively working on a tool to establish achievable and reasonable nomination capacity goals for customers more accurately to ensure stability and predictability of the program performance.

Our analysis further revealed that on average, total PY2019 nominated capacity represents 80% of the total participant baseline load[37] during the event hours, reflecting a substantial portion of demand on any given day. In fact, for 20 accounts (38%), nominated capacity represented 100% of the baseline load or more. Enel X reported purposefully setting nominated capacity values at more ambitious levels, as not to restrict participants, should they choose to pursue more aggressive performance in the DR events. Enel X reported accounting for these more ambitious goals by enrolling additional capacity in the program, above the goal.

Table 5-2 presents average event day demand savings achieved during the PY2019 event season.

Table 5-2. Business DR Program – Event Season Demand Savings

Event	MEEIA III Goal (MW)	Nominated Capacity (MW)	Event Season Performance (MW)	% of Nominated Capacity Achieved
Event 1 (August 16, 2019)	25.00	35.03	22.67	65%
Event 2 (September 25, 2019)	25.00	37.06	22.34	60%
Average Demand Savings	**25.00**	**37.06**	**22.39**	**60%**

Table 5-3 presents the PY2019 resource capability estimate. Resource capability represents the sum of average event performance across all accounts enrolled in the program as of the end of PY2019 and is an estimate of what the program can expect to have available toward the PY2020 goal. The Business DR Program is estimated to achieve 49.99 MW in event impacts through accounts enrolled in the program as of the end of PY2019. This value is 27.60 MW higher than event season performance of the accounts enrolled in the PY2019 event season. It contributes to the program performance of double the PY2019 MEEIA III goal (200%).

Table 5-3. Business DR Program – Resource Capability Estimate

Metric	Result
PY2019 resource capability estimate (MW)	49.99
PY2019 MEEIA III goal (MW)	25.00
Percent of PY2019 goal	200%

[37] Opinion Dynamics used average adjusted baseline load for the purposes of this analysis.

Table 5-4 presents the PY2019 cumulative DR capability. The value in the table represents demand impacts from tested accounts, either during the PY2019 event season or during the December test event. Cumulative DR capability represents a performance metric for the earnings opportunity award for the DR programs. The program's cumulative DR capability is 33.10 MW and represents 132% of the target.

Table 5-4. Business DR Program – Cumulative DR Capability

Metric	Result
PY2019 cumulative DR capability (MW)	33.10
PY2019 target	25.00
Percent of PY2019 target	132%

Achieving energy savings during demand response events was not the primary goal of the Business DR Program. As a result of the two test events, participants decreased consumption by a total of 94.14 MWh. The energy savings fell short of the target of 500 MWh and represent 19% of the MEEIA III goal. Table 5-5 presents the PY2019 event season energy savings. The amount of energy savings is not surprising given that only two one-hour test events were dispatched during the PY2019 event season. Event day energy savings represented 5.7% of baseline energy usage for the August 16 event and 3.24% for the September 25 event.

Table 5-5. Business DR Program – Event Season Energy Savings

Event	MEEIA III Goal (MWh)	Event Season Energy Savings (MWh)	Percent of Goal
Event 1 (August 16, 2019)		57.94	
Event 2 (September 25, 2019)		36.20	
Total	**500.00**	**94.14**	**19%**

5.1.4 Key Process Findings

As of the end of 2019, a total of 149 accounts across 122 unique facilities and 61 businesses were enrolled in the program with a nominated capacity of 77.9 MW. Enrolled customers spanned a range of business segments, including manufacturing, mining, consumer services, and transportation.

Overall, participants were pleased with the participation process across key milestones, from program enrollment to developing load reduction strategies, to event participation. More specifically, participants:

- Found program enrollment process to be easy (average rating of 5.0 on a 6-point scale, where 1 is very difficult and 6 is very easy)
- Were satisfied with the timing of event notifications (average rating of 5.4 on a scale from 1 to 6, where 1 is very dissatisfied and 6 is very satisfied) and found event notifications clear and easy to understand
- Found the process of developing load reduction strategies to be easy (average rating of 5 on a scale from 1 to 6, where 1 is very difficult and 6 is very easy). Those who relied on Enel X's help in specifying the strategies found the process helpful
- Those who received event performance scorecards found the content easy to understand and appreciated the clarity of comparisons between their goals and achievements

- Were generally satisfied with the program as well as Ameren Missouri (average rating of 4.6 and 4.5 respectively on a scale from 1 to 6, where 1 is very dissatisfied, and 6 is very satisfied)

Despite overall positive experiences with the program, the evaluation team identified several challenges to effective program execution. The key ones include a lack of experience with DR Programs among commercial customers in Ameren Missouri service territory. Enel X acknowledged that this program was new to participants, which created a challenge of accurately forecasting load reduction opportunities and associated nominated capacities. That, paired with lack of interval data to estimate load available for reduction during peak periods, contributed to imperfections in the load reduction nominations. With more interval data available for the newly enrolled customers, however, Enel X expects participant performance to be more in line with their nominated capacity values.

Furthermore, Enel X anticipates a much more predictable performance from newly enrolled customers. Based on Enel X's feedback, a lot of those customers represent corporate entities with a long history of experience participating in the DR Programs not only across the United States but the world. As a result, those customers have both the knowledge of their business operation and technology (EMS, remote control systems) to ensure reliable and predictable performance. Those customers are also weather-sensitive, which enhances their ability to deliver load reduction during the event season.

Communication and information sharing emerged as another key challenge. Through in-depth interviews with participants, we learned that not all respondents received event performance scorecards and that some participants did not have sufficient knowledge of their event performance. Most interviewed participants expressed a desire for more information and more frequent communication of their performance. Finally, participant interviews revealed an additional challenge of coordinating load curtailment within participating facility staff as impeding successful participation in the events. Despite these challenges, participants recognized the value of the program in saving energy and money as well as positioning companies as good stewards of the community.

Missouri Code of State Regulations (CSR) requires that demand-side programs, operating as part of a utility's preferred resource plan, are subject to ongoing process and impact evaluations that meet certain criteria. Table 5-6 summarizes responses to the CSR process evaluation requirements.

Table 5-6. Business DR Program – Summary of Responses to CSR Process Evaluation Requirements

CSR Required Process Evaluations Questions	Findings
What are the primary market imperfections that are common to the target market segment?	Ameren Missouri customers generally lack experience with demand response programs and therefore are less used to the load reduction strategies and not as skilled at estimating their load reduction potential during peak periods in the summer. Lack of interval data in Ameren Missouri service territory limits visibility into customer hourly load profile to ensure more effective targeting and more accurate goal-setting. Customers have various concerns related to DR Program, including concerns with comfort and facility operations and concern with losing control of core energy-using systems. Lack of customer knowledge of the program participation process is also likely to be an impediment to program engagement.
Is the target market segment appropriately defined, or should it be further subdivided or merged with other market segments?	Targeting medium and large facilities with a customized DR offering is appropriate due to heterogeneity of facility types, operations, and appropriate load reduction strategies. The

CSR Required Process Evaluations Questions	Findings
	program has been focused on customers with the highest load reduction opportunities during the peak summer period, which is consistent with the program goals of shaving peak load.
Does the mix of enduse measures included in the program appropriately reflect the diversity of enduse energy service needs and existing enduse technologies within the target market segment?	The program's approach to load reduction is customized to each facility, which is appropriate given unique energy demands of medium and large customers and the resulting load shaving opportunities.
Are the communication channels and delivery mechanisms appropriate for the target market segment?	Program participants were satisfied with the communication mechanisms deployed through the program. Nearly all participants, however, expressed a desire for more and faster feedback on their event performance as a way to course-correct their facility's operations and meet their load reduction commitment.
What can be done to more effectively overcome the identified market imperfections and to increase the rate of customer acceptance and implementation for select enduses/measure groups included in the program?	Enel X is actively working on a tool to establish more accurate achievable and reasonable nomination capacity goals for customers. Ensuring prompt follow-up and reassessment of nominated capacity to adjust for uncertainty and better align with customer performance abilities will further ensure stability and predictability of the program performance. Portfolio growth will allow Enel X to distribute the risk across more accounts, therefore, reducing reliance on each account to perform. Providing education to customers related to how the DR Program impacts facility operations and customer comfort along with providing more information on the participation process and namely the ability to override utility control of the core energy using systems will give customers confidence in their ability to stay in control of their facility energy operations.

5.1.5 Conclusions and Recommendations

The evaluation team offers the following conclusions and recommendations for the Business DR Program:

- **Conclusion 1:** Based on the program resource capability value, the program is well-positioned to achieve PY2020 goals with currently enrolled participants. However, the customers enrolled after the event season differ in terms of business segment profiles, thus presenting uncertainty around their future program performance.
  - **Recommendation 1:** Enel X should monitor those facilities closely during the PY2020 event season, as their load shaving behavior during the event season may be different than what was observed for facilities during the PY2019 event season.
- **Conclusion 2:** In PY2019, nominated capacity did not align with event performance, and in some cases represented more than the entire facility load. A number of factors are driving this misalignment, including aggressive nominations, limited pre-event period interval data to support

nomination development, customers with limited DR experience or insight into facility load profiles, a variety of diverse customer segments, and a mild PY2019 event season.

- **Recommendation 2:** It is important for Enel X to continue monitoring customer performance against nominated capacities over the course of the PY2020 event season and adjust nominations to align them with actual customer potential based both on what customers can and are willing to achieve.

- **Conclusion 3:** Participants requested more and more timely information to understand their program performance and progress toward the nomination goal to adjust their load reduction strategies as needed to achieve their load reduction commitment
  - **Recommendation 3:** Enel X should work to ensure timely communication with participants on event performance and assess opportunities to support participants in locating and achieving further load reductions.

- **Conclusion 4:** According to research conducted with program eligible Ameren Missouri customers, customers are concerned with a negative impact on comfort and facility operations. Lack of understanding of the program participation process is another likely barrier to customer engagement with the program.
  - **Recommendation 4:** When marketing the program to prospective customers, Enel X should consider addressing customer concerns of negative impact on comfort and facility operations through education and discussion of developing custom load curtailment strategies supported through highlighting implementer support and voluntary nature of the program. Providing additional customer education on the process of program participation will likely help increase customer comfort level with the process and further reduce customer uncertainty about participating in the program.

5.2 Evaluation Methodology

This section summarizes the key objectives and methods for the PY2019 Business DR Program evaluation. The key evaluation objectives included:

- Estimate energy and demand impacts;
- Determine weather-normalized resource capability for the program;
- Ensure that the implementer's tracking system contains the data necessary to support program evaluation;
- Assess how well the educational information, specifically load reduction strategies, are understood by customers;
- Understand participant barriers to meeting load reduction requirements, the degree to which participants find load reduction strategies relevant and actionable, and barriers to program enrollment;
- Measure customer satisfaction, with program processes and the aggregator, and motivations for participating;
- Identify opportunities for improvement in the customer experience; and

- Provide evaluation results that can be used to improve the design and implementation of the program.

Table 5-7 provides an overview of the Business DR Program evaluation activities. Following the table, we outline program-specific aspects of key evaluation methodologies.

Table 5-7. Business DR Program – PY2019 Evaluation Activities for the Business DR Program

Evaluation Activity	Description
Program Manager and Implementer Interviews	▪ Conducted interviews (3) before program launch to inform evaluation planning
Program Material Review	▪ Reviewed available program materials to inform evaluation activities.
Tracking System Review	▪ Reviewed the implementer's tracking system to ensure that the data required for the evaluation is being collected.
Participant Interviews	▪ Conducted interviews with program participants to assess program enrollment and participation processes.
Gross Impact Analysis	▪ Used aggregator's established baseline method to estimate hourly and average event kW and kWh savings impacts for the summer 2019 event season. ▪ Calculated average demand savings across all 2019 test events throughout the summer event season. ▪ Calculated normalized average demand savings for typical peak weather including participants enrolled in the program as of the end of 2019.

Participant Interviews

We administered qualitative interviews with program participants at the end of the 2019 summer event season. The key objective of the interviews was to collect data on participant experiences with the program. As part of the interviews, we explored the following topics:

- Motivations for and experiences with program enrollment
- Experiences with the event notification
- Experiences with the DR audit event
- Overall view of the DR Program and recommendations for program improvement

We drew a purposeful sample with consideration of participating facility type and demand reduction commitment made by participants to the program. This ensures coverage of participant experiences while maximizing the representation of participants that made large demand reduction commitments.

We completed interviews in November and December 2019. Interviewees included facility owners, managers, and directors of operations. We completed a total of six interviews. Table 5-8 summarizes the participant sample frame from which the sample was drawn, the sample, and the number of completed interviews. As can be seen in the table, the sample of six completed interviews accounted for 18% of unique contacts and 20% of nominated capacity.

Interviewee facilities included education facilities, a not-for-profit plant research facility, a corn milling company, producer of aluminum products, and a cold storage warehousing firm. Facilities ranged both in terms of square footage as well as a number of employees.

Table 5-8. Business DR Program – Participant Interview Sample

Group	Contacts		Nominated Capacity (MW)	
	Number	Percent	Number	Percent
Sample frame	34	100%	35.56	100%
Sample	15	44%	15.08	42%
Completed interviews	6	18%	7.27	20%

Impact Analysis

As part of the gross impact analysis, Opinion Dynamics estimated event-day demand and energy impacts, as well as weather-normalized resource capability. The three analyses are described below. Per industry-standard practices, we assume a net-to-gross ratio of 100% for impacts from DR events, i.e., there is no free ridership or spillover.

Event Day Demand Impacts Estimation

For each of the two event season test events as well as for the December test event, we estimated demand impacts by comparing actual interval meter readings during the event to the customer's baseline to calculate demand savings per event. We leveraged contractually agreed upon performance calculation approach between Enel X and Ameren Missouri.

We calculated event day demand impacts by taking the difference between baseline and actual demand during the event hour (Equation 1). We calculated event-specific performance independently for each account among whom the events were called. We calculated total event season performance by summing average performance across the two events for each account.[38]

Equation 1. Business DR Program – Event Day Demand Impact Calculation

$$Event\ Day\ Demand\ Impact\ (kW) = Final\ Baseline\ (Event\ Hour) - Actual\ Demand\ (Event\ Hour)$$

Baseline calculation leverages a "high 4 of 5" approach with symmetrical adjustment. The following steps were used in the calculation of the baseline.

Step 1 – Calculate Provisional Baseline

We calculated the provisional baseline as the average demand during the event hour for the highest four (4) of the last five (5) most-recent non-holiday, non-event, weekdays before the event day. NERC holidays were excluded from the calculation of the provisional baseline.

Step 2 – Calculate Baseline Adjustment

We calculated baseline adjustment as the average difference in demand on an hourly interval basis between the actual metered demand on an event day and the provisional baseline demand during a baseline adjustment window. The baseline adjustment window is defined as the two-hour period immediately preceding the start of the hour in which dispatch instructions were sent to participants.

[38] For accounts among whom only one event was dispatched, we used that event's performance. There were XX three accounts where this was the case.

Step 3 – Calculate Final Baseline

We calculated the final baseline by subtracting baseline adjustment from the provisional baseline for each hourly interval for all 24 hours (Equation 2).

Equation 2. Business DR Program – Final Baseline Calculation

$$Final\ Baseline = Provisional\ Baseline + Baseline\ Adjustment$$

Exceptions

As part of the demand impact calculations, we made one exception to the method described above. More specifically, one participating account reduced usage considerably the day of the December test event, resulting in significant downward adjustment of the provisional baseline. Based on feedback from Enel X and Ameren Missouri, the customer made a decision to change facility operation during the day of the event to best prepare for the event, and that decision was driven solely by the test event notification. In light of this information and based on additional exploration of the participant load patterns, Opinion Dynamics agreed that the baseline adjustment was not appropriate and developed demand impact calculations for that account using the provisional baseline without adjustment.

Event Day Energy Impact Estimation

Opinion Dynamics calculated event day energy savings by comparing total daily energy consumption during each event day to the total average daily energy consumption during the baseline days. Consistent with the event day demand impact approach, we used a "high 4 of 5" approach to defining baseline period, wherein we averaged total daily energy consumption for four (4) days with the highest consumption of the last five (5) most-recent non-holiday, non-event, weekdays prior to the event day. NERC holidays were excluded from the calculation of the baseline. Equation 3 details the event day energy impact calculation. We calculated event day energy impacts for each account and for each event. We summed energy impacts across accounts and events to arrive at the total event season event day energy impacts.

Equation 3. Business DR Program – Event Day Energy Savings Calculation

$$Event\ Day\ Energy\ Impact\ (kWh) = Average\ Daily\ Baseline\ Consumption\ (kWh) - Daily\ Event\ Day\ Consumption\ (kWh)$$

Resource Capability Estimation

Opinion Dynamics estimated resource capability by applying 2019 event season impacts to the population of participants and their associated nominated capacities enrolled as of the end of 2019. More specifically:

- For accounts that participated in the PY2019 event season, we used average event season performance to estimate resource capability
- For accounts that enrolled in the program post-event season, we applied the average event-season performance rate to their nominated capacity to develop resource capability estimates

To check for weather sensitivity, the evaluation team pulled data from Lambert Airport Weather Station and examined it in a correlation matrix against the usage values of all the customers enrolled in the program. Usage was not correlated with heating and cooling degree days. Therefore, we did not weather normalize event season impacts when estimating resource capability.

Cumulative DR Capability

Cumulative DR capability is a performance metric used to establish Ameren Missouri's earnings opportunity award. Opinion Dynamics calculated the cumulative DR capability consistently with the approach specified in the MEEIA III Plan. Cumulative DR capability included demand impacts only from participants tested either during the event season events or during the December Test event. More specifically:

- For accounts that participated in the PY2019 event season, we used average event season performance to estimate cumulative DR capability.
- For accounts whose performance was tested during the December Test event, we used the results of the test event to estimate cumulative DR capability.

Data Sources and Data Cleaning

Opinion Dynamics relied on two core sources of data when developing program impacts:

- Interval data: Opinion Dynamics leveraged revenue quality 15-minute interval data supplied by Ameren Missouri for all enrolled customers.
- Participation data: Opinion Dynamics obtained participation data from Enel X. The participation data extract included all customers enrolled in the program as of the end of 2019. For each customer, Enel X recorded customer account numbers, customer name and facility address, customer business segment information, load reduction nomination, and load reduction strategy.

Opinion Dynamics ingested the data from the two sources mentioned above, merged the data, and carefully processed the data to prepare it for analysis. The core data cleaning steps included the following:

- Exploration of duplicate records including duplicate accounts and interval periods
- Consolidation of multiple meters per account
- Exploring and correcting data irregularities including missing interval periods, missing accounts, periods with zero usage, low usage, or unreasonably high usage

We did not drop any records as a result of the data cleaning steps. Other revisions to the data were minimal.

The timing of the interval meter installation did not always occur in time for the event. In rare cases, interval meters were installed after an event was called. In those cases, Opinion Dynamics relied on interval data collected through Enel X's interval meters to the degree the data was available from Enel X. Furthermore, in cases of missing interval periods in existing interval data, Opinion Dynamics leveraged Enel X's interval meter data to fill the gaps. Both of the cases mentioned above were rare, affecting a total of two accounts. In one instance, interval data for one participating account was not available from either Ameren Missouri or Enel X for one of the events. We excluded that account from that event impact calculations and based that account's event season performance on the performance during the second event.

Attribution/Net Impact Analysis

Per industry-standard practices, we assume a net-to-gross ratio of 1.0 for impacts from DR events, i.e., there is no free ridership or spillover. Our estimate of non-event day energy impacts incorporates Uplight and Nest's randomized controlled trial, producing net energy impacts adjusted for free-ridership and participant spillover.

5.3 Evaluation Results

5.3.1 Process Results

Participant Composition

As of the end of 2019, a total of 149 accounts across 122 unique facilities and 61 businesses were enrolled in the program for a nominated capacity of 77.9 MW.

Enrolled customers spanned a range of industries. Table 5-9 provides a summary of participating accounts and nominated capacity by business segment. Overall, as of the end of the year, the manufacturing segment accounted for over half of the nominated capacity (52%) and over a third of enrolled accounts (34%). Event season participants were concentrated within manufacturing, agriculture, and mining, and business and consumer services segments, accounting for 91% of nominated capacity and 87% of enrolled accounts. Participants enrolled post-event season were more diverse in terms of the business segments and included customers from media and entertainment (13% of nominated capacity), government (9% of the nominated capacity), wholesale and distribution (5% of nominated capacity), and retail (4% of nominated capacity). Based on Enel X feedback, such a change in customer mix across industries is not surprising and in part drive by the length of time that some customers require to receive corporate approval to enroll in the program. That is particularly true for retail chains, such as Home Depot, where it takes time to clear corporate approval processes.

Table 5-9. Business DR Program – Participant Distribution by Industry

Business Segment	All Participants (n=149)		Participants Enrolled as of the End of the 2019 Event Season (n=53)		Participants Enrolled After the 2019 Event Season (n=96)	
	% of Accounts	% of Nominated Capacity	% of Accounts	% of Nominated Capacity	% of Accounts	% of Nominated Capacity
Manufacturing	34%	52%	60%	70%	20%	40%
Business and consumer services	23%	9%	19%	10%	25%	7%
Retail	13%	3%	2%	1%	19%	4%
Education	9%	6%	4%	1%	13%	10%
Media and entertainment	7%	8%	-	-	10%	13%
Agriculture and mining	6%	11%	8%	11%	4%	10%
Government	2%	5%	-	-	4%	9%
Transportation and storage	2%	2%	5%	5%	-	-
Healthcare, pharmaceuticals, and biotech	1%	0%	-	-	2%	1%
Wholesale and distributors	1%	3%	-	-	2%	5%
Energy and utilities	1%	1%	2%	2%	-	-

Business Segment	All Participants (n=149)		Participants Enrolled as of the End of the 2019 Event Season (n=53)		Participants Enrolled After the 2019 Event Season (n=96)	
	% of Accounts	% of Nominated Capacity	% of Accounts	% of Nominated Capacity	% of Accounts	% of Nominated Capacity
Other	1%	0%	-	-	1%	1%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Program Awareness and Motivation for Enrollment

Outreach from Enel X was the sole source of program awareness among the interviewed participants. Only 1 out of 5 interviewees reported learning about the program from staff who attended a local college's continuing education class. Energy savings and bill savings were the key motivators for program enrollment. Virtually all (5 of 6) interviewees indicated that their motivation to enroll was to save money and energy. One educational institution among these five indicated that, in addition to saving money, it could be good for their students to know they were taking part in the program. One additional participant, who did not specify money and energy as a motivation, noted they were motivated to be good stewards of the community.

Experiences with Program Enrollment

Overall, the participants we spoke with indicated that they had a positive experience with program enrollment and generally did not experience any problems. As a result, participants ranked the ease of the program enrollment process as a 5.0 on a 6-point scale, where 1 is very difficult and 6 is very easy. Notably, one participant noted that they found enrollment confusing because they had to communicate with multiple people at Enel X.

Experiences with Event Notifications

Interviewed participants overall expressed high satisfaction with the timing of the event notifications, rating their satisfaction, on average as a 5.4 on a scale from 1 to 6, where 1 is very dissatisfied and 6 is very satisfied. One participant, however, noted that the timing of the event itself was not optimal because it occurred toward the end of the school day and did not allow them the ability to shut down their operations for most of the event.

Most (5 of 6) participants we spoke with indicated that the event notifications were clear and easy to understand. One participant expressed a lack of understanding for how event days were selected, as the temperature that one of the event days was cooler than previous days. All interviewed participants indicated that they received an e-mail event notification. Most interviewees (4 of 6) also reported receiving notifications via phone and or text. All interviewed participants reported responding to event notifications confirming their participation.

Experiences with Event Participation

All interviewed participants had load reduction strategies developed prior to participation in events, and most participants (4 of 6) reported engaging Enel X in the process of developing their facility's load reduction strategy. Those participants found guidance from Enel X to be helpful. Regardless of whether Enel X was engaged in developing load reduction strategies, participants found the process to be easy, giving it an average rating of 5 on a scale from 1 to 6, where 1 is very difficult and 6 is very easy. Participant load reduction strategies were varied and included shutting down their plant operations (2 mentions), shutting down the

HVAC or lowering the set-point for their AC (2 mentions), shutting off supplemental lighting (2 mentions) and shutting down non-essential equipment like fountains, some heavy equipment, and pumps (1 mention).

All participants we spoke with indicated that they ultimately deployed the load reduction strategies they had planned, and three indicated that their load reduction strategies aligned with Enel X's.

Despite having a clear pathway to load reduction during the event period and deploying those strategies as planned, only one participant we interviewed met their load reduction goal during the test events. When asked about the reasons for underperformance, half of the responding participants reported being unaware of their actual performance. In fact, one of those participants thought that they met their goal and another thought they were close, but were not. Two more participants acknowledged their underperformance and reported a need a revisit their load reduction commitment and adjust it downward. Only one interviewed participant reported that achieving the nominated capacity goal was easy.

Enel X recognized that the load reduction goals set for participating facilities were an overestimate driven by lack of participant experience with demand response programs and load reductions strategies as well as a lack of interval data to inform goal feasibility. In addition, Enel X set nominated capacity goals higher in order to avoid being too restrictive in case facilities wanted to achieve more ambitious load reduction goals. Enel X reported accounting for possible underperformance against the nominated capacities by enrolling more overall nominated capacity.

Experiences with Post-Event Follow-Up

Half (3 of 6) of interviewed participants said they received a performance scorecard. Two others said they had not received a scorecard, and one was not sure. Those who received a performance scorecard said it was easy to understand. They specifically pointed out that the graph was helpful and that the scorecard made a clear comparison between their goal and their achievement. One interviewed participant noted that they would have liked if the scorecard also contained information on how much money they earned due to their demand reduction during the event period.

Program Satisfaction and Participation Challenges

Overall, interviewed participants were satisfied with participating in the program, and rated their satisfaction, on average, as a 4.6 on a scale from 1 to 6, where 1 is very dissatisfied and 6 is very satisfied. Participants acknowledged the energy and money savings benefits of the program and also recognized program challenges, the biggest of which is lack of awareness of their performance. Nearly all participants (5 of 6) expressed a desire for more and faster feedback on their event performance as a way to course-correct their facility's operations and meet their load reduction commitment. Two participants specifically mentioned coordinating load curtailment with their facility staff as a challenge to program participation.

Overall, participants we spoke with indicated that they are generally satisfied with Ameren Missouri, rating their satisfaction, on average, as a 4.5 on a scale from 1 to 6, where 1 is very dissatisfied and 6 is very satisfied.

Program Barriers and Opportunities

Based on the Commercial Baseline study that Opinion Dynamics completed in 2019, just over a third of business customers in Ameren Missouri service territory reported being aware of demand response programs. As part of the Baseline Study, we asked respondents about barriers to adoption of various DR solutions, including custom DR Program, where customers load reductions strategies are customized and coordinated

with Ameren Missouri; Central AC program, through which Ameren Missouri would adjust thermostat settings to achieve peak period load reductions; electric water heater program, through which Ameren Missouri would remotely access and shut off water heater to reduce peak load; and time-of-day rate program, where customers would agree to pay peak and off-peak rates. Below, we present a summary of customer sentiments related to each solution, including barriers to adoption of specific DR solutions as well as self-reported likelihood to adopt at various incentive levels.

Custom DR Solution

(Explored with medium and large businesses with at least 100 kW of peak demand)

This solution is similar to the current DR Program. Customers are most concerned with impact on comfort and facility operations when considering this solution. Knowledge about the program and participation process can also impede customer participation. Most customers may consider participating in this solution, and customer likelihood to participate increases dramatically with increasing incentives offered for load reductions. Nearly half of customers report being extremely likely to participate in the Custom DR Program at $100 per kW of load reduction. However, a small percent of customers (12%) would not participate in the program no matter what the incentive.

Consideration: Addressing customer concerns of negative impact on comfort and facility operations through education and discussion of developing custom load curtailment strategies supported through highlighting implementer support and voluntary nature of the program, while tailoring incentive levels to interest customers can help mitigate core market barriers to participation. Providing additional customer education on the process of program participation can help increase customer comfort level with the process and further reduce customer uncertainty about participating in the solution.

Central AC DR Solution

(Explored with small business customers with central air conditioning systems)

Customers have a variety of concerns about participating in the Central AC DR solution, including concerns about allowing the utility to control customer's thermostats, potential negative impact on comfort and business operations, data security, cost of smart thermostats, and knowledge of the participation process. None of them, however, emerge as extreme barriers, yet only 33% of customers at the most rate those factors as not being a barrier to participation. In fact, a relatively large share of customers (25%) report that they would not participate in the program no matter the incentive. Over a third would not participate at $50 incentive per year, and a quarter will consider participating only if incentives were to be substantial ($100 or higher).

Consideration: While this solution can present opportunity for Ameren Missouri to engage small business customers with DR solutions, special consideration needs to be given to incentive levels, as customers are unlikely to engage with the solution without considerable incentives ($100 and over). Mitigating customer concern of allowing utility to control thermostats by emphasizing the fact that customers are ultimately in control of their devices and can override temperature settings will help increase customer consideration of the solution, as will additional customer education on the strategies that the program may undertake (e.g., precooling, etc.) to address the concerns of the solution's negative impact on comfort and facility operation.

Electric Water Heater DR Solution

(Explored with small business customers with electric water heaters)

Just under half (49%) of small business customers primarily heat water with electricity, and a very small percent have tankless water heaters (8%). Customers' biggest concern with participating in the electric water heater DR solution is not having enough hot water when needed. Other concerns include allowing the utility to control water, negative impact on comfort and business operations, as well as lack of knowledge of the program participation process; however, they are less prominent. Just under a fifth of customers (19%) would not participate in the solution no matter the incentive, and 71% may consider participating at $50 incentive per year.

Consideration: Penetration of electric water heaters is a limiting factor to engaging customers, making this solution available to roughly half of small business customers. Mitigating customer concern of allowing utility to control water heater by emphasizing the fact that customers are ultimately in control of their equipment and can override temperature settings will help increase customer confidence of and consideration of the solution, as will additional customer education on the strategies that the program may undertake to address the concerns of not having hot water when needed. Providing additional customer education on the process of program participation can help increase customer comfort level with the process and further reduce customer uncertainty about participating in the solution. Special consideration needs to be given to incentive levels to provide sufficient impetus for customer interest and engagement

Time-of-Day Rate Solution

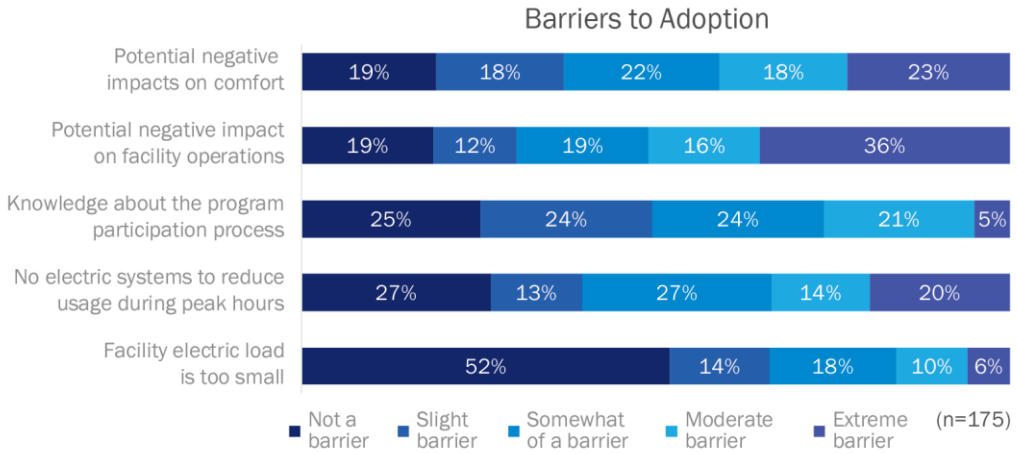
Key barriers to adopting this solution is the need to use electricity during peak hours and negative impact on facility operations and comfort. Over a third (34%) of customers would not participate, no matter the incentive.

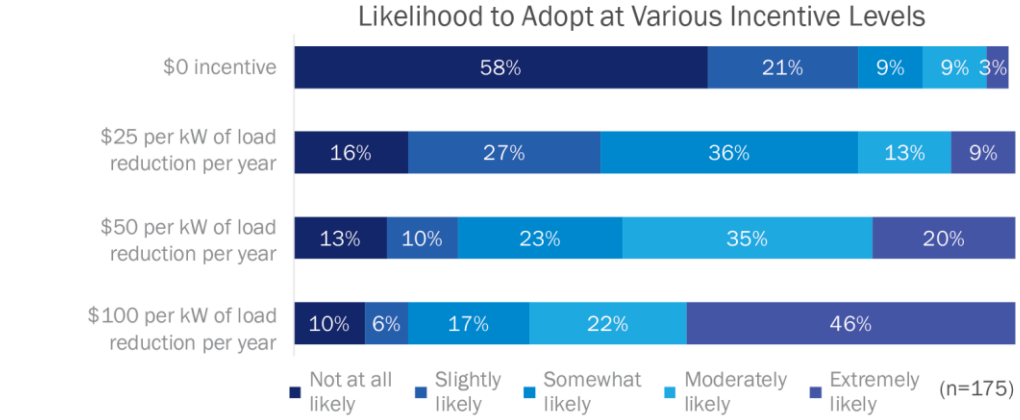
Consideration: Market barriers to this solution may be too numerous for the solution to be enticing to a large enough customer base. Helping customers understand their load reduction capabilities during peak hours and helping them estimate the impact on utility bills by shifting to the new rate structure can help mitigate the key concern of customers not having enough electric load to shed during peak hours. Carefully crafting the rate structure is important to providing enough incentive for customers to consider the solution.

Figure 5-3. Business DR Program – Custom DR Solution

Custom Demand Response Solution

Explored only with medium and large businesses with at least 100 kW peak demand





12% would not participate no matter the incentive

Reasons for non-participation include...

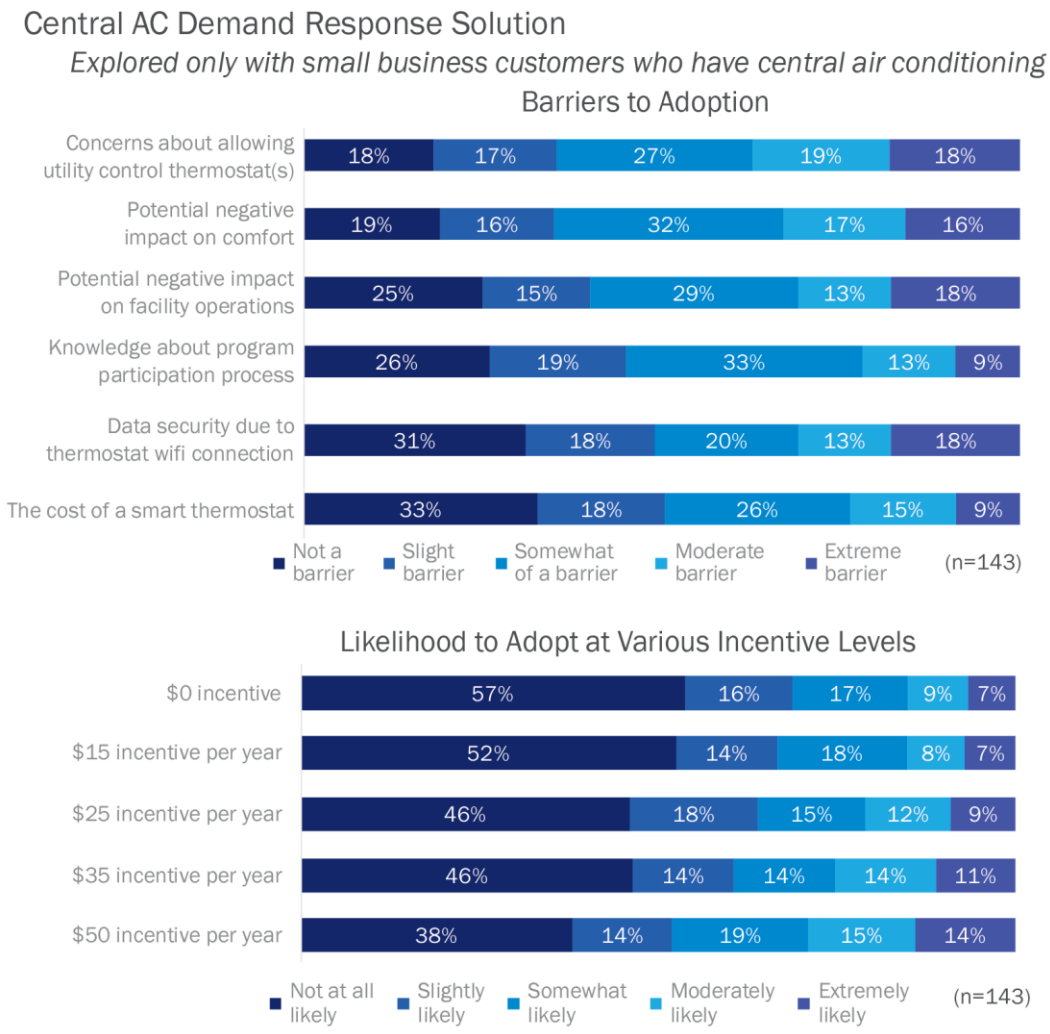
"This is a healthcare facility and patient comfort is not an option and reducing peak load will not work in this environment."

"The type of equipment that we run cannot be turned off to reduce load. Only option would be occupancy sensors to reduce loads for lighting when customers/employees are not present in certain areas."

"This is a facility that only fully functions about 4 months out of the year."

"All programs must go through the board of education."

Figure 5-4. Business DR Program – Central AC DR Solution



25% would not participate no matter the incentive.

Reasons for non-participation include...

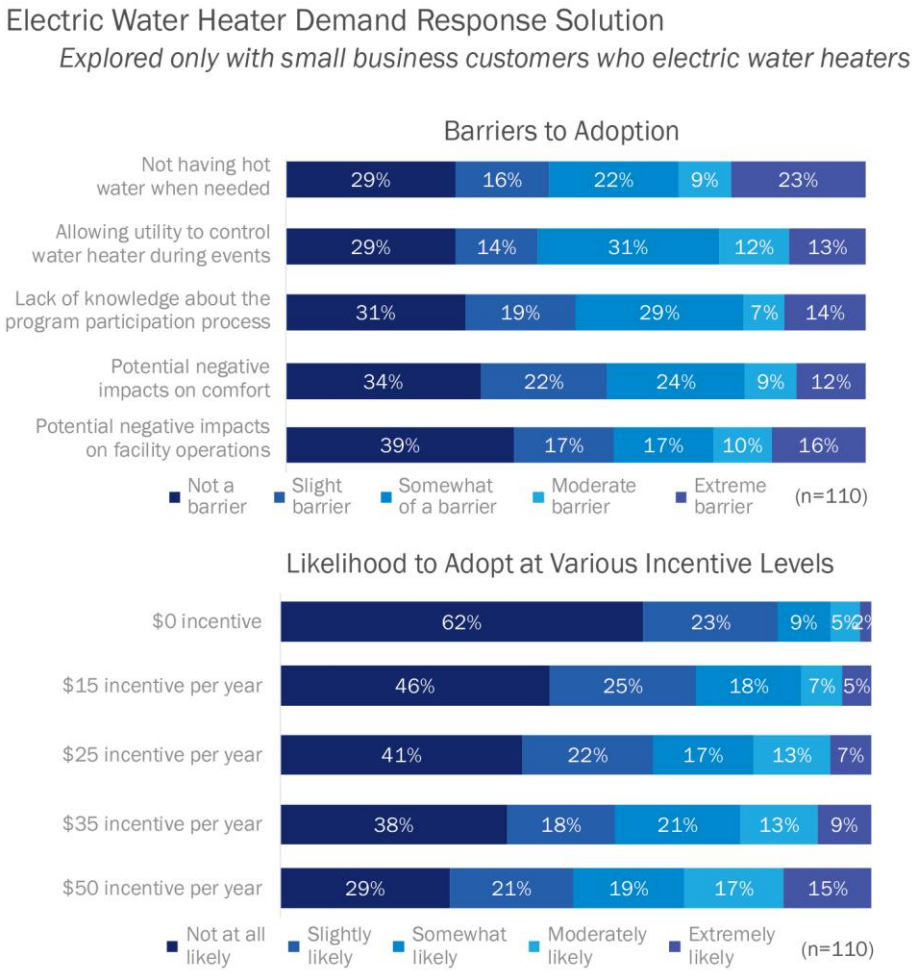
"Would lose business if people were uncomfortable, offsetting any incentive amount."

"Professional office, where need comfort"

"We lease the space - the units and incentive program would be by the owner of the strip mall property"

25% would consider participating only if incentives were substantially higher ($100+)

Figure 5-5. Business DR Program – Electric Water Heater DR Solution



13% would consider participating if the incentive were between 100 and 200 and 14% if the incentive were $200 and over.

19% would not participate no matter the incentive.

Reasons for non-participation include…

"Our corporation and health code requires us to have hot water at all times for hand washing and dish washing."

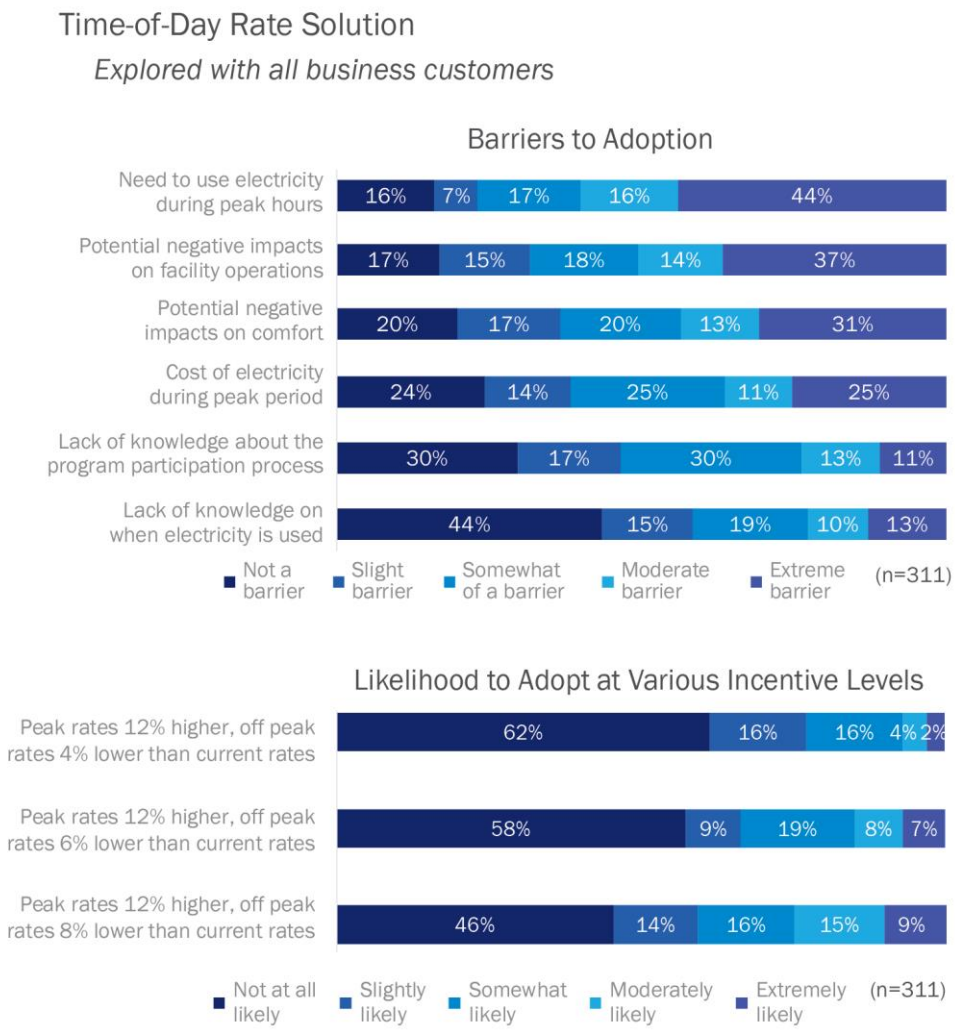
"Not big enough incentives for inconvenience of not having hot water on demand"

"Very small volume of hot water used daily, > 4 gallons."

"In a salon we need hot water at all times, we just can't shut off."

27% would consider participating only if incentives were substantially higher ($100+)

Figure 5-6. Business DR Program – Time-of-Day Rate Solution



34% would not participate no matter the incentive.

Reasons for non-participation include...

"The labor force would be extremely resistant to working off-peak hours in with a substantial incentive that we would not be able to afford."

"Peak hours is when we do most of our business and customer comfort is of top priority."

"Because the peak rates are too high."

"Because we are not here during off-peak hours."

10% would consider participating if off peak rates were 10% to $20 percent lower and 7% will consider participating if rates were 25% to 50% lower

5.3.2 Event Season Performance

Demand Savings

The Business DR Program achieved 22.39 MW in average demand savings during the PY2019 event season. PY2019 was a milder than normal summer, and participating facilities, based on Enel X's feedback, were new to the DR Program participation process. Furthermore, lack of interval data prevented a more precise development of nominated capacities for program participants. The load reduction of 22.39 MW represents 60% of the total nominated capacity from customers, among whom the events were called (Table 5-10). Participant performance during the August test event was stronger than during the September test event. Opinion Dynamics calculated event performance matches Enel X's calculations of event performance.

Table 5-10. Business DR Program – Event Performance Summary – Demand Savings

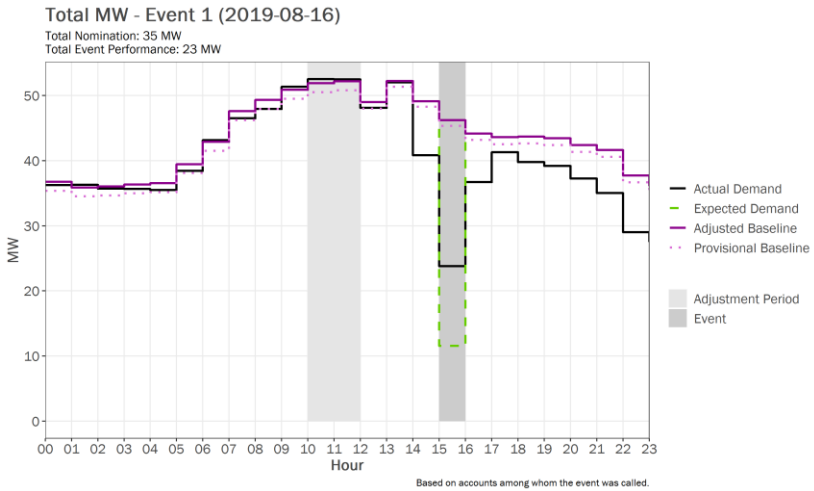
Event	Event Date	Time	Participating Accounts*	Total Nominated Capacity (MW)	Event Season Performance (MW)	Share of Nominated Capacity Achieved	Average Per Account Performance (kW)
1	August 16, 2019	3-4 pm CST	50	35.03	22.67	65%	453
2	September 25, 2019	3-4 pm CST	53	37.06	22.34	60%	422
Overall Event Season Result				**37.06**	**22.39**	**60%**	**422**

*Accounts among which the event was called.

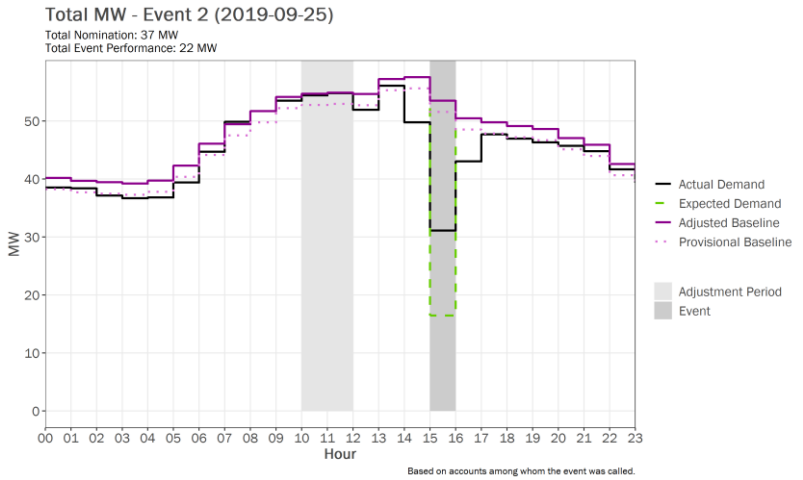
Figure 5-7 provides, for each event, detailed plots of total and average per-account actual demand on the event day, the provisional and adjusted baseline demand, and calculated baseline.

Figure 5-7. Business DR Program – Total and Per Account Performance

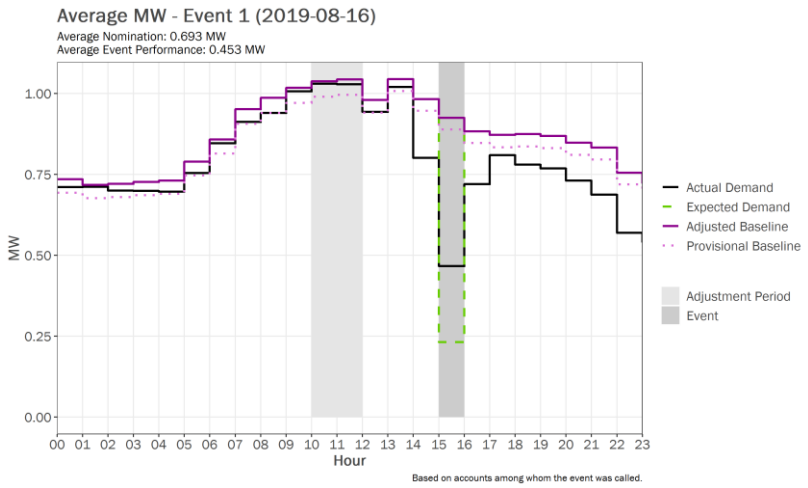
Event 1 (August 16, 2019) Total MW Performance



Event 2 (September 25, 2019) Total MW Performance



Event 1 (August 16, 2019) Average Per Account MW Performance



Event 2 (September 25, 2019) Average Per Account MW Performance

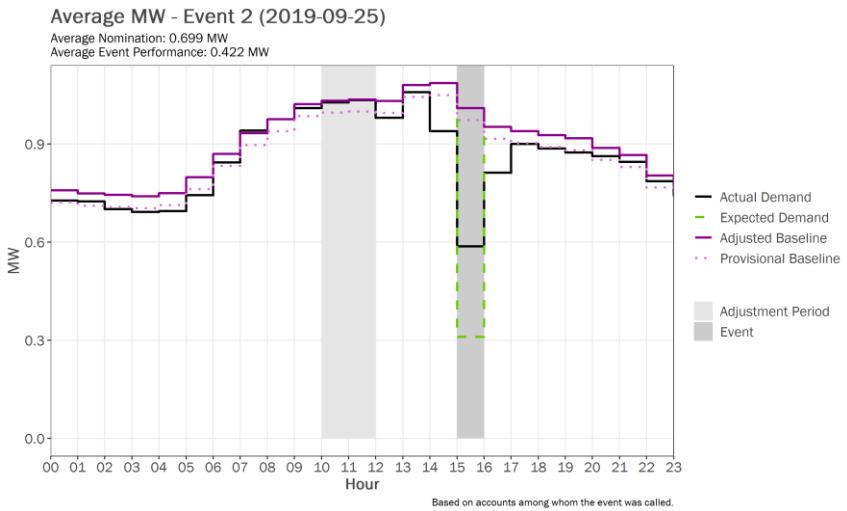
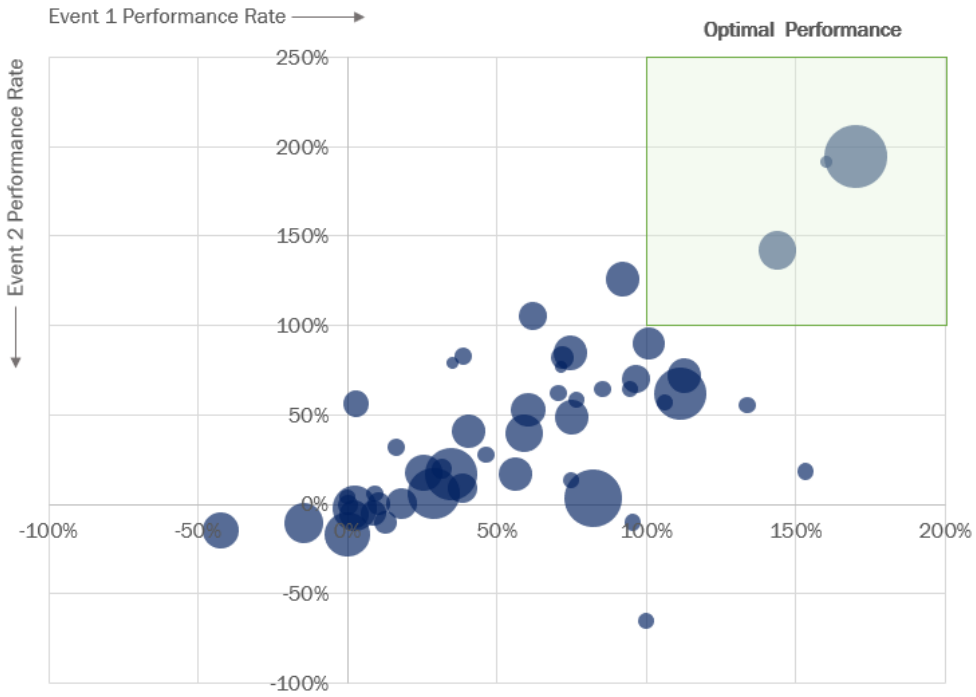


Figure 5-8 shows the distribution of performance rates for each event. The performance rate for the August 16 event is plotted along the X-axis, while the performance rate for the September 25 event is plotted along the Y-axis. The size of the bubbles represents the size of the nominated capacity for each account. The green square in the upper right corner of the graph represents the area of 100% or higher performance rate across both events. Bubbles located under the X-axis and to the left of the Y-axis represent accounts that increased load during one or both events.

Overall, 9% of all accounts met or exceeded the nominated capacity goal across both events (realization rate of 100% or higher). An additional 17% met or exceeded the nominated capacity goal in one event but came under in the other. Three quarters (74%) of all event season participating accounts did not meet the nominated capacity value in either event and had varying performance rates across the two events. Notably, four accounts (8%) increased load during the event hours as compared to the baseline, and for an additional four accounts, (8%) load during the event period remained unchanged as compared to the baseline.

Further analysis of event performance shows that performance varied across participating accounts and was inconsistent for most accounts across the two events, with some accounts performing well in the August 16 event but underperforming considerably in the September 25 event, some doing the opposite, and some underperforming across both events with considerable variation in performance rates across the two events.

Figure 5-8. Business DR Program – Distribution of Difference in Event Performance Compared to Nominated Capacity



Further exploration of performance rate by industry segment shows a lack of consistent performance by segment and variability of within-segment performance.

Opinion Dynamics reviewed average participant demand during the baseline days associated with the two test events[39]. They compared it to the nominated capacity set by Enel X. On average, nominated capacity

[39] We used the high four of five approach to baseline day selection, consistent with our impact approach.

represents 80% of the baseline load[40] during the event hours, reflecting a substantial portion of demand in any given day. For 26 out of 53 accounts (49%), nominated capacity represented 75% of baseline load or more, and for 20 accounts (38%) nominated capacity represented 100% of the baseline load or more. As referenced before, Enel X reported purposefully setting nominated capacity values at more ambitious levels, as not to restrict participants, should they choose to pursue more aggressive performance in the DR events. Enel X reported accounting for these more ambitious goals by enrolling additional capacity in the program.

Following the PY2019 event season and recognizing lower than planned event performance, Enel X adjusted nominated capacity values downward for close to half of the accounts (45%). Nominated capacity values were adjusted by 26% on average. Adjustments varied between 9% and 75% for any given account. Across all accounts participating in the event season, Enel X reduced nominated capacity from 37.1 MW to 30.8 MW for those accounts enrolled for the 2020 event season. However, comparing the adjusted nomination to the baseline load during the event hours, 32% of participating accounts will still need to reduce their load by 100% or more in a given event. For the 23 accounts with an adjusted nominated capacity of 75% or more of their baseline load, five (22%) achieved 90% or higher performance rate during the August 1 more in the first event, and two (9%) were able to do so in the second. On average, however, these customers had a performance rate of 56% across both events. Accounting for this is important when monitoring the program's progress toward 2020 MW goals to ensure enough nominated capacity to meet the goals.

Table 5-11. Business DR Program – Nominated Capacity to Baseline Load Relationship

Nominated Capacity as % of Baseline Load	Original Nomination		Adjusted Nomination	
	Number of Accounts	% of Accounts	Number of Accounts	% of Accounts
Less than 50%	13	25%	18	34%
50% to less than 75%	14	26%	12	23%
75%-less than 100%	6	11%	6	11%
100% and more	20	38%	17	32%
Total	**53**	**100%**	**53**	**100%**

Energy Savings

Achieving energy savings during demand response events was not the primary goal of the Business DR Program. As a result of the two test events, participants decreased consumption by a total of 94.14 MWh. The energy savings fell short of the target of 500 MWh and represent 19% of the MEEIA III goal (Table 5-12).

Table 5-12. Business DR Program – Event Season Energy Savings Comparison to MEEIA III Goal

Event	MEEIA III Goal (MWh)	Event Season Energy Savings (MWh)	Percent of Goal
Event 1 (August 16, 2019)		57.94	
Event 2 (September 25, 2019)		36.20	
Total	**500.00**	**94.14**	**19%**

The average per account energy savings was 0.91 MWh and represented 4.4% of the baseline load (Table 5-13).

[40] Opinion Dynamics used average adjusted baseline load for the purposes of this analysis.

Table 5-13. Business DR Program – Event Performance Summary – Energy Savings

Event	Date	Time	Participating Accounts	Total Energy Savings (MWh)	Average Per Account Energy Savings (MWh)	Percent of Savings
1	August 16, 2019	3-4 pm CST	50	57.94	1.16	5.7%
2	September 25, 2019	3-4 pm CST	53	36.20	0.68	3.2%
Overall Event Season Result				**94.14**	**0.90**	**4.4%**

5.3.3 Resource Capability Estimate

Table 5-14 presents resource capability estimates. These estimates reflect what Ameren Missouri can expect to achieve during a typical weather year and reflects available capacity from all accounts enrolled in the PY2019 event season.

For accounts participating in the event season, resource capability represents a sum of their average event performance during the season. For accounts untested during the event season (e.g., had not enrolled until after the summer event season), resource capability represents their nominated capacity adjusted by the event season performance rate across accounts that participated in the event season. We included all accounts enrolled as of the end of PY2019 and their respective nominated capacity values in the calculation of the resource capability value. We did not weather normalize resource capability given that we tested weather sensitivity of the participating accounts and found little to no correlation of load to weather. Total estimated resource capability is 49,99 MW, representing 64% of the adjusted nominated capacity of the accounts enrolled as of the end of PY2019. It is important to note that, given the differences between accounts participating in the PY2019 event season and accounts enrolled after season-end, both in terms of industry as well as nominated capacity values[41], applying the PY2019 event season performance rate to the untested accounts presents an area of uncertainty in terms of how representative the performance rate is of the future performance of the untested accounts. This is a limitation that Ameren Missouri needs to consider when interpreting the results.

Table 5-14. Business DR Program – 2020 Resource Capability Estimate

Metric	Result
Total accounts enrolled as of the end of 2019	149
Adjusted nominated capacity (MW)*	77.90
PY2019 resource capability estimate (MW)	49.99
PY2019 per-account resource capability estimate (kW)	520.70

*Reflects adjustments made by Enel X post-event season.

Looking ahead to PY2020, the Business DR Program has a resource capability of 49.99 MW, which represents nearly 100% of the total PY2020 MEEIA III goal. With this enrollment to-date, Enel X is well-positioned to meet or exceed the PY2020 demand response target. Based on Enel X's program staff feedback, as the program

[41] Participants enrolled post PY2019 event season were more diverse in terms of the business segments and included untested in PY2019 segments, such as media and entertainment, government, and other. Average nominated capacity of the participants enrolled post PY2019 season is considerably lower than that of PY2019 event season participants.

size increases in terms of enrolled accounts, the ability to spread and minimize the risk of underperformance becomes greater, as the program now can rely on more accounts to deliver the anticipated load reductions.

Notably, there has been a shift in the business sectors enrolled after the end of the PY2019 event season. This represents an additional area of uncertainty in terms of the PY2020 performance. Interviews with Enel X staff suggest, however, a much more predictable performance from the newly enrolled customers. Based on Enel X's feedback, a lot of those customers represent corporate entities with a long history of experience participating in the DR Programs not only across the United States but the world. As a result, those customers have both the knowledge of their business operation and technology (EMS, remote control systems) to ensure reliable and predictable performance in DR events. Those customers are also weather-sensitive, which means ability to deliver load reduction during the event season.

Table 5-15. Business DR Program – Comparison of Resource Capability to Goal

Metric	Result
2019 resource capability estimate (MW)	49.99
PY2019 MEEIA III goal (MW)	25.00
Percent of PY2019 goal	200%

5.3.4 Cumulative DR Capability Estimate

Table 5-16 presents the PY2019 cumulative DR capability. The value in the table represents demand impacts from tested accounts, either during the PY2019 event season or during the December test event. Cumulative DR capability represents a performance metric for the earnings opportunity award for the DR programs. The programs cumulative DR capability is 33.10 MW and represents 132% of the target.

Table 5-16. Business DR Program – Comparison of Cumulative DR Capability to Target

Metric	Result
PY2019 cumulative DR capability (MW)	33.10
PY2019 target	25.00
Percent of PY2019 target	132%

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