Opinion Dynamics

Boston | Headquarters

617 492 1400 tel
617 492 7944 fax

130 Turner Street
Building III, Suite 520
Waltham, MA 02453

Ameren Missouri Program Year 2022 Annual EM&V Report

Volume 4: Demand Response Portfolio Report

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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 resource capability and a component of Ameren Missouri's "Portfolio-wide Gross MW Target" performance bonus metric. Also used to assess retention of 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 – Twenty-four 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 –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 includes the 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 – Twenty-four 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 PY2022 Annual Report presents evaluation results for the Ameren Missouri PY2022 portfolio of demand response (DR) programs, as described in Ameren Missouri's 2019–21 Missouri Energy Efficiency Investment Act (MEEIA) Energy Efficiency Plan and the subsequent *Unanimous Stipulation and Agreement Regarding the Implementation of Certain MEEIA Programs Through Plan Year 2022* ("Stipulation PY2022"). The DR portfolio consists of two programs—the Residential DR Program (also referred to as Peak Time Savings Program) and the Business DR Program—which Ameren Missouri launched in 2019 and which are now in their fourth year of operation. In this document, the evaluation team provides portfolio-level results for PY2022 as well as detailed findings for each program.

This evaluation summarizes key lessons learned regarding data capture, program participation, and program impacts. Evaluation activities in PY2022 focused on the assessment of program impacts, including measuring event season demand reductions, energy savings on event and non-event days, as well as resource capability. Process-related research activities in PY2022 were limited to a review of program materials, analysis of participation data, and interviews with program staff and implementation contractors.

This volume is organized as follows:

- The remainder of this chapter presents key evaluation findings and recommendations for the DR portfolio.
- Chapter 3 presents the overarching evaluation objectives and an overview of the PY2022 evaluation activities and methodologies for the DR programs.
- Chapters 4 and 5 present evaluation results and detailed methods for the Residential and Business DR Programs, respectively.

2.1 Portfolio Summary

The Residential DR Program is designed to control cooling load with the help of smart thermostats to achieve peak demand savings and energy savings. Eligible customers include Ameren Missouri electric customers with central air conditioning systems, including heat pumps, and a program-qualifying smart thermostat. Qualifying smart thermostats in PY2022 included ecobee®, Nest®, and Emerson™ devices.[1] Customers either bring their own thermostats (also known as the BYOT channel) or purchase and install qualifying devices through the Ameren Missouri Online Marketplace (also known as the Marketplace channel). Franklin Energy administers the program, and Uplight delivers the program. While the program was originally designed as an integrated program aiming to deliver energy savings using optimization strategies alongside demand reductions, the program's pursuit of energy optimization savings in PY2022 was limited to Emerson devices.

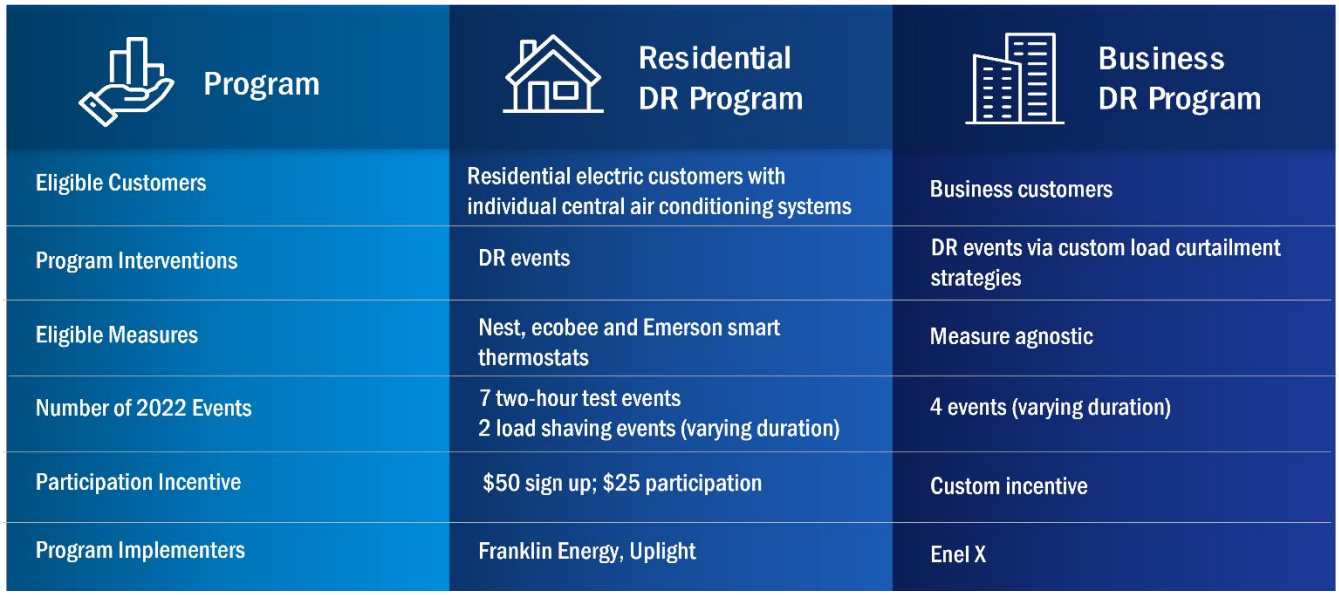
The Business DR Program is designed to reduce load during periods of peak demand. Enel X is the program aggregator, responsible for recruiting and enrolling customers, developing customized load reduction nominations and load curtailment strategies, dispatching demand response events, and maintaining customer relationships with participating businesses.[2] 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

[1] All product or company names that are mentioned in this document are tradenames, trademarks, or registered trademarks of their respective owners.
[2] In PY2022, Enel X partnered with Enersponse as part of their contract with Ameren Missouri to support recruitment of small- and medium-sized customers into the program.

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



Note: For the Business DR Program, one of the test events was dispatched in December 2022.

Table 1 shows the DR portfolio MEEIA III demand reduction and energy savings targets for the Business DR, Residential DR, and overall DR portfolio. The overall targets are 158.41 MW in demand savings and 8,547 MWh in energy savings. The Business DR Program is expected to contribute to 63% of the portfolio's demand savings target, while the Residential DR Program is expected to deliver 76% of the portfolio's energy savings target.[3]

Table 1. Incremental and Cumulative MEEIA Goals/Targets

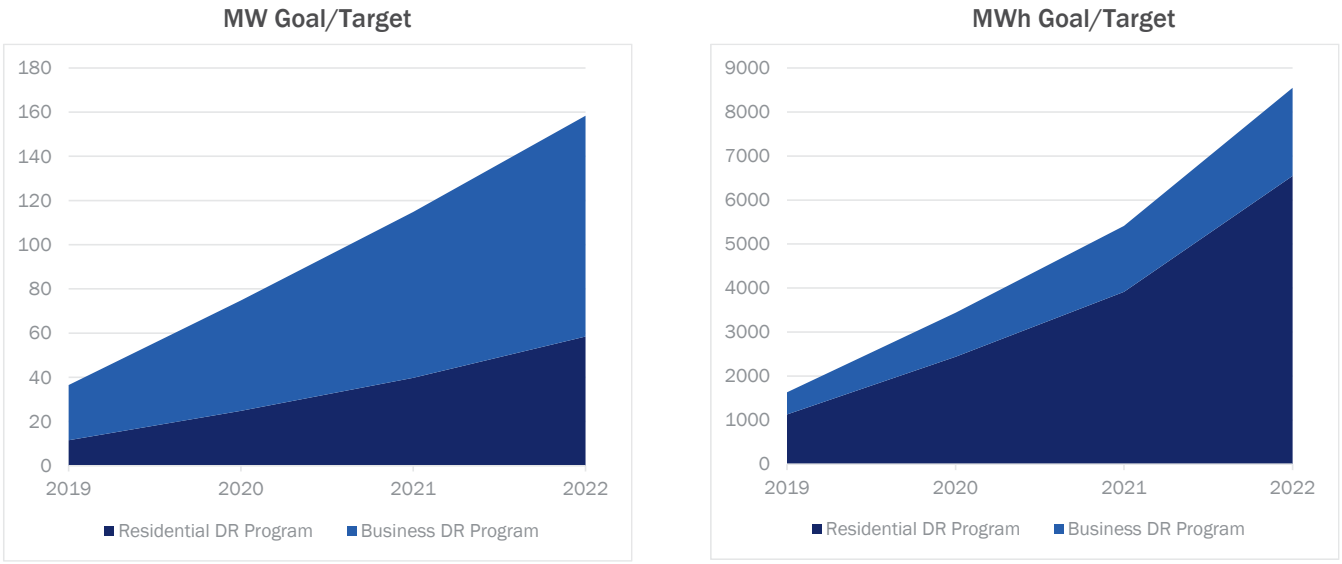
Program Year	Residential DR Program		Business DR Program		DR Portfolio	
	Incremental Goal/Target	Cumulative Goal/Target	Incremental Goal/Target	Cumulative Goal/Target	Incremental Goal/Target	Cumulative Goal/Target
Demand Savings Goal (MW)						
PY2019	11.50	11.50	25.00	25.00	36.50	36.50
PY2020	13.33	24.83	25.00	50.00	38.33	74.83
PY2021	14.96	39.79	25.00	75.00	39.96	114.79
PY2022	18.62	58.41	25.00	100.00	43.62	158.41
Total	**58.41**	**58.41**	**100.00**	**100.00**	**158.41**	**158.41**
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

[3] Stipulation PY2022 sets annual first year energy and demand savings goals/targets. In addition, Ameren Missouri developed impact metrics that are used to determine performance bonuses.

Program Year	Residential DR Program		Business DR Program		DR Portfolio	
	Incremental Goal/Target	Cumulative Goal/Target	Incremental Goal/Target	Cumulative Goal/Target	Incremental Goal/Target	Cumulative Goal/Target
PY2022	2,635	6,547	500	2,000	3,135	8,547
Total	**6,547**	**6,547**	**2,000**	**2,000**	**8,547**	**8,547**

Figure 2 summarizes cumulative DR portfolio targets. Throughout the remainder of this report, we assess the programs' performance against MEEIA cumulative PY2022 targets.

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



2.2 Portfolio Impact Results

At the end of the PY2022 event season, the demand response portfolio achieved 127.80 MW in average load reduction as well as 1,835.94 MWh in energy savings (Table 2). A limited number of events were dispatched across both the Residential and Business DR Programs over the course of the season.

Table 2. PY2022 Event Season Performance Summary

Program	Participants [A]	Event Season MW Performance	Event Season MWh Performance [B]
Residential DR Program	39,774	48.82	982.84
Business DR Program	940	78.98	853.10
Total DR Portfolio	**40,714**	**127.80**	**1,835.94**

[A] The participant count for the Residential DR Program represents the average number of participants among whom events were dispatched.
[B] Energy and Demand savings for the Business DR Program only include event season events.

To compare the DR portfolio demand savings performance against MEEIA III MW targets, the evaluation team 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 targets. As shown in the figure, the portfolio achieved a total of 138.36 MW (or 87% of target), falling short of the demand goal of 158.41 MW by 20.05 MW, and falling considerably short of the

energy savings goal, achieving 1,851 MWh of the 8,547 MWh or 22% of the target.[4] Notably, for the Residential DR Program, the MEEIA III target relied on the expectation that device optimization through the program would be performed across all participating devices. However, following the release of the energy optimization algorithms by Nest and ecobee across all of their devices, program driven optimization was no longer possible. As such, MEEIA targets are not feasible for the program to achieve.

Figure 3. DR Portfolio Performance Against MEEIA III Cumulative Goals/Targets

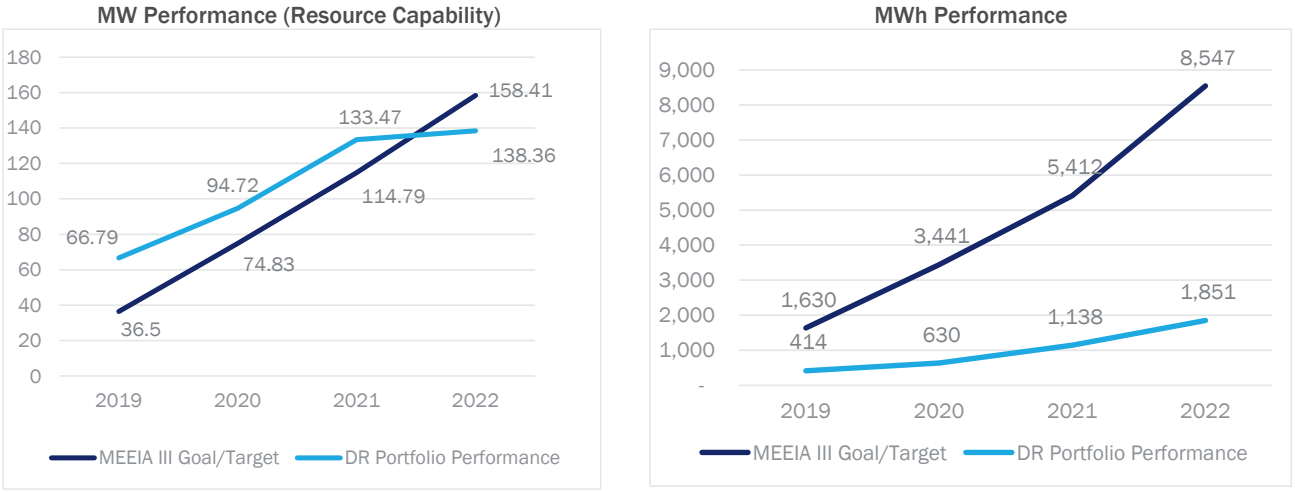


Table 3 provides a detailed summary of each program's performance against MEEIA III targets. As shown in the table, the Residential and Business DR Programs did not meet their resource capability targets, achieving 93% and 84% of their respective targets. Combined, the two programs fell short of the PY2022 target by 13%.

Both programs underperformed against their energy savings targets (15% for the Residential Program and 43% for the Business Program). Energy savings for the Residential DR Program includes event day impacts during the event season as well as energy savings achieved through optimization of Emerson devices on non-event days. Energy savings for the Business DR Program includes savings achieved during the December test event, in addition to the savings achieved during the three events called during the event season.

Table 3. DR Portfolio Performance Against MEEIA III Goals/Targets

Program	Cumulative 2022 MEEIA III Goal/Target	PY2022 Performance	Goal/Target Achieved (%)
Resource Capability (MW)			
Residential DR Program	58.41	54.25	93%
Business DR Program	100.00	84.12	84%
Total DR Portfolio	**158.41**	**138.36**	**87%**
Energy Savings (MWh)			
Residential DR Program	6,547.00	982.84	15%
Business DR Program	2,000.00	867.98	43%
Total DR Portfolio	**8,547.00**	**1,850.82**	**22%**

[4] Energy savings for the Business DR program includes savings from the December test event in addition to the event season events.

In addition to the event season performance and resource capability performance, we also calculated cumulative DR capability (Table 4). Cumulative DR capability is a component of Ameren Missouri's "Portfolio-wide Gross MW Target" performance bonus metric. For the Residential DR Program, the cumulative DR capability mirrors the resource capability; however, per the MEEIA III Plan, the cumulative DR capability is based on the performance of tested participants only, as opposed to all participants enrolled in the program at year-end.[5] In PY2022, four Business DR participating customers were not tested as part of either summer events or the winter test event. Therefore, cumulative DR capability is not equal to resource capability.

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

Program	Target (MW)	PY2022 Performance (MW)	% of Target Achieved
Residential DR Program	58.41	54.25	93%
Business DR Program	100.00	83.84	84%
Total DR Portfolio	**158.41**	**138.09**	**87%**

2.3 Portfolio Process Findings and Recommendations

In PY2022, the fourth 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 evaluation team presents the following key program-specific conclusions and recommendations:

2.3.1 Residential DR Program

- **Conclusion 1:** The Residential DR Program succeeded in enrolling 12,851 new devices into the program in PY2022. This is a substantial number of new enrollees; however, they were not sufficient to achieve program impact goals. The program achieved 93% of its target DR capability goal and resource capacity target and only 15% of its energy savings target. With an annual incremental attrition rate of 6%, a 4.16 MW shortage relative to the PY2022 target, and an incremental increase in impact goals of 8.09 MW in PY2023, the Residential DR Program will need to enroll at least 13,000 additional devices to ensure goal achievement in PY2023. Enrollment of newly purchased devices through the Marketplace channel may require additional effort and cost given current channeling processes. Opening the program to new device manufacturers can significantly expand the eligible population but can also carry performance uncertainty.
  - **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. Notably, program staff anticipate adding Honeywell devices as part of the program in PY2023.
- **Conclusion 2:** PY2022 evaluation efforts included impact analysis using AMI data. AMI data provision, ingestion, processing, and analyses were successful and paved the way to a smooth shift to AMI-based impact analysis starting in PY2023. In comparison to telemetry data, AMI-based impact analysis resulted in similar, albeit somewhat lower load impacts. The deployment of AMI meters is scheduled to be near completion by the start of the PY2023 event season. AMI data is favored as a data source for DR program impact purposes because it reflects the actual load of a

[5] Including event season DR or test events as well as winter test events.

home at a given time and can help incorporate the effects of the DR interventions on other energy using systems that are not controlled by the program. As such, the evaluation team plans to shift to the sole use of AMI data for impact evaluation purposes starting in PY2023.

  - **Recommendation 2**: Given the differences between AMI and telemetry impacts observed among PY2022 participants, program staff should incorporate AMI impacts into program planning efforts for PY2023 to better align new customer enrollment with observed performance.

- **Conclusion 3:** The implementer succeeded in dispatching events over the course of the PY2022 event season in an experimental fashion following best practices of experimental design, including assignment of devices into treatment and control groups ahead of each event dispatch and pursuing experimental assignments by device manufacturer for greater precision. The number of participants withheld from treatment did not exceed 1,150 devices per device manufacturer during any given event, which represents an average of 9% of all devices withheld from participation per event. Despite several issues with identifying and reconciling treatment and control group customer assignments, the evaluation team was able to obtain experimental assignment data and conduct impact evaluation leveraging experimental design. The implementer continued delivering energy optimization in an experimental fashion using day-design approach. Accurate tracking of experimental assignments will remain a critical step in ensuring rigorous evaluation.

  - **Recommendation 3:** The implementer should continue to deliver the program in an experimental fashion, including for future events focused on locational dispatch. The implementer should continue careful tracking of device assignments in treatment and control groups.

- **Conclusion 4:** Precooling algorithms deployed on Emerson devices resulted in aggressive load modifications prior to event dispatch leading to significant increases in cooling load for as many as nine hours preceding event dispatch. While load impacts for Emerson devices were considerably higher than for the other participating device manufacturers, such aggressive precooling strategies led to an average net increase in energy consumption of 12 kWh per device over the course of the event season and a total increase in energy consumption of 109 MWh across all participating devices over the course of the event season on event days. These increases in energy consumption can impact customer bills. This, combined with a considerably higher Emerson participant de-enrollment from the program as compared to other device manufacturers may signal potential challenges with customer experiences.

  - **Recommendation 4:** Program staff should consider balancing the aggressiveness of the precooling algorithms with load impacts and customer experiences and working with the implementer to explore opportunities for adjustments to the precooling strategies to achieve a more balanced dispatch experience.

- **Conclusion 5.** Optimization of Emerson devices on non-event days resulted in an additional 8% reduction in cooling energy usage per day during the days when the optimization algorithms ran. The implementer ran optimization using a thoughtful experimental design, allowing for a rigorous and straightforward evaluation of program impacts. Despite limiting energy optimization of Emerson devices to weekdays only, average daily energy savings remained the same as in PY2021, indicating that daily savings on weekend days are similar to daily savings on week days. Excluding weekends from optimization however, resulted in reduction in overall savings achieved through optimization algorithm deployment.

- **Recommendation 5.** The program should continue deploying optimization algorithms on Emersons using experimental design as a pathway to achieve additional energy savings.

2.3.2 Business DR Program

- **Conclusion 1:** The Business DR Program fell 15.88 MW short of its PY2022 cumulative target. The varying performance of existing customers event-to-event, smaller capacity nominations from newly enrolled customers, as well as market conditions, including inflation and employee turnover are some of the reasons for program underperformance. With no incremental goals for PY2023 and low levels of participant attrition over time, the focus of the program can shift to working with existing participants to optimize their performance and focusing on enrolling new program entrants to make up for the PY2022 shortfall.
  - **Recommendation 1:** Program staff should continue proactive outreach to new customers. To that end, Enel X can capitalize on the existing relationships and processes established in PY2022 including partnership with Enersponse in engaging small and medium-sized businesses and continued proactive outreach to participants to increase their comfort level with the program.
- **Conclusion 2:** PY2022 marked the first year of multi-hour event dispatch. As is typical with multi-hour events, load impacts decrease following the first hour of dispatch and can lead to lower overall average event performance. In the June 14 event, for example, a four-hour event dispatch resulted in a 28% attrition in load impacts in hour four as compared to hour one of the event. While HVAC loads could have had a prominent contribution to the attrition of the load impacts, additional analysis and research are needed to better understand both participant ability as well as preparedness to sustain performance during multi-hour events.
  - **Recommendation 2:** Program staff should plan for and adjust participant performance expectations with consideration of potentially lower impacts for multi-hour events. Program staff should explore reasons for attrition and consider developing strategies to encourage continued performance during multi-hour events to ensure sustained impacts. This might include educational messages with tips, conversations with customers surrounding event preparedness, and, for HVAC loads specifically, pre-conditioning strategies ahead of the event in order to deliver steady impacts while keeping facilities comfortable during event dispatch hours.
- **Conclusion 3:** Continued engagement and educational activities undertaken in PY2022, including targeted outreach to high value participants, were a useful tool to mitigating lack of knowledge of and experience with DR load curtailment strategies and presented a pathway to ensuring customer comfort with curtailing load during events.
  - **Recommendation 3:** Enel X should continue proactive outreach to update customer contact information and engage customers in training and educational activities surrounding event preparedness.

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 all five cost-effectiveness tests recommended by the California Standard Practice Manual and used in prior evaluations:[6]

- **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
- **Societal Cost Test (SCT):** Perspective of all utility customers (participants and nonparticipants) in the utility service territory[7]

Table 5 summarizes the cost-effectiveness results for both DR programs. Both programs screen cost-effective under the TRC test, while only the Business DR Program is cost effective under the UCT and RIM tests, while the Residential DR Program is not. 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	1.33	0.93	0.92	n/a
Business Demand Response	1.44	1.44	1.36	n/a

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

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

[7] 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 section presents the evaluation approach for the Ameren Missouri PY2022 Residential DR Program and the Business DR Program. The evaluation team assessed each program separately. The activities and results of each program-level evaluation are presented individually in subsequent chapters of this volume. The following subsections discuss the research objectives common to the two program evaluations and present an overview of the evaluation approach and the activities conducted to address the research objectives.

3.1 Research Objectives

The DR portfolio evaluation was designed to address numerous impact objectives. An additional objective is focused on responding to the five key research questions stipulated by the Missouri Code of State Regulations (CSR).[8] The research objectives addressed by the PY2022 DR portfolio evaluation are described in greater detail below.

3.1.1 Process Objectives

Process-related activities were limited in PY2022 and focused on targeted review and analysis of participation data streams to address the following key process evaluation objectives:

- Understand participant composition and its changes over time.
- Assess participant enrollment and de-enrollment behaviors.
- 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. We also estimated non-event energy savings associated with optimization of Emerson devices. In addition, we calculated the anticipated resource capability for the following year. There are four primary research objectives for this effort:

- Estimate ex post DR event demand impacts.
- Estimate resource capability impacts.
- Estimate DR event energy savings.
- For the Residential DR Program specifically, estimate non-event energy savings for Emerson devices.

Notably, PY2022 marked the first year when we used AMI data, in addition to device telemetry data, to develop impact estimates for the Residential DR Program.

[8] The Missouri Code of State Regulations (20 CSR 4240.22.070(8), formerly 4 CSR 240-22.070(8)) 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, including the process evaluation questions presented in this section.

3.1.3 Cost-Effectiveness Objectives

Cost-effectiveness objectives include the following:

- Assess the cost-effectiveness of each DR program and the DR portfolio using industry-standard cost-effectiveness tests.
- Ensure alignment of cost-effectiveness testing assumptions and parameters with the PY2022 DR evaluation results, Ameren Missouri's TRM Version 6.0, 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))

CSR-mandated research objectives include providing responses to the following required questions:

- 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

Table 6 shows the research activities included in the two evaluations. Additional details are included in the program-specific chapters, 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	✓	✓
Gross Impact Analysis		
Database Review	✓	✓
Ex Post Event DR Impacts	✓	✓
Ex Post Event Energy Impacts	✓	✓
Resource Capability Assessment	✓	✓
Energy Optimization Impacts	✓[A]	-

[A] Only completed for Emerson devices as only those devices received program-driven optimization interventions.

3.2.1 Program Manager and Implementer Interviews

To support evaluation planning, we gathered feedback from program implementation staff over the course of PY2022. We explored details of the design and planned implementation for the two programs; ongoing changes in design, marketing, targeting, and event dispatch occurring over the course of the year; and program staff's feedback on the programs' performance and evaluation priorities.

The evaluation team also conducted focused interviews with program and implementation staff at the end of PY2022 to develop an overall assessment of PY2022 processes and plans for programmatic changes in PY2023.

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 2022, 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 of this review were to (1) capitalize upon lessons learned throughout the PY2021 evaluation, (2) ensure the data extracts and frequency of data provision are 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

We performed the following key gross impact analyses for the PY2022 Ameren Missouri DR programs:

- Reviewed the program-tracking database to check that the databases contained all needed information to estimate program impacts.
- Characterized program participation with respect to event participation and other relevant characteristics.
- Estimated the first year ex post event day gross energy (kWh) and demand (kW) savings.
- Estimated non-event day energy optimization impacts of the Residential DR Program for Emerson devices.
- Determined resource capability for all participants enrolled throughout PY2022.

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 incorporate Uplight'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 our database review and impact analyses as well as prior participant and baseline research.

4. Residential Demand Response Program

This chapter summarizes the PY2022 evaluation methodology and results for the Residential DR Program.

The Residential DR Program, designed to control cooling load with the help of smart thermostats to achieve peak demand savings and energy savings, was in its fourth year in PY2022. Eligible customers included Ameren Missouri electric customers with central air conditioning systems (including heat pumps) who either had or were ready to purchase an eligible smart thermostat and enroll in the program. Qualifying smart thermostats in PY2022 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.[9] 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 they remain in the program, provided they actively participate in events. Historically, customers purchasing participating devices through the Online Marketplace were eligible to receive a $50 incentive for the purchase of the device in addition to the $50 sign-up bonus available through the DR Program. In PY2022, customers purchasing a Marketplace device received a $100 incentive for the purchase of the device, without the requirement to participate in the DR Program. These participants could receive an additional $50 sign-up bonus for enrolling in the Residential DR Program.

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 PY2022 was on delivering demand and energy impacts. Depending on device manufacturers, event dispatch platforms varied and as a result, so did participant notifications, precooling strategies, and event hour thermostat adjustment algorithms.

Program delivery in PY2022 included a randomized control trial (RCT) 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.

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 device manufacturer and channel, but generally included an eligibility check based on HVAC equipment, verification of customer account information, confirmation that enrolled customers were active Ameren Missouri electric customers, and customer review and acceptance of terms and conditions. Nest and ecobee conducted equipment verification and initial enrollment prior to providing 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.

[9] Devices could be self-installed or professionally installed.

Event Dispatch Processes

Over the course of the event season, Ameren Missouri successfully dispatched a total of nine demand response events, two of which were peak load shaving events. In addition, one event was scheduled to be dispatched but ultimately canceled due to weather changes. Figure 4 documents successfully dispatched event days and times alongside average temperature during the event dispatch hours. Notably, due to technical issues, outside of the control of the program, ecobee devices were not dispatched during the May 10, 2022, and May 31, 2022, events. The issue was corrected for subsequent events. Additionally, around 210 ecobee devices were "legacy devices," older generation ecobee devices prior to eco+ rollout. During the event season the implementer identified that these devices did not respond to events as expected and thus were not dispatched in the August or September events.[10] Ameren Missouri anticipates dispatching these devices in the DR events in the future years.

Figure 4. Residential DR Program: Event Days with Average Maximum Temperatures and Event Hours

Table 7 details the platforms Uplight relied on to dispatch events in PY2022. Specifically, Uplight relied on the Rush Hour Rewards (RHR) platform to dispatch events among Nest devices, the eco+ platform for ecobee

[10] Uplight anticipates that ecobee will remedy this issue and these devices will be dispatchable in future years.

devices, and the Orchestrated Energy (OE) platform for Emerson devices. Each of the platforms features its own precooling strategies as well as event hour temperature setbacks.

Table 7. Residential DR Program: Event Dispatch Platforms

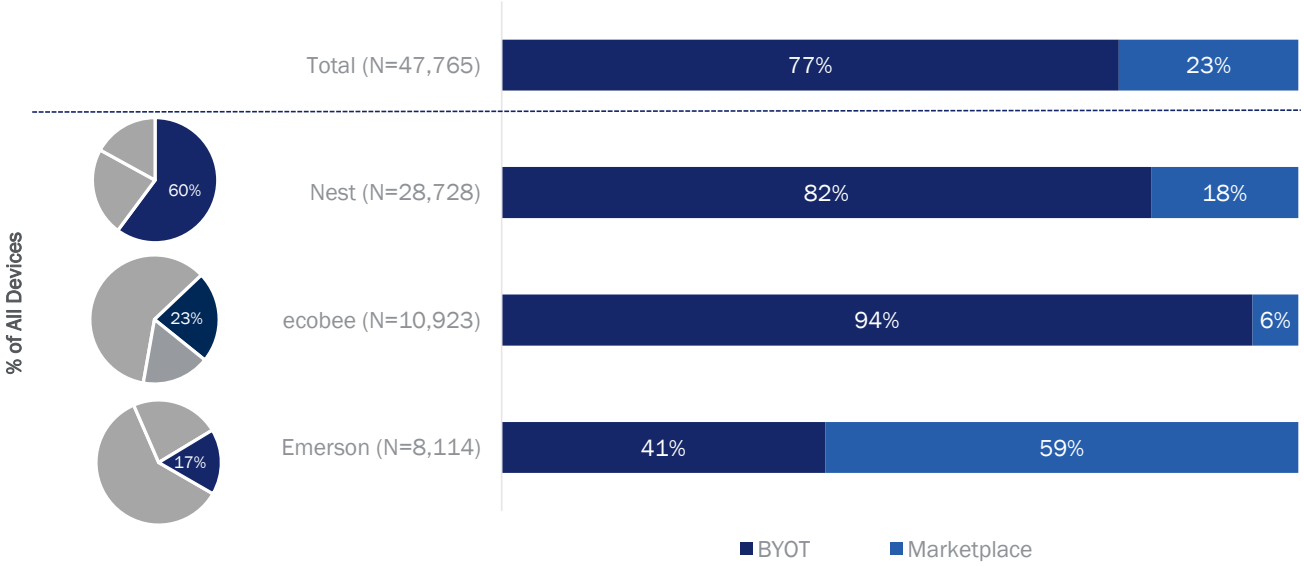
Device Manufacturer	Dispatch Platform Name	Platform Type	Events Deployed
Nest	Rush Hour Rewards (RHR)	Vendor DR platform	All events
ecobee	eco+	Vendor DR platform	All events
Emerson	Orchestrated Energy (OE)	Uplight DR platform	All events

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 using its OE platform to run optimization of ecobee devices at the beginning of the PY2019 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. Considering these changes, Uplight could not deploy program-driven energy optimization algorithms on either Nest or ecobee devices. Uplight did not dispatch OE on Emerson devices in PY2020 but did in PY2021. In PY2022, Uplight ran OE optimization algorithms on Emerson devices only, starting in early June. Unlike in PY2021, weekends were excluded from optimization of Emerson devices in PY2022. Uplight made the decision to remove weekends to prioritize customer experience and customer satisfaction.

4.1 Participation Summary

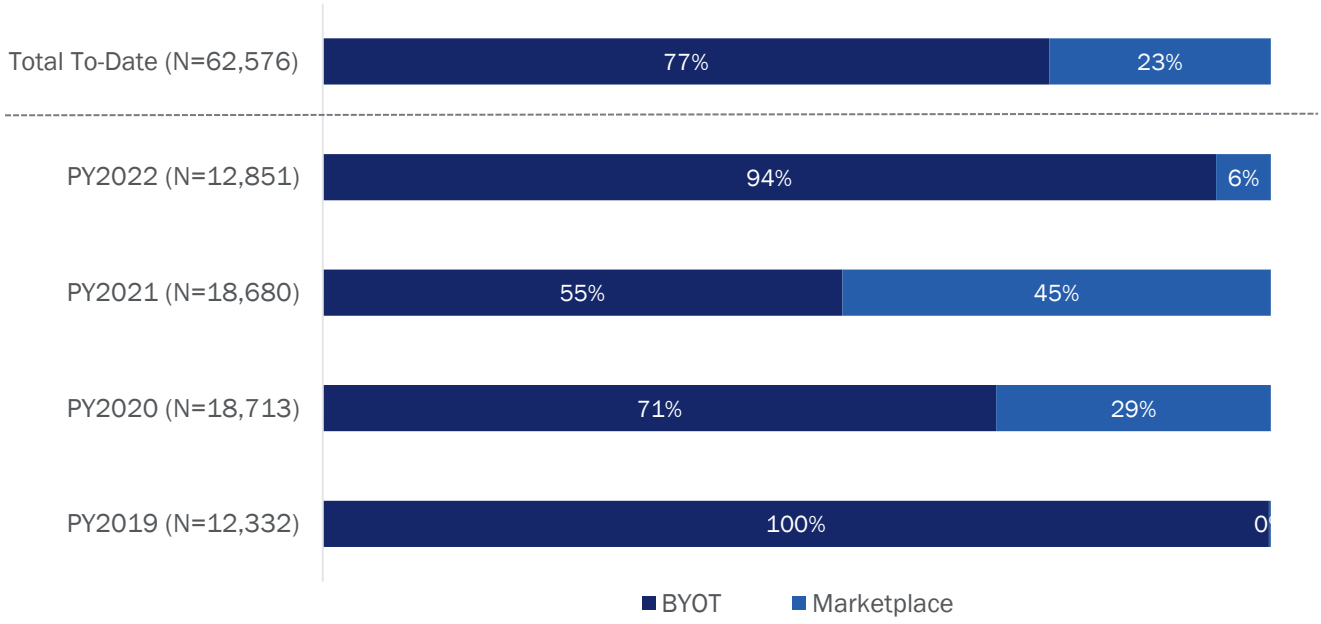
There were 41,084 active customers as of the end of 2022, with 37,433 enrolled before the end of the PY2022 event season and an additional 3,651 customers enrolled between October and December 2022. Active participants had 47,765 devices enrolled and active in the program at the end of PY2022, an average of 1.16 devices per household. Participating devices in PY2022 represented a mix of manufacturers and enrollment channels. More specifically, over half of participating devices (60%) were Nest devices, over a fifth (23%) were ecobee devices, and the remaining (17%) were Emerson devices. Overall, three-quarters of all participating devices (77%) active in the program at the end of PY2022 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 (82% and 94%, respectively). Conversely, 59% of Emerson devices entered the program via Ameren Missouri's Marketplace channel (Figure 5), which is likely due to promotional efforts in PY2022 as well as prior program years offering Emerson devices at very low or no cost to interested customers.

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



A quarter of all devices enrolled in the program over the course of the four years entered the program via the Marketplace channel. The share of devices entering the program via the Marketplace channel dropped from a three-year high of 45% in PY2021 to only 6% of all devices enrolling in the program via Ameren Missouri's Marketplace in PY2022 (Figure 6). This is not surprising, as there was a shift in the Marketplace incentives in PY2022, removing the requirement for a customer to enroll in the program to receive the incentive. Franklin Energy reported that after this change, conversion rates from purchases through the Marketplace channel into program enrollment dropped impactfully.

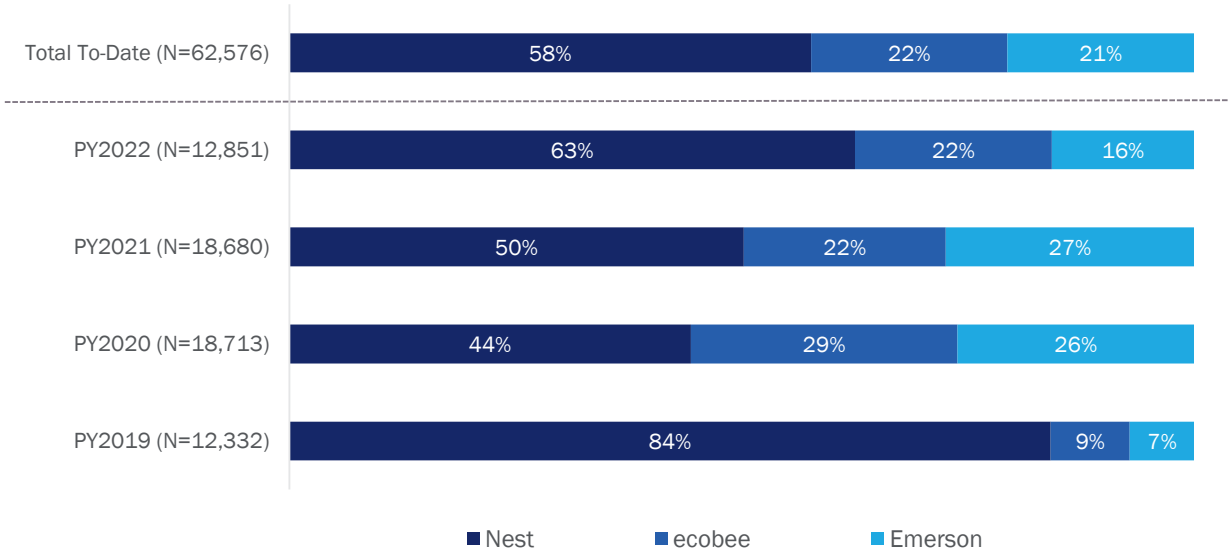
Figure 6. Residential DR Program: Device Enrollment Trends by Channel



Note: Device counts include devices that de-enrolled from the program over the course of four years and are not reflective of the active device counts as of the end of the program years.

Participating device mix changed in PY2022 as compared to the previous years in terms of manufacturer mix and enrollment channel (Figure 7). Overall, Nest devices continued to represent the majority of participating devices (58%), followed by ecobee and Emerson devices, accounting for 22% and 21%, respectively. PY2022 device mix mostly mimicked that of PY2020 and PY2021, with Nest devices increasing in presence. This increase is not surprising given that historically, Nest devices have been primarily enrolled via the BYOT channel.

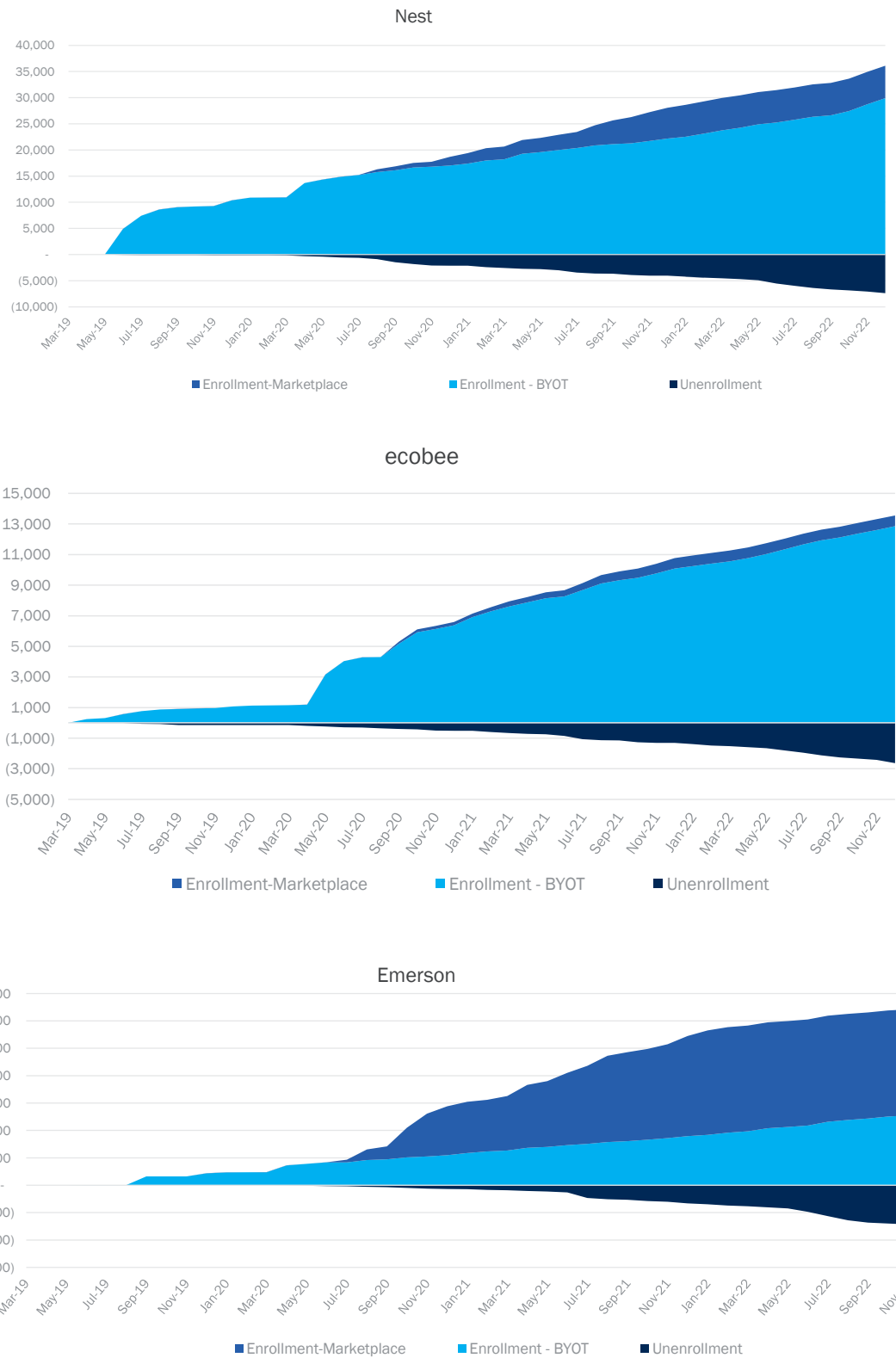
Figure 7. Residential DR Program: Device Enrollment Trends by Manufacturer



Note: Device counts include devices that de-enrolled from the program over the course of four years and are not reflective of the active device counts as of the end of the program years.

Figure 8 summarizes cumulative device enrollment and de-enrollment trends by device manufacturer over the course of four program years. Enrollment trends are shown categorized by channel with de-enrollment trends 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 BYOT 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 small but steady gains in Marketplace enrollments. Enrollment of Emerson devices via the BYOT channel continued to increase moderately over the course of PY2022.

Figure 8. Residential DR Program: Device Enrollment Over Time by Device Manufacturer



A total of 24% of participants de-enrolled from the Residential DR Program since its launch in PY2019 (Table 8). Emerson participants are more likely than other participants to de-enroll. Furthermore, BYOT and Marketplace participants are almost equally as likely to de-enroll.

Table 8. Residential DR Program: Customer De-Enrollment Trends

Device Manufacturer	De-Enrollment Rate					
	PY2022			Cumulative as of the End of PY2022		
	BYOT	Marketplace	Total	BYOT	Marketplace	Total
Nest	5%	7%	5%	22%	14%	20%
ecobee	7%	8%	7%	20%	11%	19%
Emerson	15%	26%	17%	36%	38%	37%
Total	**7%**	**12%**	**7%**	**23%**	**26%**	**24%**

Note: PY2022 de-enrollment rates include customers that enrolled and de-enrolled within 2022 but does not include customers who enrolled during previous years and de-enrolled during PY2022.

In PY2023, eligible devices will include Nest, ecobee, and Emerson Wi-Fi connected smart thermostats. Ameren Missouri is planning to expand the device mix to include Honeywell devices in PY2023. Program staff also anticipate piloting locational dispatch of DR events across the top 5% of feeders (in terms of their loading rank) and to reserve five events for MISO emergency between June 1 and August 31.

4.2 Evaluation Methodology

The PY2022 evaluation focused on impact evaluation activities to assess the performance of the Residential DR Program. The evaluation team explored the following research objectives:

- Characterize program participation concerning the devices selected, event participation, and other relevant characteristics;
- Estimate first year ex post gross energy (kWh) and demand (kW) savings;
- Determine weather-normalized DR capability for all participants enrolled in PY2022; and
- Provide evaluation results to improve the design and implementation of the program.

Table 9 provides an overview of the program evaluation activities. Following the table, we provide a detailed description of our approach to the impact analysis. The Appendix volume submitted alongside this report (hereafter referred to as the Appendix) contains additional methodological detail.

Table 9. Residential DR Program: PY2022 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 were being collected.
Impact Analysis	▪ Conducted event regression modeling to estimate hourly and average event kW and kWh impacts.

Evaluation Activity	Description
	▪ Assessed average event kW impacts under normalized weather conditions for all participants enrolled in PY2022.

4.2.1 Program Manager and Aggregator Interviews

Throughout PY2022, the evaluation team, Uplight, Franklin Energy, and Ameren Missouri staff met bi-monthly to discuss ongoing administration of the program, any changes or anticipated challenges to program delivery and goal achievement, and to provide data status updates. In addition to these conversations, the evaluation team conducted formal interviews with Uplight and Franklin Energy staff at the end of 2022 to debrief on PY2022 experiences and understand any programmatic changes going into PY2023.

4.2.2 Impact Analysis

Summary of Impact Analysis Approach

Impact Analysis Data Pathways

Impact analysis for the program consisted of several components, namely event season demand impacts, weather-normalized resource capability impacts, event day energy impacts, and non-event energy impacts. Notably, the evaluation team conducted impact analysis leveraging two distinct pathways—telemetry data and Advanced Metering Infrastructure (AMI) interval load data.

The evaluation team had leveraged telemetry data historically for load impact evaluation purposes. At the beginning of the PY2022 event season, 42% of program participants had AMI meters. Pursuing load impact analysis using both telemetry and AMI pathways allows for a successful transition to AMI-driven analysis in future program years upon full deployment of the AMI infrastructure across Ameren Missouri's service territory as well as an opportunity to compare and contrast impacts derived from two distinct data streams.[11] We based all impact results presented in this report on the telemetry pathway. A comparative analysis summary of impact results from the two pathways is provided in Section 4.3. The Appendix contains detailed impact results from the AMI and telemetry data pathways.

Data Discrepancy Resolutions

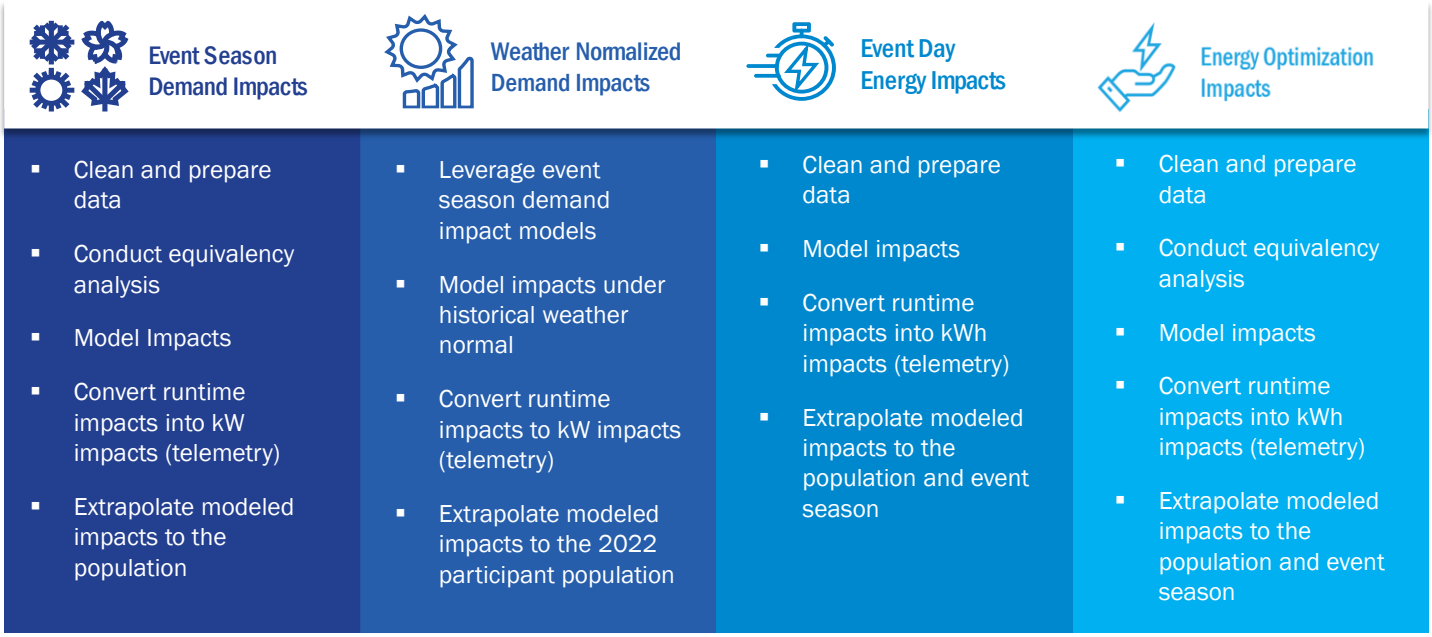
Throughout the evaluation year, Ameren Missouri, Uplight, Franklin Energy, and the evaluation team collaborated to ensure data completeness, accuracy, and validity, including reviewing telemetry and AMI data part way through the season and resolving discrepancies in event dispatch and participation. Despite continued anonymization of Nest telemetry data and the inability to incorporate experimental assignments as part of the telemetry data extract, the Uplight data team was able to provide additional data sets that allowed the evaluation team to perform planned analyses leveraging experimental program design.[12]

[11] Telemetry data include HVAC runtime, as opposed to load data, and require assumptions about participants' HVAC connected load. Furthermore, Nest telemetry data are anonymized, not allowing to merge it with the participant or other data streams. AMI data, on the other hand, contain whole house data, as opposed to HVAC load data, but are only available for a subset of participants.

[12] Nest telemetry data had historically contained anonymized (hashed) device serial numbers, making it impossible to merge the data with any other data streams, such as participant data. Despite the fact that events were dispatched in an experimental fashion with the control group set aside ahead of each event, telemetry data historically had not contained experimental assignment of devices in treatment vs. control groups, making evaluation analyses challenging.

Figure 9 provides an overview of the data cleaning and preparation steps associated with each impact analysis component. Following the figure, we detail data sources that the evaluation team leveraged to complete each analysis as well as summarize our approach.

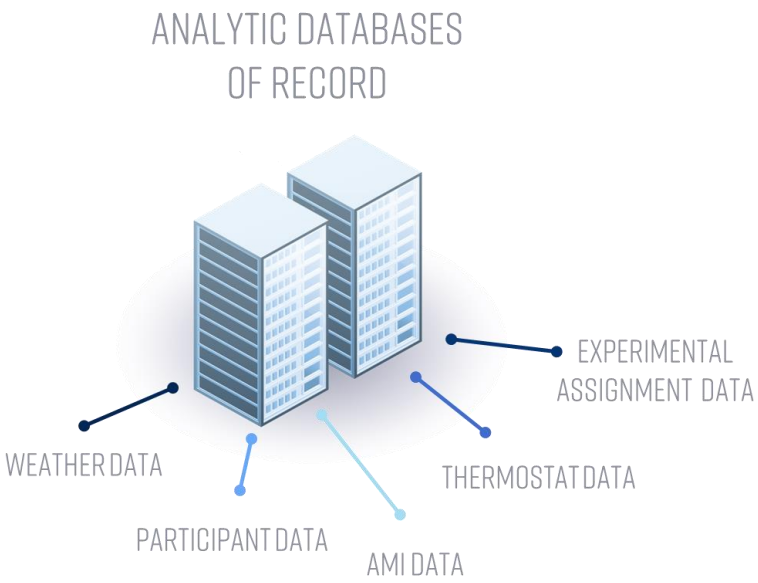
Figure 9. Residential DR Program: Gross Impact Analysis Overview



Data Cleaning and Preparation

We used data from several sources in support of the gross impact analysis, namely participant, experimental assignment, weather, thermostat, and AMI data. We processed data from each source separately before integrating them in analytic databases to support the impact analysis and modeling efforts. Figure 10 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 10. Residential DR Program: Overview of Data Sources



Weather Data

We used weather data from the nearest weather station for each account. The exception were accounts with Nest devices, as device location was not available due to data anonymization. In those instances, we used St. Louis' Lambert airport weather data for all participants. 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 those stations for 2022. As part of the data preparation, we calculated cooling degree hours with an outdoor base temperature of 75°F for use in the model. We chose 75°F as the base temperature because that is the approximate point at which participants start using their central air conditioners during summer afternoons.

Participant Data

We relied on participant data extracts provided by 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 four 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 all participating devices were associated with Ameren Missouri electric accounts. Finally, we verified the accuracy of the customer program enrollment date. This date was essential to validate participant counts for the impact analysis.

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 the day type (demand-response, learning, inoperative, etc.). Device identifiers for Nests were anonymized and could not be linked to the device information in the participant dataset. Emerson and ecobee device identifiers, on the other hand, were not anonymized and could be linked to external data sources such as the participant data. 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.

Customer AMI Data

We received 15-minute whole house AMI data for 42% of program participants active during the PY2022 summer event season. The AMI data contained account-level interval load data. We assessed the extent to which the available data were representative of the program participant population across available observable information (e.g., comparison of participants with and without AMI data with respect to geographic distribution, enrollment channel, device manufacturer, and enrollment year). We did not find any large or meaningful differences in the composition of participants with and without AMI data. The Appendix contains analysis results.

As part of the AMI data cleaning, we scrutinized the data for duplicate records, missing records, and outlier records. Detailed data cleaning steps are included in the Appendix.

Experimental Assignment Data

We received a separate set of files containing participant assignments into treatment and control group for each event. We scrutinized the data for duplicate records, conflicting assignments, and merged the data with the participant and telemetry files to ensure completeness and validity. Notably, for Nest devices, we received two distinct files with experimental assignments designed to facilitate analysis of anonymized telemetry data as well as non-anonymized AMI data. Detailed data cleaning steps are included in the Appendix.

Event Season Demand Impacts

The event season DR impact analysis estimated event period demand impacts for devices (telemetry pathway)/accounts (AMI pathway) that were in place and operational during the PY2022 event season. Below, we outline analytical activities that were a part of the analysis.

Conduct Equivalency Analysis

Before running the models, we performed an equivalency analysis to ensure treatment and control groups were equivalent in terms of runtime/load shapes on non-event days. A separate experimental design was dispatched on each event day and by each manufacturer. As such, we performed a separate equivalency analysis for each event for each manufacturer to ensure the fidelity of each experimental design. For the telemetry pathway, the analysis was performed at the device level, while the analysis for the AMI pathway was performed at the account level.[13] The Appendix of this report contains detailed results from the equivalency analysis.

[13] Notably, we treated the analysis following the AMI pathway as quasi-experimental in nature due to not having access to the AMI data for the entire population of participants.

Convert Runtime to kW (Telemetry Data)

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

Model Impacts

We used linear regression modeling to develop event season demand impacts. Telemetry data modeling was performed at the device level, while AMI data modeling was performed at the account level. The model estimated the hourly kW demand impacts on a per-device level for the telemetry pathway and per-account level for the AMI pathway. Across all device manufacturers, we included treatment devices/accounts as part of the modeling dataset, regardless of whether the dispatch signal was received or not. Devices assigned as control were used to construct baseline or counterfactual load. As such, our modeled impacts reflect intent to treat (ITT).

Event impacts were calculated as the mean difference between the modeled (predicted) baseline kW and the modeled (predicted) event kW over the event period. For Nest and ecobee devices, we incorporated fixed effects terms to control for time-invariable, unobservable, device-level factors affecting demand (i.e., factors that do not change over the study period, such as square footage of the home) without measuring those factors explicitly in the models. For Emerson devices we were unable to incorporate fixed effects terms as part of the modeling process due to continuous load modification on event days: Load modification for Emerson devices was not limited to event hours and to pre-cooling in the hours immediately preceding event hours, and instead leveraged linear ordinary least squares (OLS) model specification.

Both fixed effects and OLS models specify a linear relationship between dependent and independent variables. A fixed effects model allows to better control for time-invariant unobservable characteristics by leveraging a device/account specific intercept and thus fixed effects model tend to explain more variation, as evident in the R-squared statistic. Despite low R-squared values associated with the OLS model outputs for Emerson devices, the model presents an appropriate and robust solution, especially in the context of an experimental event dispatch.

As is standard practice for impact analysis, we tested several different model specifications before selecting the best model. The Appendix contains the final model specifications and model fit outputs.

Extrapolate Modeled Impacts to Population

For the telemetry pathway, we calculated total impacts for each event by multiplying the per-device per-event modeled impacts by the number of devices assigned as treatment for each event day. For the AMI pathway, we calculated total impacts for each event by multiplying the per-account per-event modeled impacts by the number of accounts assigned as treatment for each event day.

We validated and aligned the population of treatment devices/accounts using participant and experimental assignment data and verified and resolved any discrepancies in device/account counts across the different files with Uplight and Franklin Energy.

Total event-season demand impacts, expressed as the weighted average of impacts across events, were calculated by thermostat manufacturer, weighting by the number of treated devices (telemetry pathway)/accounts (AMI pathway) in each event.

Weather-Normalized Resource Capability

An estimate of weather-normalized resource capability reflects estimated demand impacts from devices enrolled as of the end of PY2022 under peak weather conditions.

Model Impacts Under Peak Weather Normals

To determine weather-normalized resource capability, we fit a series of fixed-effects models for each device manufacturer, pooling all event day data to create a single model for each device manufacturer. We trained the models on 2022 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.

We fit these models using hourly load data separately for each device manufacturer. Telemetry data modeling was performed at the device level, while AMI data modeling was performed at the account level. Upon fitting these models, we estimated the predicted event impact for an average event duration observed during the PY2022 event season. The predicted event impact is the predicted baseline demand minus the predicted event demand for each of the event hours.

The Appendix contains the final model specification and model fit output for the selected model specification.

Extrapolate Modeled Impacts to Population

For the telemetry pathway, we calculated total weather-normalized resource capability by multiplying the weather-normalized per-device impacts for each manufacturer by the number of devices enrolled in the program as of the end of PY2022. For the AMI pathway, we calculated total weather-normalized resource capability by multiplying the weather-normalized per-account impacts for each manufacturer by the number of accounts enrolled in the program at the end of PY2022. We used participant data extracts to derive the total number of enrolled devices and accounts.

Cumulative DR Capability

Cumulative DR capability is a component of Ameren Missouri's "Portfolio-wide Gross MW Target" performance bonus metric. The evaluation team 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 in the event season demand impact analysis, 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 using the telemetry pathway, we multiplied the predicted impacts for each event by the number of devices who participated in those events and then summed impacts across events. For the AMI pathway, we multiplied the predicted impacts for each event by the number of accounts 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 (telemetry pathway), modeled impacts to estimate event day energy impacts, and extrapolated modeled savings to participating devices/accounts.

Non-Event Day Energy Impacts

Energy Optimization Impacts

In addition to DR events, Uplight deployed Orchestrated Energy algorithms on Emerson devices over the course of the summer. The algorithms adjusted thermostat temperature setpoints over the course of the day to harvest additional energy savings. Uplight launched the PY2022 optimization interventions on June 1, 2022, and ran them until the end of the event season (September 30, 2022). Non-event energy optimization design for Emerson devices is structured as a crossover design, where Uplight randomly assigns 20% of Emerson devices into a control group. Assignments are performed in two-day blocks. For devices assigned to the control group for a given two-day block, no optimization is performed until the end of the two-day block. At the end of the two-day block, new randomization assignments are made into the treatment and control groups. Since no optimization is performed on weekends or holidays, those days are excluded from both treatment and control assignments. As part of our analysis, we modeled savings using a linear fixed effects regression model.

Clean and Prepare Data

To support this analysis, we leveraged the same runtime and AMI data we used for the event season demand impact analysis. As part of the data cleaning process, we identified and removed devices/accounts that were not part of the experimental design as well as devices/accounts without experimental assignments. We also removed devices/accounts assigned to just control or just treatment categories and not both over the course of the summer. Detailed data cleaning steps are included in the Appendix.

Conduct Equivalency Analysis

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

Convert Runtime Impacts to kWh Impacts (Telemetry Data)

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

Model Impacts

We relied on the control days to establish the counterfactual, (i.e., the baseline run time that participants likely would have used in the absence of the optimization intervention). We specified a linear fixed effects model. Our analysis resulted in energy savings per treatment day and per device (telemetry pathway)/account (AMI pathway).

Extrapolate Modeled Impacts to Population and Event Season

To extrapolate results to the eligible population, we calculated the total number of treatment devices for each of the treatment days in the season. We then multiplied modeled per-day treatment energy-saving impacts by the total number of treatment participant days in order to arrive at overall event season non-event energy savings.

4.3 Evaluation Results

This section presents our response to the five CSR process questions as well as detailed impact evaluation results for the Residential DR Program.

4.3.1 Process Results

The Missouri Code of State Regulations 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 10 summarizes responses to the CSR process evaluation requirements for the Residential DR Program.

Table 10. 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?	Based on research conducted in PY2019, customers have a variety of concerns about participating in the central air conditioning 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 barrier about which customers reported the most worry.
Is the target market segment appropriately defined, or should it be further subdivided or merged with other market segments?	All residential customers with central air conditioning systems (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. Inclusion of devices from other manufacturers, however, could help increase the program's reach. It is our understanding that Uplight and Franklin Energy are working on introducing additional device manufacturers as part of the program in PY2023.
Are the communication channels and delivery mechanisms appropriate for the target market segment?	E-mail outreach, along with outreach via devices, device apps, and manufacturers are cost-effective and targeted given program design and the target market segment. Recent changes to customer channeling via the Marketplace channel presented challenges to effective enrollment of customers with newly purchased devices into the program. Choice of pre-conditioning strategies can impact both the depth of load impacts, customer experiences, and total energy consumption.
What can be done to more effectively overcome the identified market imperfections and to increase the rate of customer acceptance and implementation for select endmuuses/measure groups included in the Program?	Aligning acquisition channels and introducing new device manufacturers into the program could help capture more customers as well as different customers, thus ensuring achievement of participation goals in future years and serving a broad spectrum of Ameren Missouri customer segments. Monitoring de-enrollment trends and reasons can help anticipate additional enrollment needs, as well as craft program engagement to minimize participant attrition. Working to ensure sustained performance over multi-hour events by better understanding override behaviors and tailoring messaging and engagement strategies to minimize those behaviors, thus increasing the depth of demand impacts, will be important to continued effectiveness of the program.

4.3.2 Impact Results

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

Event Season Demand Impacts

The Residential DR Program achieved 48.82 MW in average event season demand impacts across all treated devices. Table 11 provides event season demand impacts by event and device manufacturer. Event day demand impacts represent average impacts across all event hours. Per device demand impacts range from 0.69 to 1.51 kW.

The Appendix contains detailed tables with hourly demand impacts by event and device manufacturer.

Table 11. 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		
May 10, 2022	Nest	25,983	24,730	40.79	26.21	1.65	1.06	64%	90
	ecobee								
	Emerson	10,277	9,154	14.85	9.75	1.62	1.07	66%	89
	Total	**36,260**	**33,884**	**55.64**	**35.96**	**1.64**	**1.06**	**65%**	**90**
May 31, 2022	Nest	26,161	24,760	41.53	28.89	1.68	1.17	70%	88
	ecobee								
	Emerson	10,291	9,188	14.74	11.85	1.60	1.29	80%	87
	Total	**36,452**	**33,948**	**56.27**	**40.75**	**1.66**	**1.20**	**72%**	**88**
June 14, 2022	Nest	26,219	24,778	51.93	23.35	2.10	0.94	45%	97
	ecobee	10,178	8,925	19.55	7.34	2.19	0.82	38%	96
	Emerson	10,277	9,158	19.88	12.05	2.17	1.32	61%	96
	Total	**46,674**	**42,861**	**91.36**	**42.74**	**2.13**	**1.00**	**47%**	**97**
June 16, 2022	Nest	26,174	24,713	54.85	29.04	2.22	1.18	53%	96
	ecobee	10,192	8,996	20.17	6.17	2.24	0.69	31%	95
	Emerson	10,253	9,160	20.47	13.55	2.23	1.48	66%	95
	Total	**46,619**	**42,869**	**95.50**	**48.76**	**2.23**	**1.14**	**51%**	**95**
June 21, 2022	Nest	26,166	24,674	51.66	29.08	2.09	1.18	56%	96
	ecobee	10,211	8,976	18.72	9.48	2.09	1.06	51%	96
	Emerson	10,241	9,114	19.45	13.72	2.13	1.51	71%	96
	Total	**46,618**	**42,764**	**89.83**	**52.28**	**2.10**	**1.22**	**58%**	**96**
July 5, 2022	Nest	25,836	24,316	56.10	25.88	2.31	1.06	46%	100
	ecobee	10,248	9,042	21.72	6.93	2.40	0.77	32%	100
	Emerson	10,159	9,043	21.03	12.72	2.33	1.41	60%	100
	Total	**46,243**	**42,401**	**98.86**	**45.53**	**2.33**	**1.07**	**46%**	**100**
August 3, 2022	Nest	26,043	23,940	45.87	29.89	1.92	1.25	65%	82
	ecobee	10,209	8,853	17.00	10.01	1.92	1.13	59%	85
	Emerson	10,115	8,987	17.88	13.04	1.99	1.45	73%	85

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		
	Total	**46,367**	**41,780**	**80.75**	**52.94**	**1.93**	**1.27**	**66%**	**83**
September 19, 2022	Nest	26,153	24,071	44.70	29.45	1.86	1.22	66%	93
	ecobee	10,385	8,871	16.61	11.13	1.87	1.26	67%	93
	Emerson	9,925	8,802	15.88	11.43	1.80	1.30	72%	93
	Total	**46,463**	**41,744**	**77.19**	**52.01**	**1.85**	**1.25**	**67%**	**93**
September 20, 2022	Nest	26,135	24,032	45.45	28.21	1.89	1.17	62%	97
	ecobee	10,384	8,875	17.94	10.64	2.02	1.20	59%	97
	Emerson	9,902	8,779	16.93	12.12	1.93	1.38	72%	97
	Total	**46,421**	**41,686**	**80.32**	**50.97**	**1.93**	**1.22**	**63%**	**97**

Note: The total number of devices participating in an event excludes devices assigned as control for that event.

Table 12 provides a summary of average demand impacts, by device manufacturer, for the event season. Across the PY2022 season events,[14] the program achieved 1.15 kW in per-device demand impact. The average per event demand impact for the PY2022 event season is 48.82 MW. Emerson devices achieved higher per-device demand impacts than ecobee and Nest devices on average (1.35 kW vs. 0.99 and 1.14 kW).

Table 12. 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	26,097	24,446	48.11	27.77	1.97	1.14	58%	93
ecobee	10,258	8,934	18.83	8.80	2.11	0.99	47%	95
Emerson	10,160	9,043	17.91	12.25	1.98	1.35	68%	93
All	**46,515**	**42,423**	**84.85**	**48.82**	**2.00**	**1.15**	**58%**	**94**

Note: The total number of devices participating in an event excludes devices assigned as control for that event.

The Appendix contains detailed plots and tables 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 PY2022 that are anticipated to participate in events. Table 13 details resource capability impacts by device manufacturer as well as cumulatively across all manufacturers.

Anticipated demand impacts are 54.25 MW. Average per-device impacts under TRM-defined peak weather conditions are estimated at 1.14 kW and are higher for Emerson and Nest devices (1.35 kW and 1.14 kW, respectively) than for ecobee devices (0.97 kW).

[14] Note that ecobee devices were not dispatched for the first two events and those events are excluded from ecobee average calculations.

Table 13. Residential DR Program: Resource Capability Impacts

Manufacturer	Total Number of Devices Enrolled	Aggregate (MW)		Per Device (kW)		% Load Impact
		Baseline Load	Load Impact	Baseline Load	Load Impact	
Nest	28,728	64.64	32.62	2.25	1.14	50%
ecobee	10,923	25.20	10.64	2.31	0.97	42%
Emerson	8,114	18.27	10.99	2.25	1.35	60%
All	**47,765**	**108.11**	**54.25**	**2.26**	**1.14**	**50%**

Table 14 compares the resource capability impacts to the PY2022 MEEIA III targets. Weather-normalized demand impacts of 54.25 represents 93% of the cumulative PY2022 target.

Table 14. Comparison of Resource Capability Impacts to Goal

Metric	Result
Resource capability load impact (MW)	54.25
Cumulative PY2022 MEEIA III goal/target (MW)	58.41
Percent of PY2022 goal/target	93%

Cumulative DR Capability

Cumulative DR capability for the Residential DR Program mirrors resource capability and is presented in Table 15. Cumulative DR capability is a component of Ameren Missouri's PY2022 "Portfolio-wide Gross MW Target" performance bonus metric.

Table 15. Residential DR Program: Comparison of Cumulative DR Capability to Target

Metric	Result
Cumulative DR capability (MW)	54.25
PY2022 target (MW)	58.41
Percent of PY2022 target	93%

Summary of Energy Impacts

Energy impacts in PY2022 included event day impacts as well as non-event impacts resulting from the optimization activity performed on Emerson devices. Table 16 summarizes energy savings achieved during event days as well as energy savings achieved through the optimization of Emerson devices. As can be seen in the table, the total energy savings achieved during the PY2022 event season were 983 MWh which is 15% of the MEEIA III target. The MEEIA III target relied on the expectation that device optimization through the program would be performed across all participating devices. However, following the release of the energy optimization algorithms by Nest and ecobee across all of their devices, program driven optimization was no longer possible. As such, MEEIA targets are not feasible for the program to achieve.

Table 16. Residential DR Program: Energy Savings Summary

Metric	Result
Event season energy savings (MWh)	983
Event day energy savings (MWh)	48
Energy savings from the optimization component (MWh)	935

Metric	Result
PY2022 MEEIA III goal/target (MWh)	6,547
Percent of PY2022 goal/target	15%

Event Day Energy Impacts

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

Table 17 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 across all nine events. Energy savings range from -4.46 kWh to 1.02 kWh per treated device, depending on the event and manufacturer. Negative energy savings are not uncommon 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. Negative energy savings are only observed for Emerson devices, likely due to their aggressive pre-cooling strategies.

Table 17. 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		
May 10, 2022	Nest	25,983	24,730	543.89	6.76	21.99	0.27	1%	81
	ecobee								
	Emerson	10,277	9,154	197.44	-40.80	21.57	-4.46	-21%	80
	Total	**36,260**	**33,884**	**741.33**	**-34.04**	**21.88**	**-1.00**	**-5%**	**81**
May 31, 2022	Nest	26,161	24,760	568.14	12.55	22.95	0.51	2%	82
	ecobee								
	Emerson	10,291	9,188	203.45	-21.23	22.14	-2.31	-10%	81
	Total	**36,452**	**33,948**	**771.59**	**-8.68**	**22.73**	**-0.26**	**-1%**	**82**
June 14, 2022	Nest	26,219	24,778	902.74	13.23	36.43	0.53	1%	90
	ecobee	10,178	8,925	342.36	7.55	38.36	0.85	2%	89
	Emerson	10,277	9,158	336.79	-13.68	36.78	-1.49	-4%	89
	Total	**46,674**	**42,861**	**1,581.89**	**7.10**	**36.91**	**0.17**	**0%**	**90**
June 16, 2022	Nest	26,174	24,713	872.35	18.23	35.30	0.74	2%	89
	ecobee	10,192	8,996	331.48	3.62	36.85	0.40	1%	89
	Emerson	10,253	9,160	324.74	-17.75	35.45	-1.94	-5%	88
	Total	**46,619**	**42,869**	**1,528.57**	**4.11**	**35.66**	**0.10**	**0%**	**89**
June 21, 2022	Nest	26,166	24,674	718.66	11.35	29.13	0.46	2%	87
	ecobee	10,211	8,976	270.84	5.04	30.17	0.56	2%	86
	Emerson	10,241	9,114	268.54	-6.13	29.46	-0.67	-2%	86
	Total	**46,618**	**42,764**	**1,258.04**	**10.26**	**29.42**	**0.24**	**1%**	**87**
July 5, 2022	Nest	25,836	24,316	945.24	13.89	38.87	0.57	1%	92
	ecobee	10,248	9,042	367.16	8.48	40.61	0.94	2%	92
	Emerson	10,159	9,043	346.25	-5.33	38.29	-0.59	-2%	92
	Total	**46,243**	**42,401**	**1,658.66**	**17.03**	**39.12**	**0.40**	**1%**	**92**

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		
August 3, 2022	Nest	26,043	23,940	695.32	8.24	29.04	0.34	1%	83
	ecobee	10,209	8,853	263.28	4.36	29.74	0.49	2%	83
	Emerson	10,115	8,987	280.69	9.19	31.23	1.02	3%	83
	Total	**46,367**	**41,780**	**1,239.29**	**21.78**	**29.66**	**0.52**	**2%**	**83**
September 19, 2022	Nest	26,153	24,071	638.18	16.93	26.51	0.70	3%	84
	ecobee	10,385	8,871	241.31	5.97	27.20	0.67	2%	83
	Emerson	9,925	8,802	224.63	-7.47	25.52	-0.85	-3%	83
	Total	**46,463**	**41,744**	**1,104.11**	**15.43**	**26.45**	**0.37**	**1%**	**84**
September 20, 2022	Nest	26,135	24,032	646.92	13.03	26.92	0.54	2%	86
	ecobee	10,384	8,875	254.79	8.34	28.71	0.94	3%	85
	Emerson	9,902	8,779	237.35	-6.24	27.04	-0.71	-3%	84
	Total	**46,421**	**41,686**	**1,139.07**	**15.12**	**27.32**	**0.36**	**1%**	**85**

Table 18 summarizes event day energy savings by device manufacturer across all events.[15] As can be seen in the table, event day energy savings averaged 1.16 kWh per-device and represented <1% change of the total baseline usage. Across the nine demand response events dispatched in PY2022, Nest and ecobee devices decreased energy consumption by 157 MWh but Emerson devices increased it by 109 MWh. This increase in energy consumption for Emerson devices is likely due to aggressive precooling algorithms, which in turn likely support deeper load impacts during event hours by keeping participant homes more comfortable. Notably, this increase in energy consumption is fully offset by the energy savings achieved through Emerson thermostat optimization. Overall, the Residential DR Program decreased energy consumption by 48 MWh across all event days.

Table 18. 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	26,097	24,446	6,531	114	267	4.7	2%
ecobee	10,258	8,934	2,071	43	232	4.9	2%
Emerson	10,160	9,043	2,420	-109	267	-12.0	-5%
All	**46,515**	**42,423**	**11,023**	**48**	**260**	**1.2**	**<1%**

Impacts from Device Optimization

Optimization of Emerson devices ran from June 1, 2022, through the end of the event season (September 30, 2022). Table 19 summarizes energy savings from the device optimization component. By running optimization algorithms on participating Emerson devices over the course of the event season, the program achieved 1.57 kWh in per-device, per-day savings and 935 MWh in total energy savings across all treated days and devices. The average per-device, per-day savings rate was 8%.

[15] Note that ecobee devices were not dispatched for the first two events; therefore, those events are excluded from ecobee average calculations.

Table 19. Residential DR Program: Device Optimization Energy Savings Summary

Manufacturer	Number of Device Days	Aggregate (MWh)		Per Device Per Day (kWh)		% Savings
		Baseline Usage	Energy Savings	Baseline Usage	Energy Savings	
Emerson	595,764	11,464	935	19.24	1.57	8%

Comparison of Impact Results from Telemetry and AMI Pathways

Table 20 compares event season and resource capability estimates using the telemetry and AMI data streams. Savings are presented on a per-account basis as well as in aggregate. As can be seen in the table, load impact estimates using telemetry data tended to be higher than load impact estimates derived using AMI data. Differences were the largest for Emersons and smallest for ecobees. Across all devices, load impact estimates using AMI data were 15% lower than load impact estimates using telemetry data. The reason for this difference is not clear but could stem from any of the following factors:

- **Connected load assumption.** The telemetry analysis pathway requires a conversion of runtime data from minutes to load using a connected load assumption. This assumption is the best available average and may not be accurately reflecting true HVAC system size and efficiency of the participant population. It is possible that the connected load assumption developed for the purposes of this evaluation may lead to higher energy savings. Notably, it is common to make assumptions about participants' average connected load, and it is a known common limitation of the telemetry-based analysis of load impacts.

- **Other sources of load and participant behaviors.** AMI-driven analysis leverages whole house data, which includes load from enduses other than the one that is directly modified by the Residential DR Program. As such, these other sources of load can introduce noise and potential error. Conversely, telemetry data captures load specific to the energy-using system being modified during the events. However, it is possible that, in response to DR events, participants increase or decrease load from other sources. For instance, participants could deploy other energy using systems during DR events, such as fans, in order to stay comfortable, or further reduce their load during events by shifting other activities, such as taking showers, or doing laundry, to non-event hours, thus contributing additional load curtailment. Telemetry data does not capture those additional actions, whereas AMI data does.

- **Participant population profile.** The AMI analysis pathway was based on less than half of the participant population due to partial deployment of the AMI meters in Ameren Missouri service territory. We explored differences between the participant population with and without AMI data on available observable characteristics, such as enrollment channel, device manufacturer, zip code, weather, and runtime, and found slight differences in runtime shapes as well as slight departures in enrollment channel and year of enrollment. We could not scrutinize whole house AMI data and therefore cannot speak to the equivalency of the participant subpopulation with AMI data present and the entire population on other unobservable characteristics, such as building shell and other energy-using systems and behaviors of customers.

Table 20. Comparison of Load Impacts Using Telemetry and AMI Data Pathways

Manufacturer	Per Account (kW)		Aggregate (MW)		% Difference (AMI/Telemetry)
	Telemetry	AMI	Telemetry	AMI	
Event Season Impacts					

Manufacturer	Per Account (kW)		Aggregate (MW)		% Difference (AMI/Telemetry)
	Telemetry	AMI	Telemetry	AMI	
Nest	1.33	1.10	27.77	23.08	83%
ecobee	1.20	1.03	8.80	7.56	86%
Emerson	1.51	1.19	12.25	9.59	78%
All	**1.34**	**1.11**	**48.82**	**40.23**	**82%**
Resource Capability Impacts					
Nest	1.33	1.10	32.62	26.97	83%
ecobee	1.17	1.02	10.64	9.27	87%
Emerson	1.48	1.17	10.99	8.70	79%
All	**1.32**	**1.09**	**54.25**	**44.95**	**83%**

Table 21 presents differences in event day energy savings estimates using the telemetry and AMI data streams. As can be seen in the table, there is much greater variation in estimates across device manufacturers for energy savings than seen in resource capability and event season estimates. For Nest devices, energy savings using AMI and telemetry data are within 6% of each other. For ecobees, the estimates are 35% apart, and for Emersons, the difference is more than 80%. Most of these differences are not statistically significant, including those for Emersons. Upon exploring the differences in energy savings in greater depth, including running telemetry-based energy savings models separately for participants with and without AMI data and scrutinizing telemetry based load shapes across the two participant groups, we believe that the differences in point estimates are a function of variation in the data as opposed to a systematic and directionally consistent difference in energy savings between the two data streams. For Emersons specifically, it is possible that aggressive and varying pre-cooling strategies during hours preceding event dispatch contribute to greater variation in energy savings estimates as compared to the other two device manufacturers.

Table 21. Comparison of Event Day Energy Savings Using Telemetry and AMI Data Pathways

Manufacturer	Per Account (kWh)		Aggregate (MWh)		% Difference (AMI/Telemetry)
	Telemetry	AMI	Telemetry	AMI	
Nest	5.45	5.13	114.20	107.45	94%
ecobee	5.92	3.86	43.36	28.27	65%
Emerson	-13.52	-1.44	-109.44	-11.74	11%
All	**1.32**	**3.41**	**48.12**	**123.98**	**258%**

Table 22 presents a comparison of energy savings estimates resulting from the optimization of Emerson devices between AMI and telemetry pathways. As can be seen in the table, AMI estimates are 15% lower than the telemetry estimates.

Table 22. Comparison of Savings from Emerson Optimization Using Telemetry and AMI Data Pathways

Manufacturer	Per Account Per Day (kW)			Aggregate (MW)		
	Telemetry	AMI	% Difference (AMI/Telemetry)	Telemetry	AMI	% Difference (AMI/Telemetry)
Emerson	1.74	1.47	85%	934.73	791.06	85%

Without conducting further analysis and exploration, it is not possible to point to the exact source(s) of discrepancies in impact estimates between telemetry and AMI. However, this comparison can help prepare program staff for a transition to evaluation using AMI data and support planning assumptions for the program moving forward. The Appendix contains detailed plots and tables of impact estimates using AMI data.

4.4 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 enrolling 12,851 new devices into the program in PY2022. This is a substantial number of new enrollees; however, they were not sufficient to achieve program impact goals. The program achieved 93% of its target DR capability goal and resource capacity goal and only 15% of its energy savings goal. With an annual incremental attrition rate of 6%, a 4.16 MW shortage relative to the PY2022 goal, and an incremental increase in impact goals of 8.09 MW in PY2023, the Residential DR Program will need to enroll at least 13,000 additional devices to ensure goal achievement in PY2023. Enrollment of newly purchased devices through the Marketplace channel may require additional effort and cost given current channeling processes. Opening the program to new device manufacturers can significantly expand the eligible population but can also carry performance uncertainty.
  - **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. Notably, program staff anticipate adding Honeywell devices as part of the program in PY2023.
- **Conclusion 2:** PY2022 evaluation efforts included impact analysis using AMI data. AMI data provision, ingestion, processing, and analyses were successful and paved the way to a smooth shift to AMI-based impact analysis starting in PY2023. In comparison to telemetry data, AMI-based impact analysis resulted in similar, albeit somewhat lower load impacts. The deployment of AMI meters is scheduled to be near completion by the start of the PY2023 event season. AMI data is favored as a data source for DR program impact purposes because it reflects the actual load of a home at a given time and can help incorporate the effects of the DR interventions on other energy using systems that are not controlled by the program. As such, the evaluation team plans to shift to the sole use of AMI data for impact evaluation purposes starting in PY2023.
  - **Recommendation 2**: Given the differences between AMI and telemetry impacts observed among PY2022 participants, program staff should incorporate AMI impacts into program planning efforts for PY2023 to better align new customer enrollment with observed performance.
- **Conclusion 3:** The implementer succeeded in dispatching events over the course of the PY2022 event season in an experimental fashion following best practices of experimental design, including assignment of devices into treatment and control groups ahead of each event dispatch and pursuing experimental assignments by device manufacturer for greater precision. The number of participants withheld from treatment did not exceed 1,150 devices per device manufacturer during any given event, which represents an average of 9% of all devices withheld from participation per event. Despite several issues with identifying and reconciling treatment and control group customer assignments, the evaluation team was able to obtain experimental assignment data and conduct impact evaluation leveraging experimental design. The implementer continued delivering energy optimization in an experimental fashion using day-design approach. Accurate tracking of experimental assignments will remain a critical step in ensuring rigorous evaluation.

- **Recommendation 3:** The implementer should continue to deliver the program in an experimental fashion, including for future events focused on locational dispatch. The implementer should continue careful tracking of device assignments in treatment and control groups.

- **Conclusion 4:** Precooling algorithms deployed on Emerson devices resulted in aggressive load modifications prior to event dispatch leading to significant increases in cooling load for as many as nine hours preceding event dispatch. While load impacts for Emerson devices were considerably higher than for the other participating device manufacturers, such aggressive precooling strategies led to an average net increase in energy consumption of 12 kWh per device over the course of the event season and a total increase in energy consumption of 109 MWh across all participating devices over the course of the event season on event days. These increases in energy consumption can impact customer bills. This, combined with a considerably higher Emerson participant de-enrollment from the program as compared to other device manufacturers may signal potential challenges with customer experiences.

  - **Recommendation 4:** Program staff should consider balancing the aggressiveness of the precooling algorithms with load impacts and customer experiences and working with the implementer to explore opportunities for adjustments to the precooling strategies to achieve a more balanced dispatch experience.

- **Conclusion 5**. Optimization of Emerson devices on non-event days resulted in an additional 8% reduction in energy usage per day during the days when the optimization algorithms ran. The implementer ran optimization using a thoughtful experimental design, allowing for a rigorous and straightforward evaluation of program impacts. Despite limiting energy optimization of Emerson devices to weekdays only, average daily energy savings remained the same as in PY2021, indicating that daily savings on weekend days are similar to daily savings on week days. Excluding weekends from optimization however, resulted in reduction in overall savings achieved through optimization algorithm deployment.

  - **Recommendation 5.** The program should continue deploying optimization algorithms on Emersons using experimental design as a pathway to achieve additional energy savings.

5. Business Demand Response Program

This chapter summarizes the PY2022 evaluation methodology and results for the Business Demand Response (DR) Program.

The Business Demand Response Program was in its fourth year of deployment in PY2022. The program was designed to reduce load during periods of peak demand. Enel X acted as the program aggregator in PY2022, 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 PY2022, as in the previous years, 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, 2022. Enel X also called an additional test event in December 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.[16] Events could last for up to four hours in duration each, regardless of event type. No more than two events could be called on consecutive days.

Figure 11 provides a visual overview of the event notification process that Enel X followed in PY2022 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. Enel X requested and recorded participant confirmation of the intent to participate. After the event ended, Enel X sent a final e-mail confirming the end of the DR event dispatch.

Figure 11. Business DR Program: Event Notification Flow

[16] Emergency demand response events were not planned for the 2022 event season.

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 has 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.

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

5.1 Participation Summary

Based on the Stipulation PY2022, the program cumulative target for PY2022 was 100 MW of capacity reduction. Enel X had enrolled 940 customers by the end of the PY2022 event season with a total nominated capacity of 153.65 MW, which represents 154% of the PY2022 target of 100 MW (Table 23).[17]

Table 23. Business DR Program: Goals/Targets and Participation Summary

Metric	Cumulative MEEIA III Goal/Target	Enrollment	% of Goal/Target
End of the PY2022 Event Season Enrollment Summary			
Accounts		940	
Enrolled Nominated capacity (MW)	100	153.65	154%

In PY2022, Ameren Missouri used the program for peak shaving purposes. To assess participant performance, Enel X called one four-hour peak shaving event, one two-hour peak shaving event, and one one-hour test event during the event season. Following the completion of the event season, Enel X dispatched one two-hour test event to ascertain nominated capacity values for customers enrolled in the program after the end of the 2022 event season. Figure 12 provides details for each event.

[17] Customers are defined as unique accounts.

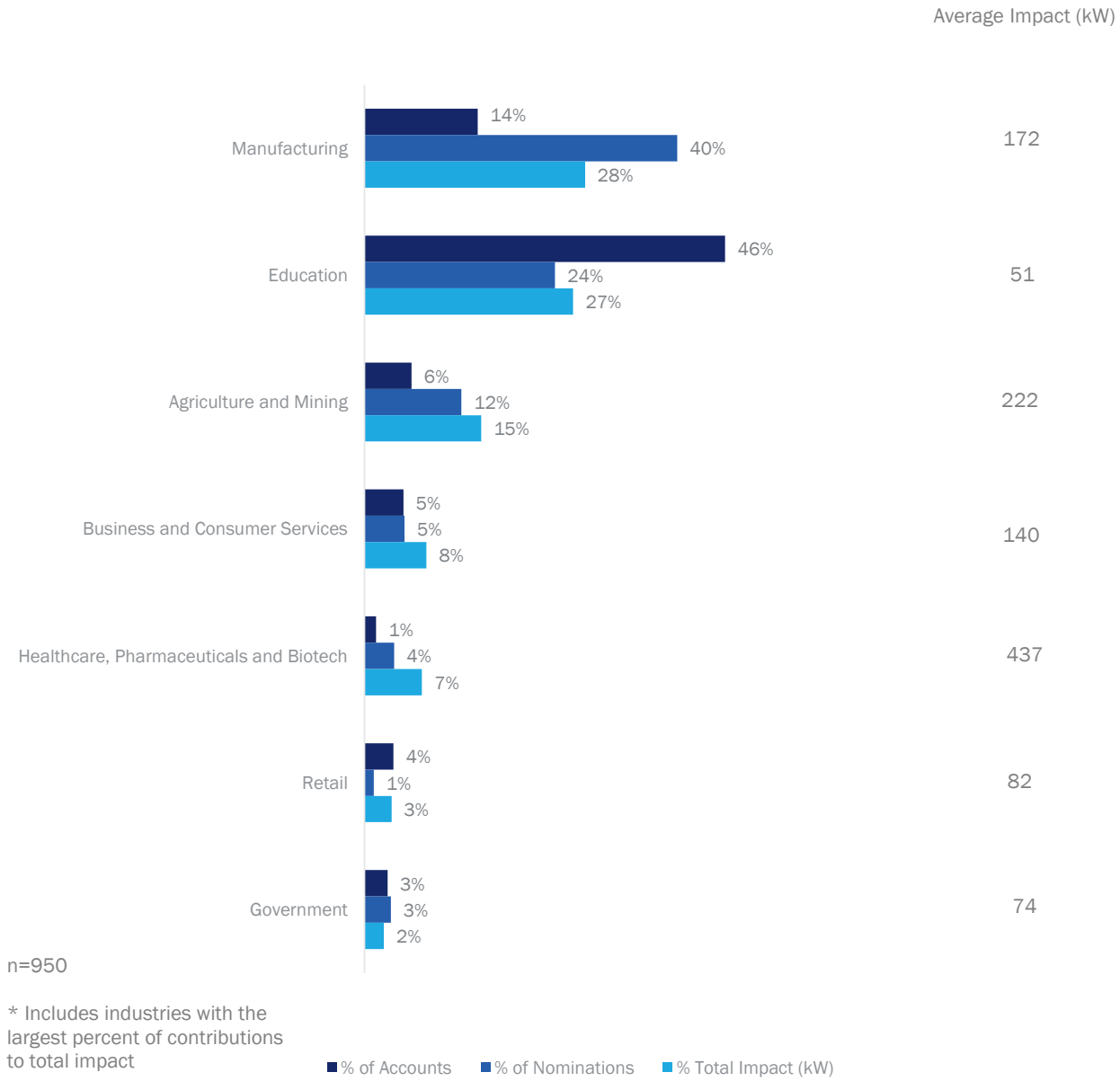
Figure 12. Business DR Program: Overview of PY2022 Events

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

PY2022 Participant Composition and Performance

At the end of PY2022, a total of 950 accounts were enrolled in the program with a nominated capacity of 158.48 MW. Enrolled customers spanned a range of business segments, including manufacturing, mining, consumer services, and transportation. Figure 13 shows the distribution of PY2022 program participants by segment both in terms of number of accounts as well as nominations and kW performance. The figure also contains average per account kW performance achieved by each segment through participation in PY2022 events. As can be seen in the figure, most customers in PY2022 were education and manufacturing facilities. These segments were also key contributors to program impacts from a volumetric perspective. On a per-account basis, however, agriculture and mining offered deeper load reductions compared to other segments. Compared to their nominations, the healthcare, retail, and education segments overperformed on average, whereas manufacturing underperformed.

Figure 13. Business DR Program: PY2022 Customer Distribution by Segment

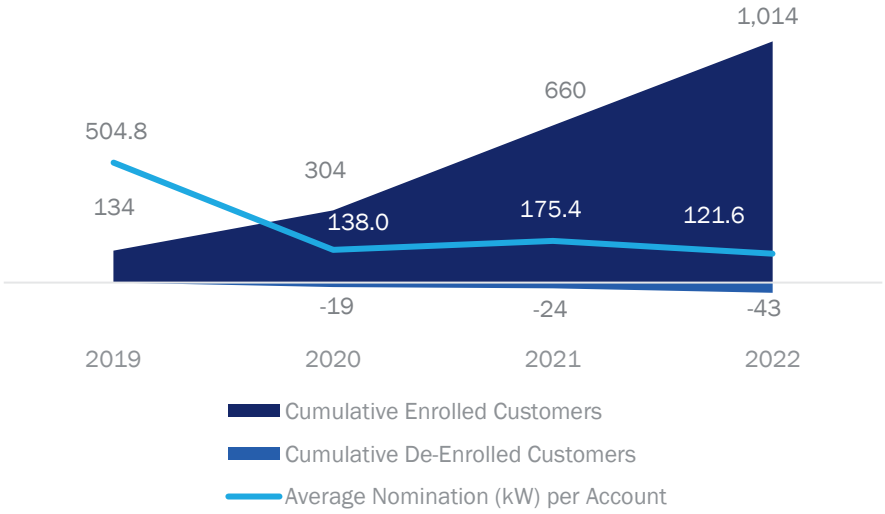


Note: Business segments may not always be accurate.

Program Enrollment Trends Over Four Years

Since the program's inception in PY2019, a total of 1,014 customers were enrolled in the program by Enel X, with 43 de-enrolling by the end of PY2022. Figure 14 shows customer enrollment and de-enrollment trends overlayed with average per-customer nomination reflective of customers enrolled in a given program year. As can be seen in the figure, customer nominations changed over time. Nominations were highest in PY2019 and lowest in PY2022. While this trend is not surprising and is consistent with Enel X targeting strategies focused on the largest accounts followed by outreach and marketing to smaller customers, it does signal that future participants will likely continue featuring smaller load curtailment potential for the program.

Figure 14. Business DR Program: PY2019–PY2022 Customer Enrollment



Customer Engagement

Enel X's process for new customer engagement is multi-step and involves a range of touchpoints to inform customers of the program, learn about business operations, as well as work with the potential customer to identify load curtailment opportunities and onboard them into the program. Enel X targets all Ameren Missouri's commercial and industrial customers with over 100 kW in peak demand who are not opted out of MEEIA Programs. Additionally, in 2022, Enel X, under their contract with Ameren Missouri, engaged and partnered with Enersponse to target and engage small and mid-sized customers belonging to business chains. Through this partnership, Enel X was able to enroll new sites that may not have been reached historically.

Enel X does both scheduled and unscheduled outreach to existing customers. Scheduled engagements are seasonally occurring readiness outreach. This includes checking and updating customer contact information, working to adjust load curtailment plans and nominations as necessary, and testing notification communications. Unscheduled engagement is outreach related to customer performance during the event season. This includes deeper engagement with customers to understand reasons for low performance and make adjustments, and to explore opportunities for even deeper performance with well-performing customers.

In 2022, Enel X launched an initiative to strengthen customer engagement, centering around identifying high-value customers and cultivating strong performers to increase performance and retention. Enel X identified 40 high-value customers after the first event, determined by size and potential, and increased personal interaction with them, including training and education efforts. Enel X observed a noticeable difference in the performance of some of these customers due to these additional, focused efforts.

Business Operations

In 2022, Enel X faced a combination of external and internal challenges enrolling new customers and achieving sustained levels of performance among existing customers. Inflation reached its highest levels in decades in 2022. The high inflation rates impacted participants' ability to invest in business growth and simultaneously decreased the value of the incentive. High inflation rates also influenced some participants' decisions to maintain production, and therefore revenue, rather than curtail load during events. If inflationary pressures persist, they may impact the influx of new business customers into Ameren Missouri's service territory. Despite the challenging economic and grid conditions, Enel X successfully added 354 participants in 2022, with only 19 participants unenrolling.

Additionally, participating customers experienced higher than usual staff turnover, consistent with broader employment trends. Staff turnover at customer sites led to contact challenges with already enrolled customers. The most common reason customers reached out to Enel X in 2022 was to inform them that the contact they sought was no longer with the company. Enel X responded to staff turnover by increasing efforts to understand the different site contacts and positions and identify the correct contact at the site. Enel X further reached out to new contacts and provided them with information on the program. The new staff contacts were less comfortable with the implementation of DR curtailment, likely due to limited knowledge and experience, thus impacting load impacts achieved during events.

Program De-Enrollment

A total of 43 accounts de-enrolled from the program, which represents 4% of all accounts enrolled in the program between PY2019 and PY2022. De-enrolled accounts span a range of segments, including manufacturing, education, business, and media and entertainment. Most customers who de-enrolled from the program did so right after enrolling, generally prior to development or finalization of their nominations. Other reasons for de-enrollment include the curtailment cost, the site shutting down, and onsite construction.

Future Program Implementation

Enel X does not plan to pursue any additional program design or implementation modifications in PY2023. The Business DR Program will continue to deploy existing best practices for customer engagement, will update customer nominations for PY2023, and will continue to be available for MISO emergency events.

5.2 Evaluation Methodology

This section summarizes the key objectives and methods for the PY2022 Business DR Program evaluation. The key evaluation objectives included the following:

- 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;
- Determine DR capability for all participants enrolled in PY2022;
- Estimate first year ex post gross energy (kWh) and demand (kW) savings; and
- Provide evaluation results to improve the design and implementation of the program.

Table 24 provides an overview of the Business DR Program evaluation activities. Following the table, we outline program-specific aspects of key evaluation methodologies.

Table 24. Business DR Program: PY2022 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 PY2022. ▪ Supported bidding of DR program impacts as a load modifying resource into MISO market.

5.2.1 Program Manager and Aggregator Interviews

Throughout PY2022, 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 target 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 beginning of 2023 to debrief on PY2022 experiences and understand any programmatic changes going into PY2023.

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.

Event Day Demand Impacts Estimation

For each event season event, as well as for the December test event, we estimated demand impacts by comparing actual interval meter readings during the event to the customer's baseline, which we used 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 included in the event. We calculated total event season performance by taking the average event performance of each account and summing it across all accounts.[18]

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

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

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

[18] For accounts with only one event dispatched, we used that event's performance.

Step 1: Calculate Provisional Baseline

We calculated the provisional baseline as the average demand during the event hour for the highest four of the most recent five non-holiday, non-event, weekdays before the event day. North American Reliability Corporation (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. 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 the 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

Some participating accounts in PY2022 were completely missing from the interval data or only had partial interval data available to calculate demand impacts using the above-described approach. To mitigate data gaps, the evaluation team used the following approach for calculating demand impacts:

- For accounts where bill grade interval data were not available, the evaluation team relied on non-bill grade interval data. When those data were not available, the evaluation team relied on the KYZ data collected by Enel X.
- For accounts with interval data available for four, as opposed to five, baseline days, we included those four days in the baseline calculation (a four-in-four baseline day approach instead of a four-in-five).
- 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 events, the evaluation team imputed performance using a weighted average of per-account performance across all participating accounts with valid interval data.

The evaluation team imputed demand savings for 13 accounts or 1.4% out of 946 accounts participating in any of the events. Of those 13 accounts, 6 did not have any interval data for any of the events. Overall, accounts without any interval data accounted for less than 1% of PY2022 nominations. Missing data can occur for a variety of reasons, including non-operational meter equipment or interval metering equipment not deployed in advance of the DR event. To further ensure the above-described imputations were reasonable,

the evaluation team worked with Enel X to obtain participant confirmation of event participation and validate that all accounts with missing data actively confirmed their intent to participate in the event(s).[19]

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 the four days with the highest consumption of the most recent five non-holiday, non-event, weekdays prior to the event day. NERC holidays were excluded from the calculation of the baseline. Additionally, we used the same baseline adjustment as for demand savings to calculate energy savings for each account. As part of the energy savings calculation process, we carefully explored adjusted and unadjusted baselines for each event, both in aggregate as well as by participating accounts. We further conducted weather sensitivity testing of participant loads over the course of the event season and explored the impact of baseline adjustments for weather sensitive vs. non-weather sensitive loads. Event day load shapes and adjusted and unadjusted baselines for all events are provided in the Appendix. Our analysis confirmed that baseline adjustments for the purposes of calculating energy savings are appropriate and support a more accurate estimation of the counterfactual event day load.

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

$$\begin{aligned} &Event\ Day\ Energy\ Impact\ (kWh) \\ &\quad = Average\ Daily\ Final\ Baseline\ Consumption\ (kWh) \\ &\quad - Daily\ Event\ Day\ Consumption\ (kWh) \end{aligned}$$

Missing Data

Similar to demand savings, not every participating account in PY2022 had interval data available to calculate energy savings. We used the same imputation processes to calculate energy savings as we did for demand savings.

The evaluation team imputed energy savings for the same number of accounts as in the case of the demand savings imputations. Average energy savings across the event season for accounts with at least one imputation totaled 9,433 kWh and represented less than 2% of total energy savings achieved for the year.

[19] As part of the event notification communications, Enel X requests that participants confirm their intent to participate in the upcoming event. Participants may choose to reply back confirming their participation, declining participation, or they may choose not to respond. All of the 13 accounts with imputations actively confirmed their intent to participate in the respective events, per the Enel X records shared with us.

Resource Capability Estimation

Annual resource capability is the sum of the demand response impacts each facility can provide, as demonstrated during the events called in a year. Resource capability is calculated by averaging the evaluated impacts across events (if a facility participated in multiple events) and summing across 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.[20]

To check for weather sensitivity, the evaluation team pulled data from St. Louis' Lambert Airport Weather Station and examined it in a correlation matrix against the summer usage values of all the customers enrolled in the program. Our analysis found that 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 component of Ameren Missouri's "Portfolio-wide Gross MW Target" performance bonus metric. The evaluation team calculated the cumulative DR capability consistent with the approach specified in the MEEIA III Plan. Cumulative DR capability included demand impacts from participants tested either during the event season events or during the December test event only. More specifically,

- For accounts that participated in the PY2022 event season, we used average event season performance to estimate cumulative DR capability.
- For accounts whose performance was tested during the December test event, we used the results of the test event to estimate cumulative DR capability. No account participated in both the event season and the December test event, so averaging performance was not necessary.

Data Sources and Data Cleaning

The evaluation team relied on four 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.
- Non-revenue quality interval data: In cases where revenue quality interval data were not available, the evaluation team used non-revenue quality interval data supplied by Ameren Missouri.
- Enel X KYZ data: In cases where interval data were missing, the evaluation team worked with Enel X to obtain interval data they collected through KYZ pulse outputs at participating facilities.
- Participation data: The evaluation team obtained participation data from Enel X. 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 Enel X and Ameren Missouri, 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;

[20] 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. In 2022, the only accounts to which this applied were prior participants who de-enrolled and then re-enrolled in 2022 but did not participate in the 2022 event season. For these prior participants, we used their average performance from previous seasons instead of an applied demand response impact value.

- 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.

Attribution/Net Impact Analysis

Per industry-standard practices, we assumed a net-to-gross ratio of 1.0 for impacts from DR events, that is, there is no free ridership or spillover.

5.3 Evaluation Results

5.3.1 Process Results

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 25 summarizes responses to the CSR process evaluation requirements.

Table 25. 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 fourth year, some program participants are gaining more experience. Inflationary pressures and staff turnover impact customer knowledge, comfort with, as well as willingness to curtail load.
Is the target market segment appropriately defined, or should it be further subdivided or merged with other market segments?	Targeting 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 to explore ways to achieve more performance among already enrolled participants. Enel X plans to continue deploying additional customer engagement to provide training, education, and update customer contacts to increase performance and retention.

5.3.2 Impact Results

Event Season Demand Savings

The Business DR Program achieved 78.98 MW in total demand savings during the PY2022 event season. The load reduction of 78.98 MW represents 51% of the total nominated capacity from customers, among whom the events were called (Table 26). The event performance calculated by the evaluation team matches Enel X's calculations of event performance.

Table 26. 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	June 14, 2022	2-6 pm CST	827	139.34	75.19	54%	91.14
2	July 5, 2022	4-6 pm CST	886	147.57	65.30	44%	73.71
3	September 9, 2022	3-4 pm CST	109	13.73	11.92	87%	109.31
Overall Event Season Result				**153.65**	**78.98**	**51%**	**84.02**

Note: Participating accounts include those among which the event was called.

PY2022 marked the first year of multi-hour event dispatches among Business DR Program participants. Table 27 summarizes average per-account performance in each of the event hours. As can be seen in the table, participants were able to sustain performance across the two hours of the July 5 event, though average per account performance was the lowest of the three events. Per account load impacts decline in hours two, three, and four of the June 14 events with overall attrition in load impact of 28% in hour four as compared to hour one. Attrition of load impacts in multi-hour events is commonly observed and can be explained by comfort, energy using system operation patterns, business needs, and other reasons. Enel X noted that declining load impacts in the June event hours can be attributed to participants relying on HVAC systems for load curtailment.

Table 27. Business DR Program: Event Performance by Hour

Event	Date	Time	Participating Accounts	Average Per Account Load Impacts (kW)			
				Hour 1	Hour 2	Hour 3	Hour 4
1	Event 1 (June 14, 2022)	2-6 pm CST	827	105	97	86	76
2	Event 2 (July 5, 2022)	4-6 pm CST	886	73	73		
3	Event 3 (September 20, 2022)	3-4 pm CST	109	113			

Note: Average per account load impacts are calculated excluding imputations

Not all participants delivered consistent or desired performance. More specifically, 11% of all accounts delivered negative impacts across all events, meaning that their load during event hours increased. Almost two-thirds of participants (58%) delivered positive load reductions during events. The remaining participants delivered mixed load reductions.

A total of 880 customers participated in two or more events over the course of the PY2022 event season. We explored consistency of those customers' performance across the events. Of those, only 275 customers (31%) performed consistently.[21] Consistently performing customers also performed well below the average event season performance rate, collectively averaging a 41% performance rate. The stability of performance event-

[21] Consistent performance is defined as performance rates within 20 percentage points of one another.

to-event alongside the alignment of performance with nominated capacity is key to anticipating and adapting the program to ensure continued success.

Table 28 summarizes event season performance by industry. As can be seen in the table, healthcare and transportation, followed by media and entertainment, wholesale and distributors, agriculture and mining, and manufacturing industries yielded the best performance per participating account. Motor vehicle parts manufacturing, surgical, and travel and recreation industries delivered the lowest load reduction impacts per account. Mining and quarrying, retail, transportation, and healthcare participants delivered impacts above their nominated capacity, suggesting participants in these segments are capable of better and deeper performance than initially anticipated.

Enel X's focus in the coming years will be on working with existing customers to improve their program performance, while pursuing the engagement of new customers.

Table 28. Business DR Program: Event Performance by Segment

Industry	Number of Accounts at the End of the Event Season	Average per Account Nomination (kW)	Event Season Per Account Average Performance (kW)	Event Season Average Performance Rate (%)
Mining and Quarrying of Nonmetallic Minerals	1	10	28	277%
Retail	35	53	82	155%
Transportation and Storage	1	295	420	142%
Healthcare, Pharmaceuticals, and Biotech	14	427	437	103%
Wholesale and Distributors	6	415	318	77%
Media and Entertainment	1	600	387	64%
Agriculture and Mining	56	348	222	64%
Nonclassifiable Establishments Class	6	116	74	64%
Education	434	88	51	58%
Miscellaneous Plastics Products	1	235	135	57%
Primary and Secondary Education	20	84	45	54%
Energy and Utilities	120	15	8	54%
Business and Consumer Services	46	105	48	45%
Government	28	190	74	39%
Manufacturing	135	459	175	38%
Real Estate and Construction	18	298	112	38%
Other	10	170	38	22%
Metal Forgings and Stampings	1	240	28	12%
Travel and Recreation	4	118	8	7%
Surgical	1	210	4	2%
Motor Vehicle Parts Manufacturing	2	48	-11	-23%
Total	**940**	**163**	**84**	**51%**

Achieving energy savings during demand response events was not the primary goal of the Business DR Program. As a result of the three events during the event season and the additional test event dispatched in December, participants decreased consumption by a total of 868 MWh. The energy savings fell short of the target of 2,000 MWh and represent 43% of the cumulative target for PY2022 (Table 29).

Table 29. Business DR Program: Energy Savings Comparison to PY2022 Goal/Target

Event	MEEIA III Goal/Target (MWh)	Event Season Energy Savings (MWh)	Percent of Goal/Target
Event 1 (June 14, 2022)		382.16	
Event 2 (July 5, 2022)		448.17	
Event 3 (September 5, 2022)		22.78	
Event 4 (December 7, 2022)		14.88	
Total	**2,000.00**	**867.98**	**43%**

The average per account energy savings was 0.92 MWh. Savings varied by event, but on average represented 5% of the baseline load (Table 30).

Table 30. Business DR Program: Performance Summary, Energy Savings

Event	Date	Time	Participating Accounts	Total Energy Savings (MWh)	Average Per Account Energy Savings (MWh)	Savings as Percent of Baseline Load
1	Event 1 (June 14, 2022)	2-6 pm CST	827	382.16	0.46	5%
2	Event 2 (July 5, 2022)	4-6 pm CST	886	448.17	0.51	6%
3	Event 3 (September 20, 2022)	3-4 pm CST	109	22.78	0.21	3%
4	Event 4 (December 7, 2022)	3-5 pm CST	6	14.88	2.48	11%
			Overall Result	**867.98**	**0.92**	**5%**

Note: Savings as a percent of baseline load is calculated excluding imputations.

Resource Capability Estimate

Table 31 presents resource capability estimates. These estimates reflect available capacity from all accounts enrolled at the end of the PY2022 event season.

For accounts participating in the event season, resource capability represents the average event performance during the season summed across accounts. For accounts untested during the PY2022 event season that had participated in earlier years (e.g., had de-enrolled at the start of PY2022 and not re-enrolled until after the summer event season), resource capability represents their average event performance during the event seasons that they were active. This applies to four accounts. For accounts untested during the 2022 event season that had not participated in earlier years (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 PY2022, there were no accounts enrolled by the end of the year that were untested. We did not weather normalize resource capability since we tested weather sensitivity of the participating accounts and generally found little to no correlation between load and weather. Total estimated resource capability is 84.12 MW, representing 53% of the nominated capacity of the accounts enrolled as of the end of PY2022.

Table 31. Business DR Program: PY2022 Resource Capability Estimate

Metric	Result
Total accounts enrolled as of the end of 2022	950
Total nominated capacity (MW)	158.48
PY2022 resource capability estimate (MW)	84.12
PY2022 per-account resource capability estimate (kW)	88.54

Looking ahead to PY2023, the Business DR Program resource capability of 84.12 MW represents 84% of the cumulative PY2023 target of 100 MW (Table 32). Given enrollment to-date, Enel X is well-positioned to meet the PY2023 demand response target provided sustained performance in PY2023 and successful efforts to enroll additional customers in the program.

Table 32. Business DR Program: Comparison of Resource Capability to Goal/Target

Metric	Result
PY2022 resource capability estimate (MW)	84.12
PY2022 goal/target (MW)	100.00
Percent of PY2022 goal/target	84%

Cumulative DR Capability Estimate

Table 33 presents the PY2022 cumulative DR capability. The values in the table represent demand impacts from tested accounts, either during the PY2022 event season or during the December test event.[22] Cumulative DR capability is a component of Ameren Missouri's PY2022 "Portfolio-wide Gross MW Target" performance bonus metric. The program's cumulative DR capability is 83.84 MW and represents 84% of the target.

Table 33. Business DR Program: Comparison of Cumulative DR Capability to Target

Metric	Result
PY2022 cumulative DR capability (MW)	83.84
PY2022 target	100.00
Percent of PY2022 target	84%

5.4 Conclusions and Recommendations

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

- **Conclusion 1:** The Business DR Program fell 15.88 MW short of its PY2022 cumulative target. The varying performance of existing customers event-to-event, smaller capacity nominations from newly enrolled customers, as well as market conditions, including inflation and employee turnover are some of the reasons for program underperformance. With no incremental goals for PY2023 and low levels of participant attrition over time, the focus of the program can shift to working with existing participants to optimize their performance and focusing on enrolling new program entrants to make up for the PY2022 shortfall.
  - **Recommendation 1:** Program staff should continue proactive outreach to new customers. To that end, Enel X can capitalize on the existing relationships and processes established in

[22] 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.

PY2022 including partnership with Enersponse in engaging small and medium-sized businesses and continued proactive outreach to participants to increase their comfort level with the program.

- **Conclusion 2:** PY2022 marked the first year of multi-hour event dispatch. As is typical with multi-hour events, load impacts decrease following the first hour of dispatch and can lead to lower overall average event performance. In the June 14 event, for example, a four-hour event dispatch resulted in a 28% attrition in load impacts in hour four as compared to hour one of the event. While HVAC loads could have had a prominent contribution to the attrition of the load impacts, additional analysis and research are needed to better understand both participant ability as well as preparedness to sustain performance during multi-hour events.
  - **Recommendation 2:** Program staff should plan for and adjust participant performance expectations with consideration of potentially lower impacts for multi-hour events. Program staff should explore reasons for attrition and consider developing strategies to encourage continued performance during multi-hour events to ensure sustained impacts. This might include educational messages with tips, conversations with customers surrounding event preparedness, and, for HVAC loads specifically, pre-conditioning strategies ahead of the event in order to deliver steady impacts while keeping facilities comfortable during event dispatch hours.
- **Conclusion 3:** Continued engagement and educational activities undertaken in PY2022, including targeted outreach to high value participants, were a useful tool to mitigating lack of knowledge of and experience with DR load curtailment strategies and presented a pathway to ensuring customer comfort with curtailing load during events.
  - **Recommendation 3:** Enel X should continue proactive outreach to update customer contact information and engage customers in training and educational activities surrounding event preparedness.

For more information, please contact:

Antje Flanders
Vice President

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

130 Turner Street
Building III, Suite 520
Waltham, MA 02453