Opinion Dynamics

Boston | Headquarters

617 492 1400 tel
617 497 7944 fax
800 966 1254 toll free

1000 Winter St
Waltham, MA 02451

Ameren Missouri Program Year 2020 Annual EM&V Report

Volume 4: Demand Response Portfolio Report

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Opinion Dynamics

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1. Glossary of Terms Acronyms and Abbreviations

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

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.

Dispatch platform – a software solution comprised of a set of algorithms designed to modify smart thermostat setpoints to achieve load reductions.

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.

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

Marketplace – program enrollment 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 by the Program Aggregator.

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.

Systemwide event – a dispatch of participants in a program wherein all participants receive an event signal.

2. Executive Summary

This volume of the PY2020 Annual Report presents evaluation results from the Ameren Missouri PY2020 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 PY2020 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 and planned to incorporate energy efficiency (EE) savings within the design strategy through smart thermostat optimization. In 2019, Ameren Missouri launched two DR Programs, which are now in their second year of operation:

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

This evaluation summarizes key lessons learned regarding data capture, program participation, and program impacts. Evaluation activities in PY2020 focused on the assessment of program impacts, including event season demand and energy savings impacts, as well as resource capability, which is the degree to which Ameren Missouri can reliably capture demand impacts in PY2021 based on a forecast of program enrollment and demand impacts estimated in PY2020. Process-related research activities in PY2020 were limited to a review of program materials, analysis of participation and device telemetry data, and interviews with program staff and implementation contractors. The evaluation team also leveraged limited insights from the participant survey conducted by Uplight as part of the Residential DR program administration in PY2019 and PY2020 as well as from Ameren Missouri residential customer segment assignments.

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

- Section 3 presents the general evaluation approach for the demand response programs, including overarching evaluation objectives and an overview of the PY2020 evaluation activities and methodologies.
- Section 4 and 5 present evaluation results and detailed methods for the Residential and Business DR programs, respectively.

2.1 Portfolio Summary

The DR portfolio is comprised of two programs: one residential and one commercial. For the residential program, Ameren Missouri continued to work with a team of partners to capture demand and energy benefits. The Residential DR Program was 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 PY2020 include ecobee®, Nest®, and Emerson™ devices.[1] 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. While the program was originally designed as an integrated

[1] All product or company names that may be mentioned in this publication are tradenames, trademarks or registered trademarks of their respective owners.

program aiming to deliver energy savings using optimization strategies alongside demand reductions, the program's pursuit of energy optimization savings in PY2020 was limited by wide deployment of energy optimization algorithms by two major manufacturers (Nest and ecobee). The program therefore focused its efforts on demand reductions and associated event day energy savings.

In addition to the Residential DR Program, Ameren Missouri continued offering 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 1 provides a summary of the DR portfolio program designs.

Figure 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
Program Interventions	DR events	DR events via custom load curtailment strategies
Eligible measures	Nest, ecobee and Emerson smart thermostats	Measure agnostic
Number of 2020 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: For the Business DR program, in addition to the two one-hour test events dispatched during the event season, two additional test events were dispatched in December 2020.

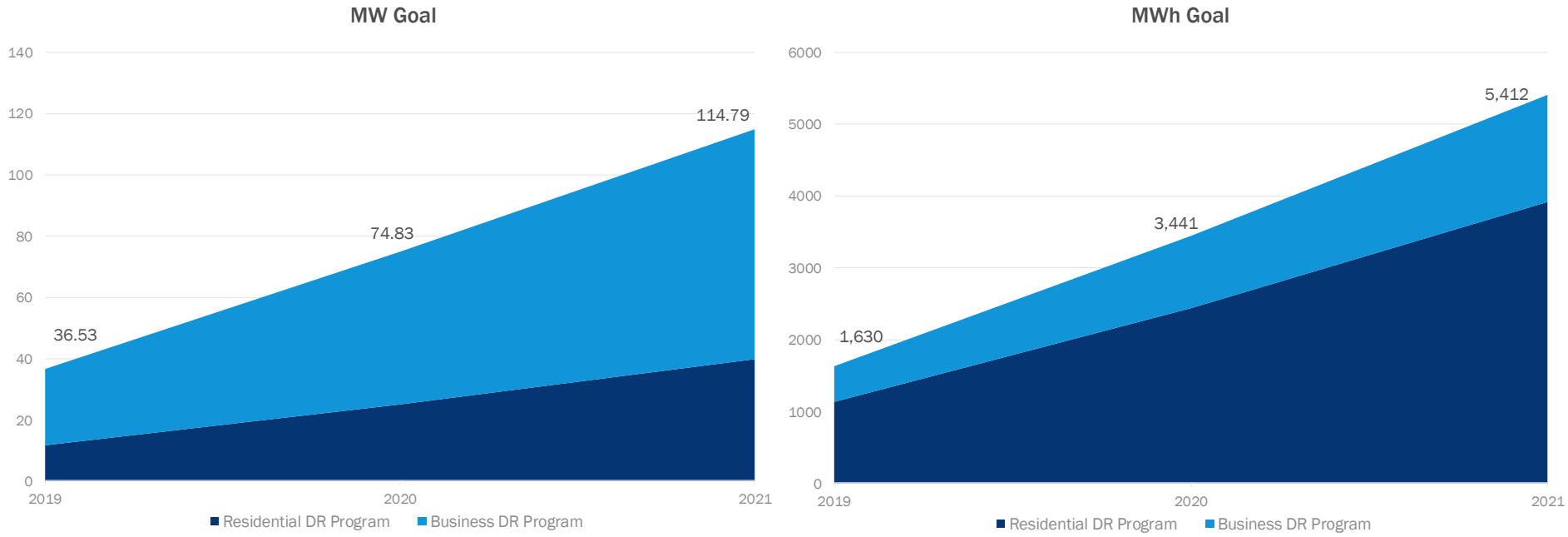
The DR portfolio MEEIA III demand reduction and energy savings goals for the three-year cycle aim to achieve 114.79 MW in demand savings and 5,412 MWh in energy savings across the Residential and Business DR Programs. The Business DR Program is expected to contribute the majority of the portfolio's demand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

Table 1. Incremental and Cumulative MEEIA Goals

Program Year	Residential DR Program		Business DR Program		DR Portfolio	
	Incremental Goal	Cumulative Goal	Incremental Goal	Cumulative Goal	Incremental Goal	Cumulative Goal
Participation Goal (Customers)						
PY2019	6,533	6,533	50	50	6,583	6,583
PY2020	7,905	14,438	50	100	7,955	14,538
PY2021	9,206	23,644	50	150	9,256	23,794
Total	**23,644**	**23,644**	**150**	**150**	**23,794**	**23,794**
Demand Savings Goal (MW)						
PY2019	11.50	11.50	25.00	25.00	36.50	36.50
PY2020	13.33	24.83	25.00	50.00	38.33	74.83
PY2021	14.96	39.79	25.00	75.00	39.96	114.79
Total	**40**	**40**	**75.00**	**75.00**	**114.79**	**114.79**
Energy Savings Goal (MWh)						
PY2019	1,130	1,130	500	500	1,630	1,630
PY2020	1,311	2,441	500	1,000	1,811	3,441
PY2021	1,471	3,912	500	1,500	1,971	5,412
Total	**3,912**	**3,912**	**1,500**	**1,500**	**5,412**	**5,412**

Figure 2 summarizes cumulative DR portfolio goals. Throughout the remainder of this report, we assess the programs' performance against MEEIA cumulative PY2020 goals.

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



2.2 Portfolio Impact Results

At the end of the PY2020 event season, the demand response portfolio achieved 71.09 MW in average load reduction as well as 475.02 MWH in energy savings (Table 2). Milder than normal temperatures during the PY2020 event season, the effects of the COVID-19 pandemic on business customer load and ability to perform in events, and challenges associated with event dispatches for certain thermostat manufacturers on the Residential DR side were the key driving factors behind the savings.

Table 2. PY2020 Event Season Performance Summary

Program	Participants[a]	Event Season MW Performance	Event Season MWH Performance[b]
Residential DR Program	13,041	17.40	94.75
Business DR Program	279	53.69	380.27
Total DR Portfolio	**13,320**	**71.09**	**475.02**

[a] Participant count for the Residential DR program represents the average number of participants among whom events were dispatched.
[b] Energy savings for the Business DR program only include event season events.

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 assumptions. Figure 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 74.83 MW by 9.27 MW for a total of 84.10 MW, achieving 112% of the goal, but fell considerably short of the energy savings goals, achieving 495.43 MWH of the 3,411 MWH (14%).[2]

Figure 3. DR Portfolio Performance Against MEEIA III Cumulative Goals

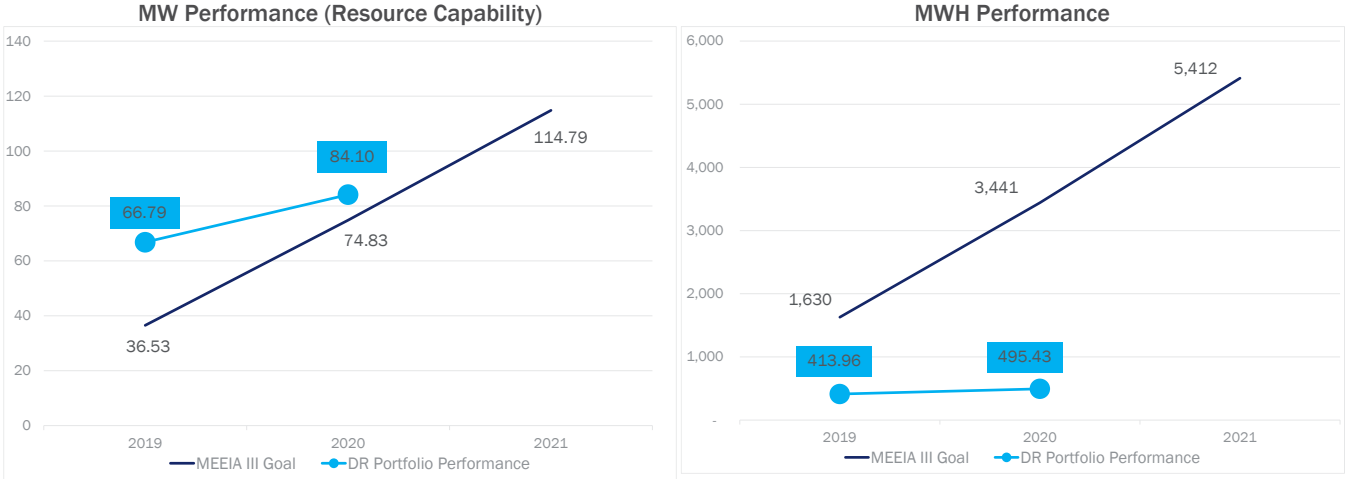


Table 3 provides a detailed summary of each program's performance against MEEIA III goals, including participation goals. As can be seen in the table, both programs exceeded goals in terms of customer enrollment. As of the end of PY2020, the Residential DR Program achieved 172% of its enrollment goal, while the Business DR program achieved 285% of the enrollment goal. From a resource capability perspective, both

[2] Energy savings for the Business DR program include savings from the two December test events in addition to the event season events.

programs had a strong performance, which positions them well for the years ahead. More specifically, the Residential DR Program achieved 28.74 MW and 116% of its goal, while the Business DR Program achieved 55.36 MW and 111% of its goal. Both programs underperformed against the energy savings goal (4% and 40% for the Residential and Business DR programs, respectively). Energy savings for the Residential DR program are calculated based on event day impacts during the event season. Energy savings for the Business DR program include savings achieved during the two December test events, in addition to the savings achieved during the two events called during the event season. Across the portfolio, lower than planned energy savings are due to fewer than expected events dispatched in PY2020 due to milder than normal weather. For the Residential DR Program specifically, energy savings were primarily impacted by inability to dispatch program-driven energy optimization algorithms.

Table 3. DR Portfolio Performance Against MEEIA III

Program	Cumulative 2020 MEEIA III Goal	PY2020 Performance	Goal Achieved (%)
Participation as of the End of PY2020 (Participants)			
Residential DR Program	14,438	24,835	172%
Business DR Program	100	285	285%
Total DR Portfolio	**14,538**	**25,120**	**173%**
Resource Capability (MW)			
Residential DR Program	24.83	28.74	116%
Business DR Program	50.00	55.36	111%
Total DR Portfolio	**74.83**	**84.10**	**112%**
Energy Savings (MWH)			
Residential DR Program	2,441	94.75	4%
Business DR Program[a]	1,000	400.68	40%
Total DR Portfolio	**3,441**	**495.43**	**14%**

[a] Includes energy savings achieved during the two December test events.

In addition to the event season performance and resource capability performance, we also calculated cumulative DR capability (Table 4). 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. For the Business DR Program, however, per the MEEIA III Plan,[3] 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.[4] In PY2020, all Business DR participating customers were tested as part of either summer events or events dispatched in the winter. Therefore, cumulative DR capability is equal to the resource capability.

Table 4. DR Portfolio Summary of Cumulative DR Capability Estimated Impacts by Program

Program	Target (MW)	PY2020 Performance (MW)	% of Target Achieved
Residential DR Program	24.83	28.74	116%
Business DR Program	50.00	55.36	111%
Total DR Portfolio	**74.83**	**84.10**	**112%**

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

2.3 Portfolio Process Findings and Recommendations

In PY2020, the second year of operation for Ameren Missouri's demand response portfolio, Ameren Missouri continued to work with an array of implementation partners across both programs, including Enel X, Franklin Energy, and Uplight. Ameren Missouri offered a Residential DR Program that balanced smart thermostats, market channels, and intervention strategies, as well as a Business DR Program designed to bid into the Midcontinent Independent System Operator, Inc. (MISO) market.

The DR 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. While the Business DR program ran smoothly with little changing in the way of program implementation and event dispatch, the Residential DR program encountered several unexpected challenges related to changes in dispatch platforms.

Looking forward, Ameren Missouri should continue to focus on continued engagement of enrolled participants as well as targeted enrollment of future participants to balance performance against 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, encouraging desired behaviors, and 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 conclusions and recommendations:

Residential DR Program

- **Conclusion 1:** The Residential DR program succeeded in successfully enrolling significantly more customers than planned. Program demand planning assumptions remained considerably higher than what the program delivered in PY2020, both in terms of actual as well as weather-normalized demand savings. Moving forward, the program will either need to continue enrolling more participants than planned or achieve greater per-device impacts to meet demand impact goals. Enrollment of additional devices to achieve goals will likely carry higher cost for the program.
  - Recommendation 1: Program staff should continue to balance participant enrollment targets with consideration of both resource capability and event season demand impacts to optimize the program's performance against the demand goal.
- **Conclusion 2:** The Residential DR Program fell short of the MEEIA III energy savings goals and likely faces considerable shortfalls in the future. The shortfall in energy savings in PY2020 was primarily due to ecobee and Nest opening their optimization platforms to all device owners, which limited the program's ability to harvest additional savings via optimization driven interventions. The shortfall was also in part driven by a limited number of events dispatched in PY2020.
  - Recommendation 2: Program staff should consider a two-pronged approach to achieving additional energy savings in PY2021. For Emerson device owners, program staff should consider offering OE optimization. For Nest and ecobee owners, program staff could consider tailored messaging aimed at and encouraging more participants to enroll in Seasonal Savings and eco+, respectively. For eco+ specifically, program staff could further tailor messaging to encourage selection of more aggressive optimization algorithms. Should the program pursue the latter set of recommendations, discussion of the appropriate evaluation approach to

capture program attributable changes in energy consumption should occur prior to messaging launch in order to ensure the evaluability of these interventions.

- **Conclusion 3:** The program de-enrollment rate of 7% over two years signals sustained participation and participant satisfaction. Data limitations preclude the evaluation team from determining drivers for de-enrollment (e.g., relocation vs. participant experiences). The number of events dispatched and participant comfort level during the events are typically the driving factors behind participant experience and satisfaction. Both PY2019 and PY2020 had milder than normal summer temperatures which resulted in the minimal number of events dispatched. The de-enrollment rate could increase under hotter summer temperatures and more events.

  - Recommendation 3: Program staff should consistently track de-enrollments reasons to better understand de-enrollment drivers. As part of the planning efforts, program staff should also consider the risks associated with increased de-enrollment rates under hotter event season and increased number of events and plan for that accordingly.

- **Conclusion 4:** This evaluation highlighted differences in participant composition across Ameren Missouri customer segments, enrollment channels, and device manufacturers as well as participant engagement with the program. These insights can offer additional strategies for calibrating successful program enrollment, de-enrollment, and impacts. For instance, insight into differences in Marketplace enrollment rates for each manufacturer can inform targeted messaging to decrease de-enrollment. Varying manufacturer demand savings performance can help effectively plan for anticipated impacts in case of changing manufacturer mix. Understanding of participant population across Ameren Missouri customer segments can offer opportunities to tailor program messaging depending on the segments of interest.

  - Recommendation 4: Data-driven insights can help the Program calibrate enrollment with performance expectations thus positioning the program for continued success.

- **Conclusion 5:** The current Residential DR Program participants are likely to be comprised of early adopters. As smart thermostat adoption enters the mainstream market, the Residential DR Program participant composition may change, with potential implications on energy consumption patterns associated with the size of the home, size and vintage of the HVAC system, as well as participant presence at home during various times of the day. This changing participant composition may lead to changes in future program engagement, and associated demand savings opportunities.

  - Recommendation 5: As the program matures, we recommend that program staff identify factors driving program performance, for example, 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:** The evaluation team identified a number of inconsistencies and limitations in the available data that limited the ability to match participants with telemetry and usage data. This necessitated changes in the evaluation approach. 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. Data issues also resulted in a more labor-intensive evaluation process.

- Recommendation 6: Ameren Missouri and program staff should consider revisiting the data tracking processes and data pipelines in conjunction with the evaluation team to ensure sufficiently detailed and consistently tracked data across core input fields. This will ensure more rigorous, accurate, and cost-effective evaluation efforts.

Business DR Program

- **Conclusion 1:** The Business DR program exceeded its MEEIA III participation and demand savings goals and is well-positioned for continued success. The Business DR program fell short of the MEEIA III energy savings goal. The key driver behind the shortfall is a dispatch of a limited number of events in PY2020. According to Enel X, future program participants are likely to be smaller in terms of their nominated capacity, which will require enrollment of more participants for the program to meet its goals.
  - Recommendation 1: Program staff should balance participant enrollment with the size of their nominations and uncertainty surrounding their performance.
- **Conclusion 2:** Program de-enrollment affects large participants presenting a risk for program performance.
  - Recommendation 2: Program staff should explore reasons for de-enrollment to mitigate de-enrollment moving forward. Program staff should factor de-enrollment in its planning efforts.
- **Conclusion 3:** COVID-19 impacted Business DR program enrollment and performance in PY2020 and will likely continue to impact the program in PY2021. COVID-19 impacted different customers differently, leading to load increase among some and significant load decrease among others.
  - Recommendation 3: Program staff should continue to aggressively pursue new participants and deploy a custom approach when assessing the likely impact of the COVID-19 pandemic on participant performance, taking into account participant past performance, tenure with the program, and business segment.
- **Conclusion 4:** Availability of interval data for some accounts resulted in inability to calculate event performance based on the actual customer behaviors and resulted in the need for data imputations.
  - Recommendation 4: As customer enrollment continues to grow in PY2021, Enel X and Ameren Missouri should consider continued collaboration to ensure timely communication around participant enrollment and meter upgrades.

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 cost-effectiveness tests recommended by the California Standard Practice Manual and used in prior evaluations:[5]

- **Total Resource Cost (TRC) Test:** Perspective of all utility customers (participants and non-participants) 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 non-participating ratepayers overall;
- **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 5 summarizes the cost-effectiveness results for both DR programs. Both programs screen cost-effective under the TRC test, the UCT, and the RIM test. The PCT is not applicable to DR programs because there is no cost to the participants.

Table 5. Summary of Demand Response Cost-Effectiveness Results

Program	TRC	UCT	RIM	PCT
Residential Demand Response [A]	2.13	2.13	1.93	n/a
Business Demand Response [A]	1.60	1.60	1.54	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.

[5] California Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects. October 2001.
[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 approach for the Ameren Missouri PY2020 portfolio of DR 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. The research objectives generally applied to both DR programs. The remainder of this chapter discusses the research objectives common to the two 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 DR 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 PY2020 DR portfolio evaluations are described in greater detail below.

3.1.1 Process Objectives

Process-related activities were limited in PY2020 and focused on targeted mining of telemetry, interval, customer, and participation data streams to address the following key process evaluation objectives:

- Understand participant composition and changes to it over time;
- Assess participant enrollment and de-enrollment behaviors;
- Understand impacts of the COVID-19 pandemic on participant load and ability to perform in events;
- Identify opportunities for improvement; and
- Provide evaluation results that can be used to improve the design and implementation of the Program.

3.1.2 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. Research objectives for this effort include:

- Estimate ex post demand response event impacts;
- Estimate resource capability impacts; and
- Estimate event energy savings.

3.1.3 Cost-Effectiveness Objectives

Cost-effectiveness objectives include:

- Assess the cost-effectiveness of each DR program and the DR portfolio as a whole using industry-standard cost-effectiveness tests.
- Ensure alignment of cost-effectiveness testing assumptions and parameters with the PY2020 DR 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.

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

SCR mandated research objectives include providing responses to the following requirements:

- 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 6 shows the research activities included in each of the evaluations. Program-specific details are included in each program chapter where relevant.

Table 6. 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	-	-
Participant In-Depth Interviews	-	-
Market Partner Survey	-	-
Trade Ally/Service Provider In-Depth Interviews	-	-
Participating Developer & Designer Interviews	-	-
Gross Impact Analysis		

Research Activity	Residential DR Program	Business DR Program
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	-	-

3.2.1 Program Manager and Implementer Interviews

To support evaluation planning, we gathered feedback from program implementation staff over the course of PY2020. We explored details of the design and planned implementation for each program, ongoing changes in design, marketing, targeting, and event dispatch occurring over the course of the year, as well as program staff's feedback on programs' performance and evaluation priorities.

The Evaluation Team conducted focused interviews with program and implementation staff at the end of PY2020 with the focus on overall assessment of the PY2020 processes and plans for programmatic changes in PY2021.

3.2.2 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 evaluation team with details of program design and implementation.

3.2.3 Tracking System Review

In the spring of 2020, the evaluation team revisited program tracking, telemetry, and interval data systems and provision processes across Ameren Missouri, Franklin Energy, Uplight, Nest, ecobee, Emerson, as well as Enel X. The goals in doing so were to (1) capitalize upon lessons learned throughout the PY2019 evaluation, (2) ensure that the data extracts and the frequency of data provision aligned with evaluation goals and timelines, and (3) ensure the data extracts contained the necessary data to complete our evaluation accurately.

3.2.4 Gross Impact Analysis

The PY2020 impact analyses for the Ameren Missouri demand response programs included review of the program-tracking database, statistical analysis, and customer baseline (CBL) approach. Our team estimated energy and demand impacts associated with demand response events (i.e., event day impacts), which we outline below.

Key objectives of the PY2020 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 PY2020.

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 used 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. We used the following steps to complete our statistical analysis of the Residential DR Program:

- Select proxy days to represent counterfactual energy behavior on non-event days that are similar to event days in weather profiles;
- Assess event participation, including device assignment to control group, failures, and opt-outs;
- Conduct event regression modeling to estimate hourly and average event kW and kWh impacts; and
- Assess average event kW impacts under normalized weather conditions for all participants enrolled in PY2020.

For the Business DR Program, we verified event performance using the contractually 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. We outline the steps we used below:

- 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 as well as winter test events.
- Assess average event kW impacts under all participants enrolled and tested in PY2020.

Event Day Energy 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 energy 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.

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 PY2020.

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. Additionally, the calculation reflected event-season impacts normalized to Ameren Missouri system peak weather and extrapolated to all participants enrolled as of the end of PY2020. 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 PY2020. 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 PY2020 but were not tested. As such, it can be lower than the resource capability.

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 by leveraging participant research, database review, impact analyses, and baseline research.

4. Residential Demand Response Program

This chapter summarizes the PY2020 evaluation methodology and results for the Residential Demand-Response (DR) Program, or Peak Time Savings Program.

4.1 Evaluation Summary

4.1.1 Program Description

The Residential DR Program was in its second year in PY2020. The program was designed to control 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 who either had or were ready to purchase an eligible smart thermostat and enroll in the program.[7] Qualifying smart thermostats in PY2020 included ecobee, Nest, and Emerson devices. 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.[8] Customers could enroll multiple 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, provided their active participation in events. The program was administered by Franklin Energy, responsible for customer acquisition and marketing, and delivered by Uplight. Uplight was responsible for event dispatch, overall program delivery and event-related 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. The focus of the program in PY2020 was on delivering demand impacts. Depending on device manufacturer, event dispatch platforms varied and as a result, so did participant notifications, precooling strategies, and event hour thermostat adjustment algorithms.

Program delivery in PY2020 included a randomized control trial design, wherein, for each event, devices were randomly assigned into treatment and control groups. Treatment group devices received event notifications and event signals, while control group devices did not. Control group sizes varied by manufacturer. The exception to this was a system reliability event, during which all devices received an event signal.

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

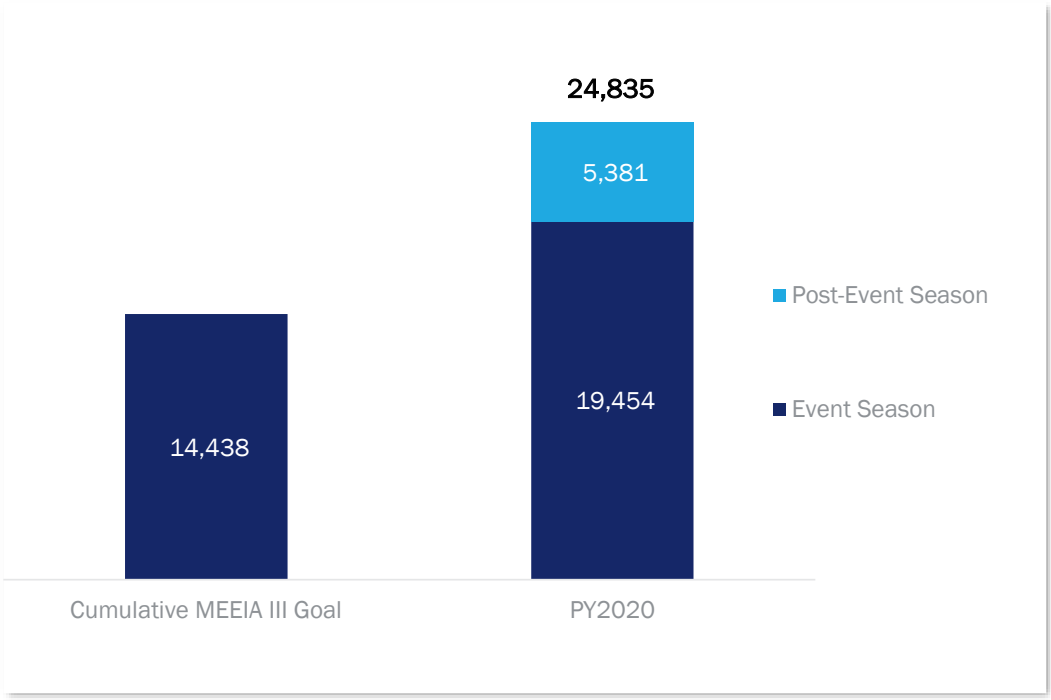
Program participation processes varied by the device manufacturer and channel, but generally included an eligibility check based on HVAC equipment, verification of customer account information, confirmation that enrolled customers are Ameren Missouri electric customers, and customer review and acceptance of terms and conditions. Nest and ecobee conducted equipment verification and initial enrollment prior to handing data to Uplight for final verification and enrollment, whereas Uplight conducted all verification and enrollment for Emerson devices. Uplight sent successful enrollments to Franklin Energy daily for official records and incentive payments.

[7] Including customers with heat pumps.
[8] Devices could be self-installed or professionally installed.

4.1.2 Participation Summary

Figure 4 presents participation in the Residential DR Program during PY2020 and compares participation against the MEEIA III participation goal. As can be seen in the figure, there were 24,835 active customers as of the end of the year, with 19,454 being enrolled before the end of the PY2020 event season and additional 5,381 customers enrolled between October and December 2020.[9] Active participation of 24,835 customers represents 172% of the MEEIA III cumulative participation goal.[10]

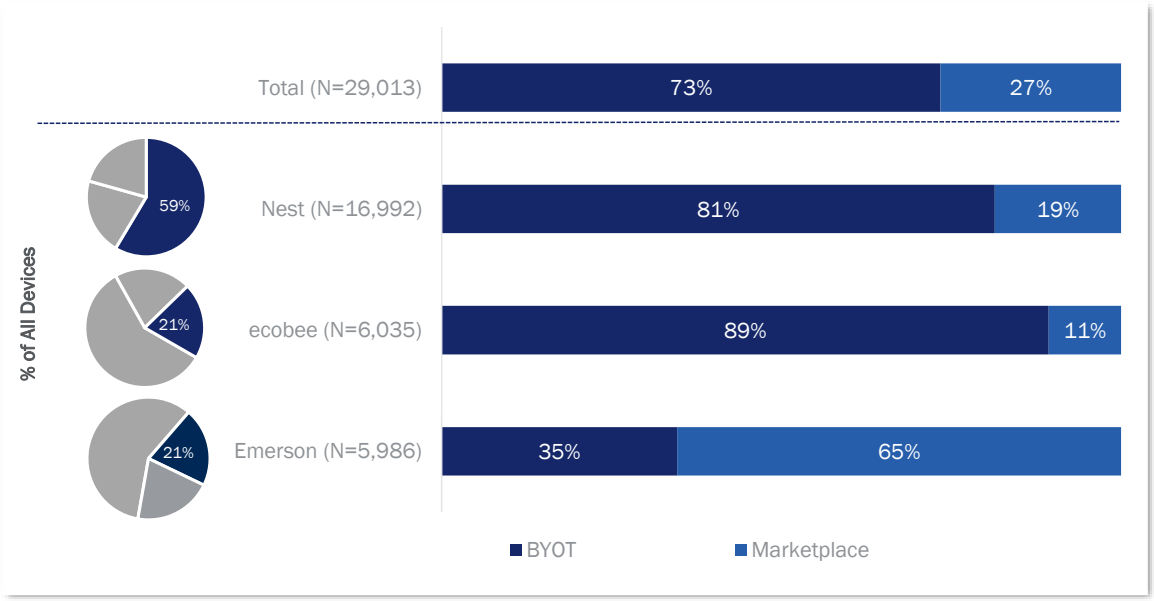
Figure 4. Residential DR Program: PY2020 Program Participation Summary (Customers)



Active participants had 29,013 devices enrolled and active in the program as of the end of PY2020, which represents 1.2 devices per household. Participating devices represented a mix of manufacturers and enrollment channels. More specifically, over half of participating devices (59%) were Nests, a fifth (21%) were ecobees, and the remaining fifth (21%) were Emersons. Overall, nearly three-quarters of all participating devices (73%) active in the program as of the end of PY2020 enrolled in the program via the BYOT channel, while the remainder entered the program via the Marketplace channel. Nest and ecobee devices were predominantly enrolled via the BYOT channel (81% and 89% respectively). Conversely, nearly two-thirds of Emersons (65%) entered the DR program via Ameren Missouri's Marketplace channel (Figure 5). This volume of enrollment via the Marketplace was driven primarily by a fall promotion where Ameren Missouri offered Emerson devices for free upon enrollment in the DR program.

[9] Includes customers enrolled in PY2019 who continue their participation but excludes customers who unenrolled from the program either in PY2019 or PY2020.
[10] MEEIA III incremental participation goal includes enrollment of 7,905 participants in PY2020. A total of 15,781 new participants were enrolled in the program in PY2020.

Figure 5. Residential DR Program: Device Distribution by Manufacturer and Enrollment Channel



4.1.3 Program Implementation Summary

Over the course of the event season, Ameren Missouri dispatched a total of four demand response events. Due to a mild summer in PY2020, no load-shaving events were triggered, and only test events were called, including one system reliability test event on August 26, 2020. Figure 6 documents event days and times alongside average temperature during the event dispatch hours.

Figure 6. Residential DR Program: Event Days with Average Maximum Temperatures and Event Hours

Depending on device manufacturer, events were dispatched using several platforms. Table 7 below details platforms that Uplight relied on to dispatch events in PY2020. Notably, Emerson devices received dispatch via two platforms for two out of four events. This dispatch approach was necessitated by device settings and the resulting responsiveness to the specific platform's dispatch signal. In PY2021, Uplight will rely on the Rush Hour Rewards (RHR) platform to dispatch events among Nest devices, eco+ platform for ecobee devices, and the Orchestrated Energy (OE) platform for Emerson devices.

Table 7. Residential DR Program: Event Dispatch Platforms

Device Manufacturer	Dispatch Platform Name	Platform Type	Events Deployed
Nest	Rush Hour Rewards (RHR)	Vendor DR platform	All events
ecobee	eco+	Vendor DR platform	All events
Emerson	Emerson DR platform	Vendor DR platform	Event 1, Event 2, Event 3
	Orchestrated Energy (OE)	Uplight DR platform	Event 2, Event 3, Event 4

The Residential DR Program was originally designed as an integrated demand response and energy efficiency program aimed at not only achieving demand reductions but also harvesting energy savings on non-event days. To that end, Uplight started running optimization of the ecobee devices using its OE platform at the beginning of the summer season (May 2019). Nest launched energy optimization using its Seasonal Savings platform in early August 2019. Uplight did not run optimization on Emerson devices during the PY2019 event season. In PY2020, ecobee made their energy optimization platform, eco+, broadly available to device owners, which eliminated Uplight's ability to offer its OE platform for ecobee devices as part of the program. In the summer of 2020, Nest made its Seasonal Savings platform available to a broad customer base, as opposed to just utility program participants. In light of these changes, Uplight could not deploy program-driven energy optimization algorithms on either Nest or ecobee devices. Uplight did not dispatch OE on Emersons in PY2020.

4.1.4 Key Impact Results

At the end of the event season, the Residential DR Program had 19,454 participants and achieved 17.40 MW in average demand savings (Table 8). Milder than normal temperatures during the event season, event dispatch challenges for Emerson devices, and a change in event dispatch platforms for ecobee devices were key contributing factors to program performance. The program also achieved 94.75 MWh in energy savings. While originally designed as an integrated DR and EE program, energy optimization was not a part of the programmatic intervention in PY2020 due to broad availability of eco+ optimization platform for ecobee devices and Seasonal Savings platform for Nest devices. This impacted the Program's ability to harvest additional energy savings.

Table 8. Residential DR Program: Summary of Event Season Performance

Metric	Performance
Participant count	19,454
Demand impact (MW)	17.40
Energy impact (MWH)	94.75

Table 9 presents the PY2020 resource capability estimate. Resource capability reflects the weather-normalized demand impacts applied to the population of devices enrolled as of the end of PY2020. As can be seen in the table, the program's resource capability estimate is 28.74 MW, which represents 116% of the PY2020 MEEIA III goal. Given these results, combined with participation enrollment achievements to-date, the program is well-positioned to achieve its PY2021 goal.

Table 9. Residential DR Program: Comparison of Resource Capability Impacts to Goal

Metric	MEEIA III Goal
Resource capability (MW)	28.74
PY2020 MEEIA III goal (MW)	24.83
Percent of PY2020 goal	116%

Table 10 presents the PY2020 cumulative DR capability. For the Residential DR Program for PY2020 cumulative DR capability is equivalent to the resource capability.

Table 10. Residential DR Program: Cumulative DR Capability

Metric	Result
Cumulative DR capability (MW)	28.74
PY2020 target (MW)	24.83
Percent of PY2020 target	116%

Nest devices comprised over half of all participating devices as of the end of PY2020 and accounted for the largest share of demand and energy impacts due to higher per-device savings as compared to the other two manufacturers. Figure 7 summarizes event season energy and demand impacts overall and by device manufacturer. As can be seen in the figure, per-device event season demand impacts were the highest Nest devices at 1.19 kW and lowest for ecobee devices at 0.91 kW. Emerson devices averaged 0.99 kW in per-device event season impacts. Changes in dispatch platform for Emersons from Vendor DR to OE partway through the event season resulted in the need to calibrate the OE platform to certain Emerson thermostat settings in order to effectively dispatch an event. While Uplight was performing the calibration, a subset of devices with problematic settings either did not receive the event signal or received a modified event signal for some events. This led to lower energy and demand savings for Emersons during the season compared to what could have been achieved with proper dispatch of the OE algorithms.

Figure 7. Residential DR Program: Summary of Program Impacts

		Nest	ecobee	Emerson	Total
Event Season Demand Impacts	Number of Events	4	4	4	4
	Average Number of Participating Devices*	11,337	2,578	1,320	15,235
	Per Device kW Impact	1.19	0.91	0.99	1.13
	Total MW Impact	13.66	2.41	1.32	17.40
	% of Cooling Load Reduced	69%	58%	59%	66%
Weather Normalized Resource Capability Estimates	Average Number of Participating Devices**	14,637	5,119	5,894	25,650
	Per Device kW Impact	1.19	0.91	1.13	1.12
	Total MW Impact	17.41	4.65	6.68	28.74
	% of Cooling Load Reduced	56%	53%	56%	56%
Event Day Energy Savings	Average Number of Participating Devices*	11,337	2,580	1,320	15,237
	Per Device kWh Impact	6.43	5.29	4.22	6.05
	Total MWh Impact	75.59	13.64	5.52	94.75
	% of Baseline Energy Usage Reduced	6%	6%	4%	6%

Note: Device counts for event season demand impacts only include devices among which the event was dispatched, as opposed to all devices enrolled and active in the program as of the day of event dispatch.

Note: Device counts for weather normalized resource capability estimates only includes devices among which the event is anticipated to be dispatched as opposed to all devices enrolled and active in the program as of the end of PY2020.

4.2 Key Process Findings

Throughout PY2020, the Residential DR program continued to successfully engage eligible Ameren Missouri residential customers to deliver load reductions. Key participation highlights for PY2020 include:

- Program eligible devices consisted of three major thermostat manufacturers (Nest, ecobee, and Emerson) and spanned a variety of device models.
- Program implementation contractors continued to rely on two key channels—the BYOT and Marketplace—for program enrollment.
- Program marketing and messaging was effective in reaching and engaging customers, evidenced by higher than planned program enrollment. As of the end of PY2020, the Residential DR Program had a total of 29,013 enrolled and active devices across 24,835 customers, which averaged to 1.2 participating devices per customer. This level of participant enrollment represents 172% of the MEEIA III goal.
- Since program launch in PY2019, a total of 7% of customers de-enrolled from the program. This attrition rate is expected for DR programs and signals strong and sustained participation year-over-year. De-enrollment rates varied by device manufacturer and enrollment channel. Due to data gaps in participant data tracking extracts (discussed later in this section), the evaluation team does not have detailed insight into reasons for de-enrollment. Based on feedback from Ameren Missouri, some de-enrollments—specifically for Nest and ecobee devices—were a result of the device manufacturers requiring customers to accept new terms and conditions in order to remain active participants in the DR program. Other common reasons for de-enrollment from a DR program include relocation and dissatisfaction with program experiences, specifically comfort level due to events and inconvenience caused by multiple events dispatched.
- The Residential DR program participants represented all key Ameren Missouri segments but, when compared to a broader population of Ameren Missouri residential customers, skewed disproportionately toward Proud Providers and Digital Starters and away from Skeptical Savers.[11] Each device manufacturer and enrollment channel contributed a unique mix of participating customers. Notably, Skeptical Savers and Eco-Aspirers comprised a higher share of participating Emerson owners as compared to Nest and ecobee owners, while Proud Providers comprised a higher share of participating Nest and ecobee owners. The BYOT channel attracted considerably more Proud Providers than the Marketplace channel, while the Marketplace channel attracted considerably more Eco-Aspirers, Digital Starters, and Skeptical Savers.
- Stay-at-home orders, social distancing, and sustained work-from-home behaviors across the state of Missouri and the rest of the country caused by the COVID-19 pandemic led to a change in energy usage patterns in 2020 starting in April.[12] A focused analysis of runtime data and available survey

[11] Ameren Missouri groups its customers into five customer segments based on their interest in managing their energy use and their expectation of the role their utility plays in their lives: (1) Satisfied Autopilots who are happy with their current lifestyle and are only looking for their utility to be reliable provider of reasonably priced energy; (2) Proud Providers are proactive customers who take pride in their ability to provide their families the lifestyle and home they want, even via the latest technology; (3) Eco-Aspirers are customers looking to lead a more energy-efficient life for both monetary and environmental reasons, but income constraints impede their aspirations; (4) Digital Starters are customers who are digitally and socially connected, leading busy lives, often energy companies must move fast to keep up with them; and (5) Skeptical Savers are customers who are struggling to make ends meet, but remain skeptical of energy companies' willingness to help them.

[12] In April 2020, Missouri Governor Parson set a shelter-in-place order in response to the COVID-19 pandemic. After subsequent phases of recovery, Governor Parson lifted all state-wide COVID-19 policies in June 2020. (Source: "Governor Parson Announces Missouri will fully Reopen, Enter Phase 2 of Recovery Plan on June 16." June 11, 2020. https://governor.mo.gov/press-releases/archive/governor-parson-announces-missouri-will-fully-reopen-enter-phase-2-recovery)

data shows increased runtime and a higher rate of customer presence at home during events. Our analysis, however, indicates limited impact of the pandemic on either customer setpoints or override behaviors during events. As Missouri and the rest of the United States enter the second year of the pandemic and residential customers will likely face continued adjustments to their lifestyle driven by the pandemic, it is feasible that existing participant performance will continue to reflect their PY2020 behaviors.

Program enrollment and de-enrollment trends experienced meaningful change from PY2019 to PY2020 across the following dimensions:

- Device mix became more balanced across key manufacturers. Nest devices represented 59% of all program devices at the end of PY2020 as compared to 85% in PY2019. Emerson and ecobee devices each accounted for just over a fifth of all devices in PY2020.
- Device enrollment nearly tripled year over year in the Marketplace channel in PY2020 as compared to PY2019 (27% vs. 10%, respectively).
- The Ameren Missouri Marketplace fall promotion of Emerson devices led to a spike in Emerson enrollment, driving both the share of Marketplace devices as well as the share of Emerson devices in the program in PY2020.
- DR program enrollment via the Marketplace increased dramatically from PY2019–PY2020. Customers purchasing thermostats via the Marketplace channel receive a rebate for purchasing the device through the Marketplace channel. Concurrently, participants could choose to receive an additional $50 bonus incentive to enroll their newly purchased device in the Residential DR program. In PY2019, 17% of all Marketplace thermostat purchasers enrolled their devices in the Residential DR program. In PY2020, the rate more than doubled to 41% across all manufacturers, but most prominently for ecobee and Emerson devices.
- Depending on device manufacturer, de-enrollment rate changed between PY2019 and P2020. More specifically, it increased for Nest devices and decreased considerably for ecobee devices. This decrease in ecobee de-enrollments may be tied to a shift from the OE platform to the eco+ platform.[13] Reasons for a rise in Nest de-enrollments are not clear; it is likely related, however, to an updated terms and conditions agreement that customers had to sign in order to remain active in the program.

PY2020 was also marked by considerable modifications to program design and implementation. Key PY2020 modifications included:

- Widespread optimization through eco+ and Seasonal Savings affected the program's ability to dispatch optimization interventions to achieve energy savings. Specifically, in May 2020 ecobee made their eco+ software platform broadly available to all customers for voluntary enrollments, with all newly purchased ecobee devices automatically using eco+. In the summer of 2020, Nest made its Seasonal Savings optimization platform available to all its customers, as opposed to offering this platform as part of the utility programs. Given these changes, the Residential DR program could no longer meet the energy savings goals, which energy optimization interventions were intended to achieve. Furthermore, widespread availability of manufacturer optimization platforms can have an impact on customer baseline usage and lead to decreased demand impacts achieved through event dispatches.

[13] OE platform featured more aggressive temperature adjustments as part of event dispatch as well as optimization algorithms.

- In PY2019, ecobee and Emerson dispatched events through Uplight's OE platform. The introduction of the eco+ platform resulted in a shift of event dispatch platform for ecobee devices from Uplight's OE to eco+. This shift required Uplight to develop and deploy a new data ingestion and transfer pipeline. Uplight and ecobee experienced challenges finalizing the pipeline and sufficiently troubleshooting the platform in time for the evaluation. For Emerson devices, a portion of 2020 events were dispatched using the Emerson DR platform, a portion were dispatched using Uplight's OE platform, and a portion was dispatched using both.

  These shifts in dispatch platforms uncovered OE platform limitations in dispatching events for Emerson devices with certain settings. Each dispatch platform features unique temperature control algorithms, from precooling to setpoint adjustments during events, to post-dispatch temperature stabilization. Differences in participant composition for each manufacturer, as well as changes in impact methodology in PY2020 from PY2019 due to data and implementation challenges, limit our ability to directly compare and contrast each platform's performance to determine the effect of these changes across the distinct dispatch platforms. These challenges are not expected to impact the PY2021 event season.

The Evaluation Team encountered several data-driven challenges in conducting the evaluation as initially planned. They include the following:

- Inconsistencies and gaps in device status tracking and device participation assignment, along with gaps caused by eco+ data pipeline challenges, prevented the evaluation team from using the RCT design in our evaluation and resulted in the need to shift an alternative evaluation methodology.[14]
- The evaluation team's ability to compare impacts year-over -year was limited due to data limitations. These limitations required us to shift to an approach that estimates average treatment effect on the treated (ATT), rather than developing impact estimates consistent with the intent-to-treat (ITT) approach deployed in the PY2019 evaluation.
- The Evaluation Team was unable to map Emerson devices to the participant data in PY2020. Consistent with PY2019, Nest did not provide a way to match participant to telemetry data necessitating continued adjustments to the planned approach to estimate energy and demand impacts. While the evaluation team was able to estimate demand and energy impacts using assumptions and extrapolations, 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.
- Additional data imperfections, such as inconsistency in tracking de-enrolled accounts, lack of information on de-enrollment reasons, inconsistency in tracking program enrollment channels, and enrollment timelines resulted in resource-heavy and largely manual cross-validation, verification, and imputations over the course of the evaluation process.

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 11 summarizes responses to the CSR process evaluation requirements for the Residential DR Program.

[14] Event dispatch in PY2020 across all manufacturers was designed as an experiment, wherein for each event a random subset of devices was assigned to the control group, with one exception— a single systemwide event designed to be dispatched across all devices enrolled and active at the time of the event. For all except the systemwide event, the design called for the treatment group to receive an event signal while the control group did not, thus forming a baseline to determine program impacts.

Table 11. 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 the Ameren Missouri service territory was relatively low in PY2019, with 8% of all thermostats being smart thermostats. It is likely that most, if not all, of the devices enrolled in the program in PY2020 were newly purchased devices as the program marketed to and enrolled all interested existing smart thermostat owners as part of the PY2019 outreach. Program participation goals for PY2021 will require continued strong sales of smart thermostats and strong engagement in order to sustain future enrollment goals. Broadband internet access, which is presently at 85% in Ameren Missouri service territory limits the number of homes that can participate in the program. Based on research conducted in PY2019, customers have a variety of concerns about participating in central air conditioning (CAC) 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 these concerns emerged as extreme barriers, comfort was 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 (CAC) systems (including heat pumps) and a program-supported smart thermostat are eligible to participate. Given the nature of the program design, which relies on smart thermostats to deliver demand impacts during DR 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, inclusion of devices from other manufacturers can help increase the program's reach. It is our understanding that Uplight and Franklin Energy are working on introducing those devices as part of the program in PY2021.
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. The "virtual" aspect of program enrollment and event dispatch ensures that program operations remain uninterrupted during COVID-19.
What can be done to more effectively overcome the identified market imperfections and to increase the rate of customer acceptance and implementation for select end uses/measure groups included in the Program?	Aligning acquisition channels and introducing new device manufacturers into the program can help capture more customers as well as different customers, thus ensuring achievement of participation goals for the MEEIA III cycle and serving a broad spectrum of Ameren Missouri customer segments. Leveraging insight into differences in participant composition across Ameren Missouri customer segments, enrollment channels and device manufacturers can help tailor messaging to improve participation. Further 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

CSR Required Process Evaluations Questions	Findings
	actively providing information on what the participation process looks like will help mitigate known barriers to customer engagement with the Program.

4.2.1 Conclusions and Recommendations

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

- **Conclusion 1:** The Residential DR program succeeded in successfully enrolling significantly more customers than planned. Program demand planning assumptions remained considerably higher than what the program delivered in PY2020, both in terms of actual as well as weather-normalized demand savings. Moving forward, the program will either need to continue enrolling more participants than planned or achieve greater per-device impacts to meet demand impact goals. Enrollment of additional devices to achieve goals will likely carry higher cost for the program.
  - Recommendation 1: Program staff should continue to balance participant enrollment targets with consideration of both resource capability and event season demand impacts to optimize the program's performance against the demand goal.
- **Conclusion 2:** The Residential DR Program fell short of the MEEIA III energy savings goals and likely faces considerable shortfalls in the future. The shortfall in energy savings in PY2020 was primarily due to ecobee and Nest opening their optimization platforms to all device owners, which limited the program's ability to harvest additional savings via optimization driven interventions. The shortfall was also in part driven by a limited number of events dispatched in PY2020.
  - Recommendation 2: Program staff should consider a two-pronged approach to achieving additional energy savings in PY2021. For Emerson device owners, program staff should consider offering OE optimization. For Nest and ecobee owners, program staff could consider tailored messaging aimed at and encouraging more participants to enroll in Seasonal Savings and eco+, respectively. For eco+ specifically, program staff could further tailor messaging to encourage selection of more aggressive optimization algorithms. Should the program pursue the latter set of recommendations, discussion of the appropriate evaluation approach to capture program attributable changes in energy consumption should occur prior to messaging launch in order to ensure the evaluability of these interventions.
- **Conclusion 3:** The program de-enrollment rate of 7% over two years signals sustained participation and participant satisfaction. Data limitations preclude the evaluation team from determining drivers for de-enrollment (e.g., relocation vs. participant experiences). The number of events dispatched and participant comfort level during the events are typically the driving factors behind participant experience and satisfaction. Both PY2019 and PY2020 had milder than normal summer temperatures which resulted in the minimal number of events dispatched. The de-enrollment rate could increase under hotter summer temperatures and more events.
  - Recommendation 3: Program staff should consistently track de-enrollments reasons to better understand de-enrollment drivers. As part of the planning efforts, program staff should also consider the risks associated with increased de-enrollment rates under hotter event season and increased number of events and plan for that accordingly.
- **Conclusion 4:** This evaluation highlighted differences in participant composition across Ameren Missouri customer segments, enrollment channels, and device manufacturers as well as

participant engagement with the program. These insights can offer additional strategies for calibrating successful program enrollment, de-enrollment, and impacts. For instance, insight into differences in Marketplace enrollment rates for each manufacturer can inform targeted messaging to decrease de-enrollment. Varying manufacturer demand savings performance can help effectively plan for anticipated impacts in case of changing manufacturer mix. Understanding of participant population across Ameren Missouri customer segments can offer opportunities to tailor program messaging depending on the segments of interest.

- Recommendation 4: Data-driven insights can help the Program calibrate enrollment with performance expectations thus positioning the program for continued success.

- **Conclusion 5:** The current Residential DR Program participants are likely to be comprised of early adopters. As smart thermostat adoption enters the mainstream market, the Residential DR Program participant composition may change, with potential implications on energy consumption patterns associated with the size of the home, size and vintage of the HVAC system, as well as participant presence at home during various times of the day. This changing participant composition may lead to changes in future program engagement, and associated demand and energy savings opportunities.

  - Recommendation 5: As the program matures, we recommend that program staff identify factors driving program performance, for example, high cooling load, engagement with devices, and 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:** The evaluation team identified a number of inconsistencies and limitations in the available data that limited the ability to match participants with telemetry and usage data. This necessitated changes in the evaluation approach. 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. Data issues also resulted in a more labor-intensive evaluation process.

  - Recommendation 6: Ameren Missouri and program staff should consider revisiting the data tracking processes and data pipelines in conjunction with the evaluation team to ensure sufficiently detailed and consistently tracked data across core input fields. This will ensure more rigorous, accurate, and cost-effective evaluation efforts.

4.3 Evaluation Methodology

The evaluation team performed both impact and process evaluation activities to assess the performance of the Residential DR Program in PY2020. 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 PY2020; and

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

Table 12 provides an overview of the program evaluation activities. Following the table, we provide a detailed description of our approach to the impact analysis.

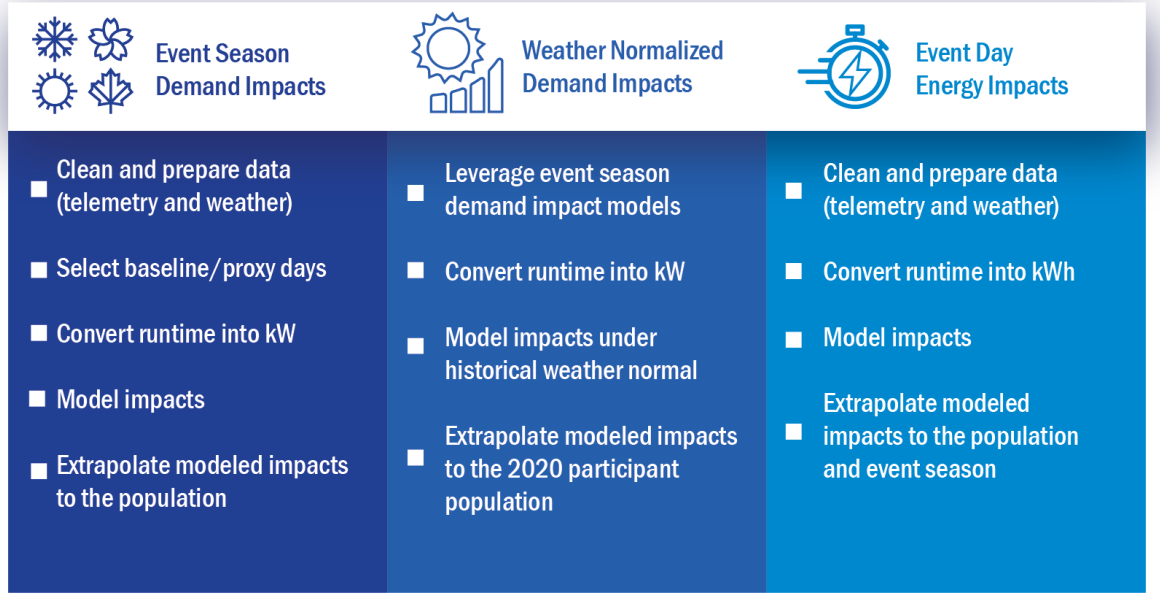
Table 12. Residential DR Program: PY2020 Evaluation Activities for the Demand Response Program

Evaluation Activity	Description
Program Manager and Implementer Interviews	▪ Gathered feedback to understand program staff's perspective on program performance. Feedback was gathered on a continuous basis as part of periodic check-in meetings over the course of the program year.
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 was being collected.
Impact Analysis	▪ Conducted event regression modeling to estimate hourly and average event kW, and kWh impacts. ▪ Assessed average event kW impacts under normalized weather conditions for all participants enrolled in PY2020.

4.3.1 Impact Analysis

Impact analysis for the program consisted of several components, namely event season demand impacts, weather-normalized resource capability impacts, and event day energy impacts. Figure 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. The Appendix volume submitted alongside this report contains further methodological details.

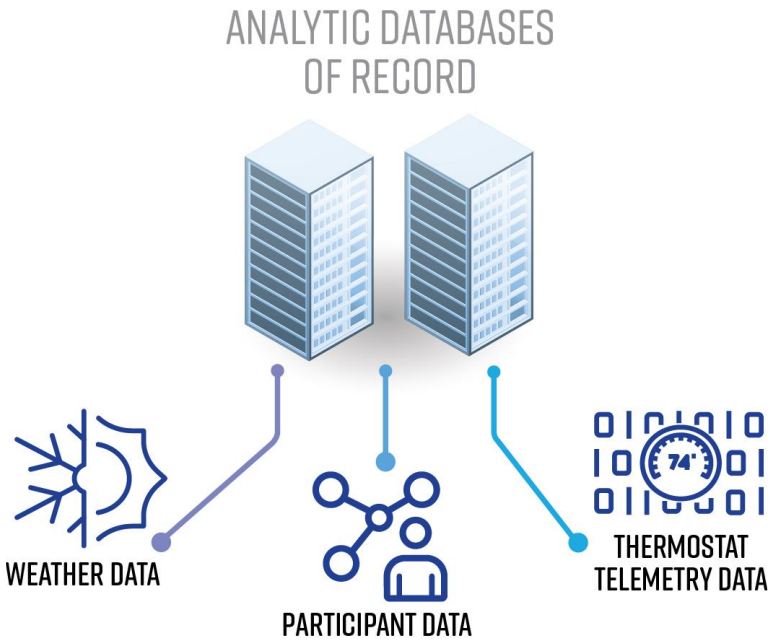
Figure 8. Residential DR Program: Gross Impact Analysis Overview



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 them in analytic databases to support the impact analysis and modeling efforts. Figure 9 provides a visual representation of the various data sources that supported the gross impact analysis. Following the graphic, we provide detail on each source.

Figure 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 for this analysis. 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 2020. As part of the data preparation, we calculated cooling degree hours with an outdoor base temperature of 75° Fahrenheit for use in the model. We chose 75° Fahrenheit as the base temperature because 75° Fahrenheit is approximately the point at which participants start using their CAC during summer afternoons.

Participant Data

We relied on participant data extracts provided separately by Uplight and Franklin Energy. The Franklin Energy file served as the file of record. As part of the file, we received device enrollment and de-enrollment records for two program years. Each record contained associated customer information, enrollment dates, de-enrollment dates (where applicable), device manufacturer information, and device enrollment channel, among other data fields. As part of the data cleaning process, we reconciled participant counts, reviewed and eliminated duplicate records, and addressed gaps, missing, and unreasonable values, where possible and feasible. 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 verified the accuracy of the date of customer enrollment in the program. This date was essential for determining participant counts for the impact analysis. Throughout the cleaning process, we worked closely with Franklin Energy and Uplight to reconcile problematic and conflicting cases. In cases of uncertainty, we worked to make reasonable imputation and/or drop decisions. Throughout the data cleaning process, several areas of uncertainty emerged. We discuss those, along with recommendations for mitigation in the process section of this report.

Device Telemetry Data

We received ecobee, Emerson, and Nest telemetry data from Uplight. The data included hourly runtime with associated setpoints and indoor temperatures. Additionally, the data contained device identifiers and detail on day type (demand-response, learning, inoperative, etc.). Similar to the participant data cleaning process, we scrutinized the data for duplicate records, missing records, and outlier records. Detailed data cleaning steps are included in the Appendix Volume accompanying this report.

Data Challenges and Impact Analysis Implications

During PY2020 ecobee transitioned to the eco+ platform requiring Uplight to develop and troubleshoot a new data ingestion pipeline to support device telemetry data transfer. Throughout this process, Uplight reported encountering data pipeline issues resulting in data gaps and requiring Uplight to manual backfilling the data. Over the course of the event season, Uplight also encountered data pipeline challenges with the other two manufacturers, which also led to manual backfilling of the data. Given these challenges, our team paid special attention to and performed extensive exploration of runtime trends to ensure that the runtime data was reasonable for the purposes of the analysis. As part of the process, we discovered several data imperfections. We describe them below along with implications of each for this evaluation.

Quality of ecobee Runtime Data

We identified challenges with ecobee runtime data. The most prominent challenge was the recording of timestamps for a portion of ecobee devices in different time zones (UTC vs. Central) throughout the telemetry data extract. This led to shifts of runtime data, setpoints, and other data fields in time. Despite efforts to remedy this issue, we were unable to fully resolve it.[15] As a result, we were unable to leverage device setpoint information or other data for ecobee devices for process analysis purposes. We also observed data quality issues, likely including timestamp shifts, which impacted our ability to confidently measure impacts for ecobee devices for one of the events (Event 4, September 8, 2020). We therefore omitted that event from our analysis of total impacts for ecobee devices.

Device Status Field

Uplight documents device status in each event via an MV_DAY_TYPE field. Devices can be marked as dispatched for an event, inoperative, ineligible, and assigned to the control group, among other status categories. As part of the telemetry data cleaning process, Opinion Dynamics scrutinized the status variable to ensure accuracy of device assignment into various status categories. Among other steps, we (1) compared device treatment and control groups against a Treatment-Control assignment file provided separately by Uplight, 2) validated device status through runtime data explorations, and 3) explored uncertainties and mitigation strategies with Uplight. We discovered several imperfections that required a custom approach to

[15] Not all participating devices were affected by the time zone issue, and accurately identifying devices that were affected was not always possible.

device classification to ensure accurate estimation and application of savings. The imperfections also caused a recalibration of our impact evaluation approach. Below is a summary of the data imperfections and resulting remedies:

- **Changes in dispatch platform for Emerson devices from Vendor DR to OE.** This change resulted in differences in how events were dispatched. More specifically, some devices in certain modes for the two events received planned OE dispatch, others received modified OE dispatch, others received Vendor DR signal, and others received no event signal. Opinion Dynamics worked with Uplight to carefully classify each device for each event into the correct dispatch category and appropriately include devices in the analysis.
- **Inability to accurately classify Nest devices into treatment and control groups.** The MV_DAY_TYPE data field for Nest devices did not allow for accurate classification of customers in the treatment and control groups without labor intensive telemetry data exploration and participant classification.
  - As a result, Opinion Dynamics was unable to leverage the RCT approach as part of our impact evaluation. Opinion Dynamics shifted to an alternative approach which includes selecting proxy days to act as counterfactual baseline. To maintain consistency of impact approach across all device manufacturers, Opinion Dynamics leveraged the proxy day approach across all device manufacturers. We did not leverage the RCT design for any of our evaluation efforts in PY2020.
  - Historically, our modeling efforts included all participants, both treated and intended to be treated but not treated.[16] Modeled impacts therefore represented the intention-to-treat (ITT) effect of the program. Inability to classify Nest devices into treatment and control groups also meant an inability to parse out inoperative and ineligible treatment devices from inoperative and ineligible control devices, precluding us from pursuing modeling efforts in an ITT fashion. As a result, we recalibrated our modeling efforts to be based on only treated participants (e.g., those known to have received a dispatch signal). Consequently, modeled impacts reflect average treatment effect on the treated (ATT). In comparison, in PY2019, we deployed an ITT-based approach to savings estimation. Therefore, comparison of any PY2020 impacts to PY2019 impacts should be conducted with consideration of the differences in methods.

Event Season Demand Impacts

The event season DR impact analysis resulted in event period demand impacts for devices in place and operational during the PY2020 event season. Below, we outline analytical activities that were a part of the analysis.

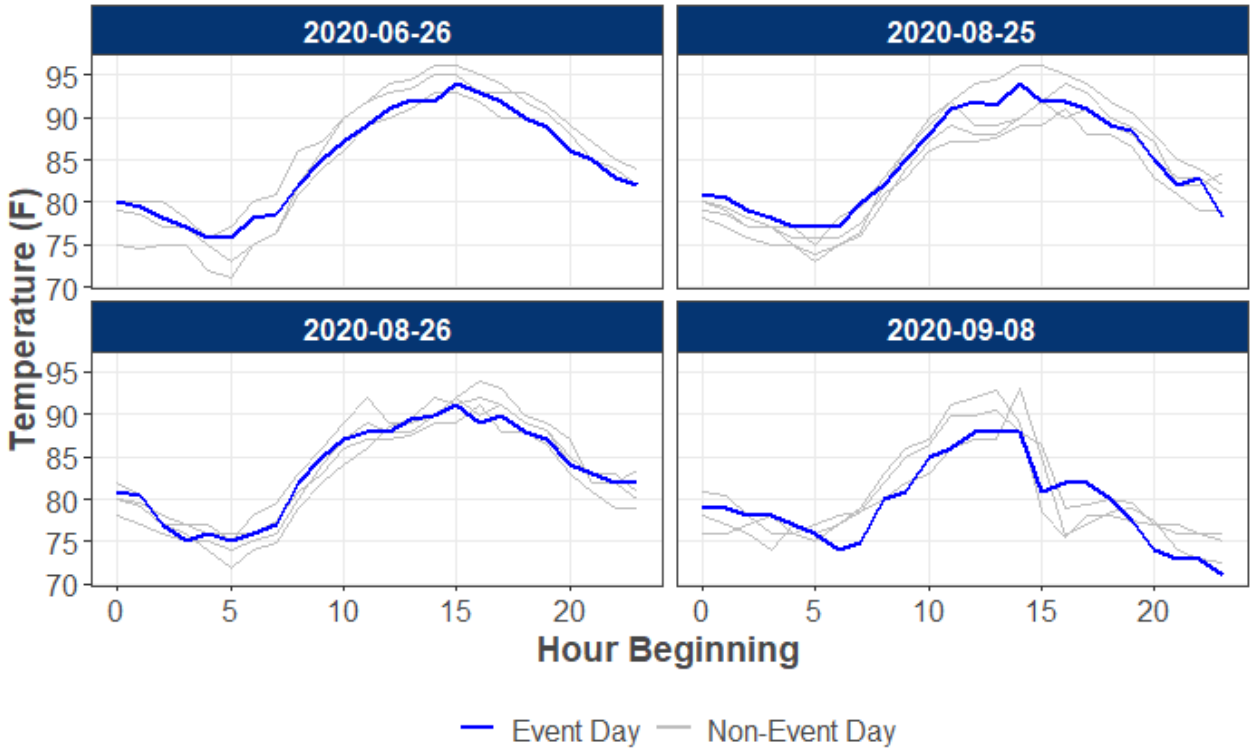
Select Baseline Days

As a result of the data challenges described in the section above, we relied on a quasi-experimental design to evaluate program impacts. To develop matches, we used Euclidean distance matching to select best matching 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 10 shows the weather profiles for each event day and the selected proxy non-event days. 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 well between the event and matched comparison days for all

[16] Non-treatment can occur due to devices being offline, in heating mode, or in modes that prevent receipt of the event dispatch signal.

events, especially for the critical event hours. Notably, the weather profile for the fourth event is unusual as a result of a summer storm on that day. The matching algorithm performed a reasonably good job of selecting proxy days with similar weather profiles to that day. Despite the unusual weather profile, we included that event day in the assessment of event season impacts.

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



Convert Runtime to kW

Because telemetry data contains runtime information, as opposed to cooling load, it is necessary to convert runtime data to 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. The Appendix volume submitted alongside this report contains further detail on the approach used to develop the connected load assumption. The resulting per-device connected load is 3.07 kW. We converted runtime to cooling load prior to modeling.

Model Impacts

We only included devices among which events were dispatched. Modeled impact estimates therefore represent ATT program effects.

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 modeled (predicted) event kW over the event period. 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 several different model specifications. We selected the final model specification by calculating the Root Mean Squared Error (RMSE) on a testing/evaluation dataset. This process involved randomly splitting the data into two subsets with 80%/20% ratio—the first (larger one) to train the model and the other (smaller one) to evaluate the model. This 80%/20% split was stratified by day to ensure that each set of data would have the same proportion of proxy day data to event day data. The primary benefit to using a testing/evaluation set when comparing models is to prevent model overfitting.

To assess whether the models could accurately predict runtimes, the team used each model to predict cooling load for both event days and non-event days and compared to actual runtime for the previously unseen data in the testing/evaluation set. These models were run after converting runtime to load, so the final evaluation was done by comparing the RMSE of predicted kW values across model specifications to determine which model best fit the unseen testing data. The Appendix volume submitted alongside this report contains the final model specification, model fit output, and RMSE values for the selected final model specification.

We ran separate models for each event and manufacturer.

Extrapolate Modeled Impacts to Population

We calculated total impacts for each event by multiplying the per-device ATT impacts by the number of enrolled devices that received event dispatch. We determined the enrolled device counts for each event using the participant data extract. We used the participant data extract because it contained verifiable participant information. We could not link Emerson or Nest telemetry data to participant extract to validate telemetry data against verifiable participant data. We determined enrolled device counts based on the enrollment date available in the participant extract. Devices enrolled the day before the event were classified as enrolled for that event. Because our modeled estimates are ATT, we needed to adjust the population of enrolled devices for each event to represent treated devices (or devices that received event dispatch). Applying ATT impact estimates to all enrolled devices would have resulted in an overestimate of savings.

We adjusted enrolled device counts in the participant extract by the expected "treatment rate." The treatment rate was developed by dividing the total number of treated devices by the total number of enrolled devices. We derived treatment rates from the telemetry data for each event and applied them to the active device count available for each event from the participant data extract.

Total event-season demand impacts as the weighted average of impacts across events were calculated by thermostat manufacturer, weighting by the number of treated devices in each event. As mentioned in the section above, we excluded the September 8 event from the total event-season demand impacts for ecobee devices due to persisting concerns with runtime data quality.

Notably, demand impact estimates for ecobee and Nest devices are inclusive of the energy optimization components (eco+ and Seasonal Savings, respectively) 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 PY2020 under peak weather conditions.

Model Impacts Under Peak Weather Normals

To determine weather-normalized resource capability, we trained a separate set of models utilizing the same model specification used for event season demand impacts. Similar to the event season models, we only included treated devices as part of the modeling effort. Modeled impact estimates therefore represent ATT program effects.

We fit a series of fixed-effects models for each device manufacturer, pooling all event season data to create a single model for each device manufacturer. We trained the models on 2020 weather data and evaluated them at a peak temperature of 99°F as specified in the Ameren Missouri TRM. To account for differing event dispatch windows, our models included flexible hour terms defined as the number of hours relative to the start of an event.

Given unusual event dispatch occurrences as well as data challenges, we purposefully selected observations to include in the modeling efforts:

- For Emerson devices, we only included devices that received "as intended" event dispatch via the OE platform. We excluded events dispatched using the Vendor DR platform as well as problematic OE dispatch cases. Future events will be dispatched using the OE platform and problematic dispatches have been remedied in the OE algorithms, per Uplight's feedback.
- Similar to the event season modeling effort, for ecobee devices, we excluded Event 4 (September 8, 2020) from the resource capability models as well due to persisting runtime data quality concerns.

We fit these models using the hourly cooling load data separately for each device manufacturer. Upon fitting these models, we estimated the predicted event impact for a standard three-hour event. The predicted event impact is the predicted baseline demand minus the predicted event demand for these three event hours.

The Appendix volume submitted alongside this report contains the final model specification, model fit output, and RMSE values for the selected model specification.

Extrapolate Modeled Impacts to Population

We calculated total weather-normalized resource capability by multiplying the weather-normalized per-device ATT impacts for each manufacturer by the number of devices enrolled in the program as of the end of PY2020 and anticipated to participate in events. We used participant data extracts to derive the total number of enrolled devices. We adjusted device counts in the participant extract by the expected "treatment rate." We developed the treatment rate by dividing the total number of treated devices by the total number of devices assigned as treatment. Treatment devices excluded devices assigned as control in PY2020. For Nest devices, the device status field did not allow us to parse out treatment and control devices. Consequently, we relied on reasonable assumptions about the share of devices assigned as control. For Emerson devices, treatment devices only included devices treated via the OE platform or devices that could be treated via that platform. In other words, we excluded control devices as well as devices that could not be treated via the OE platform due to the device settings that prevented OE driven dispatch.

We derived treatment rates for each manufacturer from the telemetry data and developed independent treatment rates for each event in the event season. We then weighted each event's treatment rate by the number of treatment devices in each event to arrive at the average weighted treatment rate for each device 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 except we compared the predicted baseline load to the predicted event day load for all hours of the event day. Therefore, the event day load reduction is estimated as the difference between the predicted baseline and event day load 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 predicted impacts for each event by the number of devices who participated in those events and then summed impacts across events. The Event Season Demand Impacts section above provides additional detail regarding data cleaning and preparation, selected baseline days, converted runtime to load, modeled impacts to estimate event day energy impacts, and extrapolated modeled savings to participating devices. To account for persisting data quality concerns with ecobee devices during Event 4 (September 8, 2020), instead of using that event's modeled energy impacts, we relied on average per device energy impacts observed for ecobee devices across the three other events.

4.4 Evaluation Results

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

4.4.1 Process Results

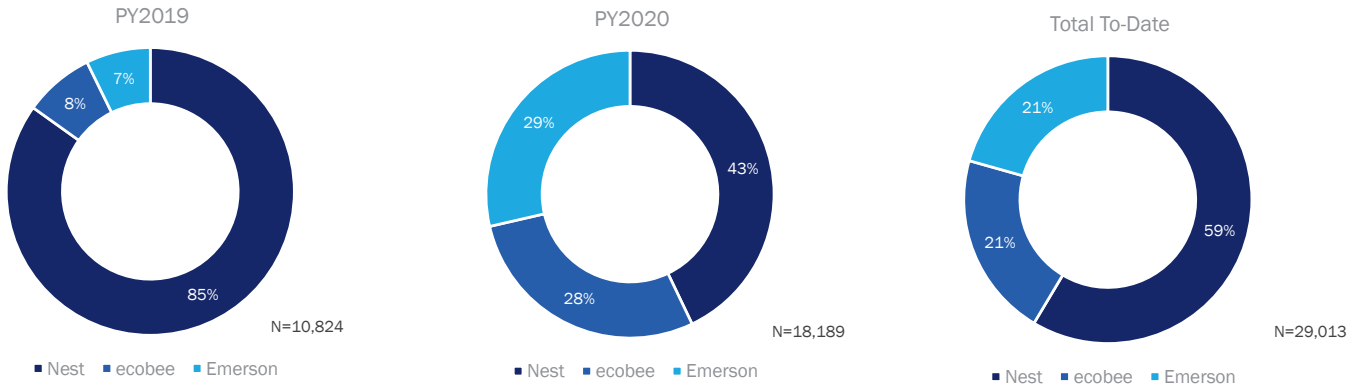
Participation Summary

At the end of PY2020, a total of 29,013 devices across 24,835 customers were actively enrolled in the program. On average, a participating home had 1.2 devices. Nearly 85% of customers had only one device enrolled and less than 1% had two or more devices enrolled in the program.

Participating device mix changed in PY2020 as compared to PY2019 in terms of manufacturer mix and enrollment channel (Figure 11 and Figure 12). Overall, Nest devices continued to represent the majority of participating devices (59%), followed by ecobee and Emerson devices, each accounting for 21% of all active devices as of the end of PY2020. However, the share of Nest devices decreased considerably from 85% of all devices enrolled in PY2019 to 43% of all devices enrolled in PY2020. A rapid growth in Emerson devices was driven in large part by a fall 2020 promotion of those devices via Ameren Missouri Marketplace program, where customers could get those devices for free after receiving Ameren Missouri incentives.[17]

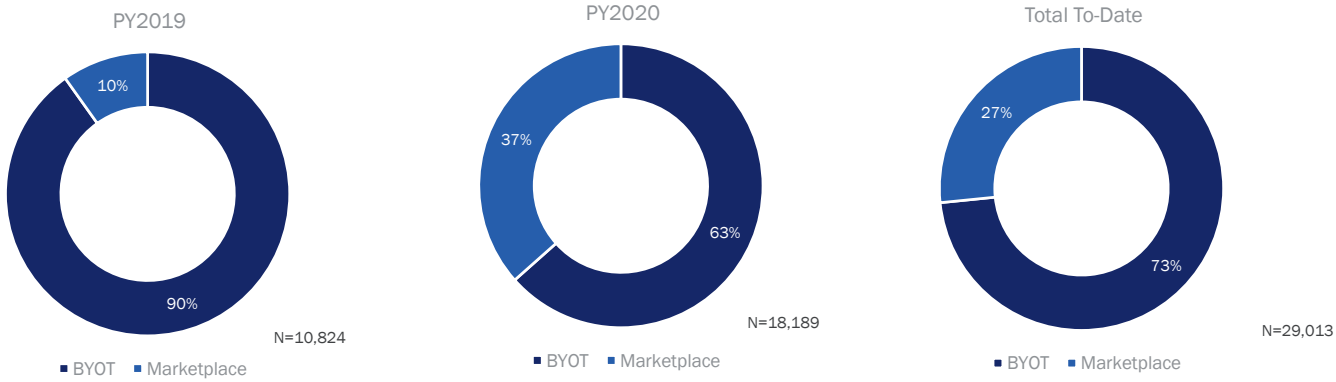
[17] Marketplace program is also known as the Online Store program where participants receive an instant thermostat rebate as well as an additional rebate for enrolling in the DR program.

Figure 11. Residential DR Program: Device Enrollment Trends by Manufacturer



BYOT remained the primary enrollment channel throughout PY2020. Nearly three-quarters of all devices active at the end of PY2020 (73%) entered the program via that channel. Compared to PY2019, where nine in ten devices enrolled in the program via the BYOT channel, in PY2020 two-thirds of devices entered the program via that channel (Figure 12). The increase in the prominence of the Marketplace channel is driven in part by Marketplace promotions (including the fall promotion described above) and in part by the program having already tapped into the existing inventory of devices. Any new devices entering the program via the BYOT channel are likely newly purchased devices.

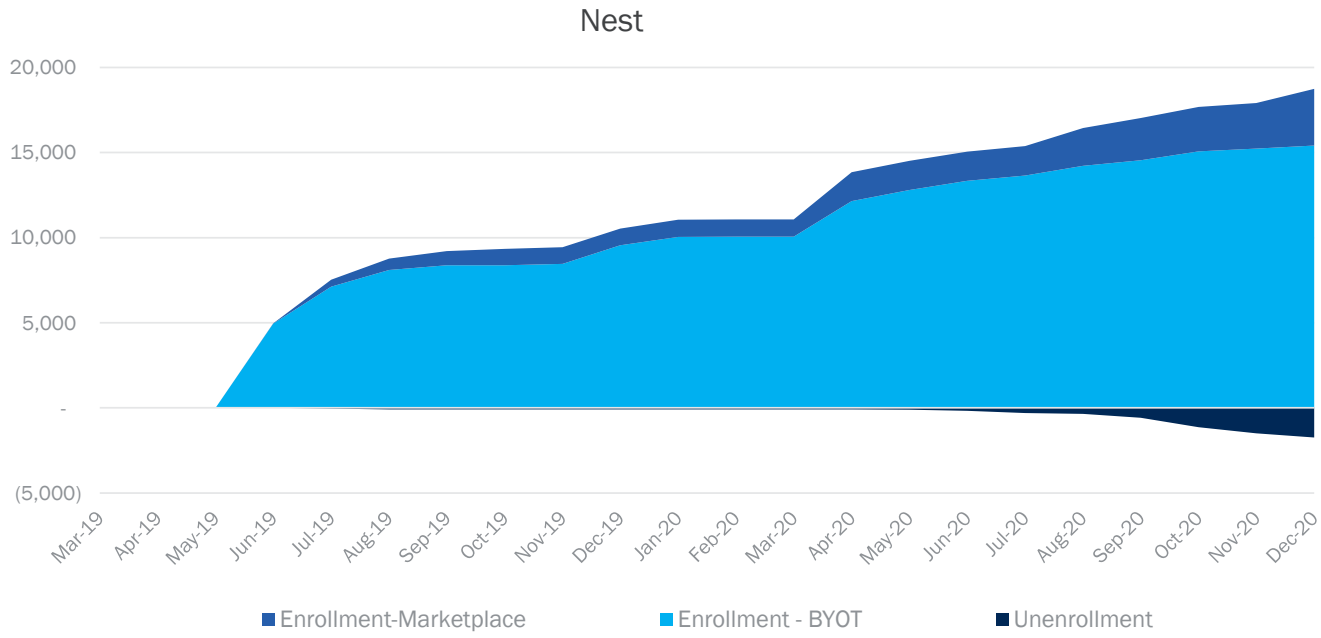
Figure 12. Residential DR Program: Device Enrollment Trends by Channel

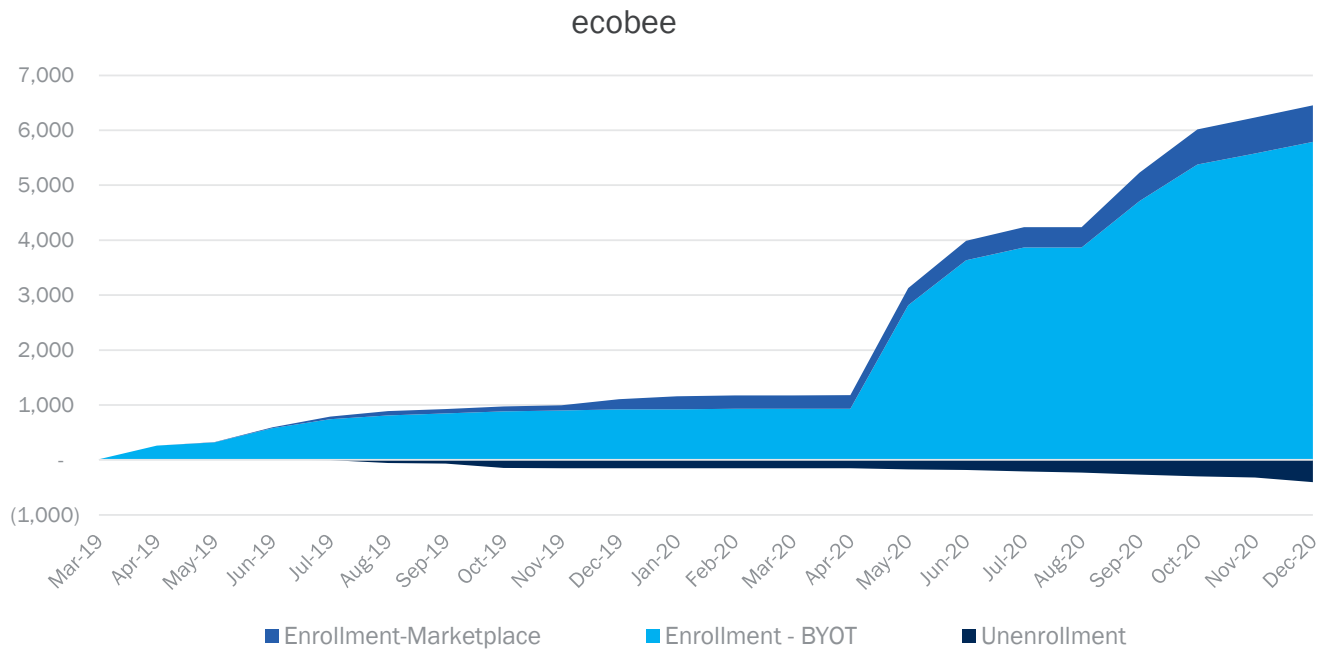


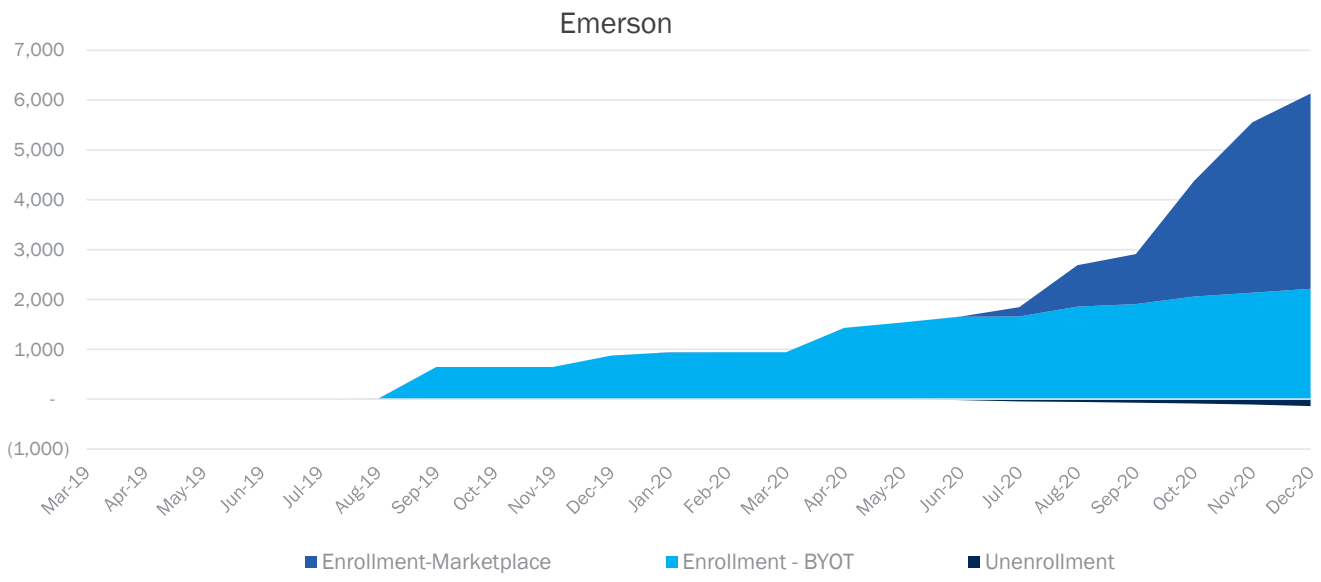
Enrollment Trends

Figure 13 summarizes cumulative device enrollment and de-enrollment trends by device manufacturer throughout PY2019 and PY2020. Enrollment trends are categorized by channel, and de-enrollment trends are overlaid on top of enrollment trends for each device. Enrollment trends for Nest devices show steady gains over time with a slight increase prior to the PY2020 event season. The Marketplace channel trends show a steady increase in prominence for Nest devices, while de-enrollments increase at the end of the season. Ecobee device enrollment experienced a significant spike prior to the start of the PY2020 event season, with steady gains in Marketplace enrollments. Coincident with the fall promotion, enrollment of Emerson devices via the Marketplace channel increased considerably.

Figure 13. Residential DR Program: Device Enrollment Over Time by Device Manufacturer







Notably, while device incentives did not change between PY2019 and PY2020, enrollment of devices into the DR program via the Marketplace channel increased markedly. Table 13 shows DR program enrollment rate among Marketplace devices. The enrollment rate is calculated by dividing the total number of devices enrolled in the DR program via the Marketplace channel by the total number of devices incented by Ameren Missouri via the Marketplace channel. As can be seen in the table, DR enrollment rate more than doubled from 17% in PY2019 to 41% in PY2020. This increased enrollment rate is present across all device manufacturers but is most pronounced for ecobee devices. Notably, there were very few Emerson devices enrolled in the DR program via the Marketplace channel in PY2019 despite over a thousand devices discounted by the program on the Marketplace website. While it is unclear what the drivers of the increased DR program enrollment are, maintaining high levels of DR program enrollment through appealing messaging and marketing will help capitalize on the Marketplace-driven device purchases in order to reach PY2021 DR Program enrollment goals.

Table 13. Residential DR Program: Program Enrollment Rate of Marketplace Devices

Device Manufacturer	PY2019 Marketplace DR Enrollment Rate (N=1,168)	PY2020 Marketplace DR Enrollment Rate (N=6,745)
Nest	20%	30%
ecobee	46%	69%
Emerson	<1%	54%
Total	**17%**	**41%**

Participant Composition

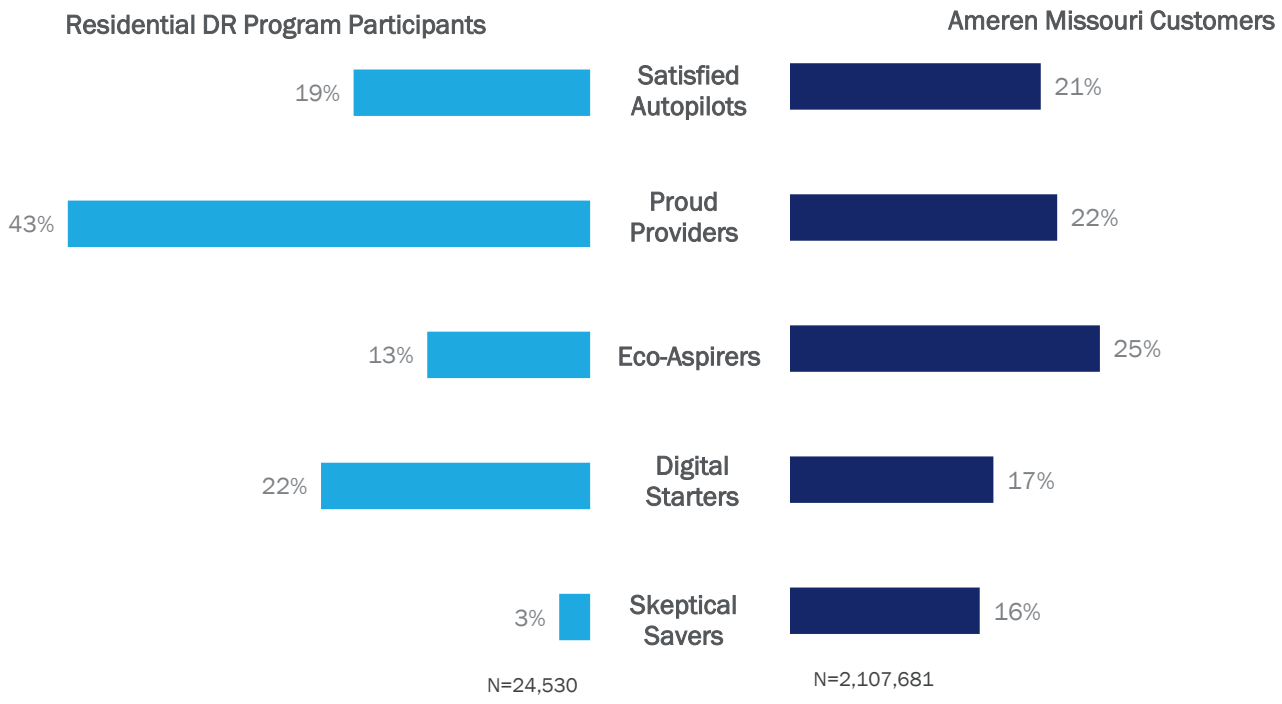
Ameren Missouri groups its customers into five customer segments based on their interest in managing their energy use and their expectation of the role their utility plays in their lives:

- Satisfied Autopilots: Happy with current lifestyle and are only looking for their utility to be reliable provider of reasonably priced energy;

- Proud Providers: Proactive customers who take pride in their ability to provide their families the lifestyle and home they want, even via the latest technology;
- Eco-Aspirers: Looking to lead a more energy efficient life for both monetary and environmental reasons, but income constraints hinder their aspirations;
- Digital Starters: Digitally and socially connected, leading busy lives. Energy companies must move fast to keep up with them; and
- Skeptical Savers: Struggling to make ends meet, but skeptical of energy companies' willingness to help them.

As part of our analysis, the evaluation team merged the above segment data with the DR program participation data and explored participant composition across these segments. As can be seen in Figure 14, the Residential DR Program has attracted a disproportionate number of Proud Providers. The percentage of Digital Starters among participant population is also higher than among Ameren Missouri's customer base. Eco-Aspirers and Skeptical Savers are underrepresented among the Residential DR Program participant population as compared to the general population of Ameren Missouri customers. The distribution of participant population changed slightly over time. In PY2020 the program attracted a higher share of Eco-Aspirers (increase from 11% in PY2019 to 15% in PY2020) and a lower share of Proud Providers (decreased from 46% in PY2019 to 41% in PY2020).[18]

Figure 14. Residential DR Program: Segment Distribution Across Participant Population and Ameren Missouri's Customer Base

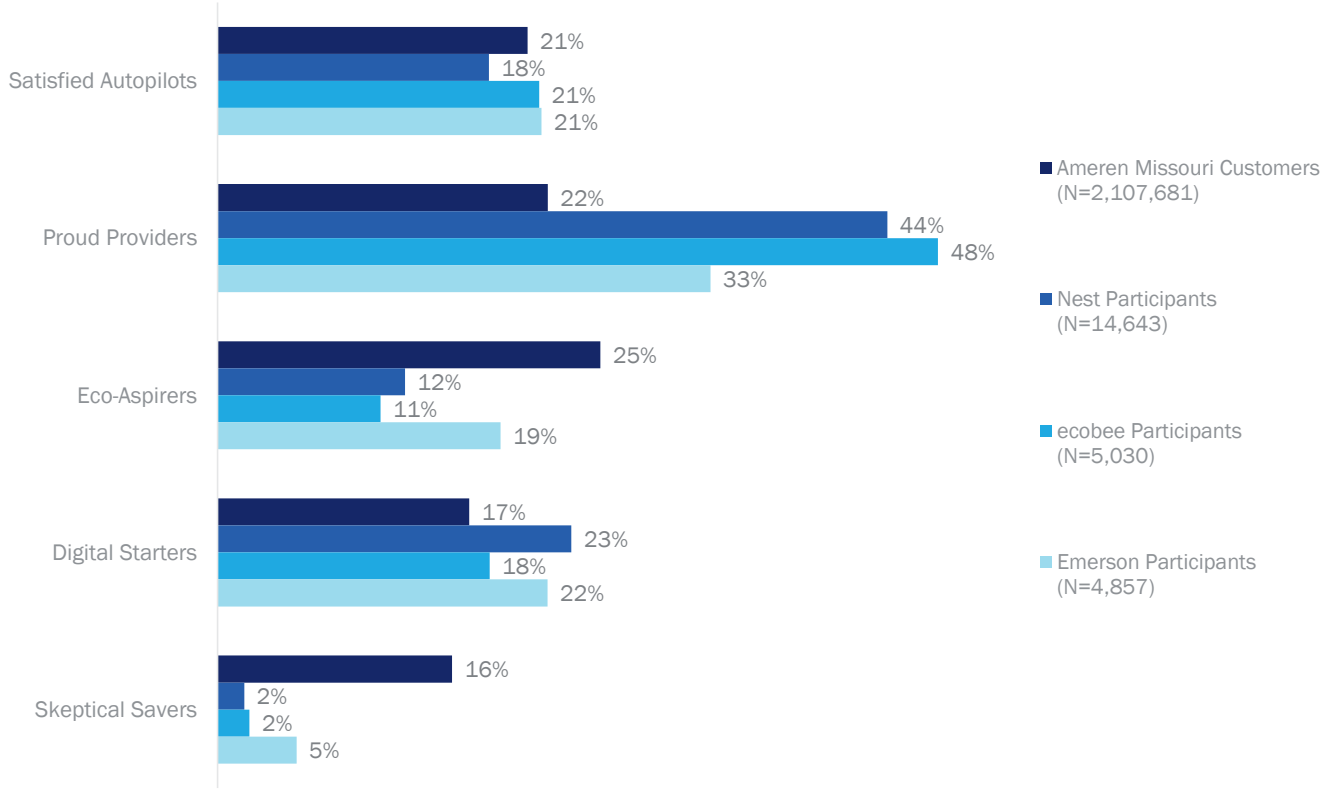


Different device manufacturers attract a different mix of customer segments (Figure 15). Notably, Skeptical Savers and Eco-Aspirers comprise a higher share of participating Emerson device owners as compared to Nest

[18] Percentage difference is based on incremental participants enrolled in the program in each Program Year.

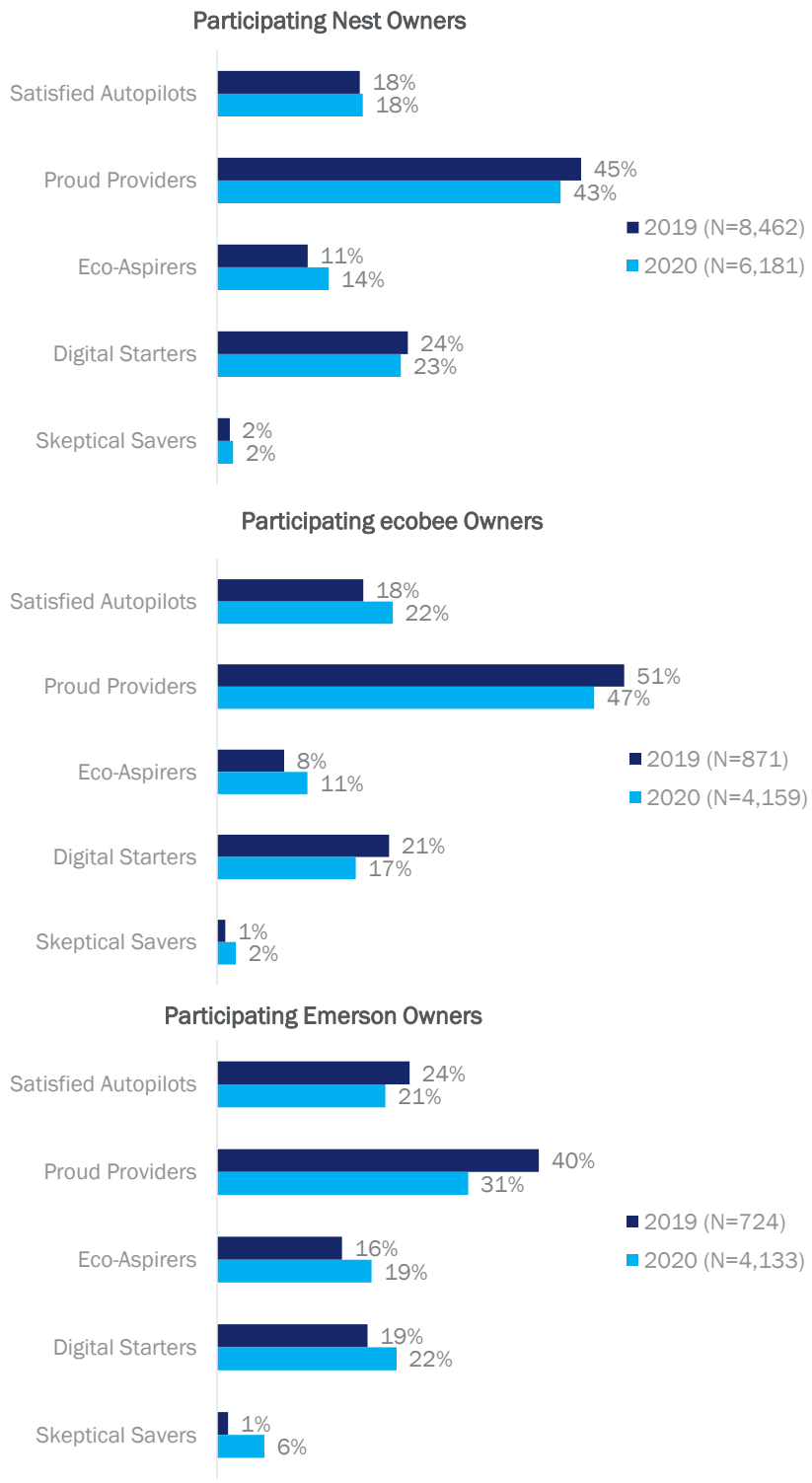
and ecobee device owners; while Proud Providers comprise a higher share of participating Nest and ecobee device owners.

Figure 15. Residential DR Program: Segment Distribution by Device Manufacturer



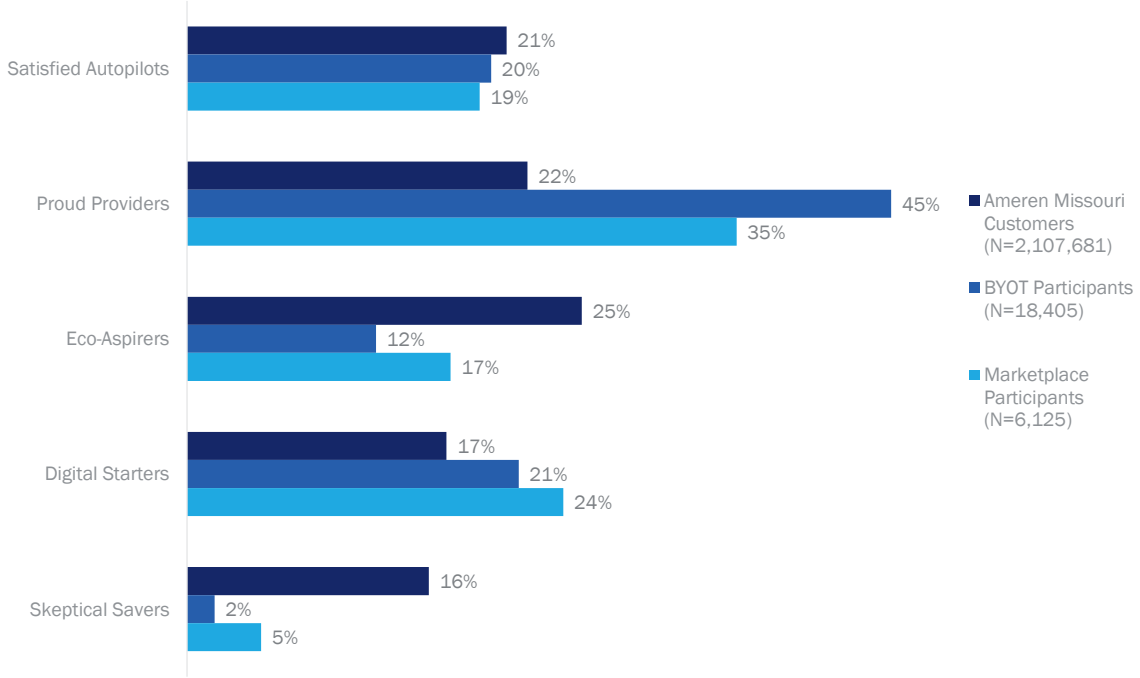
The share of Skeptical Savers among Emerson participant population was much higher in PY2020 than in PY2019, likely due to the fall promotion, while the share of Proud Providers was much lower. The share of Proud Providers and Digital Starters among PY2020 enrolled ecobee participant population was slightly lower than among the PY2019 enrolled participants, while the share of Autopilots and Eco-Aspirers was slightly higher. Aside from a slight increase in the share of Eco-Aspirers in PY2020 as compared to PY2019, the Nest customer segment composition remained largely unchanged over the two Program Years (Figure 16).

Figure 16. Residential DR Program: Segment Distribution by Device Manufacturer and Year of Enrollment



Different program channels attract different customer segments. Specifically, the BYOT channel attracted considerably more Proud Providers than the Marketplace channel (45% vs. 35%), while the Marketplace channel attracted considerably more Eco-Aspirers, Digital Starters, and Skeptical Savers (Figure 17).

Figure 17. Residential DR Program: Segment Distribution by Enrollment Channel



While the impact of engaging different customer segments with the DR program on program performance is unclear without additional analysis, it is possible that different segments respond differently to program messages as well as event signals. It is also possible that different segments are motivated by different stimuli to enroll their devices in the program and perform as desired as part of the program. Availability of the segment data for the entire Ameren Missouri residential customer population may present a powerful tool to help calibrate program enrollment to reach select segments of interest. It can also allow Ameren Missouri to tailor program messaging to better resonate with each segment's motivators and priorities. This, in turn, can lead to improved enrollment success and result in stronger program performance.

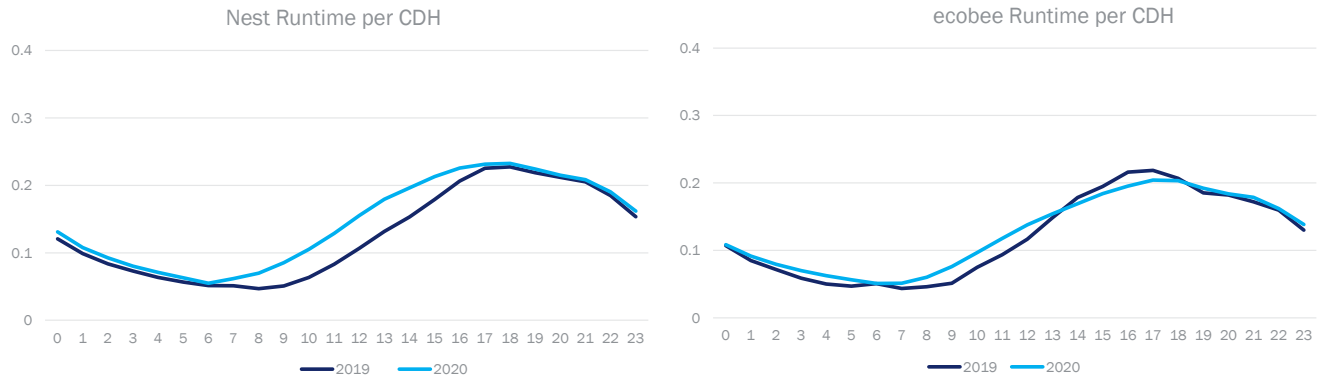
Participant Program Experiences

Stay-at-home orders, social distancing, and sustained work-from-home behaviors across the state of Missouri and the rest of the country caused by the coronavirus pandemic led to a change in energy usage patterns in 2020 starting in April.[19] As part of this evaluation, the evaluation team conducted a focused exploration of the possible effects of the pandemic on participant behaviors during the PY2020 DR events. We relied on the exploratory analysis of the telemetry data as well as analysis of the results from a brief post-event survey that Uplight conducted in September 2019 and June–July 2020.[20]

[19] See note 12 above.
[20] Uplight sent the survey to all participants following the September 3, 2019 event and June 26, 2020 event. Uplight completed 635 surveys in 2019 and 1,188 surveys in 2020. Notably, most questions in the 2019 survey were administered with only Nest participants.

Analysis of runtime data during proxy days selected for impact analysis shows an increase in cooling load in PY2020 as compared to PY2019 for Nest and ecobee devices.[21] Figure 18 shows, for Nest and ecobee devices separately, average hourly runtime per cooling degree hour (CDH) for 24 hours across 2019 and 2020 proxy days.[22] We do not show similar results for Emerson devices due to a small number of devices enrolled in PY2019. In PY2020, runtime is higher than in PY2019 by 16% for Nest devices and 6% for ecobee devices. As can be seen in the graph, temperature alone likely does not account for increased runtime. While it is possible that the composition of participant population changed considerably between PY2019 and PY2020[23] leading to changes in cooling runtime patterns, there is reason to believe that the increase was in part caused by the pandemic.

Figure 18. Residential DR Program: Year-Over-Year Proxy Day Runtime and Temperature Comparisons



Stay-at-home orders and work-from-home behaviors caused more participants to be home during event hours in PY2020. Based on the results of the post-event participant surveys, 67% of participants in PY2019 reported being home for the whole event or part of it. In PY2020, significantly more (87%) participants reported the same. Despite a higher rate of being at home during event hours, there has been no impact on temperature overrides between PY2020 and PY2019, as reported by participants (12% vs. 13% respectively).[24] Telemetry data corroborates this finding. Table 14 shows temperature setpoints for Nest devices during each event hour across all events in PY2019 and PY2020.[25] As can be seen in the table, changes in temperature setpoints are generally similar across the two years, as are the changes in baseline setpoints, suggesting limited change in override behaviors year-over-year.

Table 14. Residential DR Program: Differences in PY2020 Nest Setpoints by Event Hour

Event Hour	PY2019		PY2020	
	Event Setpoint	Baseline Setpoint	Event Setpoint	Baseline Setpoint
Hour 1	78	75	78	75
Hour 2	77	75	77	75
Hour 3	76	75	77	75

While program participants were at home more during the PY2020 event season and despite increased load, our focused analysis suggests limited effects of the pandemic on participant performance during the events.

[21] Proxy days are non-event days with temperature and usage patterns similar to those observed on event days.
[22] CDH calculated using base temperature of 75°Fahrenheit
[23] PY2020 devices included devices that were enrolled in PY2019 as well as devices enrolled in PY2020.
[24] 13% represents only Nest devices, which, at the time of the survey accounted for most of participating devices.
[25] We could not run comparisons for ecobee devices due to PY2020 setpoint data being impacted by the shifted timestamp issue.

As Missouri and the rest of the United States enter the second year of the pandemic and residential customers will likely face continued adjustments to their lifestyle driven by the pandemic, it is feasible that existing participant performance will continue to reflect their PY2020 behaviors.

Program De-Enrollment

A total of 7% of participants de-enrolled from the Program since its launch in PY2019 (Table 15). Nest device owners are more than twice as likely to de-enroll as Emerson device owners and are 25% more likely to de-enroll than ecobee device owners. This trend can be observed across all devices enrolled between PY2019 and PY2020, as well as across only devices enrolled in PY2020. The de-enrollment rate is half of that observed among Nest device owners who purchased their devices through the Marketplace channel as compared to the Nest device owners who entered the program via the BYOT channel. However, the de-enrollment rate differences between the Marketplace and the BYOT channel for ecobee and Emerson devices should be interpreted with caution. Deployment of OE algorithms on ecobee devices in PY2019 resulted in a high de-enrollment rate, with most ecobee devices entering the program via the BYOT channel that year. This skews the total de-enrollment rates for the BYOT channel for ecobee devices. For Emerson devices, enrollment via the Marketplace channel only started ramping up toward the end of the summer 2019, and with de-enrollment often being a result of event experiences, Marketplace customers may not have had experiences and similar duration in the program that could lead to de-enrollment.

Table 15. Residential DR Program: Customer De-Enrollment Trends

Device Manufacturer	De-Enrollment Rate								
	PY2019*			PY2020*			Total as of the End of PY2020		
	BYOT	Market place	Total	BYOT	Market place	Total	BYOT	Market place	Total
Nest	1%	0%	1%	6%	3%	5%	10%	5%	9%
ecobee	17%	1%	16%	3%	3%	3%	7%	3%	6%
Emerson	0%	0%	0%	4%	0%	1%	6%	0%	2%
Total	**2%**	**0%**	**2%**	**4%**	**1%**	**3%**	**9%**	**2%**	**7%**

Note: Includes customer enrolled and de-enrolled within the program year. Does not include customers who enrolled during the program year and de-enrolled during the following program year.

Thermostat Optimization Trends

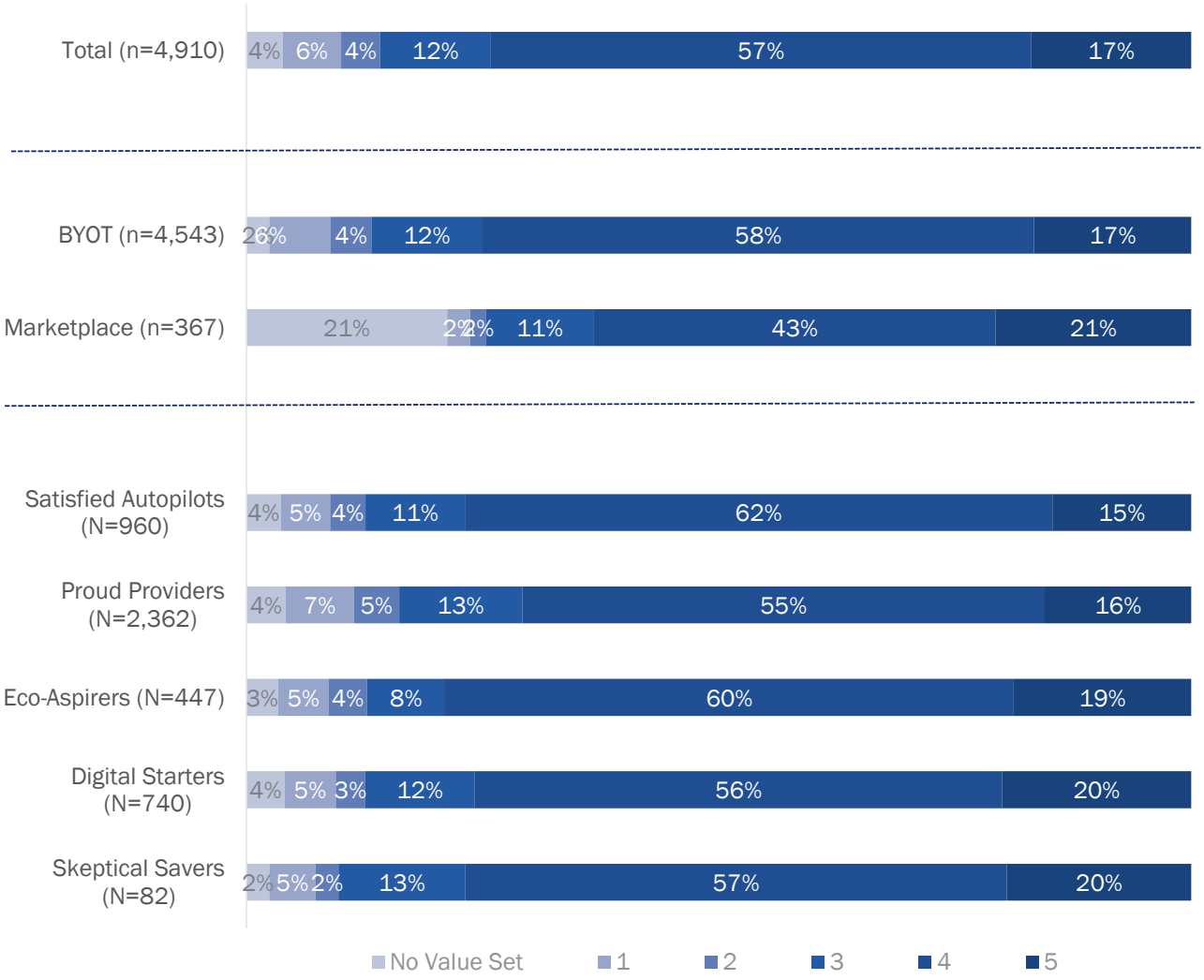
Ecobee made their eco+ optimization platform available on all ecobee devices in the spring of 2020. The platform prompts customers to indicate their desired level of optimization in order to balance comfort versus savings. The eco+ platform features several components, including energy efficiency optimization. As part of the energy efficiency optimization component, customers can choose their desired level of savings using a slider scale from 1 to 5, with 1 being least aggressive optimization for energy efficiency and 5 being most aggressive.

At the end of June 2020, Nest made its Seasonal Savings optimization platform available to all its customers, as opposed to offering this platform as part of the utility programs.

Widespread availability of optimization platforms may have affected the DR program impacts, both energy and demand. By optimizing devices during the day, optimization algorithms may be reducing baseline HVAC load, thus resulting in decreased event day demand impacts. Without additional analysis and access to the optimization uptake data, the effect of the optimization platforms on program impacts is unclear. The evaluation team, however, was able to obtain and analyze DR program participant selection of the eco+ energy efficiency slider setting as of October 2020 and is a snapshot in time. Figure 19 shows the selections broken

down by enrollment channel and customer segment. As can be seen in the figure, 17% of ecobee participants selected the most aggressive slider setting and an additional 57% selected the next most aggressive setting. A very small percent of participants did not set any values. A much higher share of Marketplace participants did not set any slider values on their devices. At the same time, more Marketplace participants selected the most aggressive optimization setting as compared to the BYOT participants. Eco-Aspirers are more likely to select more aggressive settings, though differences across customer segments are not strongly pronounced.

Figure 19. Residential DR Program: Eco+ Slider Selection



Data Limitations and Opportunities

The evaluation team encountered several data challenges and imperfections that limited our ability to conduct the evaluation as initially planned and resulted in several areas of uncertainty. Data imperfections spanned both participant data as well as telemetry data and included the following:

- **Inconsistency in tracking of de-enrolled accounts, program enrollment channels, and enrollment timelines.** The evaluation team observed inconsistencies in account de-enrollment from the

program, requiring cross-validation of the data across multiple files, including going back to PY2019 data extracts, and conducting follow-up conversations with Franklin Energy and Uplight. The evaluation team also encountered inconsistencies in terms of the enrollment channel and program enrollment dates across the Franklin and Uplight files. These latter imperfections were not frequent yet, given the importance of the data fields to the evaluation, required manual comparison and investigation.

- **Telemetry data quality.** ecobee's shift to the eco+ platform necessitated development and troubleshooting of Uplight's data ingestion pipelines. Pipeline issues were not fully resolved in time for evaluation, resulting in data quality issues, the most prominent of which was timestamp shifting, which is described in detail in the methods section earlier in this report.
- **Device event participation status.** Tracking of device status in each event is critical to support accurate device assignment for impact purposes and extrapolation of impacts to the right participant population. PY2020 device assignments were inconsistent, incomplete, and not sufficiently detailed, resulting in a change of the impact approach and requiring a series of assumptions in order to develop program impacts, namely resource capability.
- **Anonymization of device data in the telemetry files.** Consistent with PY2019, Nest did not provide a way to link participant with telemetry data necessitating continued adjustments to the planned approach to estimate energy and demand impacts. The evaluation team was also unable to map Emerson devices to the participant data in PY2020. While the evaluation team was able to estimate demand and energy impacts using assumptions and extrapolations, 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.

The data issues described above limited the evaluation team's ability to execute the evaluation as planned and required additional time and resources to resolve data imperfections and advance evaluation efforts. Addressing these issues in the future is important to ensuring high-quality and cost-effective evaluation.

4.4.2 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.

Event Season Demand Impacts

The Residential DR Program achieved 17.40 MW in average event season demand impacts across all treated devices. Table 16 provides event season demand impacts by event and device manufacturer. Event day demand impacts represent average impacts across all event hours. The Appendix volume submitted alongside this report contains detailed tables with hourly demand impacts by event and device manufacturer. Due to ecobee data challenges for the September 8, 2020 event, the results for the final event were modeled and presented here for reference; however, they were not used in final calculations of event season impacts. For ecobee devices, the total event season impacts were calculated using the results from the June 26, August 25, and August 26, 2020 events.

Per device demand impacts range from 0.8 to 1.25 kW and are generally higher on hotter days. On average, per-device demand impacts during the September 8, 2020 event (when the temperature was the lowest of the four events) were the lowest of the event season at 1.07 kW. In contrast, the remaining three events (with temperatures of 90° Fahrenheit and higher) had the highest average per-device impacts at 1.12, 1.14, and

1.18 kW for the June 26, August 25, and August 26, 2020 events, respectively. Overall demand impacts were generally highest for Nest devices across all events when compared to other manufacturers. Event season impacts for Emerson devices were likely affected by a shift to the OE dispatch platform and resulting issues with the OE algorithms being able to dispatch events among devices with specific device settings (autocool and off modes). Impacts for ecobee devices reflect eco+ platform algorithms.

Table 16. Residential DR Program: Demand Impacts by Event and Manufacturer

Event	Manufacturer	Total Number of Enrolled Devices	Total Number of Devices Participating in Event	Aggregate (MW)		Per Device (kW)		% Load Impact	Average Event Day Temp. (F)
				Baseline Load	Load Impact	Baseline Load	Load Impact		
June 26, 2020	Nest	13,573	9,299	17.03	11.05	1.83	1.19	65%	93
	ecobee	3,748	2,066	3.19	1.77	1.54	0.86	56%	
	Emerson	1,544	1,195	2.17	1.29	1.81	1.08	59%	
	Total	**18,865**	**12,561**	**22.39**	**14.12**	**1.78**	**1.12**	**63%**	
August 25, 2020	Nest	15,058	11,536	21.44	13.94	1.86	1.21	65%	93
	ecobee	4,125	2,584	4.11	2.31	1.59	0.89	56%	
	Emerson	2,546	1,409	2.57	1.53	1.82	1.08	59%	
	Total	**21,729**	**15,530**	**28.12**	**17.77**	**1.81**	**1.14**	**63%**	
August 26, 2020	Nest	15,084	12,472	22.38	15.64	1.79	1.25	70%	90
	ecobee	4,125	3,083	4.71	2.93	1.53	0.95	62%	
	Emerson	2,554	1,080	1.80	1.14	1.67	1.05	63%	
	Total	**21,763**	**16,634**	**28.89**	**19.71**	**1.74**	**1.18**	**68%**	
September 8, 2020	Nest	15,946	12,039	17.37	13.38	1.44	1.11	77%	86
	ecobee								
	Emerson	2,674	1,597	2.32	1.28	1.45	0.80	55%	
	Total	**18,620**	**13,636**	**19.68**	**14.65**	**1.44**	**1.07**	**74%**	

Table 17 provides a summary of average demand impacts by device manufacturers for the event season. Across the PY2020 season events,[26] the program achieved 1.13 kW in per-device demand impact. The average per event demand impact for the PY2020 event season is 17.40 MW.[27] Nest devices achieved higher per-device demand impacts than ecobee and Emerson devices on average (1.19 kW vs. 0.91 and 0.99 kW). Across all manufacturers, per-device impacts were considerably lower than the planned value (2.01 kW).[28]

[26] Note that we excluded the September 8 event for ecobee devices due to data quality concerns.
[27] Note that this value does not include the September 8 event in the average due to the removal of ecobee devices, causing a slight difference in aggregate demand impact depending on the calculation approach.
[28] This value is based on MEEIA III PY2020 enrollment goal of 14,438 participants and 24.83 MW in demand savings and an assumption of 1.17 devices per participant. The most recent version of the Ameren MO TRM deems the demand savings at 1.53 kW per thermostat.

Table 17. Residential DR Program: Average Event Season Demand Impacts by Manufacturer

Manufacturer	Average Number of Enrolled Devices	Average Number of Devices Participating in Event	Aggregate (MW)		Per Device (kW)		% Load Impact	Average Event Temp. (F)
			Baseline Load	Load Impact	Baseline Load	Load Impact		
Nest	14,915	11,337	19.71	13.66	1.73	1.19	69%	90
ecobee	3,999	2,578	4.10	2.41	1.55	0.91	58%	92
Emerson	2,330	1,320	2.24	1.32	1.68	0.99	59%	90
All	**21,244**	**15,235**	**26.06**	**17.40**	**1.69**	**1.13**	**66%**	**91**

Note: ecobee impacts exclude Event 4 (September 8, 2020)

The Appendix volume submitted alongside this report 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 PY2020 that are anticipated to participate in events. Table 18 details resource capability impacts by device as well as cumulatively across all devices.

Anticipated demand impacts are 28.74 MW. Average per-device impacts under TRM-defined peak weather conditions are estimated at 1.12 kW and are higher for Nest and Emerson devices (1.19 and 1.13 kW, respectively) than for ecobee devices (0.91 kW). The average demand impact is considerably lower than the per-device planned value of 2.01 kW,[29] indicating that even under peak weather conditions the program will likely fall short of the goal.

Table 18. Residential DR Program: Resource Capability Impacts

Manufacturer	Total Number of Devices Enrolled	Total Number of Devices Anticipated to Participate in Events	Aggregate (MW)		Per Device (kW)		% Load Impact
			Baseline Load	Load Impact	Baseline Load	Load Impact	
Nest	16,992	14,637	30.83	17.41	2.11	1.19	56%
ecobee	6,035	5,119	8.76	4.65	1.71	0.91	53%
Emerson	5,986	5,894	11.85	6.68	2.01	1.13	56%
All	**29,013**	**25,650**	**51.44**	**28.74**	**2.01**	**1.12**	**56%**

Note: ecobee impacts exclude Event 4 (September 8, 2020)

Table 19 compares the resource capability impacts to the PY2020 MEEIA III goals. Weather-normalized demand impacts of 28.74 represents 116% of the cumulative PY2020 goal.

Table 19. Comparison of Resource Capability Impacts to Goal

Metric	Result
Resource capability load impact (MW)	28.74

[29] This value is based on MEEIA III PY2020 enrollment goal of 14,438 participants and 24.83 MW in demand savings and an assumption of 1.17 devices per participant. The most recent version of the Ameren MO TRM deems the demand savings at 1.53 kW per thermostat.

Metric	Result
Cumulative PY2020 MEEIA III goal (MW)	24.83
Percent of PY2020 goal	116%

Cumulative DR Capability

Cumulative DR capability for the Residential DR program mirrors resource capability and is presented in Table 20. Cumulative DR capability represents a performance metric for the earnings opportunity award for the DR programs.

Table 20. Residential DR Program: Comparison of Cumulative DR Capability to Target

Metric	Result
Cumulative DR capability (MW)	28.74
PY2020 target (MW)	24.83
Percent of PY2020 target	116%

Summary of Energy Impacts

Energy impacts in PY2020 were limited to event day impacts. Ameren Missouri did not pursue energy optimization as part of the Residential DR program due to broad availability of optimization algorithms for two of the three participating device manufacturers (eco+ for ecobees and Seasonal Savings for Nests). Because these optimization algorithms are not program-driven but are rather offered by device manufacturers to all their devices, the savings resulting from those algorithms cannot be attributed to the program. In fact, presence of broadly available algorithms may have an impact on baseline load and may negatively impact device performance by downward adjusting the HVAC load during event hours.

Table 21 compares total event season energy savings to the MEEIA III goal.[30] The Residential DR Program achieved 94.75 MWh out of target 2,441 MWh, which represents 4% of the MEEIA III goal.

Table 21. Residential DR Program: Comparison of PY2020 Event Season Energy Savings to Goal

Metric	Result (MWh)
Event season energy savings	94.75
PY2020 MEEIA III goal	2,441
Percent of goal	4%

Table 22 details event day per-device and total energy savings by manufacturer. Energy savings presented in the table reflect cumulative reductions in energy over the 24-hour period, as compared to baseline days, across all four test events.[31] Energy savings range from -0.10 kWh to 2.78 kWh per treated device, depending on event and manufacturer. Negative energy savings are common for DR programs and are often a result of precooling in advance of the event or snapback following the event leading to higher energy consumption than any reductions achieved during event hours.

[30] Goals are based on the MEEIA III Plan filing for the Residential DR program.
[31] Energy savings for ecobee devices for Event 4 (September 8, 2020) were imputed based on the average per-device savings across all other event performance for ecobees.

Table 22. Residential DR Program: Event Day Energy Savings by Event and Device Manufacturer

Event	Manufacturer	Total Number of Enrolled Devices	Total Number of Devices Participating in Event	Aggregate (MWh)		Per Device (kWh)		% Savings	Average Event Day Temp. (F)
				Baseline Usage	Energy Savings	Baseline Usage	Energy Savings		
June 26, 2020	Nest	13,573	9,299	268.97	7.97	28.92	0.86	3%	93
	ecobee	3,748	2,066	50.96	3.52	24.66	1.70	7%	
	Emerson	1,544	1,195	33.68	-0.12	28.18	-0.10	0%	
	Total	**18,865**	**12,561**	**353.60**	**11.36**	**28.15**	**0.90**	**3%**	
August 25, 2020	Nest	15,058	11,536	342.04	15.45	29.65	1.34	5%	93
	ecobee	4,125	2,584	64.61	1.45	25.00	0.56	2%	
	Emerson	2,546	1,409	40.89	0.42	29.01	0.30	1%	
	Total	**21,729**	**15,530**	**447.54**	**17.32**	**28.82**	**1.12**	**4%**	
August 26, 2020	Nest	15,084	12,472	372.01	34.69	29.83	2.78	9%	90
	ecobee	4,125	3,083	76.92	5.26	24.95	1.71	7%	
	Emerson	2,554	1,080	29.86	2.54	27.66	2.35	8%	
	Total	**21,763**	**16,634**	**478.80**	**42.49**	**28.78**	**2.55**	**9%**	
September 8, 2020	Nest	15,946	12,039	287.11	17.48	23.85	1.45	6%	86
	ecobee	4,134	2,587	53.51	3.42	20.69	1.32	6%	
	Emerson	2,674	1,597	37.50	2.68	23.48	1.68	7%	
	Total	**22,754**	**16,223**	**378.12**	**23.58**	**23.31**	**1.45**	**6%**	

Note: Ecobee per device savings for September 8, 2020 event represent average per device savings across the three previous events.

Table 23 summarizes event day energy savings by device manufacturer across all events. As can be seen in the table, event day energy savings averaged 6.05 kWh per-device and represented 6% of the total baseline usage. Across the four demand response events dispatched in PY2020, the Residential DR Program achieved 94.75 MWh in energy savings. As with the demand savings, Nest contributed the most savings to the event season total (80%).

Table 23. Residential DR Program: Event Day Energy Savings by Device Manufacturer

Manufacturer	Average Number of Enrolled Devices	Average Number of Devices Participating in Event	Aggregate (MWh)		Per Device (kWh)		% Savings
			Baseline Usage	Energy Savings	Baseline Usage	Energy Savings	
Nest	14,915	11,337	1,270.13	75.59	112.25	6.43	6%
ecobee	4,033	2,580	246.01	13.64	95.31	5.29	6%
Emerson	2,330	1,320	141.93	5.52	108.33	4.22	4%
All	**21,278**	**15,237**	**1,658.07**	**94.75**	**109.04**	**6.05**	**6%**

Note: Ecobee per device savings for Event 4 (September 8, 2020) represent average per device savings across the three previous events.

5. Business Demand Response Program

This section summarizes the PY2020 evaluation methodology and results for Ameren Missouri's Business Demand Response (DR) Program.

5.1 Evaluation Summary

5.1.1 Program Description

The Business Demand Response Program was in its second year of deployment in PY2020. The program was designed to reduce load during periods of peak demand. Enel X acted as the program aggregator in PY2020, 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 generation. 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 PY2020, as in PY2019, leveraging behind-the-meter generation to support load reductions 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, 2020. Enel X also called additional test events in December in order to test the capability of the customers enrolled in the program after the completion of the summer season and prior to the end of the program year. Enel X could call up to five peak shaving events and up to two test events.[32] Both event types could last for up to four hours in duration. No more than two events could be called consecutively.

Figure 20 provides a visual overview of the event notification process that Enel X followed in PY2020 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 sent participants an e-mail with advance notice for a likely event day. Participants also received a reminder notification a few days before the event day. On the day of the event, Enel X issued 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 have received a second alert. After the event ends, Enel X sent a final e-mail confirming the end of the DR event dispatch.

[32] Emergency demand response events were not planned for the 2020 event season.

Figure 20. 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 historically focused its outreach on larger customers to ensure sufficient DR opportunities. Once a customer agrees to participate, Enel X installs its metering equipment to collect interval electric usage data. In cases where enrolled customers do not have interval metering equipment, Ameren Missouri upgrades those customers' meters to capture energy consumption at 15-minute intervals.

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

Ameren Missouri registered Business DR program as a Load Modifying Resource in the Midcontinent Independent System Operator (MISO) market in PY2020.

5.1.2 Participation Summary

Based on the MEEIA III filing, the program cumulative goal for PY2020 was 50 MW of capacity reduction. In PY2021, Ameren Missouri will raise its MEEIA III goal to 75 MW of capacity reduction. Enel X enrolled 279 customers by the end of the PY2020 event season with a total nominated capacity of 59.97 MW, which represents 120% of the PY2020 MEEIA III goal.[33]

Table 24. Business DR Program: Goals and Participation Summary

Metric	Cumulative MEEIA III Goal	Enrollment	% of Goal
End of the PY2020 Event Season Enrollment Summary			
Accounts	100	279	279%
Enrolled Nominated capacity (MW) as of PY2020 Year-End	50	59.97	120%

In PY2020, Ameren Missouri used the program for peak shaving purposes. To assess participant performance, Enel X called two one-hour test events during the event season on August 20 and September 17. Following the completion of the event season, Enel X dispatched two one-hour test events on December 8, 2020 and on December 17, 2020 to ascertain nominated capacity values for customers enrolled in the program after the end of the 2020 event season. The December 8 test event had a single participant with 1 MW of nominated capacity, and the December 17 test event had five participants with a cumulative 1 MW of nominated capacity.

[33] Customers are defined as unique accounts.

Figure 21 below provides details for each test event.

Figure 21. Business DR Program: Overview of PY2020 Events

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

PY2020 participants spanned a range of business types, including education, mining, big box retail, and agriculture. Manufacturing, agriculture, mining, and educational facilities were the biggest contributors in terms of nominated capacity.

5.1.3 Key Impact Results

The Business DR Program achieved 53.69 MW in average demand savings during the PY2020 event season. Program participants achieved 91% of the nominated capacity in both the August 20 test event and the September 17 test event. Table 25 presents average event day demand savings achieved during the PY2020 event season.

Table 25. Business DR Program: Event Season Demand Savings

Event	Nominated Capacity (MW)	Event Season Performance (MW)	% of Nominated Capacity Achieved
Event 1 (August 20, 2020)	57.87	52.82	91%
Event 2 (September 17, 2020)	59.97	54.56	91%
Average Demand Savings	**58.92**	**53.69**	**91%**

Table 26 presents the PY2020 resource capability estimate. Resource capability represents the sum of average event performance across all accounts enrolled in the program as of the end of PY2020 and is an estimate of what the program can expect to have available toward the PY2021 goal. Notably, resource capability includes customers who were enrolled in the program after the completion of the event season but before the end of the program year and whose performance was tested during the December test events. The Business DR Program is estimated to achieve 55.36 MW in event impacts through accounts enrolled in the program as of the end of PY2020. This represents 111% of PY2020 cumulative MEEIA III MW goal. Section 5.3.3 has more information on the resource capability estimate calculation.

Table 26. Business DR Program: Resource Capability Estimate

Metric	Result
PY2020 resource capability estimate (MW)	55.36
PY2020 cumulative MEEIA III goal (MW)	50.00
Percent of PY2020 goal	111%

Table 27 presents the PY2020 cumulative DR capability. The value in the table represents demand impacts from tested accounts, either during the PY2020 event season or during the December test event. The main difference between resource capability and cumulative DR capability is that resource capability can include accounts that were enrolled during a program year but not tested, while cumulative DR only includes tested accounts. In PY2020, all accounts enrolled in the program participated in a test event, therefore resource capability and cumulative DR capability values are the same. Cumulative DR capability represents a performance metric for the earnings opportunity award for the DR programs. The program's cumulative DR capability is 55.36 MW and represents 111% of the target.

Table 27. Business DR Program: Cumulative DR Capability

Metric	Result
PY2020 cumulative DR capability (MW)	55.36
PY2020 target	50.00
Percent of PY2020 target	111%

Achieving energy savings during demand response events was not the primary goal of the Business DR Program. Nonetheless, participants decreased consumption by a total of 400.68 MWh in the four test events. The energy savings fell short of the target of 1,000 MWh and represent 40% of the MEEIA III cumulative energy savings goal. Table 28 presents the PY2020 event season energy savings. The amount of energy savings is not surprising given that only two one-hour test events were dispatched during the PY2020 event season.

Table 28. Business DR Program: Energy Savings

Event	Cumulative MEEIA III Goal (MWh)	Event Season Energy Savings (MWh)	Percent of Goal
Event 1 (August 20, 2020)		225.64	
Event 2 (September 17, 2020)		154.63	
Event 3 (December 8, 2020)		22.65	
Event 4 (December 17, 2020)		-2.25	
Total	**1,000.00**	**400.68**	**40%**

5.1.4 Key Process Findings

In PY2020, the Business DR program continued effective customer engagement and event dispatch. Key participation highlights include the following:

- A total of 285 accounts across 236 unique facilities and 91 businesses were enrolled in the program at the end of PY2020 with a nominated capacity of 62.12 MW.
- A total of 31 accounts de-enrolled from the program in PY2020, representing a 10% de-enrollment rate. De-enrolled customers span various segments and tend to be large in terms of their nominated capacity (678 kW compared to 218 kW among active accounts as of the end of PY2020).
- Enrolled customers spanned a range of business segments, including manufacturing, mining, consumer services, and transportation. PY2020 enrollment shifted toward education, agriculture, and mining sectors. Nominated capacity among PY2020 enrolled participants was 2.5 times lower than the nominated capacity among participants enrolled in PY2019.
- In PY2020, Enel X reported that program operations ran smoothly with no challenges with event notifications or dispatch. Notably, as Enel X was enrolling participants and preparing for event dispatches, not all participants had their meters upgraded to interval meters in time for event dispatch. This resulted in uncertainty related to participant event performance and necessitated limited imputations in participant performance.
- The COVID-19 pandemic disrupted business operations across the country, however, including within Ameren Missouri's service territory, affecting all aspects of the program operation as a result.[34] Business DR participants experienced significant changes to the normal state of operation during the pandemic. Enel X reported experiencing challenges with enrolling new customers as well as with achieving expected performance from the already enrolled customers. Some participants were unwilling to dispatch due to COVID-19 placing greater strains on their business due to increased production demands. Others saw reduced load due to business closures. Our focused analysis of 44 participants who participated in the program in PY2019 and PY2020 showed a slight increase in load, continuously high performance but a slight decrease in PY2020, and reduced variation in performance across events year-over-year.[35] The subset of 44 participants was comprised of strong performers and included mostly manufacturing facilities. It

[34] See note 12 above.
[35] Changes in variation in performance in PY2020 could be due to participants gaining experience with the program in the second year of participation.

is not surprising therefore that these participants sustained load and performance during the pandemic.

Moving forward, Enel X is anticipating making further improvements to their program targeting and delivery process. More specifically, Enel X is planning to deploy additional cost-effective and streamlined customer enrollment strategies, mine additional participants for more savings, and improve the speed of interval data ingestion to offer customers a faster turnaround of their event performance feedback as well as incentive payments.

Missouri 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 29 summarizes responses to the CSR process evaluation requirements.

Table 29. 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. As the program enters its third year, some program participants are gaining experience. However, thus far the only DR events called have been test events. Program participants have yet to participate in an actual event, and therefore are missing experience under actual grid event conditions. 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.
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 the heterogeneity of facility types, operations, and appropriate load reduction strategies. The 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 implementer feedback indicates no program delivery issues.
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 developing processes for expediting participant payment. Enel X is also exploring strategies for streamlined and cost-effective enrollment of customers with smaller nominations to ensure cost-effective recruitment and engagement of customers. Enel X is actively working to explore ways to achieve more performance among already enrolled participants.

5.1.5 Conclusions and Recommendations

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

- **Conclusion 1:** The Business DR program exceeded its MEEIA III participation and demand savings goals and is well-positioned for continued success. The Business DR program fell short of the MEEIA III energy savings goal. The key driver behind the shortfall is a dispatch of a limited number of events in PY2020. According to Enel X, future program participants are likely to be smaller in terms of their nominated capacity, which will require enrollment of more participants for the program to meet its goals.
  - Recommendation 1: Program staff should balance participant enrollment with the size of their nominations and uncertainty surrounding their performance.
- **Conclusion 2:** Program de-enrollment affects large participants presenting a risk for program performance.
  - Recommendation 2: Program staff should explore reasons for de-enrollment to mitigate de-enrollment moving forward. Program staff should factor de-enrollment in its planning efforts.
- **Conclusion 3:** COVID-19 impacted Business DR program enrollment and performance in PY2020 and will likely continue to impact the program in PY2021. COVID-19 impacted different customers differently, leading to load increase among some and significant load decrease among others.
  - Recommendation 3: Program staff should continue to aggressively pursue new participants and deploy a custom approach when assessing the likely impact of the COVID-19 pandemic on participant performance, taking into account participant past performance, tenure with the program, and business segment.
- **Conclusion 4:** Availability of interval data for some accounts resulted in inability to calculate event performance based on the actual customer behaviors and resulted in the need for data imputations.
  - Recommendation 4: As customer enrollment continues to grow in PY2021, Enel X and Ameren Missouri should consider continued collaboration to ensure timely communication around participant enrollment and meter upgrades.

5.2 Evaluation Methodology

This section summarizes the key objectives and methods for the PY2020 Business DR Program evaluation. The key evaluation objectives included:

- Ascertain changes to program delivery, customer enrollment, load reduction strategies, and nominated capacities;
- Understand and describe participant mix in terms of size, business segment, and other available characteristics;
- Identify program successes and challenges, especially in the context of the COVID-19 pandemic; and

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

Table 30 provides an overview of the Business DR Program evaluation activities. Following the table, we outline program-specific aspects of key evaluation methodologies.

Table 30. Business DR Program: PY2020 Evaluation Activities for the Business DR Program

Evaluation Activity	Description
Program Manager and Implementer Interviews	▪ Gathered feedback to understand program staff's perspective on program performance. Feedback was gathered on a continuous basis as part of periodic check-in meetings over the course of the program year.
Program Material Review	▪ Reviewed available program materials to inform evaluation activities.
Gross Impact Analysis	▪ Used aggregator's established baseline method to estimate hourly and average event kW and kWh savings impacts. ▪ Calculated average demand savings across all peak shaving events throughout the summer event season. ▪ Calculated demand savings including participants enrolled in the program as of the end of PY2020. ▪ Support bidding of DR program impacts as a load modifying resource into MISO market.

5.2.1 Program Manager and Aggregator Interviews

Throughout PY2020, the evaluation team, Enel X, and Ameren Missouri staff met monthly to discuss ongoing administration of the program, any changes or anticipated challenges to program delivery and goal achievement, and to help finalize results after demand response events. In addition to these monthly conversations, the evaluation team conducted a formal interview with Enel X staff at the end of 2020 to debrief on PY2020 experiences and understand any programmatic changes going into PY2021.

5.2.2 Impact Analysis

As part of the gross impact analysis, the evaluation team estimated event-day demand and energy impacts, as well as 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 two December test events, 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 the 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 test events for each account.[36]

[36] For accounts with only one event dispatched (total of 11 accounts), we used that event's performance.

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 of the last five 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

The baseline adjustment is symmetrical and is calculated 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. Baseline adjustment is capped at 75% of the provisional baseline.[37] In other words, in cases where an account's baseline adjustment amounts to 75% or more of its provisional baseline, the adjustment is not applied.

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

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

Missing Data

Not every participating account in PY2020 had interval data available to calculate demand impacts using the above-described approach. Furthermore, some accounts did not have full interval data necessary to calculate demand impacts. To mitigate data gaps, the evaluation team used the following approach to calculating demand impacts:

- For accounts where bill grade interval data was not available, the evaluation team relied on the metered consumption data collected by Enel X.
- For accounts with interval data available for four, as opposed to five, baseline days, we included all four days in the baseline calculation.
- For accounts with no interval data for one event but data present for the other event, the evaluation team imputed the other event's performance for the event with missing data.
- For accounts with no interval data for any of the events, the evaluation team imputed performance using a weighted average per-account performance across all participating accounts with valid interval data.

[37] This represents a modification to the baseline adjustment calculation instituted in PY2020.

The evaluation team imputed demand savings for 13 total accounts, of which seven accounts did not have any interval data for any of the events. The accounts missing data were all relatively small in terms of nominated capacity—all had a nominated capacity less than 300 kW. The evaluation team conducted sensitivity analysis and determined that the imputations did not significantly impact event results or the performance rate. The evaluation team may revise this approach in the future evaluation years, depending on the type, size, and frequency of accounts with missing data. Any future modifications will need to consider tradeoffs between accuracy and the level of effort associated with the imputation approaches.

Event Day Energy Impact Estimation

The evaluation team 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 days with the highest consumption of the last five 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

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

Missing Data

Similar to demand savings, not every participating account in PY2020 had interval data available to calculate energy savings. We used the same imputation processes as for demand savings to calculate energy savings. Additionally, in cases where baseline load for accounts was missing, it was imputed using average baseload values across all participating accounts with valid interval data.

The evaluation team imputed energy savings for 13 total accounts, of which seven accounts did not have interval data for any of the events. The same accounts missing data for demand were missing data for energy savings.

Resource Capability Estimation

Annual resource capability is the sum of the demand response impacts each facility can provide, as demonstrated during the events called that year. Resource capability is calculated by adding the evaluated impacts or average evaluated impacts across events (if a facility participated in multiple events) from each participating facility during the year under consideration. If a customer enrolls during the program year but is not able to participate in a test event, they can also be included in resource capability using an applied demand response impact value.[38]

To check for weather sensitivity, the evaluation team pulled data from Lambert Airport Weather Station and examined it in a correlation matrix against the summer usage values of all the customers enrolled in the

[38] The applied demand response impact value is the nominated capacity adjusted by the event season performance rate across accounts that participated in the event season.

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. The evaluation team 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 events. More specifically:

- For accounts that participated in the PY2020 event season, we used average event season performance to estimate cumulative DR capability.
- For accounts whose performance was tested during the December test events, we used the results of the test event to estimate cumulative DR capability. No account participated in both December test events, so averaging performance was not necessary.

Data Sources and Data Cleaning

The evaluation team relied on two core sources of data when developing program impacts:

- Interval data: The evaluation team leveraged revenue quality 15-minute interval data supplied by Ameren Missouri for all enrolled customers.
- Participation data: The evaluation team obtained participation data from Enel X. The participation data extract included all customers enrolled in the program as of the end of 2020. 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.

The evaluation team 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:

- Exploration of duplicate records including duplicate accounts and interval periods;
- Consolidation of multiple meters per account; and
- 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.

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.

5.3 Evaluation Results

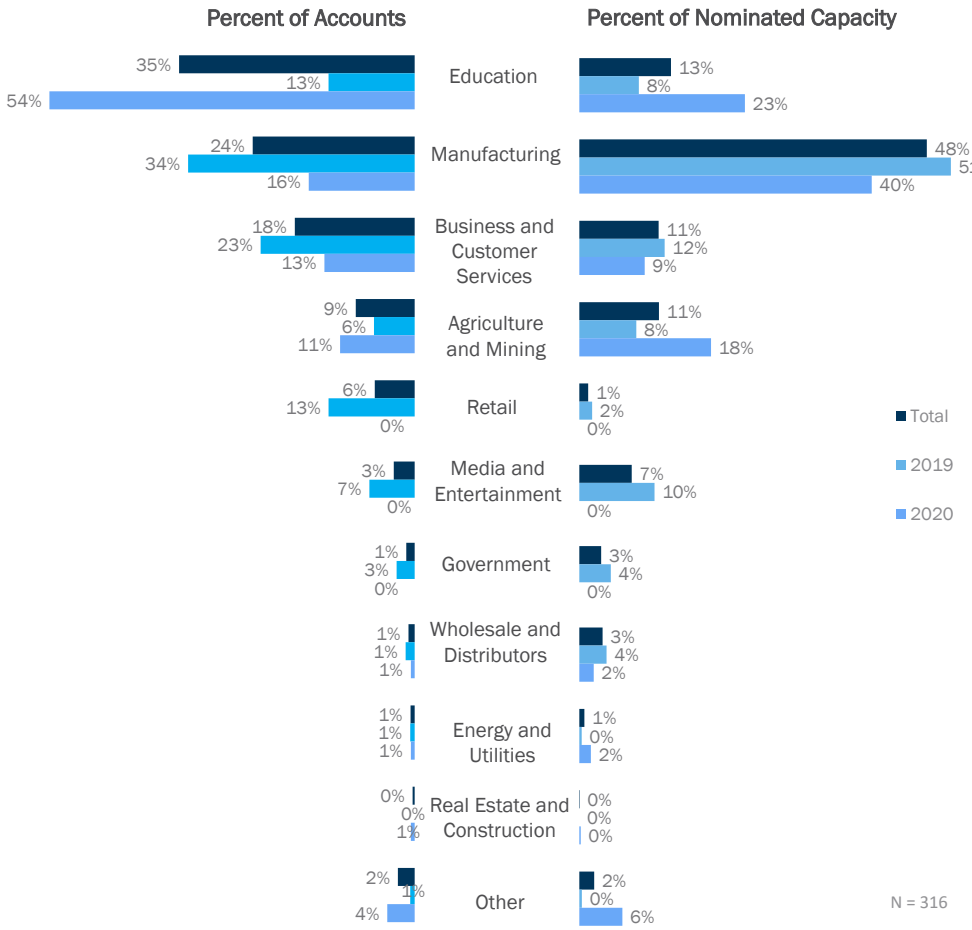
5.3.1 Process Results

Participant Composition

As of the end of PY2020, a total of 285 accounts across 236 unique facilities and 91 businesses were enrolled in the program with a nominated capacity of 62.12 MW. Enrolled customers spanned a range of business segments, including manufacturing, mining, consumer services, and transportation.

Figure 22 provides a summary of participating accounts and nominated capacity by business segment. Additionally, the figure compares distribution of segments by their total nominated capacity across accounts enrolled in PY2019 and PY2020. Overall, as of the end of the year, the largest share of nominations were concentrated within the manufacturing, agriculture, mining, education, and retail. PY2020 enrollment notably shifted toward the education, agriculture, and mining sectors.

Figure 22. Business DR Program: PY2020 Nominated Capacity and Accounts Distribution by Market Segment



Note that PY2019 values included accounts that enrolled in PY2019 and subsequently de-enrolled from the program in PY2020.
Note that business segments may not always be accurate.

As the program continues to mature, identifying and recruiting new customers will present a challenge for the program. Based on Enel X's feedback, the program has reached and attempted to engage Ameren Missouri's largest customers and has exhausted large load reduction opportunities within its service territory. Future participants will likely be smaller and will therefore be able to contribute smaller levels of capacity to the program. As a result, Enel X will need to enroll more customers to meet the program's aggressive goals. To that end, Enel X is looking to pilot two distinct approaches:

- **Tech Touch:** A solution aimed at customers with interval meters to streamline and automate enrollment of those customers into the program.
- **Existing Customer Engagement:** A process of engaging with existing customers to improve their performance through sharing customer performance over time, drawing comparisons with other participants in the industry, and offering insight into additional incentives that those participants will be able to harvest from improved performance.

Program De-Enrollment

A total of 31 accounts de-enrolled from the program, which represents 10% of all accounts enrolled in the program, between PY2019 and PY2020. De-enrolled accounts span a range of segments, including manufacturing, media and entertainment, and education among others. Average nominated per account capacity of de-enrolled accounts is 678 kW, which is considerably higher than the nominated capacity of the participants enrolled and active in the program at the end of PY2020 (218 kW). Reasons for participant de-enrollment are not clear. Accounting for participant attrition especially with an eye toward the impact of attrition on performance is an important strategy in ensuring adequate levels of available capacity to achieve goals.

Business Operations

The COVID-19 pandemic disrupted business operations across the country, including Ameren Missouri's service territory, affecting all aspects of the program operation as a result.[39] Business DR participants experienced significant changes to the normal state of operation during the pandemic. Enel X reported experiencing challenges with enrolling new customers as well as with achieving expected performance from the already enrolled customers. Some participants were unwilling to participate due to COVID-19 placing greater strains on business due to increased production demands. Others saw reduced load due to business closures.

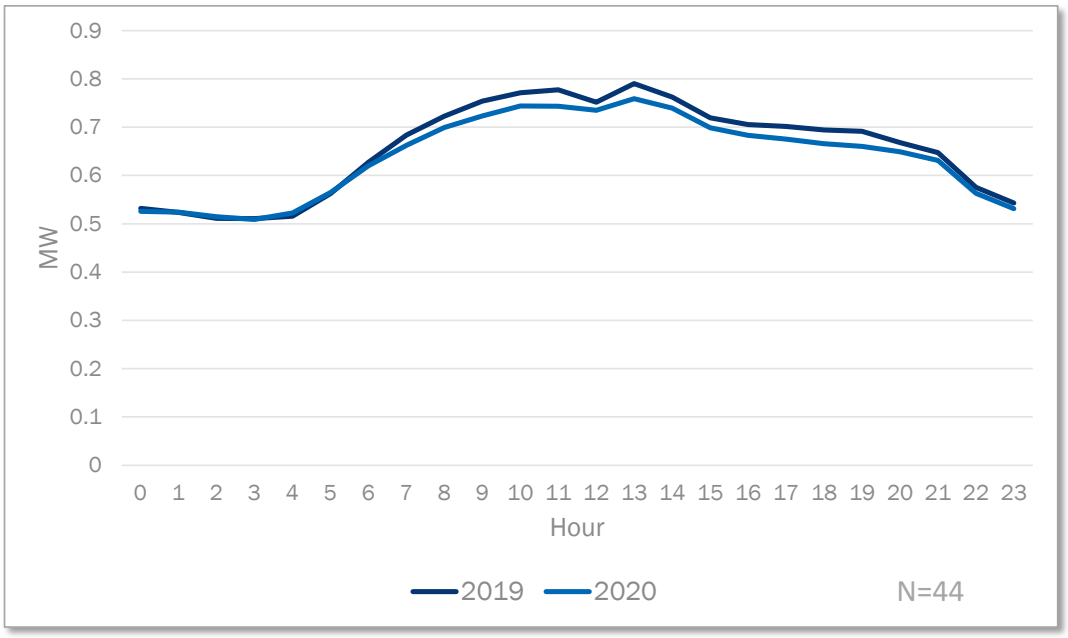
To assess the impact of the COVID-19 pandemic on program operations, the evaluation team conducted a focused comparative assessment of load patterns and participant performance over time. More specifically, we compared electric load during baseline days (high four out of five days preceding events) in PY2019 and PY2020 among 44 program participants enrolled in the program in both years (Figure 23). This comparison allowed us to isolate changes in load and/or performance from newly enrolled customers. The 44 customers we explored accounted for 34% of nominated capacity and 16% of all accounts enrolled and active as of the end of PY2020. Compared to the total PY2020 participant population, the 44 accounts were disproportionately manufacturing facilities (79% of total nominated capacity vs. 55% of total nominated capacity across all participants enrolled and active as of the end of PY2020).

Overall, electric load reduced by 2.4% from PY2019 to PY2020 during September and August among those accounts, which is considerably lower than load changes observed by the Energy Information Administration

[39] See note 12 above.

for the Midwest as well as average 30% reduction in load Enel X reported in our interview.[40] A likely reason for the difference is the fact that participating facilities are predominantly manufacturing plants, including food and beverage manufacturing, and COVID-19 likely did not result in considerable load changes.

Figure 23. Business DR Program: Participant Baseline Load Comparison



In addition to comparing changes in load, we compared changes in performance between PY2019 and PY2020. More specifically, we explored variance in performance for the same 44 accounts across the two years, as well as changes in average per account performance across the two years.[41] Variance in performance was lower in PY2020 as compared to PY2019. Per account kW impacts were 5% lower in PY2020 as compared to PY2019 and the performance rate against nominated capacity was also 5% lower. As Missouri and the rest of the United States enter the second year of the pandemic and business customers will likely face continued adjustments to their operations driven by the pandemic, it is feasible that the observed participant performance will continue in PY2021. Notably, the 44 participants included in this analysis have historically offered overall consistent and strong performance against their nominations (their performance rate was on average 88% in 2019 and 84% in 2020) (Table 31). The PY2020 performance rate of the remaining participants was 75% on average, which is considerably lower.[42] Keeping this core group of high performing participants engaged and participating will be important for continuing to see robust performance in future years of the program. Enel X may want to interview some of these customers to see how they kept their performance robust during COVID-19 and if there are lessons to pass on to other program participants. Additionally, Enel X may want to consider doing outreach and strategic engagement with them to ensure they are retained.

[40] The Energy Information Administration released an article on May 7, 2020 showing that COVID-19 decreased weekday electricity demand in the central United States by 9%–13% in the months of March and April 2020 compared to their predictions, after correcting for weather. EIA (May 7, 2020) "Daily electricity demand impacts by COVID-19 mitigation efforts differ by region." https://www.eia.gov/todayinenergy/detail.php?id=43636

[41] Variance is the sum of the differences between each observation and the sample mean divided by the total observations in the sample.

[42] Performance rate is calculated by dividing load reductions achieved during the events by the nominated capacity.

Table 31. Business DR Program: Participant Performance Comparison

Metric	PY2019 (N=44)	PY2020 (N=44)	PY2020/PY2019 (N=44)
Variance[43] in kW impact	525,439	490,240	93%
Average per-account savings (kW)	491	464	95%
Performance rate	88%	84%	95%

Program Implementation and Participant Experiences

Enel X did not report any issues with event notifications, event dispatches, or challenges with event participation among participants. Notably, as Enel X was enrolling participants and preparing for event dispatches, not all participants had their meters upgraded to interval meters in time for event dispatch. This resulted in uncertainty related to participant event performance and necessitated limited imputations in participant performance. Enel X reported doing the same for the purposes of the incentive pay out. As customer enrollment continues in PY2021, Enel X and Ameren Missouri should consider continued collaboration to ensure timely communication around participant enrollment and meter upgrades.

Moving forward, Enel X is anticipating making further improvements to program implementation processes, including improving the speed of interval data ingestion to offer customers a faster turnaround of their event performance feedback as well as incentive payments.

5.3.2 Event Season Performance

Demand Savings

The Business DR Program achieved 53.69 MW in total demand savings during the PY2020 event season. The load reduction of 53.69 MW represents 91% of the total nominated capacity from customers, among whom the events were called (Table 32). Participant performance during the August test event was similar to performance during the September test event. The evaluation team calculated event performance matches Enel X's calculations of event performance.

Table 32. 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 20, 2020	3-4 pm CST	274	57.87	52.82	91%	192.77
2	September 17, 2020	3-4 pm CST	279	59.97	54.56	91%	195.56
Overall Event Season Result				**58.92**	**53.69**	**91%**	**194.16**

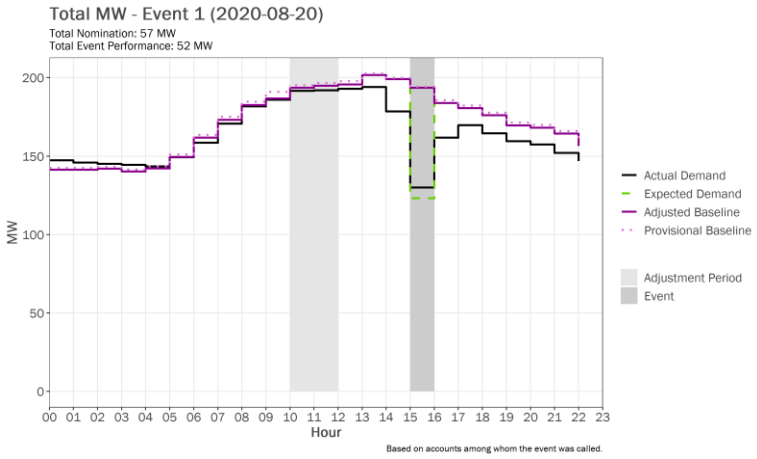
Note: Accounts among which the event was called.

Figure 24 provides, for each event dispatched during the event season, detailed plots of total and average per-account actual demand on the event day, the provisional and adjusted baseline demand, and calculated baseline.

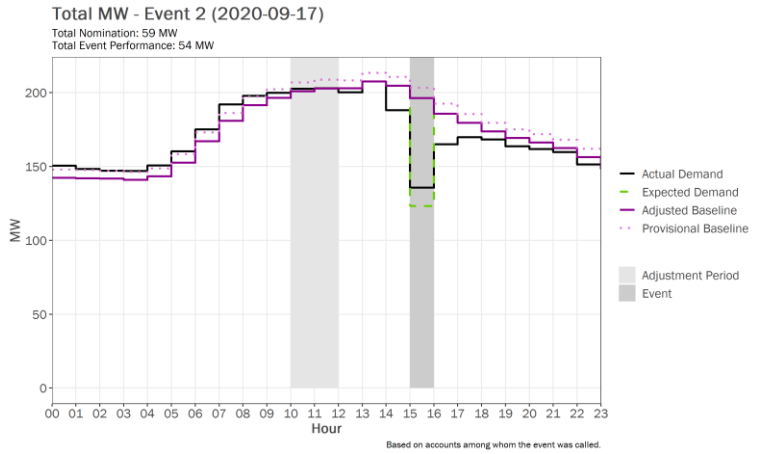
[43] Variance is the sum of the differences between each observation and the sample mean divided by the total observations in the sample.

Figure 24. Business DR Program: Total and Per Account Performance

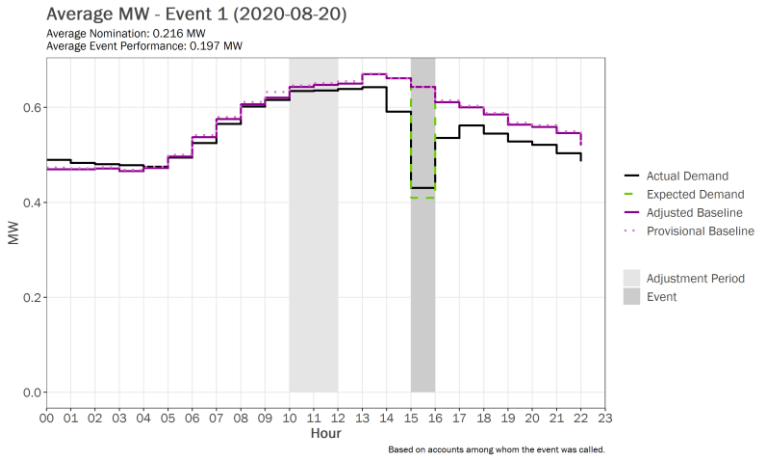
Event 1 (August 20, 2020) Total MW Performance



Event 2 (September 17, 2020) Total MW Performance



Event 1 (August 20, 2020) Average Per Account MW Performance



Event 2 (September 17, 2020) Average Per Account MW Performance

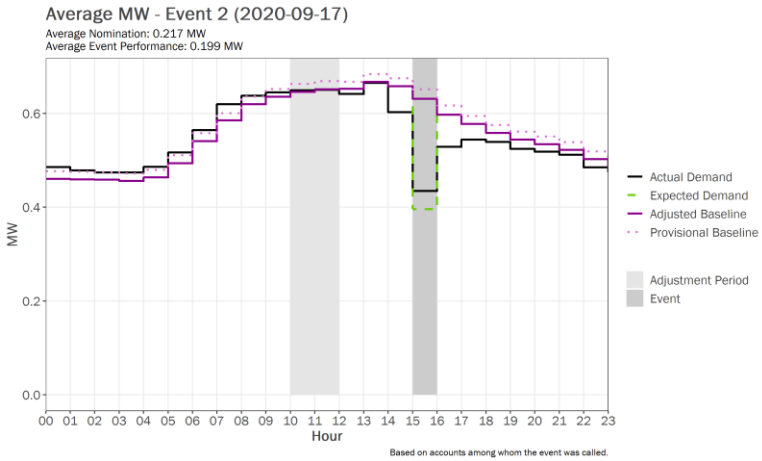
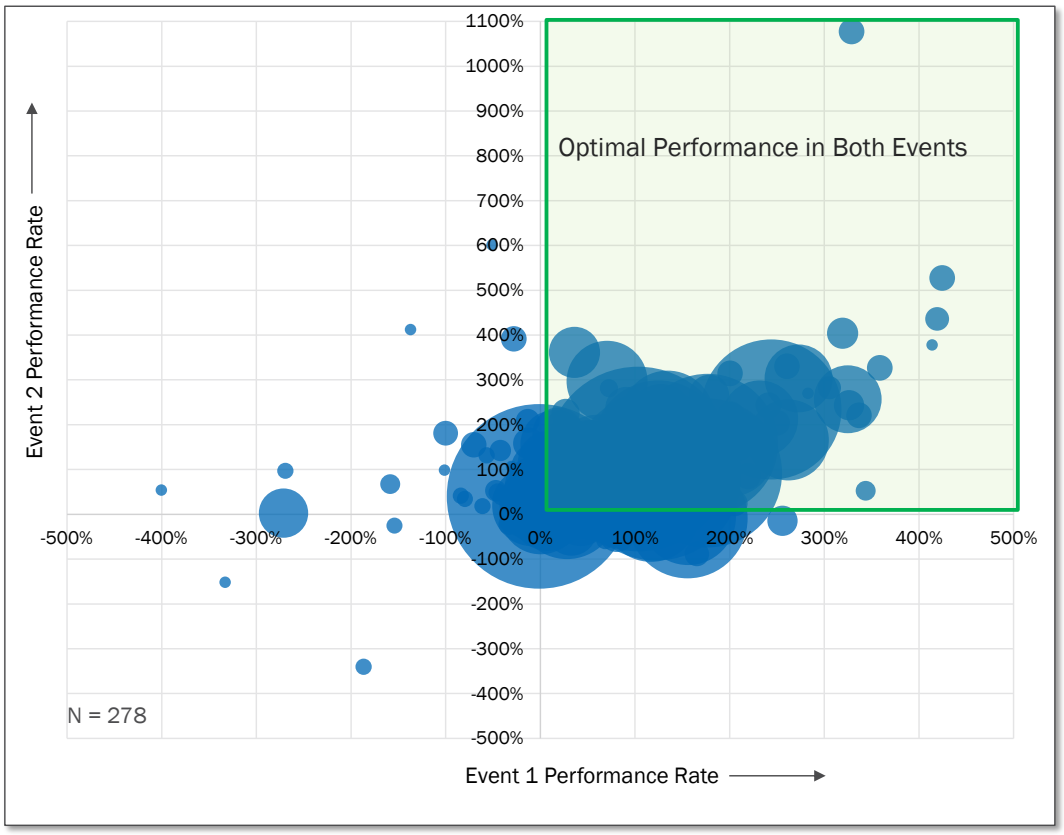


Figure 25 shows the distribution of performance rates for each event. The performance rate for the August 20 event is plotted along the X-axis, while the performance rate for the September 17 event is plotted along the Y-axis. The size of the bubbles represents the size of the nominated capacity for 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. As can be seen in the graphic, account performance varied across the two events. Overall, 23% of all accounts met or exceeded the nominated capacity goal across both events (performance rate of 100% and higher). An additional 23% met or exceeded the nominated capacity in one event but not the other, while over half (54%) did not meet the nominated capacity in either event. Of those who did not meet their nominated capacity, 7% increased load during both events, this achieving negative performance, and 55% achieved less that 50% of their nominated capacity for both events.

Figure 25. PY2020 Event Season Performance Rate Comparison



Note that bubbles in the above figure represent a single account each and are sized by each account's nominated capacity.

Further exploration of performance rate by market segment shows differences in performance rates. Table 33 summarizes performance rate in each of the test events by market segment. As can be seen in the table, the manufacturing and retail segments are among the ones that offer steadily high performance across the events.

Table 33. Performance Rate by Event and Market Segment

Market Segment	Count of Accounts	August 20, 2020	September 17, 2020
Agriculture and mining	28	60%	64%
Business and consumer services	50	59%	73%
Education	102	60%	97%
Energy and utilities	2	-123%	17%
Government	4	105%	40%
Manufacturing	69	85%	99%
Real estate and construction	1	329%	1,078%
Retail	19	133%	136%
Wholesale and distributors	2	87%	61%
Other	8	12%	1%

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 during the event season and additional two test events dispatched in December, participants decreased consumption by a total of 400.68 MWh. The energy savings fell short of the target of 1,000 MWh and represent 40% of the MEEIA III goal (Table 34).

Table 34. Business DR Program: Energy Savings Comparison to MEEIA III Goal

Event	MEEIA III Goal (MWh)	Event Season Energy Savings (MWh)	Percent of Goal
Event 1 (August 20, 2020)		225.64	
Event 2 (September 17, 2020)		154.63	
Event 3 (December 8, 2020)		22.65	
Event 4 (December 17, 2020)		-2.25	
Total	**1,000**	**400.68**	**40%**

The average per account energy savings was 5.90 MWh and represented 9.9% of the baseline load (Table 35).

Table 35. Business DR Program: Performance Summary, Energy Savings

Event	Date	Time	Participating Accounts	Total Energy Savings (MWh)	Average Per Account Energy Savings (MWh)	Percent Savings
1	August 20, 2020	3-4 pm CST	274	225.64	0.82	7.6%
2	September 17, 2010	3-4 pm CST	279	154.63	0.55	4.9%
3	December 8, 2020	8-9 am CST	1	22.65	22.65	31.2%
4	December 17, 2020	2-3 pm CST	5	-2.25	-0.45	-4.1%
			Overall Result	**400.68**	**5.90**	**9.9%**

5.3.3 Resource Capability Estimate

Table 36 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 PY2020 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. For PY2020, there were no accounts enrolled by the end of the year that were untested. 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 55.36 MW, representing 89% of the adjusted nominated capacity of the accounts enrolled as of the end of PY2020.

Table 36. Business DR Program: 2020 Resource Capability Estimate

Metric	Result
Total accounts enrolled as of the end of 2020	285
Nominated capacity (MW)	62.12
PY2020 resource capability estimate (MW)	55.36
PY2020 per-account resource capability estimate (kW)	194.25

Looking ahead to PY2021, the Business DR Program resource capability of 55.36 MW represents 74% of the total PY2021 MEEIA III goal of 75 MW (Table 37). With this enrollment to-date, Enel X is well-positioned to meet the PY2021 demand response target.

Table 37. Business DR Program: Comparison of Resource Capability to Goal

Metric	Result
2020 resource capability estimate (MW)	55.36
PY2020 MEEIA III goal (MW)	50.00
Percent of PY2020 goal	111%

5.3.4 Cumulative DR Capability Estimate

Table 38 presents the PY2020 cumulative DR capability. The value in the table represents demand impacts from tested accounts,[44] either during the PY2020 event season or during the December test events. Cumulative DR capability represents a performance metric for the earnings opportunity award for the DR programs. The programs cumulative DR capability is 55.36 MW and represents 111% of the target.

[44] A "tested account" is one that has participated in a demand response event, either during the event season or in one of the additional test events called outside of the event season.

Table 38. Business DR Program: Comparison of Cumulative DR Capability to Target

Metric	Result
PY2020 cumulative DR capability (MW)	55.36
PY2020 target	50.00
Percent of PY2020 target	111%

For more information, please contact:

Antje Flanders
Vice President

617-301-4643 tel
617-497-7944 Fax
aflanders@opiniondynamics.com

1000 Winter Street
Waltham, MA 02451