2019 RESIDENTIAL WI-FI THERMOSTAT DIRECT LOAD CONTROL OFFERING EVALUATION

Prepared for:
Eversource MA, Eversource CT, National Grid MA, and Unitil MA

Submitted by:

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STUDY OVERVIEW

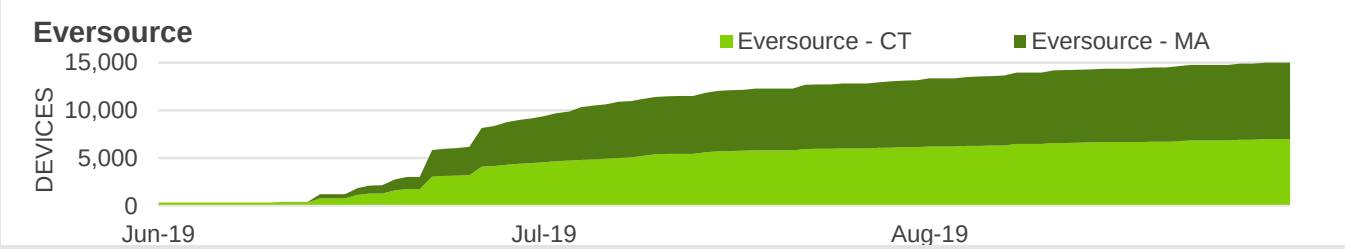
OFFERING SUMMARY

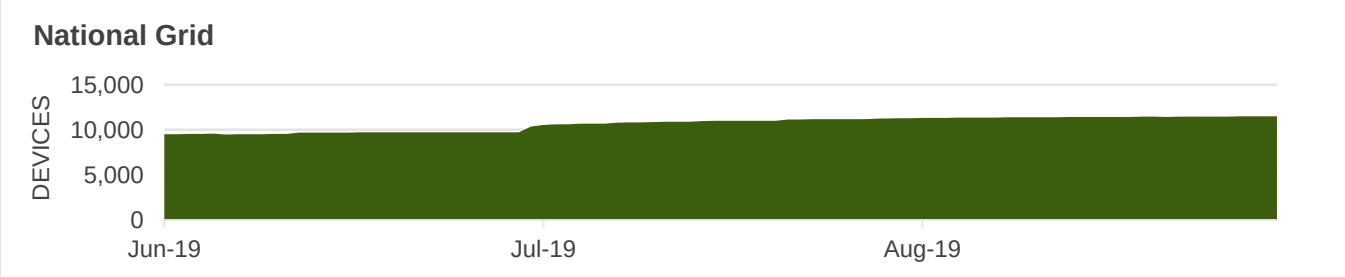
The Residential Wi-Fi Thermostat Direct Load Control (DLC) offering evaluated in this study is part of the Program Administrators' broader active demand response initiatives. The offering aims to reduce peak demand of residential central air conditioning (AC) systems by directly controlling the scheduled setpoints of Wi-Fi thermostats on specific days during the summer. Participating customers are provided sign up and annual incentives for providing the right to adjust their temperature setpoint during events, as well as for access to their thermostat data. Events during the 2019 demand response (DR) season[1] were generally 3 hours with a 3 - 4°F temperature adjustment during events. Events were called between the hours of 2 p.m. and 7 p.m. on non-holiday weekdays between June 1 and August 31 (evaluated DR season).

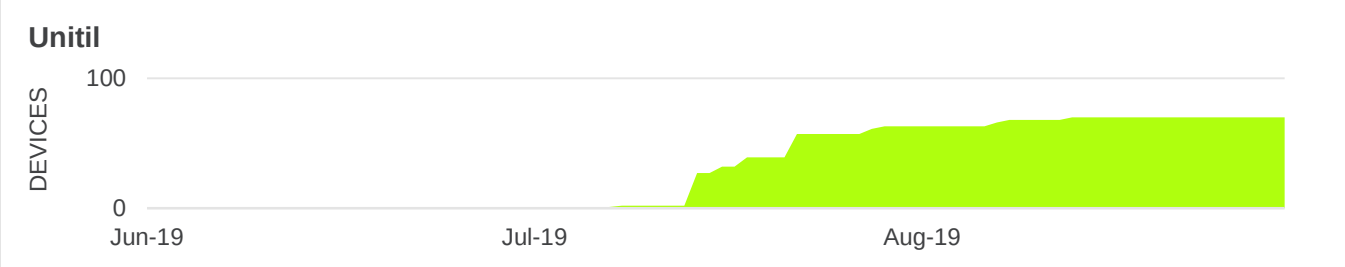
STUDY OVERVIEW

2019 Program Enrollment

2019 was the fourth year National Grid MA encouraged customers to enroll in the offering. 2019 was Eversource CT's second year, and first year with EnergyHub. For Eversource MA and Unitil MA, 2019 was the first year of the offering. The figures below show device enrollment for the period of June 1, 2019 through August 31, 2019 for Eversource, National Grid and Unitil.







[1] The 2019 DR season was June 1, 2019 to September 30, 2019. Ultimately, no events were called in September 2019.

EVALUATION OBJECTIVES

This evaluation assessed the demand and energy impacts achieved in 2019 and calculated savings adjustment factors for use by the PAs for claiming savings in future years. The evaluation also assessed customer experience and acceptance of the solution. Where appropriate, research questions were explored by PA (i.e., Eversource MA and CT, National Grid MA, and Unitil MA). Additionally, comparisons were made for the National Grid offering across program years 2016 to 2019.

EVALUATION APPROACH

The evaluation approach, which includes customer experience research and impact analysis, is summarized in the table below.

Evaluation Component	Description
Participant Survey	Navigant developed, fielded, and analyzed the results of an online survey of 316 participants at the end of the 2019 DR season.
Analysis of Enrollment Data	Navigant analyzed enrollment data to calculate the annualized rate at which thermostats leave or were removed from the program for those enrolled in 2019 (all PAs) and prior to 2019 (for National Grid and Eversource CT).
Thermostat Usage Assessment	The team analyzed thermostat telemetry data and thermostat-level participation data to assess participation status (including opt-out and connectivity rates) during events and throughout the evaluated DR season.
Impact Analysis	The evaluation measured demand and energy impacts for the National Grid and Eversource 2019 offerings during pre-cooling, event, and recovery hours using regression analysis with the experimental design and a within-subject approach.[1] The team relied on thermostat telemetry data, converting thermostat runtime into power based on data from the 2017 MA residential baseline study and 2017 National Grid MA DR field study.
Savings Adjustment Factor	Navigant developed a savings adjustment factor which will be applied to vendor-reported savings estimates for each PA to claim savings in 2019 and future years.

[1] Navigant did not conduct an impact evaluation of Unitil's 2019 offering due to low enrollment.

ANALYSIS FINDINGS

CUSTOMER EXPERIENCE RESEARCH

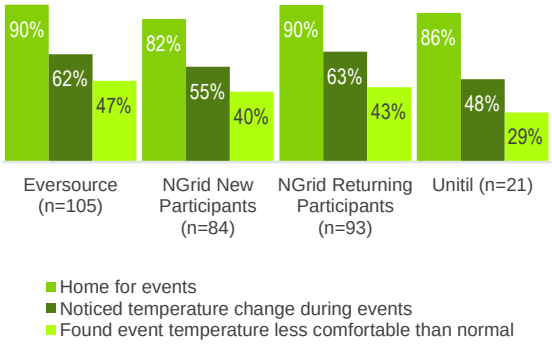
Sustained Enrollment for Devices Enrolled Since Sep 2018

Percentage of Devices still enrolled as of Aug 31 2019 (%)

Overall, 96% of thermostats that enrolled since September 30, 2018 remained enrolled through the end of the 2019 evaluated DR season. The annualized rate at which thermostats leave or are removed from the ConnectedSolutions offering ranges from **5 to 11% per year**. However, for both Eversource and National Grid, implementation vendor transitions impact the ability to fully analyze the extent to which thermostats have left the programs over time.

Event Experience

Percentage of Respondents (%)



70% of respondents who were home for events **noticed a change in temperature** during events and **50%** found the event temperature **less comfortable** than normal

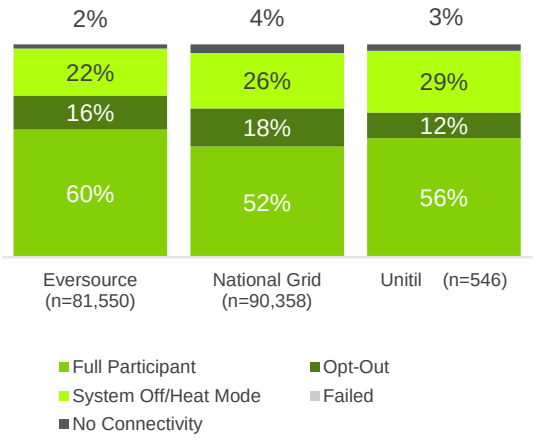
OTHER HIGHLIGHTS

Notification: 73% of respondents reported receiving event notifications. Of these, 25% would like to receive different mode of event notification than what they received in 2019.

Likelihood to continue: 85% reported being likely to continue participating in the program.

Thermostat Usage Assessment

Percentage of Thermostats (%)



2019 full participation rates exceeded 50% on average and across the season.

A significant number of devices were never in cooling mode for an event.

OTHER HIGHLIGHTS

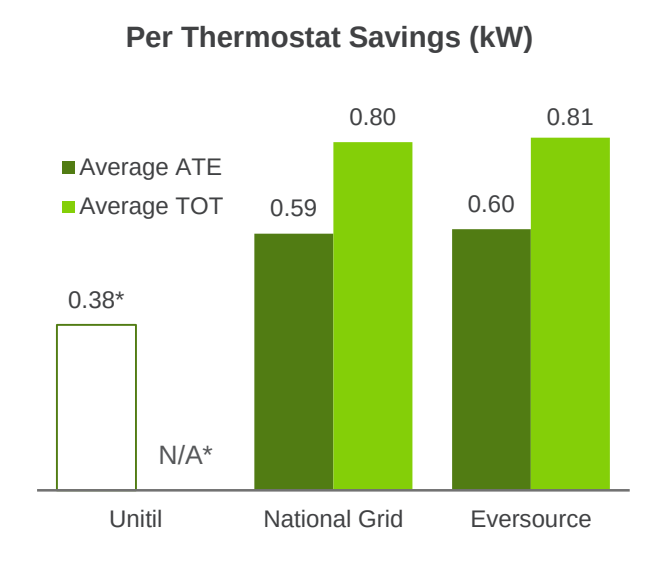
A large portion of connectivity issues stem from devices that were disconnected for the entire season.

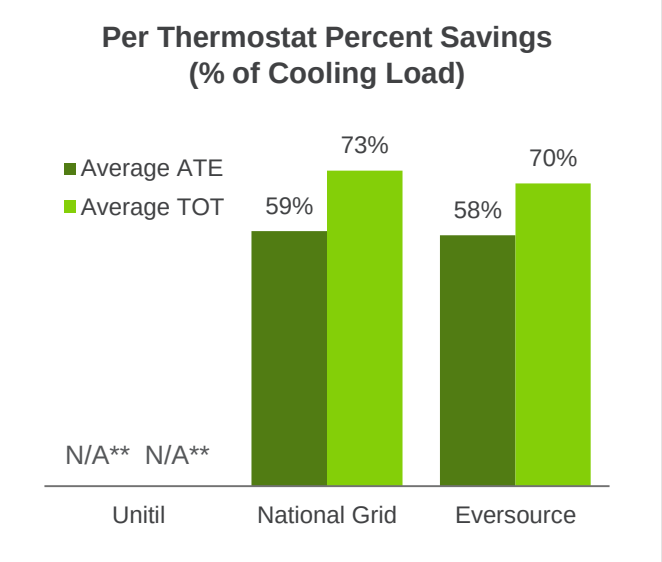
Participants exhibited no evidence of event participation fatigue (increased opt-out rates) due to back-to-back events or a higher event dispatch frequency.

ANALYSIS FINDINGS

IMPACTS

Navigant estimated average demand and energy impacts during pre-cooling, event, and recovery hours as well as total demand savings by event for the 2019 program offering for Eversource MA, Eversource CT, and National Grid MA. Navigant estimated the average treatment effect (ATE), meaning the average event impact across all dispatched devices. For Eversource and National Grid this was 0.60 kW and 0.59 kW per thermostat, respectively. To understand the impacts for fully participating thermostats (those who were successfully dispatched for the event and did not opt-out during the event), Navigant also estimated the treatment effect on the treated (TOT). For Eversource and National Grid this was 0.80 kW and 0.81 kW per thermostat, respectively. Due to low program enrollment Navigant did not estimate savings for Unitil MA but rather calculated savings using the savings adjustment factor (described later).





*Unitil's savings were calculated using the savings adjustment factor, which is applicable for the ATE. **The counterfactual event period load as predicted by the regression model was used to calculate percent savings. Since a regression analysis was not conducted for Unitil, percent savings could not be calculated.

2019 Program Savings	Eversource CT	Eversource MA	National Grid	Unitil
Average Demand Reduction per Event	3,572 kW	4,081 kW	6,031 kW	20 kW

OTHER HIGHLIGHTS

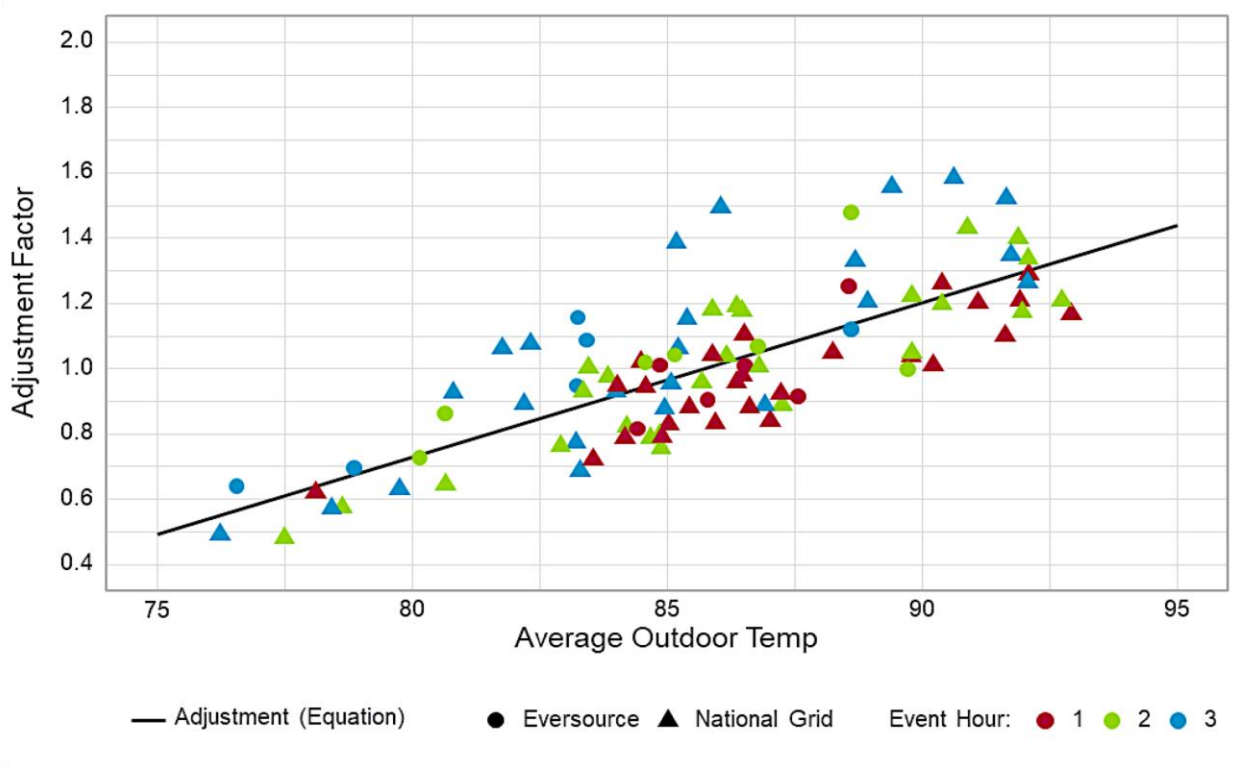
- Fully participating devices have average event savings that are over 35% higher than the average across all dispatched participants. Impacts for full participants show the technical potential of the offering. As opt-outs and other forms of non-participation are reduced, average and total event impacts should increase.
- National Grid's average demand savings per event in 2019 was 0.59 kW, a decrease from the average savings found in 2018 (0.71 kW). The lower savings likely stem from the later event times and the fewer number of event days exceeding 90°F in 2019 compared to 2018, which resulted in a lower baseline cooling load.

ANALYSIS FINDINGS

SAVINGS ADJUSTMENT FACTOR

Navigant developed a savings adjustment factor to be applied to vendor-provided savings estimates by comparing the hourly evaluated impacts for 2018 and 2019 National Grid and 2019 Eversource to the hourly impacts estimated by the implementor, EnergyHub, where the average outdoor temperature was greater than 75 degrees. The savings adjustment factor will be used to claim savings by all PAs in 2019 and future years.

Hourly Event Impact Adjustment Factor



Demand Savings Adjustment Factors

Period	Hourly Adjustment Factor	Conditions
Pre-cooling	0.72	Average Temperature ≥ 75°F 30 to 90 Minute Duration ISO-NE or PJM Baseline
Event	-3.06 + (0.05 x Avg Temp °F)	Average Temperature ≥ 75°F 3-Hour Duration ISO-NE or PJM Baseline
Recovery	0.68	Average Temperature ≥ 75°F ISO-NE or PJM Baseline

RECOMMENDATIONS & CONSIDERATIONS

Research Category	Recommendations and Considerations
Participation and Attrition	**Consideration 1:** Monitor attrition annually to identify changes in and causes of unenrollment and removal of devices from the offering. If possible, records of former participants should be maintained in the event of a change in implementation vendors.
	Recommendation 1: Unenroll thermostats from the offering that frequently opt out of events, do not have connectivity, and/or are consistently in a non-cooling mode. This will lower the costs of the Direct Load Control Offering and increase average savings per thermostat. In parallel, ensure that the enrollment tracking system allows for the tracking of unenrollment reasons related to the opt outs, connectivity and AC system mode behavior.
Program Messaging	**Consideration 2:** Clarify the messaging regarding the intent of offering by continuing to emphasize in all public-facing materials that the offering supports protecting the environment by lowering emissions and supports reliability of the electric system. Avoid language that suggests individual customers will save energy and/or money on electricity bills by participating in the offering.
Event Notifications	**Consideration 3:** During or after participants enroll, provide some "helpful program tips" including noting that, if participants would like to be notified of events through their thermostat app, they may need to adjust their phone settings in order to allow automated messages to be sent by their thermostat app when the app is not open. This is only applicable to thermostat types that provide event notification via the associated mobile app.
	Consideration 4: Give participants a few options to customize advance event notification preferences – method (email, thermostat app, or text) and timing (day-ahead or day-of) to the extent possible.
	Consideration 5: Provide a pop-up notification that asks participants who try to adjust their setpoint during events to confirm that they would like to override the event. Some thermostats already have this feature.
Pre-Cooling	**Consideration 6:** Continue pre-cooling to maximize event savings. Ensure that participants are aware that adjustments made during the pre-cooling period will prevent them from participating in the event (as applicable).
Future Savings	**Recommendation 2:** Include the count of all residential and non-residential devices and participants enrolled as of August 31 in the Massachusetts ADR BCR model. For 2019, the count of thermostats is 8,020, 11,503, and 70 for Eversource MA, National Grid MA, and Unitil, respectively. The count of participants is 5,158, 7,814, and 45 for Eversource MA, National Grid MA, and Unitil, respectively.
	Recommendation 3: Calculate ex-post savings by applying the savings adjustment factor to vendor-reported savings. Use ex-post savings for claiming savings in 2019 and in future years. For the event period, the savings adjustment factor is an equation based on average outdoor temperature: -3.06 + (0.05 x Avg Temp °F). For pre-cooling and recovery hours, the savings adjustment factors are constants, 0.72 and 0.68, respectively. The adjustment factor can apply when the ISO-NE or PJM baseline is used, pre-cooling and event duration conditions are met, the assumed AC nameplate capacity continues to be 3.5 kW in the EnergyHub portal, and the average outdoor temperature is 75 degrees F or higher. When these conditions are not met, the savings adjustment factor does not apply.
	Consideration 7: Consider conducting an evaluation in the future if the offering undergoes vendor and/or algorithm changes as the current adjusted savings framework will no longer apply with significant changes to implementation.
	Consideration 8: Consider conducting an evaluation in the future if a DR season has back-to-back 95+ degree event days as current and past evaluations have not included such extreme event conditions.
	Consideration 9: Continue to test DR setbacks to explore whether the program can achieve higher savings per thermostat without resulting in participants opting out of events at higher rates.

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2019 Residential Wi-Fi Thermostat Direct Load Control Offering Evaluation

Final Report

Prepared for:

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DISCLAIMER

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[1] On October 11, 2019, Guidehouse LLP completed its previously announced acquisition of Navigant Consulting Inc. In the months ahead, we will be working to integrate the Guidehouse and Navigant businesses. In furtherance of that effort, we recently renamed Navigant Consulting Inc. as Guidehouse Inc.

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1. INTRODUCTION

The Residential Wi-Fi Thermostat Direct Load Control (DLC) offering evaluated in this study is part of the Program Administrators' broader Active Demand Reduction initiatives. This evaluation report describes the customer experience research, thermostat usage assessment and analysis of impacts conducted by Navigant, a Guidehouse company (Navigant), in support of the Residential Wi-Fi Thermostat DLC offering (branded ConnectedSolutions and hereafter referred to as the offering). This evaluation covers the ConnectedSolutions Residential Wi-Fi Thermostat DLC offering of Eversource Massachusetts, Eversource Connecticut, National Grid Massachusetts, and Unitil Massachusetts in 2019. Navigant's methodology, data sources used, and key findings are detailed in subsequent sections of this report.

1.1 Offering Summary

The offering aims to reduce peak demand of residential central air conditioning (AC) systems by directly controlling the scheduled setpoints of Wi-Fi thermostats on specific days during the demand response (DR) season.[2,3] Participating customers are provided incentives for allowing their utility to adjust their temperature setpoint during events, as well as for access to their thermostat data. In 2016, 2017, and 2018, in Massachusetts, a Wi-Fi thermostat DLC offering was offered by National Grid.[4,5] In Connecticut, Eversource has offered a Wi-Fi thermostat DLC offering to residential customers since 2017. 2019 is the first year Eversource in Massachusetts and Unitil offered the residential Wi-Fi thermostat DLC offering.[6]

The key attributes of the 2019 offering are summarized in Table 1-1. The parameters of Eversource MA and Eversource CT offerings were identical in 2019. In 2019, some differences in implementation existed across the PAs in the following areas:

- **Incentives:** Eversource and Unitil offered a $25 one-time sign up incentive and a $20 annual incentive; National Grid offered a $20 sign-up incentive and a $25 annual incentive.
- **Event number:** Eversource called 7 events, Unitil called 11, and National Grid called 12.
- **Event setback:** National Grid and Unitil implemented a 4°F setback for all events, while Eversource had both 3°F (5) and 4°F (2) setbacks.
- **Event timing:** Eversource called events starting at 3:00 p.m. (1), 3:30 p.m. (1), and 4:00 p.m. (5); National Grid called events starting at 3:00 p.m. (6) and 4:00 p.m. (6); and Unitil called events starting at 3:00 p.m. (3), 4:00 p.m. (6), and 5:00 p.m. (2)

[2] The 2019 DR season was June 1, 2019 to September 30, 2019. Ultimately, no events were called in September 2019.

[3] Non-residential accounts with central cooling systems controlled by Wi-Fi thermostats are also eligible for the offering. In 2019, less than 1% of participating devices are associated with non-residential accounts.

[4] Parameters of National Grid's program in previous offering years are included in Appendix A.

[5] Cape Light Compact also offered a Wi-Fi thermostat DLC offering in 2016, 2017, and 2018.

[6] In 2018, Eversource MA piloted a DLC offering targeting non-residential customers that included no-cost Wi-Fi thermostats (Itron brand only) and installation.

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- **Event duration:** Eversource and National Grid events were all 3 hours, while Unitil had both 2-hour (3) and 3-hour (8) events.

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Table 1-1. 2019 Wi-Fi Thermostat DLC Offering Summary

	Eversource MA+CT	National Grid MA[ŧ]	Unitil MA
Evaluated DR Season	Jun 1–Aug 31	Jun 1–Aug 31	Jun 1–Aug 31
Potential Event Days	Non-holiday weekdays	Non-holiday weekdays	Non-holiday weekdays
Potential Event Times	2 p.m. to 7 p.m.	2 p.m. to 7 p.m.	2 p.m. to 7 p.m.
Pre-Cooling Duration	1 hr	1.5 hrs	0-0.5 hrs
Event Duration	3 hrs	3 hrs	2-3 hrs
Pre-Cooling Temp Adjustment	3°F	3°F	0°F -2°F
DR Event Temp Adjustment[7,8]	3°F -4°F	4°F	4°F
Sign-Up Incentive | Annual Incentive	$25 | $20	$20 | $25	$25 | $20
Participation Requirement	None	None	None
Event Notification Method	Varies by manufacturer (incl. email, in-app, on thermostat)	Varies by manufacturer (incl. email, in-app, on thermostat)	Varies by manufacturer (incl. email, in-app, on thermostat)
Event Notification Timing	Mostly day of[9]	Day of	Mostly day of[10]
DRMS Provider	EnergyHub	EnergyHub	EnergyHub
Eligible Thermostat Types	Nest, Honeywell, ecobee, Radio Thermostat, Alarm.com, Lux, Sensi, Vivint	Nest, Honeywell, ecobee, Radio Thermostat, Alarm.com, Lux, Sensi, Vivint	Nest, Honeywell, ecobee, Radio Thermostat, Alarm.com, Lux, Sensi, Vivint
Number of Participants[11]	MA: 5,158 CT: 4,165	7,814	45
Number of Thermostats[12]	MA: 8,020 CT: 6,969	11,503	70

[ŧ] National Grid has implemented the ConnectedSolutions Wi-Fi Thermostat DLC offering since 2016. The most notable change in 2019 was the increase in the event temperature adjustment from 3°F to 4°F.

* Event setpoint adjustments are optimized at the device level for Nest devices.

Source: Navigant

[7] Event setpoint adjustments are optimized at the device level for Nest devices.

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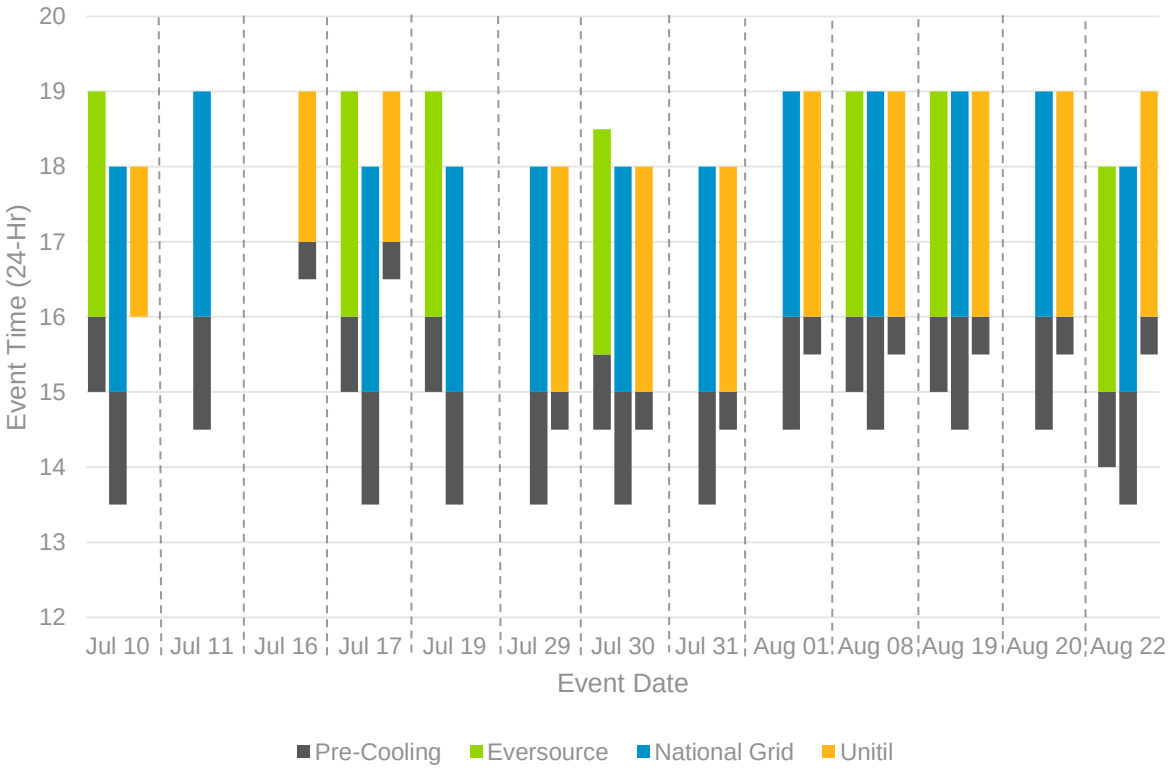
Figure 1-1. shows the timing and duration of the summer 2019 events across all three Program Administrators (PAs, i.e., Eversource MA and CT, National Grid MA, and Unitil MA).[13] Although most events were called on the same days, the pre-cool duration and total number of events differed. On days when multiple PAs called events, the event start time was not necessarily aligned.

Figure 1-1. Schedule of 2019 Events



Source: Navigant analysis of EnergyHub data

In terms of weather, 2019 was one of the hottest summers on record in Massachusetts and Connecticut. July 2019 was Boston's and Hartford's warmest month on record when looking at average temperature. In July, Hartford had 19 days exceeding 90°F. August was also a hot month, with August 19 setting record high daily temperatures in both Hartford and Boston.

[8] Additionally, National Grid used Firm Load Dispatch (FLD) for all events for non-Nest devices and Eversource used FLD for all but the first three events for non-Nest devices. Unitil did not use FLD in 2019. FLD maintains a stable target load curve by coordinating the setpoint adjustment start and end times of enrolled air conditioners. In contrast, for an event where setback is used, but FLD is not used, load reductions are highest at the beginning of the event.

[9] Eversource participants received day-ahead notification for the event on July 10, 2019.

[10] Unitil participants received day-ahead notification for the event on July 17, 2019.

[11] Enrolled as of August 31, 2019. Counts based on a combination of Verified Account Number and participant email address.

[12] Enrolled as of August 31, 2019.

[13] Event parameters, including timing, of Eversource MA and Eversource CT Wi-Fi DLC offerings were identical in 2019.

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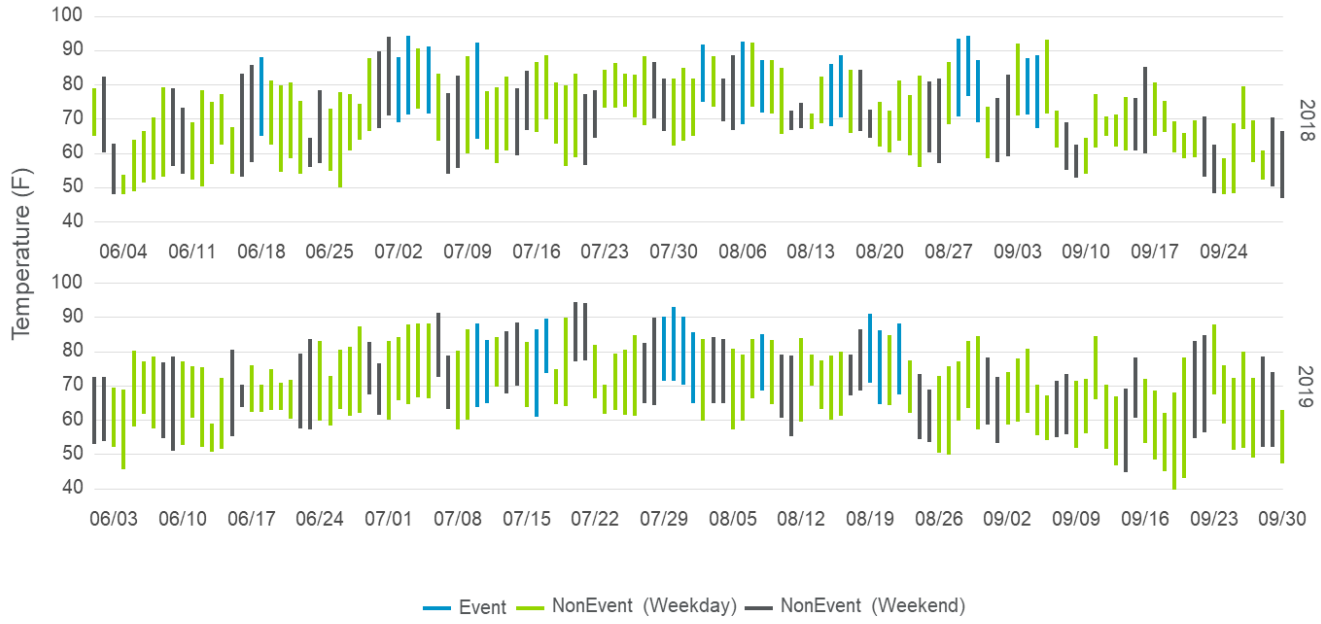
Despite this, the summer 2019 DR season experienced cooler weather on event days than the summer of 2018 (during which National Grid's offering was previously evaluated). Figure 1-2. displays the daily average high and low temperature for each day, June through September in 2018 and 2019, with the event days highlighted in blue. When comparing event days for National Grid, 2 of the 12 event days in 2019 occurred on days when the high temperature exceeded 90°F, compared to 6 of the 15 event days in 2018. Although the 2019 summer season did have more than 2 days that exceeded 90°F, several fell on weekends when events could not be called based on the PAs' program rules.

Figure 1-2. Summer 2018 and 2019 Weather and National Grid Events



Source: Navigant analysis of NOAA weather data for National Grid devices

1.2 Evaluation Objectives

This evaluation's objectives included verifying that the solution successfully enables demand reductions (and if so, by how much) and assessing the customer experience and acceptance of the solution. These objectives were achievable through the investigation of several research questions relating to 1) Customer Experience, 2) DR Impacts, and 3) Program Design and Implementation. The specific research questions are included in Table 1-2. Where appropriate, these research questions were explored by PA (i.e., Eversource MA and CT, National Grid MA, and Unitil MA).[14] The evaluation also sought to compare select metrics for this National Grid offering across 2016 to 2019.

[14] The evaluation scope did not contemplate providing results by state or by thermostat manufacturer (e.g., Nest, Honeywell, ecobee, and Alarm.com). However, offering-wide savings for 2019 are provided separately for Eversource MA and Eversource CT.

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Table 1-2. Evaluation Research Questions

Research Category	Research Questions
Customer Experience	• After signing up in 2019, have any customers unenrolled during the 2019 summer season? • After signing up in earlier years, have customers returned in 2019? (National Grid MA and Eversource CT) • What feedback do participants have to improve the offering (e.g., enrollment process, event notifications, overall)? • What are reasons customers enrolled in the program? • What are reasons customers opted-out of events?
Program Design and Implementation	• What are the opt-out rates for each DR event and throughout the DR season? • How many participants frequently opt-out of events and are there trends by average event temperature and consecutive events? • What impact did the increase in the event setback have on opt-out and drop-out rates (National Grid MA only)? • What fraction of enrolled thermostats receive the DR signal and participate when called for an event? • Are some thermostats frequently unable to participate during events due to connectivity issues? • Are participants experiencing event fatigue if multiple events are called back-to-back?
DR Impacts	• What are the demand impacts before, during, and after the DR event for each offering? • What are demand savings coincident with the ISO-NE system peak? • What are the energy impacts from calling a DR event? • What is the savings adjustment factor for demand savings?

Source: Navigant

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2. EVALUATION METHODS

The 2019 evaluation assessed the extent to which the technology solution achieves demand savings and focused on the development of a savings adjustment factor for use by the PAs in future years. It also assessed customer experience with the offering. The evaluation approach is summarized in Table 2-1 which includes customer experience research and impact analysis.

Table 2-1. Residential Wi-Fi Thermostat DLC Evaluation Approach

Evaluation Component	Description
Participant Survey	Navigant developed, fielded, and analyzed the results of an online survey of 316 participants at the end of the DR season.
Analysis of Enrollment Data	Navigant analyzed offering enrollment data to calculate attrition rates for those enrolled in 2019 (all PAs) and prior to 2019 (for National Grid and Eversource CT).
Thermostat Usage Assessment	The team analyzed thermostat telemetry data and thermostat-level participation data to assess participation status (including opt-out and connectivity rates) during events and throughout the DR season.
Experimental Design	Navigant randomized devices into one of three groups (A, B, C). Once implemented, either the A group or B group was withheld from the event dispatch to serve as the control group, while the C group was always dispatched. For events prior to the experimental design implementation, Navigant employed within-subject approach using non-event days to estimate impacts.
Data Management	Prior to conducting its analysis, Navigant performed a QA/QC of the 15-minute thermostat telemetry for 20,737 participants. The review included screening for gaps in the data, logic errors, and confirming the experimental design group assignment. The team also reviewed the National Weather Service hourly temperature data to confirm that the relevant Massachusetts and Connecticut weather stations were not missing hourly data on days of interest and had reasonable temperature and humidity readings across weather stations.
Runtime to Energy	The team relied on thermostat telemetry data, converting thermostat runtime into power based on data from the 2017 MA residential baseline study and 2017 National Grid MA DR field study.
Regression Analysis	For National Grid and Eversource, the evaluation measured demand and energy impacts during pre-cooling, event, and recovery hours using regression analysis with the experimental design and a within-subject approach. The team did not measure impacts for Unitil using regression analysis due to low program enrollment.

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Evaluation Component	Description
Savings Adjustment Factor	Navigant developed a savings adjustment factor to apply to vendor-reported savings to calculate *ex post* savings that would be claimed by the PAs, including savings to be claimed in 2019 and in future years.[15] The savings adjustment factor was informed by (1) analysis of evaluation results in 2018 and 2019 for National Grid and Eversource, and (2) developing an understanding of EnergyHub's approach to calculating savings.

Source: Navigant

The remainder of this section provides additional detail regarding the evaluation approach for each of the items listed in the above table.

2.1 Customer Experience Research

This section describes the customer experience research conducted for this evaluation. It included an online survey and an analysis of offering enrollment data.

2.1.1 Post-Season Survey

Navigant administered a post-season online survey with 2019 ConnectedSolutions participants. The survey explored the following key questions:

- What motivates customers to enroll/participate in the offering? How do customers first learn about the offering?
- How aware are participants of events (including pre-cooling)? Do they experience discomfort?
- Do participants ever opt-out of events? How often do they opt-out? Do they opt-out before or during events? Do participants experience any challenges opting out?
- How likely are customers to continue to participate in the offering in the future?
- What suggestions or recommendations do customers have related to improvement of the offering?

Navigant designed the survey instrument and had it reviewed by the PAs and EEAC consultant before fielding the survey. To avoid customer confusion and survey fatigue Navigant also coordinated with EnergyHub, which also implemented a post-season survey. The Navigant survey was administered via the Qualtrics platform from October 11 through October 21, 2019,[16] and included a soft launch to test the survey for a small number of participants. Ultimately, the

[15] For the Massachusetts PAs, *ex post* savings values will be the input to the Massachusetts Demand Reduction Benefit Cost Ratio model via the DR Impact Factor Calculator tool developed by Synapse Energy Economics.

[16] The exact start date for the survey varied across program administrators (PAs): fielding for National Grid began on October 11, while fielding for Eversource and Unitil began on October 14.

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survey had 316 completes total across the PAs (106 Eversource participants, 89 National Grid participants – new to the program in 2019, 99 returning National Grid participants, and 22 Unitil participants). The survey sample frame and response rate are detailed in Section 3.1. Appendix B provides the survey instrument. Key findings of the survey are detailed in Section 4.1. A full set of survey results appear in Appendix C.

2.1.2 Enrollment Data Analysis

Navigant analyzed enrollment data by PA to assess attrition for those newly enrolled in the Wi-Fi Thermostat DLC offering in 2019. For National Grid MA and Eversource CT, Navigant also calculated attrition for customers enrolled before September 30, 2018 to assess whether customers who had participated in early years of the offering remained enrolled through the 2019 summer season. Section 4.1 details the results of this analysis.

In addition, to calculate the final counts of enrolled devices as of August 31, 2019, the counts to be entered into the MA Active Demand Reduction (ADR) Benefit Cost Ratio (BCR) models by Eversource MA, National Grid MA, and Unitil MA (described in Appendix G), working from enrollment data files for each PA dated October 2019, Navigant summed the following:

- Devices with an "Accepted Date" before or equal to August 31, 2019 and an "Accepted" status
- Devices with an "Accepted Date" before or equal to August 31, 2019, an "Unenrolled" status, and an "Unenrolled Date" after August 31, 2019
- Devices with an "Accepted Date" before or equal to August 31, 2019, a "Removed" status, and an "Unenrolled Date" after August 31, 2019

Final device counts exclude devices with a current status of "Pending" or "Rejected." Final counts of participants and thermostats appear in Appendix G.

2.2 Thermostat Usage Assessment

Using thermostat telemetry and event participation data, Navigant analyzed dispatched thermostat participation statuses on event days for National Grid and Eversource customers that were part of the experimental design[17] and all Unitil customers, identifying key trends. To analyze the thermostat telemetry data, Navigant first categorized all enrolled thermostats by event into one of five participation status categories:

- ***Full participant:*** Thermostat used the DR setpoint or a more efficient setpoint for the full event
- ***Opt-out:*** Customer actively opted the thermostat out of an event, either before or during the event

[17] Although Eversource did not have an experimental design for the first three events, Navigant only analyzed thermostats that were assigned to the A, B, or C group. I.e., the population of thermostats in the experimental design was analyzed for all events, regardless if the experimental design was in place.

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- ***System off/heat:*** The HVAC system was in off or heat mode at the start of the event
- ***Failed:*** Thermostat likely did not participate during the event because the event notification was not received or did not correctly initiate the event
- ***No connectivity:*** Thermostat data indicates there was no connectivity during the DR event

Once thermostats were categorized into these participation categories, Navigant compared device participation across PAs, event days, experimental design groups, offering years, and device types. Additionally, Navigant explored the serial nature of device participation, analyzing how frequently each device had each participation status.

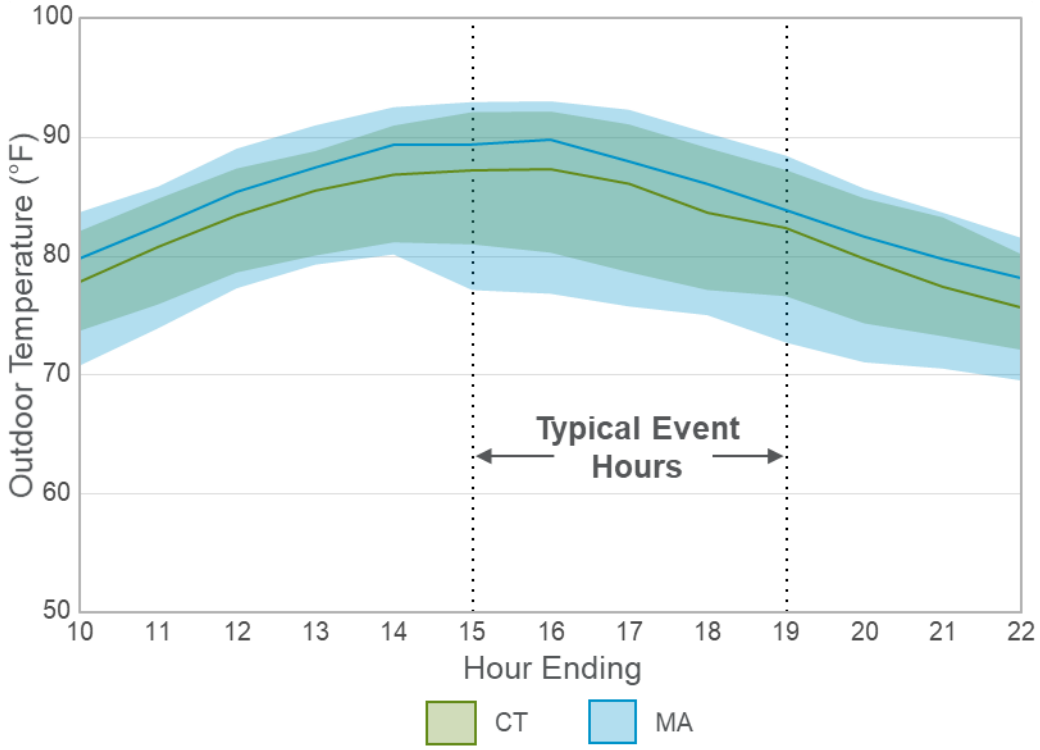
2.3 Impact Analysis

This section describes the approach used to a savings adjustment factor to be applied to vendor-provided estimates resulting in *ex post* savings to be claimed by the PAs in 2019 and in future years.

2.3.1 Combining Eversource MA and CT

For Eversource, devices in Massachusetts and Connecticut were combined for the evaluation, meaning only one demand savings estimate was produced for each event day for devices enrolled in the Eversource offering. To verify the validity of combining estimates across states, Navigant examined the average hourly event day temperature in Massachusetts and Connecticut where Eversource devices were enrolled, as shown in Figure 2-1..The blue and green lines represent the average temperature on event days across all thermostats in a given state while the shaded blue and green bands represent the range of observed temperatures. Despite small differences, event day weather across Massachusetts and Connecticut was similar. Because of these similarities, it is unlikely that differences in event impacts would exist across the two states due to weather.

Figure 2-1. Eversource Event Day Weather Comparison



Source: Navigant analysis of NOAA weather data for Eversource devices

2.3.2 Experimental Design

There are multiple approaches available to estimate hourly impacts of the ConnectedSolutions offering (e.g., ISO-NE uses an X-of-Y customer-specific baseline approach to estimate savings). When possible, Navigant recommends employing experimental design to measure and evaluate savings as an experimental design ensures the observed outcome is directly attributable to the offering intervention. Randomized control trials (RCT) are a type of experimental design in which a population is randomly assigned to two groups – a treatment group and a control group. The outcomes for these two groups can be compared and any differences identified are attributable to the treatment, in this case the DLC offering.

For this evaluation, Navigant and the PAs implemented an experimental design whereby DR participants (and associated thermostats) were randomly assigned into one of three groups – group A, group B, or group C.[18] For each DR event, group A and group B alternate which group is selected to participate in the DR event; group C is always called. The A/B/C design yields a control group for each event (participants in the control group are not informed of the event, nor

[18] Ideally all participants would be randomly assigned to a single treatment and control group for each event. This would ensure any differences in event impacts were a result of event attributes (e.g., weather, event duration, day of week, time of day) rather than a combination of event attributes and differences between the treatment and control group that may remain after randomization. However, due to the implementation challenges associated with randomizing participants prior to each event, Navigant randomly assigned customers to one of three groups.

are their thermostat set points adjusted), while providing the ability to study participation fatigue since one group is always called.[19] For this evaluation, total savings estimates do not include the control group in 2019. This is a departure from previous evaluations conducted for National Grid where the total offering savings values, on a per-event basis, included devices in the control group, in addition to devices in treatment and default groups.[20]

2.3.2.1 Experimental Design and Implementation

Navigant worked with each PA to develop and implement the experimental design. This included the following activities:

- **Feasibility and Design.** Navigant worked with each PA to assess the feasibility of using an experimental design. To maximize the precision of impact estimates based on an experimental design, Navigant initially proposed A, B and C groups that each included about 1/3 of the devices. Navigant then worked with each PA to ensure alignment on evaluation objectives and determine the minimum size of groups A and B. See Table 2-2 for a summary of the experimental design by PA.

[19] Customers (and associated thermostats) that enroll after the randomization is completed were included in a separate "default" group, which was called for each event. These participants (and associated thermostats) are not included in the analysis of per thermostat impacts by event, but are included in the overall savings estimate per event.

[20] In previous years, the DR program offering was a demonstration and therefore extrapolated program saving to the control group. In 2019, the DR program was a full offering and could not claim savings for thermostats withheld from events in a control group.

Table 2-2. Final Experimental Design by PA

PA	Description	1st Event When Implemented	Thermostat Count*			
			Group A	Group B	Group C	Default
Eversource – MA & CT	~500 in A/B groups for MA+CT combined. Emphasis on maximizing treatment group size.	July 30, 2019	495	500	10,631	Non-residential and devices enrolled after exp. design implemented
National Grid	1,000 in A/B groups to maximize precision.	July 10, 2019	1,020	998	6,635	Non-residential and devices enrolled after exp. design implemented
Unitil	No experimental design.[21] All Unitil thermostats get dispatched for every event.	N/A	N/A	N/A	N/A	All enrolled devices

*Thermostat counts represent the Navigant-provided counts for the experimental design. Actual device counts may differ slightly due to customers unenrolling prior to devices being assigned to groups on the EnergyHub portal or other technical issues.
Source: Navigant

- **Randomization.** Following the determination of group sizes, Navigant conducted a stratified randomization for National Grid and Eversource to ensure balance across groups A, B, and C by thermostat type, weather station, and average annual usage.[22]
    - Thermostat types with enough enrolled devices were included in the stratified randomization. In 2019, this included Nest, Honeywell, Alarm.com, and ecobee for both National Grid and Eversource. Thermostat types with fewer enrolled devices were combined and randomly assigned across the A, B, and C groups.
    - Navigant stratified participants by their annual usage.
    - Navigant stratified participants by their assigned weather station, which was based on mapping of ZIP Code to weather station developed by Navigant.
    - In addition, Navigant checked balance across groups for the number of thermostats per customer and (for National Grid only) new vs. returning customers.

[21] Due to low offering enrollment, Unitil and Navigant mutually agreed that Navigant would not include Unitil thermostats in an experimental design. Refer to Section 2.3.5 for Navigant's approach for developing event-specific savings estimates for Unitil.

[22] The thermostats of non-residential customers were excluded in the residential thermostat A/B/C randomization; they were assigned to a "default" group. Residential thermostat savings were still applied to non-residential enrolled thermostats.

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- **Device Assignment.** Following randomization, Navigant assigned each thermostat ID to group A, B, C, or default and securely sent the assignments to National Grid and Eversource to update within the EnergyHub portal.

2.3.2.2 Events Without Experimental Design

The experimental design was fully implemented by the first event initiated by National Grid. For Eversource, this was the first time an offering was launched across the two states. There were internal and external tracking and reporting requirements that necessitated a delay in the implementation of the experimental design. As a necessary work-around, the Navigant team used a within-subject approach for the first three events Eversource dispatched. [23] This approach is discussed further in Section 2.3.5.2.

Due to low offering enrollment, Unitil did not implement an experimental design. A within-subject model was also not feasible due to low enrollment. All results reported for Unitil in 2019 that appear in section 4.3 of this report. This approach is described further in Section 2.3.5.3 and savings adjustment factors are provided in Section 4.4.1.

2.3.3 Data Management

Prior to conducting its analysis, Navigant performed a QA/QC of the 15-minute thermostat telemetry for 20,737 participants. The review included screening for gaps in the data, logic errors, and confirming the experimental design group assignment. The team also reviewed the National Weather Service hourly temperature data to confirm that the relevant Massachusetts and Connecticut weather stations were not missing hourly data on days of interest and had reasonable temperature and humidity readings across weather stations. Section 3.2, Section 3.3. and Appendix B provide additional details on data management QA/QC procedures.

2.3.4 Runtime to Power Conversion

Navigant converted thermostat runtime to power based on an analysis of metering data from Phase 2 of the 2017 Massachusetts Baseline Study and assumptions regarding average size (3.0 tons) and efficiency (10.7 energy efficiency ratio or EER) of air conditioners based on a field study of National Grid DR offering participants conducted by Navigant in October 2017. Navigant compared these assumptions to those in the Connecticut Program Savings Document to confirm the suitability of these assumptions for devices in Eversource's Connecticut offering and found them comparable. Using this conversion, a 15-minute interval with 100% runtime at 80°F, the estimated power is 2.95 kW. The resulting equation is the following:

Equation 2-1

$$\widehat{kW} = 0.0013 + 0.8170 * \frac{\%\ Runtime * 36{,}000}{10.7 * 1000} + 0.0012 * CDH_{70} + 0.0055 * CDH_{70} * \frac{\%\ Runtime * 36{,}000}{10.7 * 1000}$$

This equation represents the relationship between the average power draw (kW) in a given time interval, the amount of time the AC is cooling during that interval (% Runtime), and the outdoor

[23] A total of 3 events were called by Eversource prior to the experimental design. These occurred on July 10, 17, and 19.

temperature represented as cooling degree hour base 70 (CDH_{70}). The equation inputs are average AC size (36,000 BTU or 3 tons) and the average AC efficiency (10.7 EER).

2.3.5 Estimating Impacts

Navigant employed two methods for estimating demand savings impacts from the 2019 offering. These are shown in the table below.

Table 2-3. 2019 Impact Methods

Method	Use
Regression with Experimental Design	Used for estimating savings associated with all National Grid events and 4 of 7 Eversource events in 2019.
Regression with Within-Subject	Used for estimating savings associated with 3 of 7 Eversource events in 2019.

Source: Navigant

The remainder of the section provides detail on each method specified above.

2.3.5.1 Regression for Experimental Design

Navigant used a regression-based modeling approach in which customers assigned to an experimental group called for an event were compared to the control group (the experimental group that was not called for the event).[24] Formally, the model specification is:[25]

$$\widehat{kW_{it}} = \alpha_i + \lambda_t + \beta_{1i}T_{it} + \beta_{2it}(Precool_t * T_{it}) + \beta_{3t}(Event_t * T_{it}) + \beta_{4t}(Recovery_t * T_{it}) + \gamma Weather_{it} + \varepsilon_{it}$$

Where,

$\widehat{kW_{it}}$	is estimated power draw by thermostat *i* during period *t*
α_i	is a customer-specific fixed effect for thermostat *i*; this picks up all customer-specific characteristics that do not change through time, like household square footage
λ_t	is a time-specific fixed effect for period *t;* this picks up temporal differences, such as occupancy and daylight hours
T_{it}	is a binary variable taking a value of 1 when thermostat *i* is in the treatment group during period *t*

[24] Refer to Section 3.2 for a summary of the population of thermostats included in the impact analysis.

[25] Navigant estimated quarter-hourly and hourly impacts for the pre-cooling, event, and recovery periods. In these models, *Pre-cool*, *Event*, and *Recovery* are a set of binary covariates corresponding to each hour or quarter-hour of the period. Navigant estimated event-specific impacts by interacting an event-specific binary variable with the time-specific fixed effect, treatment variable, and treatment interacted with *Pre-cool, Event,* and *Recovery.*

$Precool_t$	is a binary variable taking a value of 1 when *t* is in the 3 hours preceding an event and 0 otherwise
$Event_t$	is a binary variable taking a value of 1 when *t* is in the hours during an event and 0 otherwise
$Recovery_t$	is a binary variable taking a value of 1 when *t* is in the 3 hours following an event and 0 otherwise
$Weather_{it}$	is a series of weather controls specific to thermostat *i* in period *t* (e.g., cooling degree hours, heat build-up)
ε_{it}	is the error term for thermostat *i* during period *t*

Navigant modeled both the average treatment effect (ATE), in which impacts are modeled for thermostats in the following categories (full participant, opt-out, failed, and system off/heat) and the treatment effect on the treated (TOT), in which impacts are modeled for only thermostats in the full participant category.

2.3.5.2 Regression for Within-Subject

For the first three Eversource events Navigant used a within-subject methodology to estimate savings. The within-subject analysis entailed identifying suitable non-event days for each event and establishing the counterfactual for each event based on the non-event day data using regression analysis. Only treatment customers are included in the within-subject model as there is no experimental design, and therefore no control group.

Formally, the model specification is:

$$\widehat{kW_{it}} = \alpha_i + \lambda_t + \beta_{1i}T_{it} + \beta_{2it}(Precool_t) + \beta_{3t}(Event_t) + \beta_{4t}(Recovery_t) + \gamma Weather_{it} + \varepsilon_{it}$$

Where,

$\widehat{kW_{it}}$	is estimated power draw by thermostat *i* during period *t*
α_i	is a customer-specific fixed effect for thermostat *i*; this picks up all customer-specific characteristics that do not change through time, like household square footage
λ_t	is a time-specific fixed effect for period *t;* this picks up temporal differences, such as occupancy and daylight hours
$Precool_t$	is a binary variable taking a value of 1 when *t* is in the 3 hours preceding an event and 0 otherwise
$Event_t$	is a binary variable taking a value of 1 when *t* is in the hours during an event and 0 otherwise

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$Recovery_t$	is a binary variable taking a value of 1 when *t* is in the 3 hours following an event and 0 otherwise
$Weather_{it}$	is a series of weather controls specific to thermostat *i* in period *t* (e.g., cooling degree hours, heat build-up)
ε_{it}	is the error term for thermostat *i* during period *t*

2.3.6 Savings Adjustment Factor

Navigant developed a savings adjustment factor to apply to vendor-provided savings estimates to determine *ex post* savings for all PAs in 2019 and beyond (see Section 4.4). The savings adjustment factor will determine the savings the PAs will claim in 2019 and in future years.

The savings adjustment factor was informed by a comparison of the hourly evaluated impacts from the 2018 and 2019 National Grid evaluation and the 2019 Eversource evaluation for each event period (pre-cooling, event, and recovery) to the corresponding hourly savings estimated by EnergyHub where the outdoor temperature was greater than 75 degrees (F). Navigant analyzed and characterized the relationship between the savings estimates to develop the savings adjustment factor. For example, if a positive or negative correlation between outdoor temperature and the resulting adjustment was observed, Navigant recommended an equation as the adjustment factor for that period. If no strong correlation was present, Navigant recommended the average adjustment for that event period. Once Navigant developed the savings adjustment factor, we applied the savings adjustment factor to the 2019 vendor-reported savings to calculate 2019 savings for each PA.

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3. DATA SOURCES AND DATA REVIEW

This section describes the data sources used for this evaluation as well as the steps taken to prepare the data for analysis. The data sources used include survey data, various data streams from EnergyHub and temperature data from NOAA.

3.1 Survey Data

Table 3-1 outlines the various characteristics of the post-season survey. Navigant designed the survey sample to achieve statistically robust results for each study group of interest: Eversource (MA and CT) participants, Unitil participants, National Grid new participants, and National Grid returning participants. Navigant considered new and returning National Grid participants as distinct study groups to observe any differences in program experience or satisfaction levels between the two groups.

Table 3-1. Post-Season Survey Characteristics

Survey Characteristic	Description
Implementation Method	Online
Incentive	$10
Frequency/Timing	Conducted from October 11 through October 21, 2019, including soft launch.
Study Groups	Offering participants who experienced at least one event.[26] Navigant designed the sample in order to facilitate analysis and reporting of results for four separate study groups: Eversource participants,[27] National Grid new participants, National Grid returning participants, and Unitil participants.

Source: Navigant

Except for Unitil, Navigant targeted 70 completes per study group to achieve or exceed a 90/10 level of confidence and precision on group-level results. Given the size of Unitil's offering, Navigant targeted all 45 participants enrolled as of the last event (August 22, 2019) for the survey effort. Navigant provides confidence and precision levels for individual survey results in Section 4.1.3.

[26] The last event for each PA occurred on August 22, 2019.

[27] Due to the fact that there was a relatively small number of returning Eversource CT participants (425), Navigant did not break out new and returning Eversource participants into two separate study groups.

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Table 3-2. Post-Season Survey Respondents and Response Rate

Study Group	Participants Enrolled as of Last Event	Invites Sent	Target Completes	Survey Completes	Response Rate
Eversource	9,073	225	70	106	47%
National Grid – New	3,014	220	70	89	40%
National Grid – Returning	4,654	220	70	99	45%
Unitil	45	45	Up to 45	22	49%
Overall		**710**	**Up to 255**	**316**	**45%**

Source: Navigant

3.2 Data from EnergyHub

Navigant relied on several data sources provided by EnergyHub for all thermostats enrolled in the 2019 ConnectedSolutions offering, for the exploratory and impact analyses:

- **Thermostat enrollment data[28]:** This data identified each thermostat enrolled in the ConnectedSolutions offering across the three PAs and provided key information about the device's enrollment, including: the date the thermostat was accepted to the offering, the offering unenrollment date (if any), the geographic location of the thermostat, and the experimental design group to which the thermostat was assigned.

- **Thermostat telemetry data:** The telemetry data provided 15-minute runtime data for each enrolled thermostat, which Navigant converted to an estimate of power draw.

- **Event participation data:** For each event, EnergyHub provided an event participation status for each thermostat describing how the device interacted with the event (full participation, opt-out, no connectivity, incorrect mode, and failed dispatch).

- **Event load intervals:** For each event day, EnergyHub provided the aggregate 15-minute load (kW) for all enrolled thermostats and the estimated baseline load for each interval.

For the impact evaluation, Navigant validated the telemetry data and removed observations using the following steps:

- **No reported telemetry data (Alarm, Vivint):** Alarm.com and Vivint GoControl devices do not report telemetry data to the EnergyHub portal, and therefore could not be included in the analysis.

[28] As an exception, enrollment data for the 2017-2018 Eversource CT offering from prior to the integration with EnergyHub was provided to Navigant by Eversource CT.

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- **No reported telemetry data (Nest):** Any Nest device that did not report telemetry data on the specified day due to a lack of connectivity was removed from the analysis. Only Nest devices omitted telemetry data due to connectivity issues. All other devices appeared in the telemetry data with missing runtime.

- **Missing runtime data:** Devices were removed if telemetry data was missing for more than 10% of the event period.

- **Additional screens:**

    - **High setpoint:** Observations where the thermostat setpoint exceeded 100°F.

    - **Missing thermostat ID or ZIP code:** Customer was missing an ID or ZIP code.

    - **Group dispatch issue:** Device was incorrectly dispatched for an event.

    - **Missing or multiple participation statuses:** The analysis only included customers with a single participation status per event.

Table 3-3 displays the number of thermostats dropped from the impact analysis with each cleaning step. Ranges are reported as each step was implemented by event day and the number of devices excluded by day varied for certain steps. Detailed data validation steps by event day can be found in Appendix B.

Table 3-3. Telemetry Data Cleaning

Step	Eversource	National Grid
Devices in experimental design	**10,890–12,188**	**8,486–8,549**
No reported telemetry data (Alarm, Vivint)	13%–14%	16%
No reported telemetry data (Nest)	<1%	<1%
Missing runtime data	0%–5%	4%–14%
Additional screens	0%	0%
Final count of devices in Group A	**369–432**	**717–811**
Final count of devices in Group B	**390–441**	**718–806**
Final count of devices in Group C	**8,336–9,402**	**4,614–5,201**

Source: Navigant analysis of EnergyHub Data

3.3 NOAA Temperature Data

To produce kilowatt estimates for telemetry data observations, Navigant pulled in 2019 temperature data from the NOAA database for a select number of quality controlled Local Climatological Data weather stations across Massachusetts and Connecticut. Navigant scraped and cleaned the data, then calculated cooling degree-hours (base 70°F) for all intervals. Using a ZIP code to weather station map, each thermostat was assigned to a single weather station based on its location. Thus, location-specific temperature data was combined with thermostat runtime to produce kilowatt estimates at the quarter-hourly level. NOAA temperature data was

also used to inform year-over-year weather comparisons and weather comparisons across states with the Eversource service territory.

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4. ANALYSIS AND RESULTS

This section of the report details the key findings of the following evaluation activities:

- *Customer experience research:* Navigant conducted a post-season survey of participants and an analysis of enrollment data to calculate rates of attrition for participants enrolled in 2019 (all PAs) and in previous offering years (for National Grid and Eversource CT).
- *Thermostat usage assessment:* Using thermostat participation data for each event, Navigant characterized thermostat-level participation in DR events, looking at rates of full participation, opt-out, no connectivity, wrong mode, and failed.
- *Impact analysis:* Navigant measured average demand and energy impacts during pre-cooling, event, and recovery hours. Navigant also calculated total demand savings by event for Eversource, National Grid, and Unitil.
- *Support of future savings:* Navigant analyzed the relationship between evaluated impacts and vendor-reported savings per event and provides recommended savings adjustment factors for pre-cooling, event, and recovery periods for use by the PAs in future offering years.

4.1 Customer Experience Research

Following the 2019 DR season, Navigant administered a post-season survey to a sample of participants for Eversource and National Grid and to all Unitil participants to solicit feedback regarding customer acceptance of the offering, behavior during events, and likelihood to participate in the future. A complete set of post-season survey results appear in Appendix B.

Navigant also analyzed enrollment data to assess levels of sustained participation and annual attrition in the offering among participants.

4.1.1 Key Findings

Key takeaways from the post-season participant survey results include the following:

- **Overall, 96% of thermostats that enrolled since September 30, 2018 remained enrolled through the end of the evaluated 2019 DR season.** The rate of sustained enrollment for thermostats enrolled after September 30, 2018 was 97%, 94%, and 99% for Eversource, National Grid, and Unitil, respectively.
- **The annualized rate at which thermostats leave the ConnectedSolutions offering ("annualized attrition") ranges from 5 to 11% per year.**[29] For National Grid, annual attrition ranges from 6% to 10% depending on the period of enrollment, reflecting National Grid's device management plan. For Eversource, attrition ranges from 10 to 14%, depending on the period of enrollment. However, for both Eversource and National

[29] This includes thermostats associated with a customer that chooses to unenroll from the program as well as thermostats that are removed from the program by the PA or implementation vendor.

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Grid, implementation vendor transitions impact the ability to fully analyze the extent to which thermostats have left the programs over time. For Unitil, annualized attrition is 5%.

- **Across all PAs and cohorts, more than 85% of survey respondents reported that they are likely or very likely to participate again in the future.** Respondents were generally satisfied with event characteristics in 2019, including the number, length, and timing of events.

- **Bill savings is a perceived offering benefit.** Bill savings is the most commonly cited motivation for participating, including among returning National Grid customers. Although this offering achieved energy savings in 2019, the primary goal of the offering is to achieve peak demand reductions. As a result, any given participant may or may not experience bill savings by participating in the offering. The perception that participation will lead to bill savings may be a consequence of co-marketing the offering with Wi-Fi thermostat rebates.

- **55% of respondents were satisfied with the mode of notification received.** Overall, approximately 73% of survey respondents reported receiving event notification, and 75% of these respondents received their preferred mode of notification.

- **About 20% of respondents would like more flexibility in terms of how they are notified of events.** 25% of respondents *who reported receiving event notifications* would like to receive a different mode of event notification than what they received in 2019. Of these, a majority would like notifications by email.

- **Overall 17% of respondents reported not receiving event notifications and 10% were unsure whether or not they received event notifications.** 80% of Unitil and Eversource respondents reported receiving advance notifications for events while only about 62% of National Grid new participant respondents and 70% of National Grid returning participant respondents reported receiving advance notifications. The remaining participants either reported receiving no event notification or they were unsure whether or not they received notifications. Eversource and Unitil elected to send event notification emails to participants with device types that allowed this. National Grid elected not to send advance notification emails. For device types where email notification was an option the PAs could select, participants that received event notifications *only* through the thermostat provider's app had lower rates of event notification recall than those who also received an email. For respondents who reported not receiving any event notification, a majority would like to receive email notification, at a minimum.

- **Approximately two-thirds of participants reported noticing temperature changes during events but only 40% reported ever opting out**. Most of those who reported having opted out stated that they did so only sometimes (30-40%) or rarely (50-65%). When looking at thermostat telemetry data, the percentage of devices that opted out at least once over the course of the season, and the frequency with which they opted out, is somewhat higher than what survey respondents reported (see section 4.2).[30,31] Notably, 16% of National Grid returning participants reported not knowing if they ever

[30] The thermostat usage assessment (section 4.2) shows that 45% of Eversource devices, 54% of National Grid devices, and 43% of Unitil devices opted-out for at least one event during the 2019 season.

[31] The thermostat usage assessment shows that 47% and 45% of participants who opted of at least one event during the summer, for Eversource and National respectively, opted out of over half of events (see Section 4.2).

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opted-out of an event. Relatedly, over 40% of survey respondents indicated they did not recall pre-cooling happening prior to events. In open-ended feedback, three respondents noted that it was too easy to override events inadvertently.

- **Approximately 10% of survey respondents are interested in seeing changes to or the ability to customize offering design parameters.** Some survey respondents would like to see changes to or to be able to specify their preferences related to: pre-cooling temperature adjustment and/or duration (26), event duration and/or timing (16), event setpoint maximum (3). Three survey respondents would like to be able to opt back into the event after opting-out.

The remainder of this section elaborates on key findings for the following topics:

- Motivations and marketing
- Event awareness and notifications
- Comfort and behavior during events
- Offering satisfaction

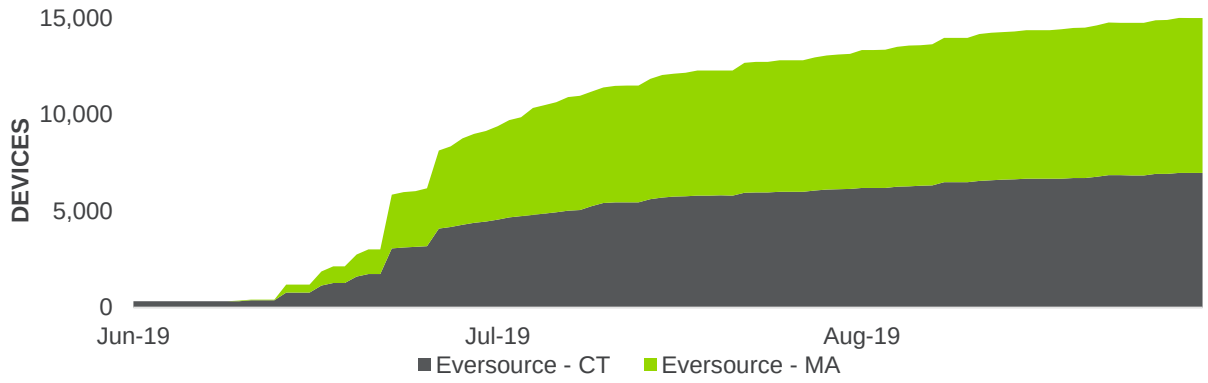
4.1.2 Enrollment Data Analysis Results

Navigant analyzed enrollment data for each PA to assess levels of sustained participation in the offering among participants and attrition rates.

This was the fourth year National Grid MA encouraged customers to enroll in the offering. This was Eversource CT's second year, and first year with EnergyHub. This was Eversource MA's and Unitil MA's first year offering the program. As a result, Eversource enrollment grew from 329 devices on June 1, 2019[32] to 14,989 devices by August 31, 2019, with 2019 marketing efforts beginning by thermostat vendor in mid-June 2019. National Grid enrollment was 9,520 devices on June 1, 2019 and grew to 11,503 devices by August 31, 2019. Unitil's offering was launched in mid-July 2019 by August 31, 2019 was 70 devices. The figures below show device enrollment for the period of June 1, 2019 through August 31, 2019 for Eversource, National Grid and Unitil.

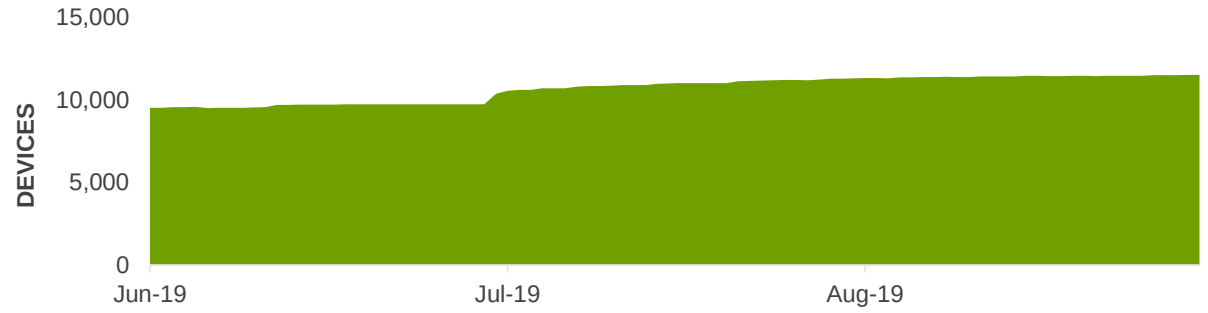
[32] There were 733 devices associated with participants of Eversource CT's 2017-2018 enrolled in the program as of August 31, 2019. However, 404 of these devices have an Accepted Date after June 1, 2019 in 2019 enrollment data provided by EnergyHub.

Figure 4-1. Eversource Enrollment – June 1 to August 31, 2019



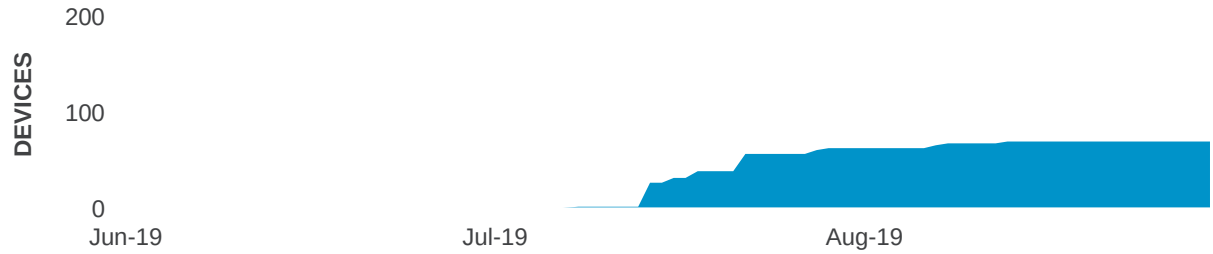
Source: Navigant analysis of enrollment data

Figure 4-2. National Grid Enrollment – June 1 to August 31, 2019



Source: Navigant analysis of enrollment data

Figure 4-3. Unitil Enrollment – June 1 to August 31, 2019



Source: Navigant analysis of enrollment data

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4.1.2.1 Sustained Enrollment and Attrition

Table 4-1 includes the thermostats tracked by EnergyHub for Eversource starting in June 2019. Due to vendor transition between the 2017-2018 Eversource CT offering and 2019 offering, a majority of thermostats that participated in the 2017-2018 Eversource CT offering were required to actively re-enroll in the program and many did not (more below). Thermostats that participated in the 2017-2018 offering, but which did not get automatically re-enrolled and which did not actively re-enroll are not tracked in the EnergyHub data and are excluded from the enrollment and attrition analysis. Table 4-1 shows that 97% of all thermostats tracked by EnergyHub for Eversource were still enrolled as of August 31, 2019. This results in an annualized attrition rate of 11% over the June through August 2019 period.

Table 4-1. Thermostat Counts and Sustained Enrollment by Enrollment Period – Eversource (MA and CT)

	Enrollment Period		
Metric Category	**2017-2018[33]**	**July 1, 2019 – August 31, 2019**	**Total**
Enrolled*	765	14,713	**16,657**
Removed**	5	236	**241**
Unenrolled**	27	221	**248**
Currently Enrolled***	733	14,256	**14,989**
Sustained Enrollment^	96%	97%	**97%**
Annualized Attrition^^	14%	10%	**11% (weighted average)**

2017-2018 CT offering data provided to Navigant by Eversource was matched to 2019 enrollment data provided by EnergyHub using account numbers (device ID was not available in the 2017-2018 data). For the purposes of calculating sustained enrollment and annual attrition, any accounts appearing in the 2017-2018 offering data as well as in the 2019 EnergyHub data are assumed to have an original enrolled date prior to 2019. This includes devices that appear in EnergyHub's 2019 enrollment data with an "Accepted Date" in 2019.

*Enrolled counts do not include any devices that were enrolled at one time but which were removed or unenrolled before June 2019 (when the transition to EnergyHub occurred), or which did not re-enroll in the 2019 offering.

**Thermostats enrolled during specified period and removed/unenrolled after June 2019.

***Currently enrolled = Accepted as of August 31, 2019.

^Meaning the % of devices that are still enrolled in the offering as of August 31, 2019.

^^The denominator used to calculate annualized attrition is 0.3 for both enrollment periods (2019 and 2017-2018) since thermostats that unenrolled prior to the transition to EnergyHub are not reflected in the table, and the vendor transition was complete and 2019 enrollment was commenced in June 2019.

Source: Navigant analysis of enrollment data

1,179 thermostats that participated in Eversource CT's 2017-2018 offering (which included only Honeywell, ecobee and Nest thermostats) do not appear in EnergyHub's 2019 enrollment data, indicating these devices are no longer enrolled. 86% of these missing devices are Nest and ecobee devices. This is explained by the fact that participants with Nest and ecobee devices

[33] The 1,179 devices associated with the 2017-2018 Eversource CT offering that do not appear in the 2019 enrollment data are not reflected in this table.

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were required to actively re-enroll in the 2019 offering. The remaining 14% of the missing devices are Honeywell devices.

Eversource was able to automatically re-enroll around 70% of the Honeywell thermostats that enrolled during the 2017-2018 time frame in to the 2019 offering. In contrast, only about 30% of Nest and ecobee devices that enrolled during the 2017-2018 time frame actively re-enrolled in the 2019 offering.

For National Grid, the longest running offering, 94% of devices enrolled since September 30, 2018 were still enrolled as of August 31, 2019 (Table 4-2). The lower percentage relative to Eversource and Unitil is likely in part due to the "weeding" National Grid conducted in the spring of 2019 to remove devices that were offline for more than 90 days. For those enrolled between September 30, 2017 and September 30, 2018, 84% were still enrolled as of August 31, 2019. Looking at device enrollment and unenrollment/removals since 2015, the weighted-average annual attrition rate is 8%. However, a true rate of attrition for devices enrolled prior to 2018 is not possible to calculate because of the fact that, likely due to vendor change, enrollment data does not track any participants that were removed or who unenrolled before January 2018. All Unenrolled Dates in the data are in 2018 or 2019.

Table 4-2. Thermostat Counts and Sustained Enrollment Percentage by Enrollment Period – National Grid

	Enrollment Period				
Metric Category	**Sep 30, 2015 – Sep 30, 2016**	**Sep 30, 2016 – Sep 30, 2017**	**Sep 30, 2017 – Sep 30, 2018**	**Sep 30, 2018 – Aug 31, 2019**	**Total**
Enrolled*	1,740	3,057	3,260	5,043	**13,100**
Removed**	185	314	347	160	**1,006**
Unenrolled**	107	193	166	125	**591**
Currently Enrolled***	1,448	2,550	2,747	4,758	**11,503**
Sustained Enrollment^	83%	83%	84%	94%	**88%**
Annualized Attrition^^	10%	9%	9%	6%	**8% (weighted average)**

Thermostats without an accepted date are excluded from the analysis.

*Enrolled counts do not include any devices that were enrolled at one time but which were removed or unenrolled before January 2018 (when the transition to EnergyHub occurred).

**Thermostats enrolled during specified period and removed/unenrolled after January 2018.

***Currently enrolled = Accepted as of August 31, 2019.

^Meaning the % of devices that are still enrolled in the offering as of August 31, 2019.

^^The denominator used to calculate annualized attrition is 1.0 for enrollment period September 30, 2018 to August 31, 2019 and 1.75 for all other enrollment periods since thermostats that unenrolled prior to the transition to EnergyHub are not reflected in the table, only those after January 2018.

Source: Navigant analysis of enrollment data

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For Unitil, 99% of all devices enrolled since offering inception (2019) were still enrolled as of August 31, 2019 (Table 4-3).

Table 4-3. Thermostat Counts and Sustained Enrollment by Enrollment Period – Unitil

	Enrollment Period	
Metric Category	**Sep 30, 2018– Aug 31, 2019**	**Total**
Enrolled	71	**71**
Removed	0	**0**
Unenrolled	1	**1**
Currently Enrolled*	70	**70**
Sustained Enrollment^	99%	**99%**
Annualized Attrition^^	5%	**5%**

*Currently enrolled = Accepted as of August 31, 2019.

^Meaning the % of devices that are still enrolled in the offering as of August 31, 2019.

^^The denominator used to calculate annualized attrition is 0.3 for enrollment period September 30, 2018 to August 31, 2019, since enrollment did not begin until June 2019.

Source: Navigant analysis of enrollment data

4.1.3 Customer Experience Survey Results

The following section describes key findings from the post-season survey.

4.1.3.1 Motivations and Marketing

As shown in Figure 4-4. Motivation for Participating, across all three of the PAs, including returning National Grid participants, bill savings was the most commonly cited motivation for participating in the offering. This indicates that there is a disconnect between the intent of the offering and the benefits participants believe the offering will or has delivered. This finding could be a consequence of co-marketing the offering with Wi-Fi thermostat rebates and/or the benefits of Wi-Fi thermostats.

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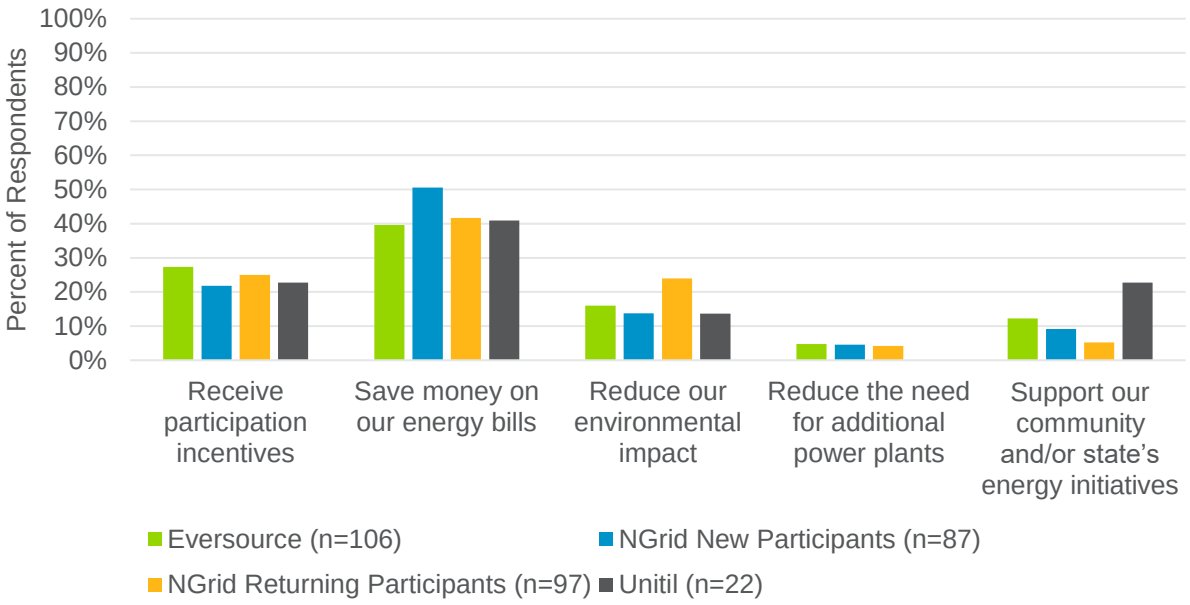
Figure 4-4. Motivation for Participating in ConnectedSolutions in 2019 (1st Reason)[34]



Q3. What was your motivation for participating in the ConnectedSolutions Program in 2019? Select your first and second reasons for enrolling.

Precision levels for the estimated proportions range from +/-0.03 to 0.09 for National Grid and Eversource and +/-0.12 to 0.17 for Unitil, assuming a 90% confidence level.

Source: Navigant analysis of online survey data

The 2019 offering was marketed through a variety of channels, including emails from the PAs, emails and in-app invitations from thermostat vendors, and web content on various websites (hosted by the individual PAs, MassSave, EnergyHub, thermostat vendors). Figure 4-5. How Participants Learned about ConnectedSolutions (multiple responses allowed) shows that many respondents first learned of ConnectedSolutions through an email from their utility. Emails and in-app communications from thermostat providers were also cited as sources for how participants learned about the offering, indicating that the PAs should continue to rely on thermostat partners for offering marketing.

[34] This question asked respondents to choose their first and second reasons for participating. Only the first reason is displayed here.

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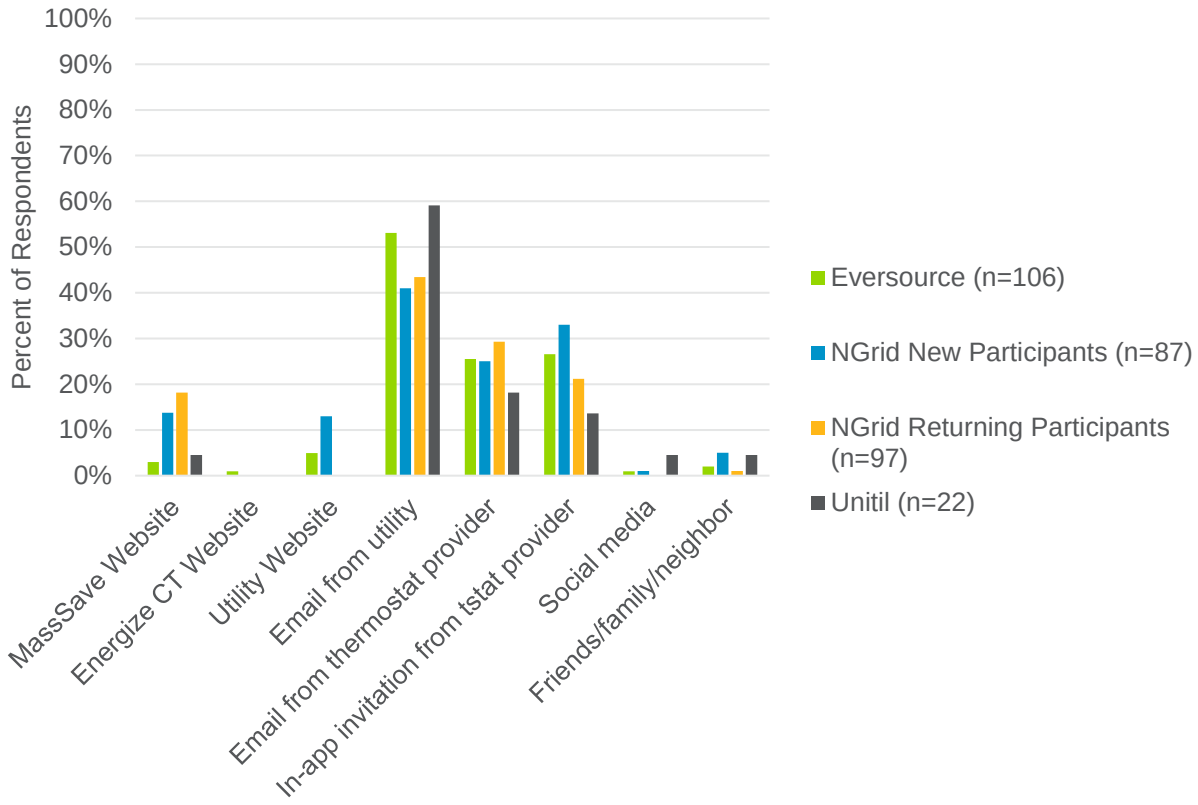
Figure 4-5. How Participants Learned about ConnectedSolutions (multiple responses allowed)



Q2. How did you become aware of the ConnectedSolutions Program? (Select all that apply)
Precision levels for the estimated proportions range from +/-0.02 to 0.09 for National Grid and Eversource and +/-0.07 to 0.17 for Unitil, assuming a 90% confidence level.
Source: Navigant analysis of online survey data

4.1.3.2 Event Awareness and Notifications

Wi-Fi thermostat DLC offering participants received different forms of advance event notification depending on the thermostat type and PA. Each PA could elect to send advance notification via email (sent by EnergyHub or through the thermostat provider[35]), for device types where that was allowed. [36] Eversource and Unitil elected to send event notification emails to participants with device types that allowed this. National Grid elected not to send advance notification emails.

All devices were provided event notifications via the thermostat manufacturer's web and mobile applications. However, depending on the provider, the notification may appear before and during the event or just during the event. Additionally, all but one device manufacturer provided event notification on the device itself. Again, some devices received the notification before and during the event and some just received this notification during the event. Finally, only few thermostat manufacturers offered SMS text message as an optional event notification that the

[35] One thermostat provider sends their own email notifications regardless of whether the PA elects to send advance emails; another requires their own email message to be sent if the PA elects to send email notifications.
[36] One thermostat provider does not allow advance email notifications to be sent to participants.

PAs could select. Eversource elected to have notifications sent through SMS text message when available.

As described above, depending on the device type and PA, participants received notification through one or more of these modes. The minimum amount of advance event notification a participant received was a notification before the event via the mobile and web app. In these cases, unless participants have push notifications turned on, they would not see the event notification unless they opened the mobile or web apps.

As shown in Figure 4-6., about 80% of Unitil and Eversource respondents reported receiving advance notifications for events while only about 62% of National Grid new participant respondents and 70% of National Grid returning participant respondents reported receiving advance notifications. Overall, 17% of respondents reported *not* receiving event notifications and 10% were unsure whether or not they received event notifications. For device types where there was an option to send an email notification (78 respondents), respondents that received event notifications *only* through the thermostat provider's mobile and web apps had lower rates of event notification recall (45 respondents, 27% recall) than those who also received an email (33 respondents, 76% recall).

The option to opt-out of advance event notifications was provided to certain participants, depending on the thermostat type (i.e., provider). About one-third of the survey respondents said they were given an option to opt-out of notifications. Only one person reported that they chose to opt-out of notifications, indicating that advance event notifications are preferred.

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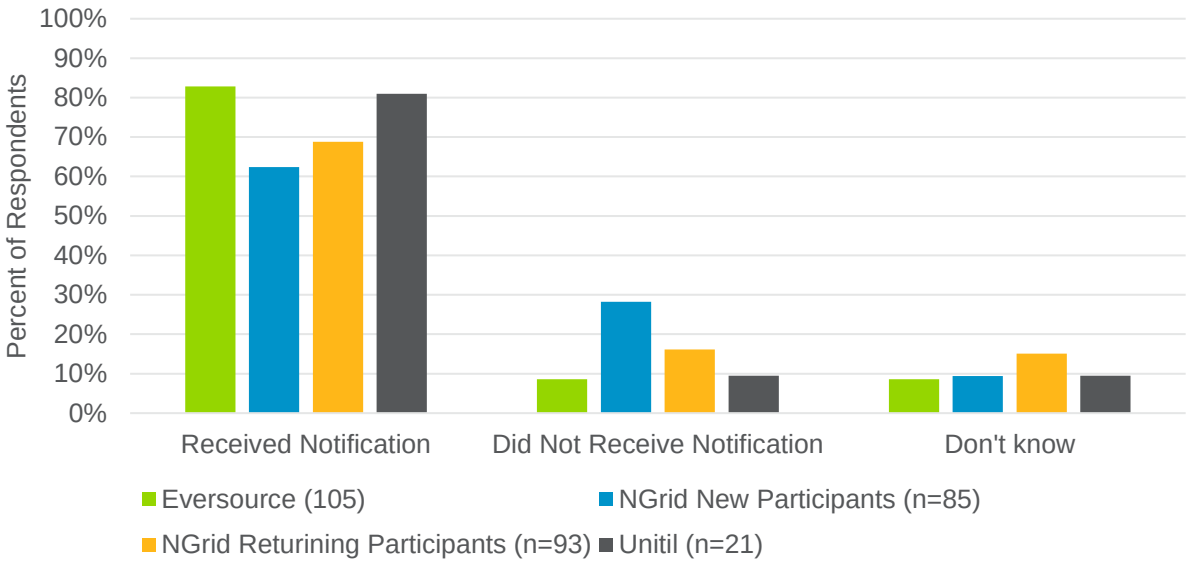
Figure 4-6. Recollection of Receipt of Advance Event Notification



Q5. During this past summer, did you receive ever advance notifications about the events?
Precision levels for the estimated proportions range from +/-0.02 to 0.09 for National Grid and Eversource and +/-0.11 to 0.14 for Unitil, assuming a 90% confidence level.
Source: Navigant analysis of online survey data

Of respondents who reported receiving event notification, 18%, 24%, 26%, and 28% of Unitil, Eversource, National Grid new, National Grid returning respondents, respectively, would prefer to receive notifications through a different mode or an additional mode (Table 4-4). Of respondents who reported receiving notifications but would prefer to receive them through a different mode or an additional mode, a majority would like notifications by email. Text message was also a relatively common preference. For respondents that reported not receiving event notification, a majority would like to receive email notification, at a minimum.

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Table 4-4. Preferred Modes of Event Notification (multiple responses allowed)

	Preferred Mode				Preferred Mode		
Respondents Who Recalled Receiving Notification but Did Not Receive a Preferred Mode	Email	T-Stat App	Text	Respondents Who Did Not Recall Receiving Any Notification	Email	T-Stat App	Text
Unitil (N=3)	0	2	1	Unitil (N=2)	2	2	1
Eversource (N=21)	12	4	7	Eversource (N=9)	6	5	1
NGrid New (N=14)	6	2	6	NGrid New (N=24)	15	12	4
NGrid Returning (N=18)	14	4	9	NGrid Returning (N=15)	13	4	3

Q7. In general, how would you prefer to be notified that an event is going to occur? (Select all that apply)
Note: Respondents were able to select more than one preferred notification mode.
Source: Navigant analysis of online survey data

During the 2019 summer season, event notification was mostly day of across all three PAs. As shown in Figure 4-7. Preferred Amount of Advance Notice, participants varied in how much advance notice they would like before events. Several respondents left open-ended feedback related to wanting more advance notice about events.

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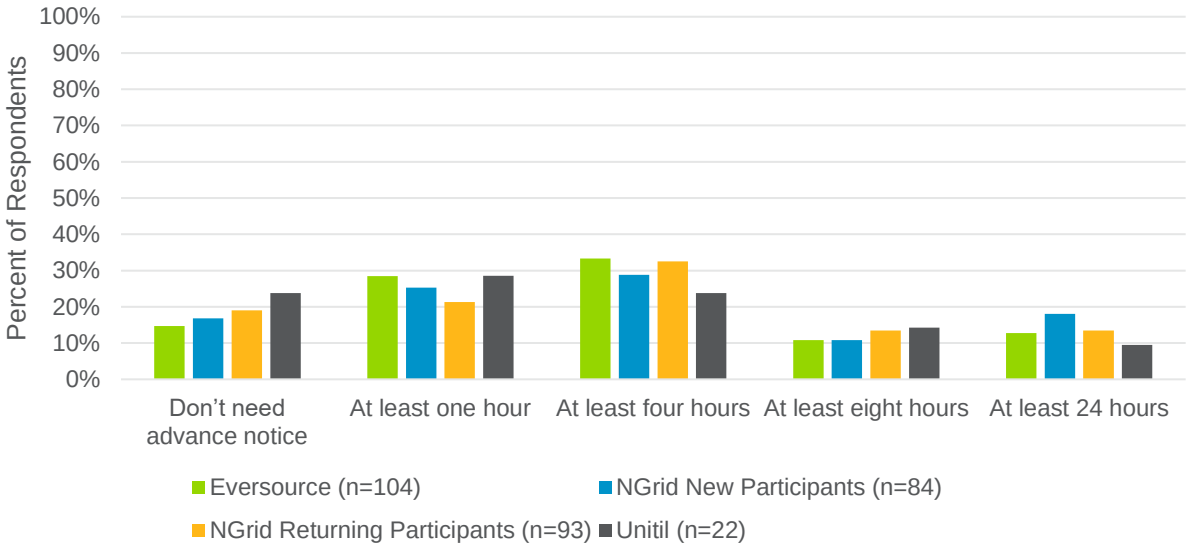
Figure 4-7. Preferred Amount of Advance Notice



Q8. In general, how much advance notice would you like before an event?
Precision levels for the estimated proportions range from +/-0.02 to 0.08 for National Grid and Eversource and +/-0.11 to 0.16 for Unitil, assuming a 90% confidence level.
Source Navigant analysis of online survey data

4.1.3.3 Comfort and Behavior During Events

During the 2019 DR season, event characteristics varied somewhat across PAs. Eversource and National Grid had 3-hour events, while three of 11 events called by Unitil were 2 hours long and the remaining were 3 hours. Additionally, while National Grid and Unitil imposed a 4°F temperature adjustment during events,[37] Eversource imposed an adjustment of 4°F for its first two events and 3°F for all remaining events. Table 1-1 in Section 1 provides a summary of 2019 event characteristics.

Figure 4-8. shows that, across all PAs, roughly 70% of the survey respondents who reported being home for events noticed a change in temperature during events and 50% found the event temperature less comfortable than normal.[38] For Unitil, only around one-third of those who were home for events reported being less comfortable. Across PAs, of survey respondents who were in the home for any part of at least one event (266), 62 reported using fans during an event to help maintain comfort.

[37] With the exception of Unitil's event on July 10, 2019, where a 0°F temperature adjustment was made during the event.

[38] The participant survey conducted for the evaluation of National Grid's 2017 Wi-Fi thermostat program ("2017 Residential Wi-Fi Thermostat DR Evaluation Final Report – Prepared for National Grid") similarly found that around 50% reported feeling less comfortable than usual during events. Events during the 2017 season were also 3 hours in duration but had a 3-degree event setpoint adjustment.

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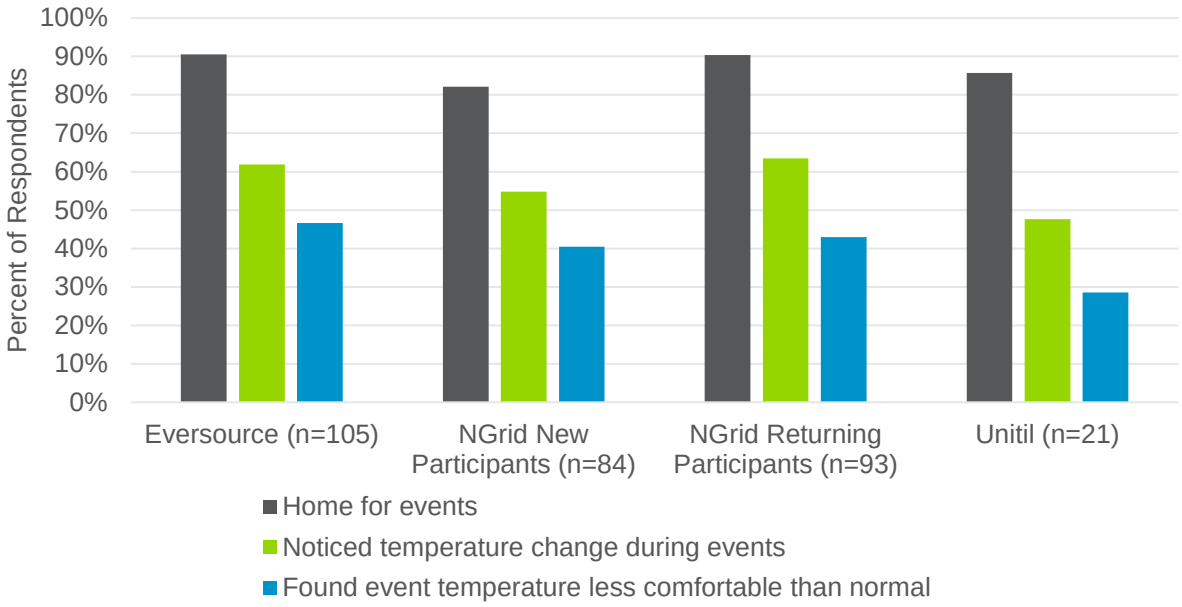
Figure 4-8. Experience During Events[39]



Q10. This summer, for the events you can recall, how often were you or another family member at home during any part of the events?

Q11. During the events you can recall, did you or another family member notice any changes to your home's indoor temperature?

Q12. During the events you can recall, using a scale of 1 to 5, where 1 means "Much less comfortable" and 5 means "Much more comfortable," how would you generally describe your comfort compared to typical afternoons with similar outdoor temperatures?

Precision levels for the estimated proportions range from +/-0.05 to 0.09 for National Grid and Eversource and +/-0.13 to 0.18 for Unitil, assuming a 90% confidence level.

Source Navigant analysis of online survey data

Figure 4-9. shows that, of those who could recall, nearly 60% of respondents across the PAs reported that they never opted-out of an event, while 40% reported that they opted-out of at least one event during the summer.[40] Notably, 16% of National Grid returning participants reported not knowing whether or not they ever opted-out of an event. This could reflect a lower level of engagement among participants who have been in the offering for some time (i.e., they do not pay as much attention to their behavior during events[41]). Out of the respondents who opted-out, most did so during events. Few respondents reported opting-out before events.

Across all three PAs, a small percentage reported opting-out of all or most events. The majority of respondents who self-reported that they opted-out of at least one event reported that they

[39] For the purposes of the chart, the denominator for each metric shown in the chart is the number of respondents, by PA, who responded to Q10. In actuality, respondents who were not home during any event did not receive Q11 or Q12. Similarly, respondents who never noticed a temperature change did not receive Q12.

[40] The thermostat usage assessment (section 4.2) shows that 45% of Eversource devices, 54% of National Grid devices, and 43% of Unitil devices opted-out for at least one event during the 2019 season.

[41] This would also suggest awareness of the fact that the annual incentive is no longer tied to event participation.

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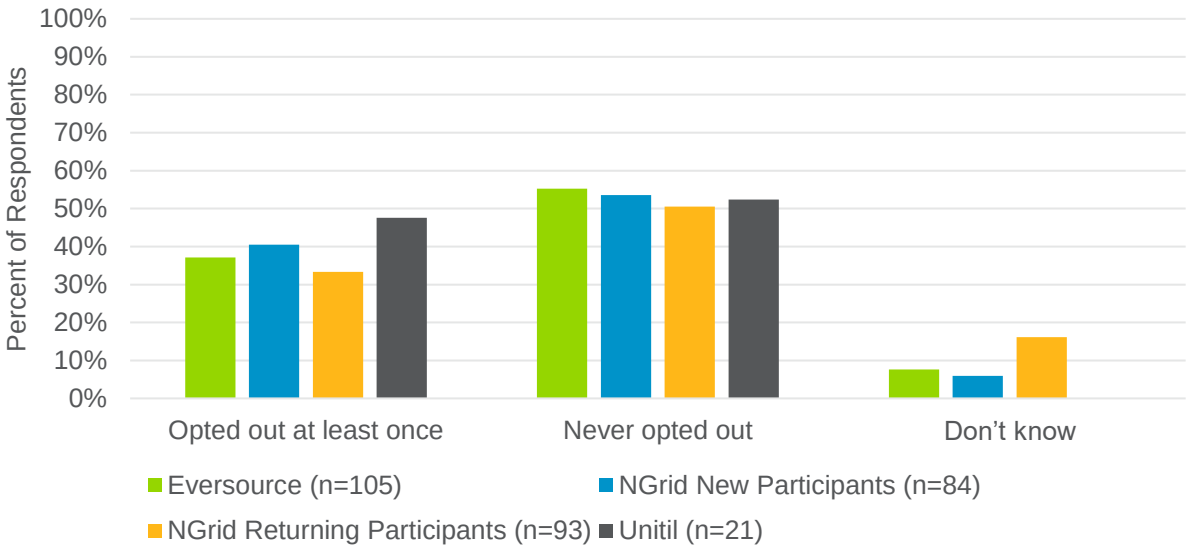
opted-out only for some events or rarely.[42] Of the respondents who opted-out of an event, 55% said they did so because they were uncomfortable with the temperature in their home, 30% opted-out because they did not want their home to get warmer, and 30% opted-out because they had guests over.[43]

Respondents indicated that they did not have any difficulty opting-out when they chose to do so. However, in open-ended feedback, three respondents noted that it was too easy to override events inadvertently.

Figure 4-9. Self-Reported Opt-Out Behavior



Q16. On event days, did you or a family member ever "opt-out" of an event or override your thermostat setting to stop the program from adjusting your thermostat during the event?

Precision levels for the estimated proportions range from +/-0.04 to 0.09 for National Grid and Eversource and +/-0.18 for Unitil, assuming a 90% confidence level.

Source Navigant analysis of online survey data

The parameters of pre-cooling conducted prior to events also varied by PA during the 2019 DR season. Each PA pre-cooled for a different length of time (Eversource: 1 hour, National Grid: 1.5 hours, and Unitil: 0.5 hours). Additionally, Eversource and National Grid pre-cooled with a negative 3°F setpoint adjustment, while Unitil pre-cooled using mostly a 2°F adjustment. Also, for the majority of device types (except ecobee), an adjustment made to temperature setpoint during pre-cooling opts the device out of the event temperature adjustment.

In terms of participants' recollection of pre-cooling prior to events, the majority of Unitil respondents did not recall pre-cooling while the split for Eversource and National Grid respondents was closer to 50-50 (Figure 4-10.) for those who felt certain one way or another. Open-ended feedback indicated that some people felt that pre-cooling made the home too cold

[42] By comparison, the thermostat usage assessment shows that 47% and 45% of participants who opted out of at least one event during the summer, for Eversource and National respectively, opted out of over half of events (see Section 4.2).

[43] Respondents could select multiple responses to this question (Q18. For what reason(s) did you opt-out or override the scheduled [EVENT_NAME] thermostat setting? (Select all that apply)).

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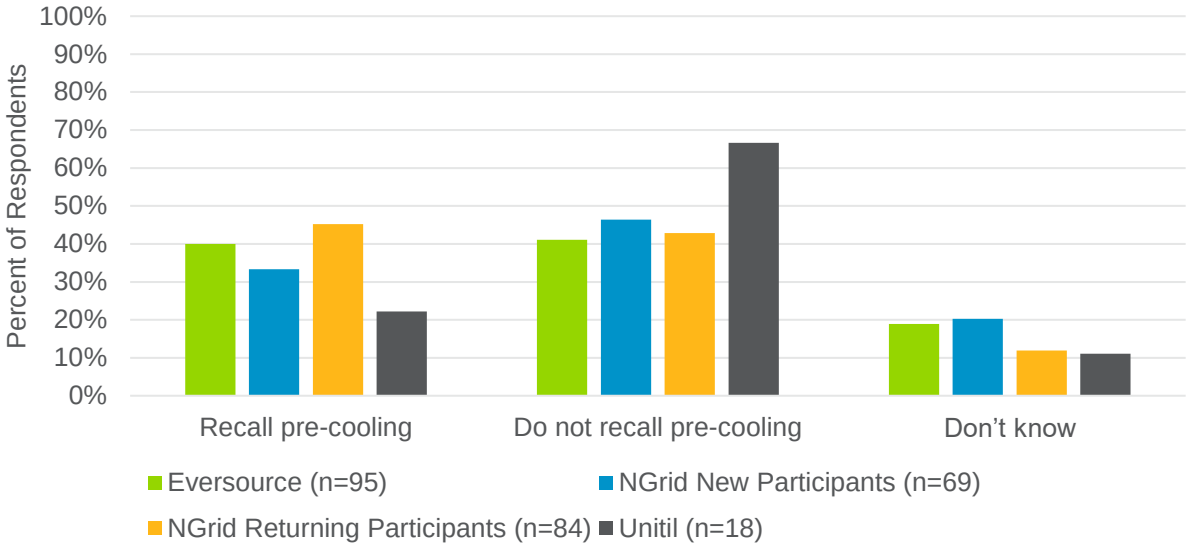
(17), while others supported it (12) or felt that more pre-cooling was needed to ensure the home was comfortable during events (9).

Figure 4-10. Awareness of Pre-Cooling



Q14. Prior to events, do you recall the program "pre-cooling" your home (i.e., providing your home extra cooling prior to event hours)?

Precision levels for the estimated proportions range from +/-0.06 to 0.1 for National Grid and Eversource and +/-0.12 to 0.18 for Unitil, assuming a 90% confidence level.

Source Navigant analysis of online survey data

4.1.3.4 Participant Satisfaction

Respondents were generally satisfied with event number, length, and timing. Figure 4-11. Satisfaction with Event Length shows participant satisfaction with the duration of events over the 2019 summer season. The breakdown of satisfaction ratings for event number/frequency and timing look similar to this figure. Over 90% of respondents rated their satisfaction with these event characteristics a 3 or higher. The most common participant recommendations related to event characteristics were:

- Shorten the event time especially on very hot days (9)
- Start/finish events earlier in the day (7)

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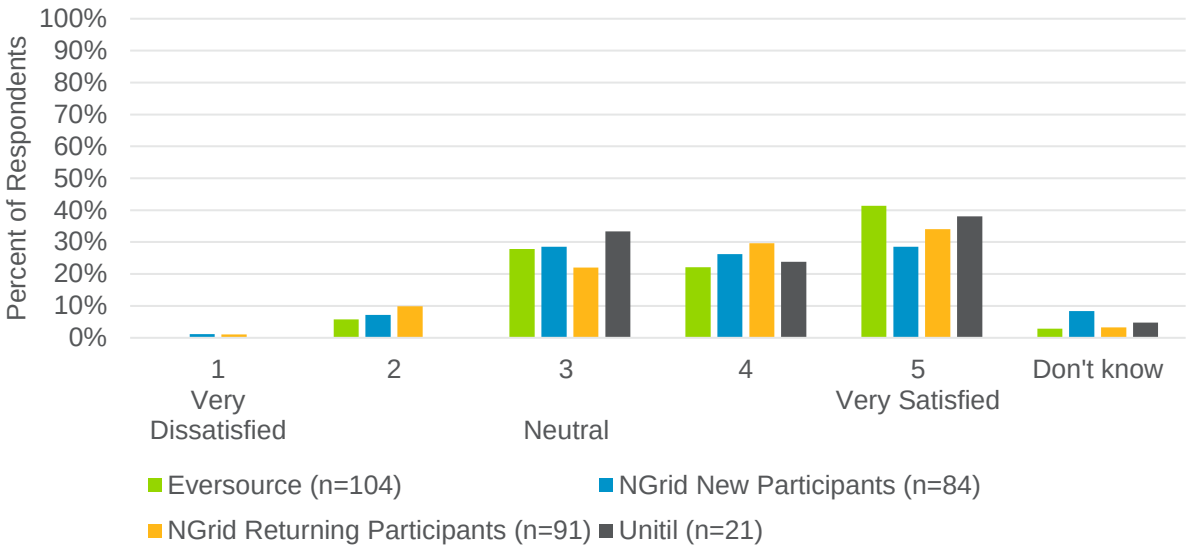
Figure 4-11. Satisfaction with Event Length



Q24b. On a scale of 1 through 5, where 1 is "Very dissatisfied" and 5 is "Very satisfied," how would you rate your satisfaction with the following aspects of the ConnectedSolutions program? - Length of events

Precision levels for the estimated proportions range from +/-0.02 to 0.08 for National Grid and Eversource and +/-0.08 to 0.17 for Unitil, assuming a 90% confidence level.

Source Navigant analysis of online survey data

Across the board, more than 85% of survey respondents reported that they are likely or very likely to participate again in the future.

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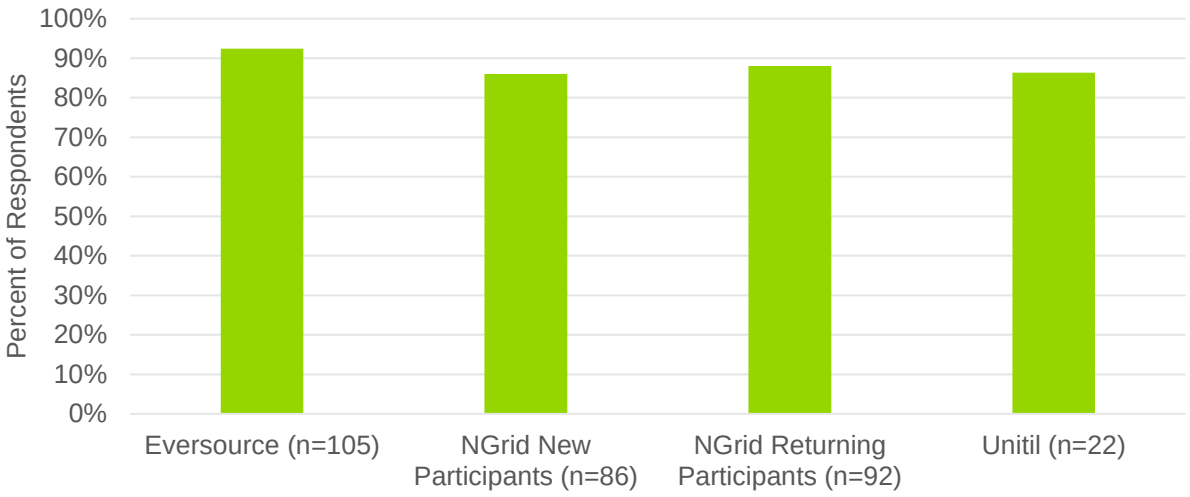
Figure 4-12. Percentage Likely or Very Likely to Continue Participating



Q28. In future summers, how likely would you be to participate in the ConnectedSolutions Program, on a scale of 1-5, where 1 is "Very Unlikely" and 5 is "Very Likely?"

Results in the chart represent combined 4s and 5s

Precision levels for the estimated proportions range from +/-0.04 to 0.06 for National Grid and Eversource and +/-0.12 for Unitil, assuming a 90% confidence level.

Source Navigant analysis of online survey data

Table 4-5. Participant Suggestions

Topic	Suggestion
Pre-cooling	• Pre-cool 3-4 hours in advance. (3) • Create an account setting that will allow someone to participate in peak events while permanently opting-out of the pre-cooling period. (3)
Events / opting out	• Address the fact that it is easy to override the event without knowing it. (3) • Add in the ability to return to event mode if one overrides the event setpoint adjustment. (3) • Allow opt-out decisions to be per thermostat and not per household. (1)[44] • Allow participants to set a maximum temperature they would be comfortable with during events and if that temperature is reached, they are automatically opted-out of the event. (3)
Other	• Provide periodic performance reports (e.g., showing how many events a household participated in). (5) • Provide bill and energy saving reports. (6) • Share other tips related to how participants can reduce energy consumption in their homes during events. (1)

Note: Respondent counts are provided in the parentheses.

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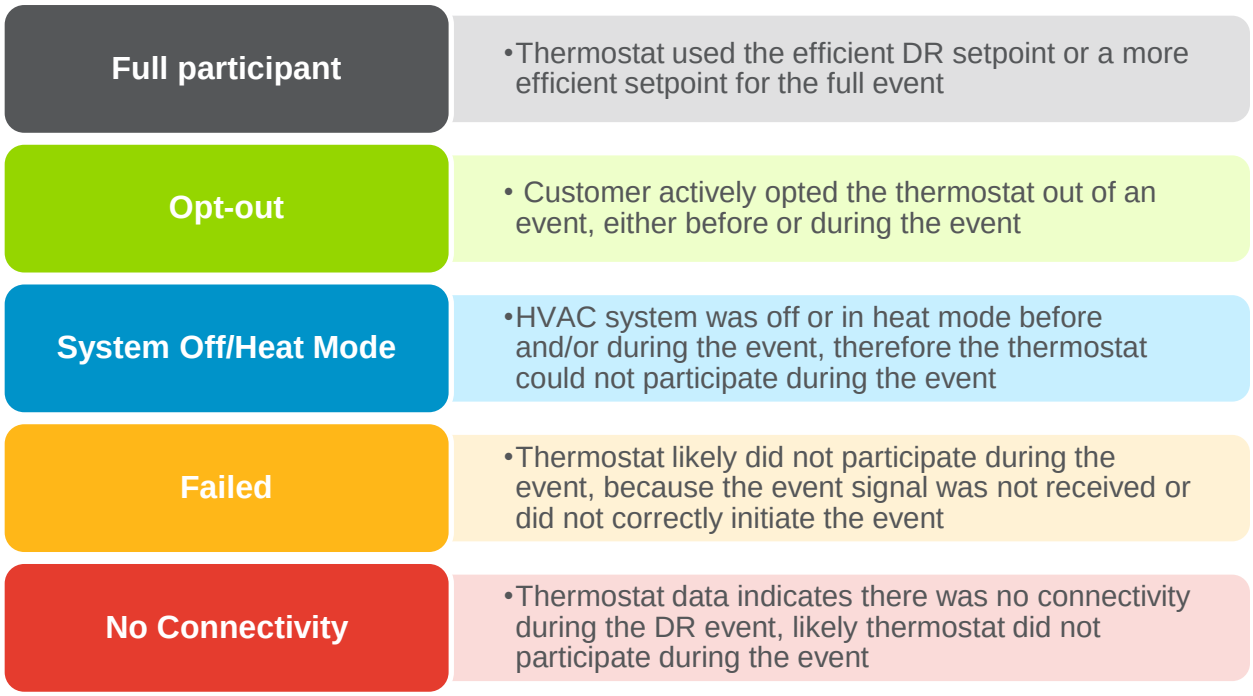
Source Navigant analysis of online survey data

4.2 Thermostat Usage Assessment

To characterize thermostat-level participation in DR events, Navigant analyzed thermostat participation data from each event. Navigant categorized all enrolled thermostats by event into one of five participation status categories. These categories are outlined in Figure 4-13.

Figure 4-13. Participant Definitions



Source: Navigant analysis of EnergyHub participation data

4.2.1 Key Findings

Key takeaways from the thermostat usage assessment include the following:

- **2019 full participation rates exceeded 50% on average and across the season.** Eversource MA and CT had the highest full participation at 60%, followed by Unitil MA at 56% and National Grid MA at 52%. The primary reason for devices not fully participating in events was not being in cooling mode. (See Figure 4-14).

- **A significant number of devices were never in cooling mode for any event.** Over 60% of system off/heat mode issues for Eversource MA and CT, National Grid MA, and Unitil MA stem from devices that were in system off/heat mode for the entire season. (See Figure 4-16 through Figure 4-18).

[44] The ability to opt-out of events at the thermostat level rather than the whole-home level appears to vary by thermostat manufacturer.

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- **Connectivity was a small issue overall during events for Eversource MA and CT, National Grid MA, and Unitil MA.** A large portion of connectivity issues stem from devices that were disconnected for the entire season. (See Figure 4-16 through Figure 4-18).

- **Participants exhibited no evidence of event participation fatigue (increased opt-out rates) due to back-to-back events or a higher event dispatch frequency.** Devices in the experimental design groups participated at similar rates regardless of the number of events for which they were dispatched. (See Figure 4-19 and Figure 4-20).

The remainder of this section elaborates on key findings for the following topics:

- Average participation
- Participation by year
- Participation by experimental design group
- Serial participation

4.2.2 Offering Event Participation

Figure 4-14 represents the average participation across the three PAs for the 2019 DR season. Eversource MA and CT had the highest full participation rate at 60% while National Grid MA had the lowest, at 52%. As shown, customers have several reasons for not participating in DR events, including opting-out of an event, the AC system being in either off or heat mode, the thermostat failing to receive the DR signal, or a connectivity issue. AC systems in the wrong mode are the primary reason for thermostats not participating in events.

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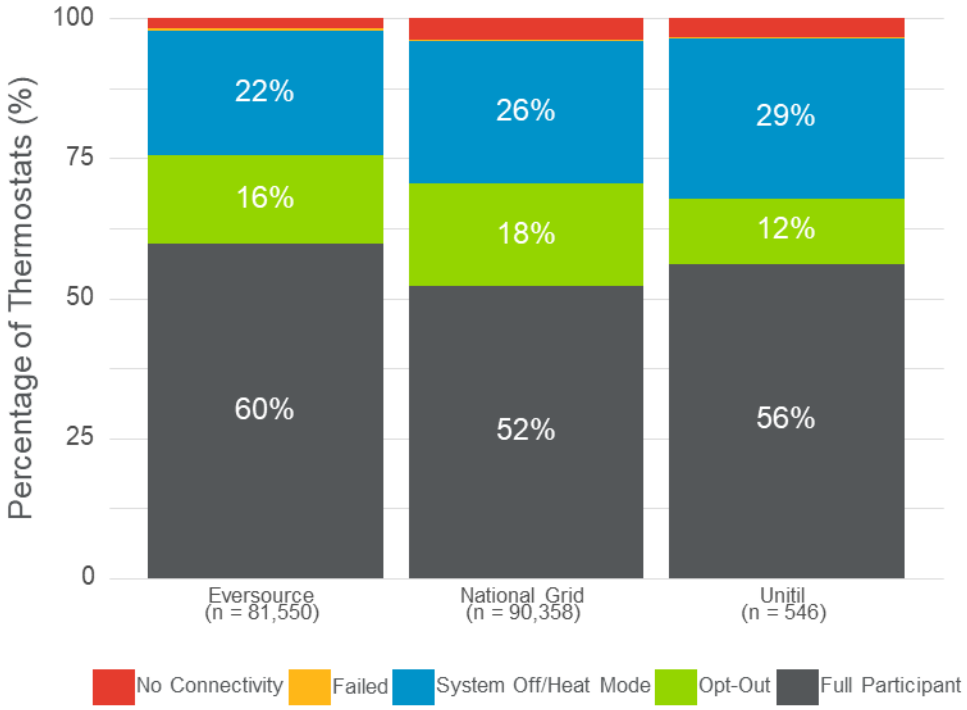
Figure 4-14. 2019 Average Participation



Note: *n* represents the total instances of thermostat participation during the DR season for each PA.
Source: Navigant analysis of EnergyHub data

Figure 4-15 shows the average event participation by season since 2016 for National Grid MA's DR offering. Additionally, the 2019 season is segmented by thermostat brands that have been eligible to participate since 2016 (Legacy) and brands introduced to the offering in late 2018 (New). For National Grid MA, device participation was lowest in 2019 relative to previous years. This was partially driven by the addition of new thermostat brands, which had a full participation rate of 30% compared to the 57% full participation rate of legacy thermostat brands. Additionally, the average opt-out rate did not change between 2018 and 2019 despite the increase in event setback (3 degrees to 4 degrees).

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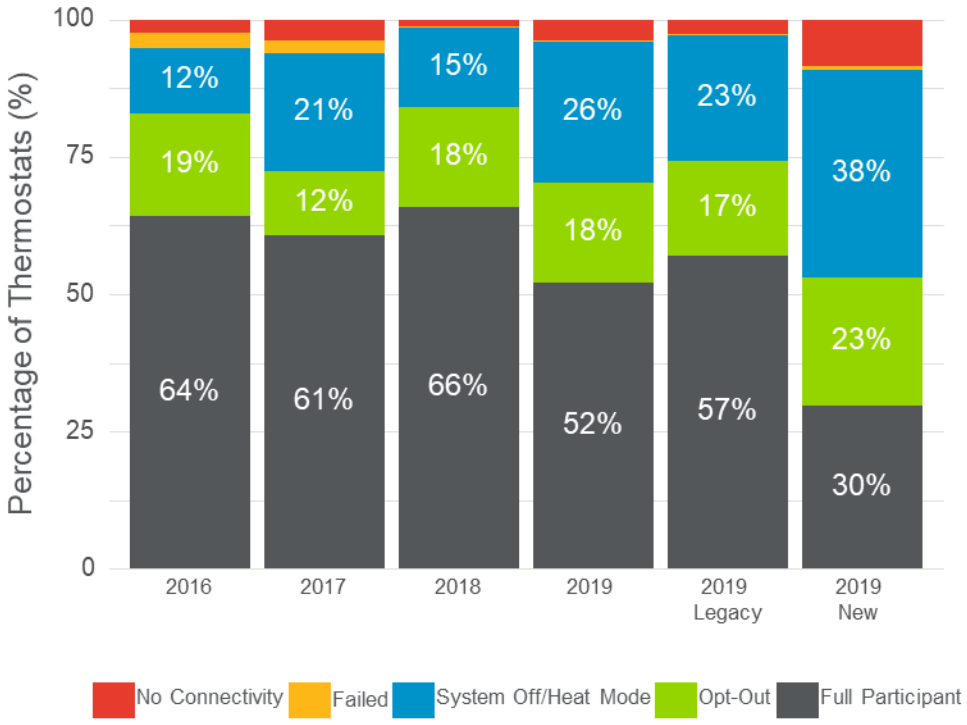
Figure 4-15. Average Participation by Year (National Grid)



Source: Navigant analysis of EnergyHub data

Figure 4-16 through Figure 4-18 show the total instances of each participation status segmented by how frequently devices exhibit that status, in 5 buckets: 1-25%, 26-50%, 51-75%, 76-99%, and 100%. For example, in Figure 4-16, 12% of failed dispatch instances was caused by thermostats failing for all (100%) of the events (red bar). In other words, a minority of dispatch failures came from devices that consistently failed to dispatch the event. For all instances of opt-outs, 17% came from devices that opt-ed out of 25% or less of events. Meaning a small portion opt-outs come from devices that opt-out of a single event.

Of cases of full participants for Eversource (Figure 4-16), 92% were thermostats that were full participants for over half of the events (red, yellow, and blue bars). Serial opt-outs were not an issue during the DR season; under one-quarter of opt-outs came from devices opting-out of more than 75% of events. One third (33%) of cases of connectivity issues were caused by 71 thermostats facing connectivity issues for all the events (red bar). Of cases of system off or heat mode, 63% were caused by 1,711 thermostats (11% of offering enrollment) in system off or heat mode for 100% of the events (red bar). These persistent cases of off or heat mode suggest these participants either rarely use their central AC, do not have AC in their home or supplement their cooling needs with a window AC. A small number of devices experienced dispatch failures throughout the season. Of the few failed dispatches, only 12% came from devices that failed to dispatch for all events.

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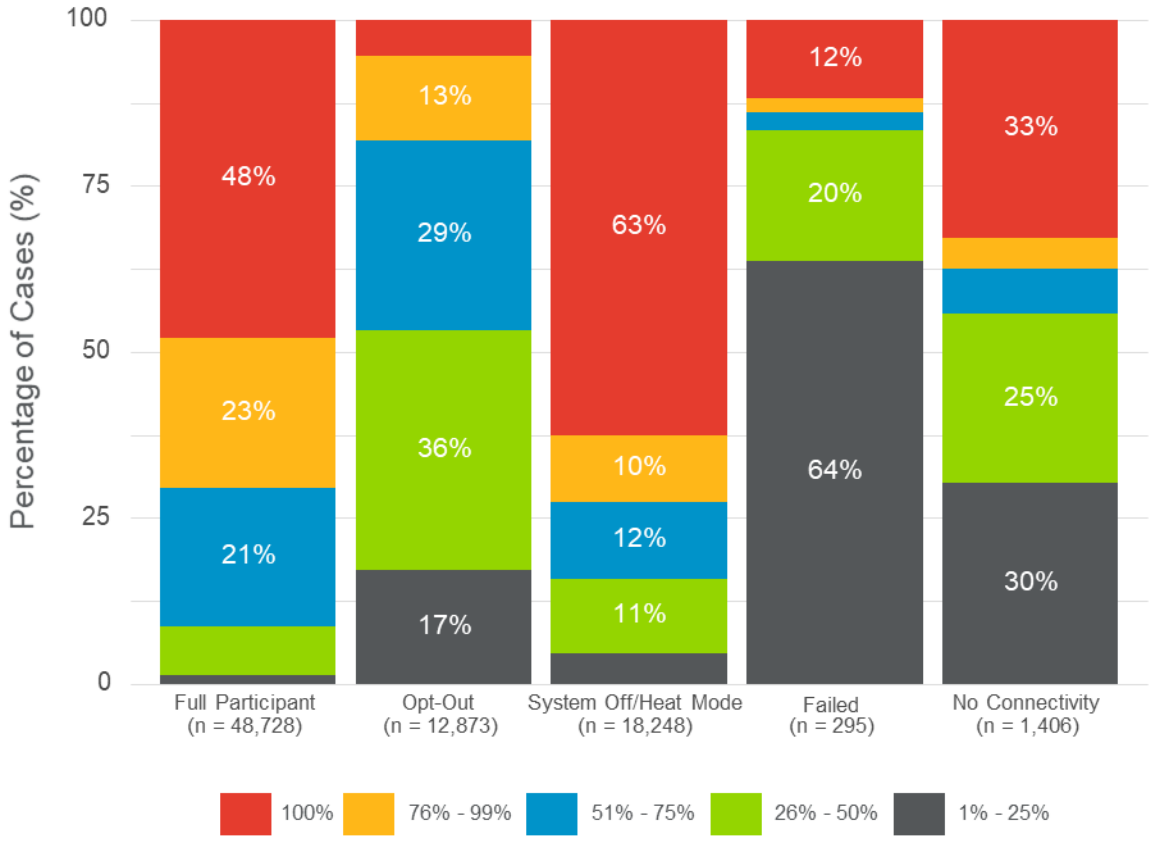
Figure 4-16. Serial Participation by Category (Eversource)



Note: *n* represents the total number of cases during the DR season for each participation status.
Source: Navigant analysis of EnergyHub data

For National Grid (Figure 4-17), 86% of full participation cases were thermostats that were full participants for over half of the events (red, yellow, and blue bars). Similar to Eversource, there were relatively few cases of serial opt-outs—under one-quarter of opt-outs came from devices opting-out of more than 75% of events. The majority (69%) of cases of connectivity issues were caused by 224 thermostats facing connectivity issues for all the events (red bar). Of cases of system off or heat mode, 60% were caused by 1,309 thermostats (11% of offering enrollment) in system off or heat mode for 100% of the events (red bar). A small number of devices experienced dispatch failures throughout the season. Of the few failed dispatches, only 13% came from devices that failed to dispatch for all events.

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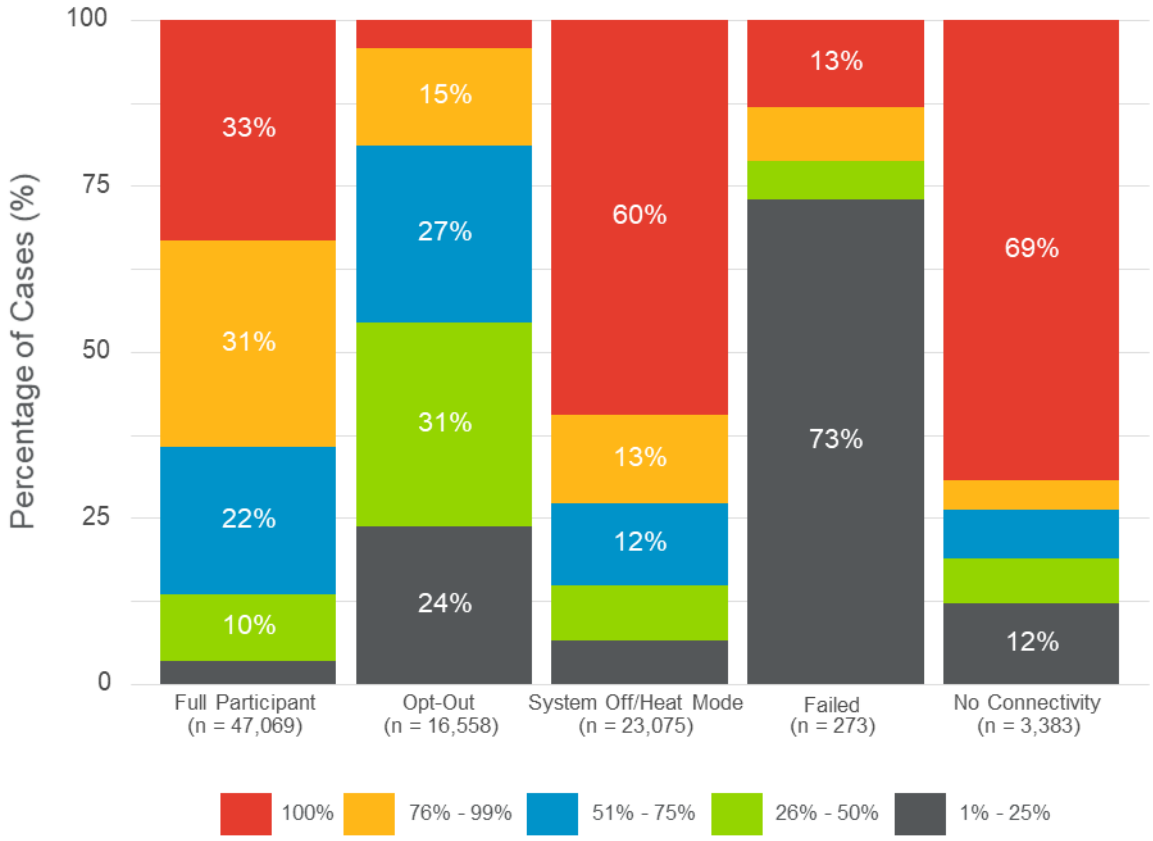
Figure 4-17. Serial Participation by Category (National Grid)



Note: *n* represents the total number of cases during the DR season for each participation status.
Source: Navigant analysis of EnergyHub data

For Unitil (Figure 4-18), the vast majority (95%) of full participation cases were thermostats that were full participants for over half of the events (red, yellow, and blue bars), similar to the other PAs. There were relatively few cases of serial opt-outs—under one-quarter of opt-outs came from devices opting-out of more than 75% of events. Under half (44%) of cases of connectivity issues were caused by a single thermostat facing connectivity issues for all the events (red bar). Of cases of system off or heat mode, 75% were caused by 17 thermostats (24% of offering enrollment) in system off or heat mode for 100% of the events (red bar). A small number of devices experienced dispatch failures throughout the season. Of the few failed dispatches, none came from devices that failed to dispatch for all events.

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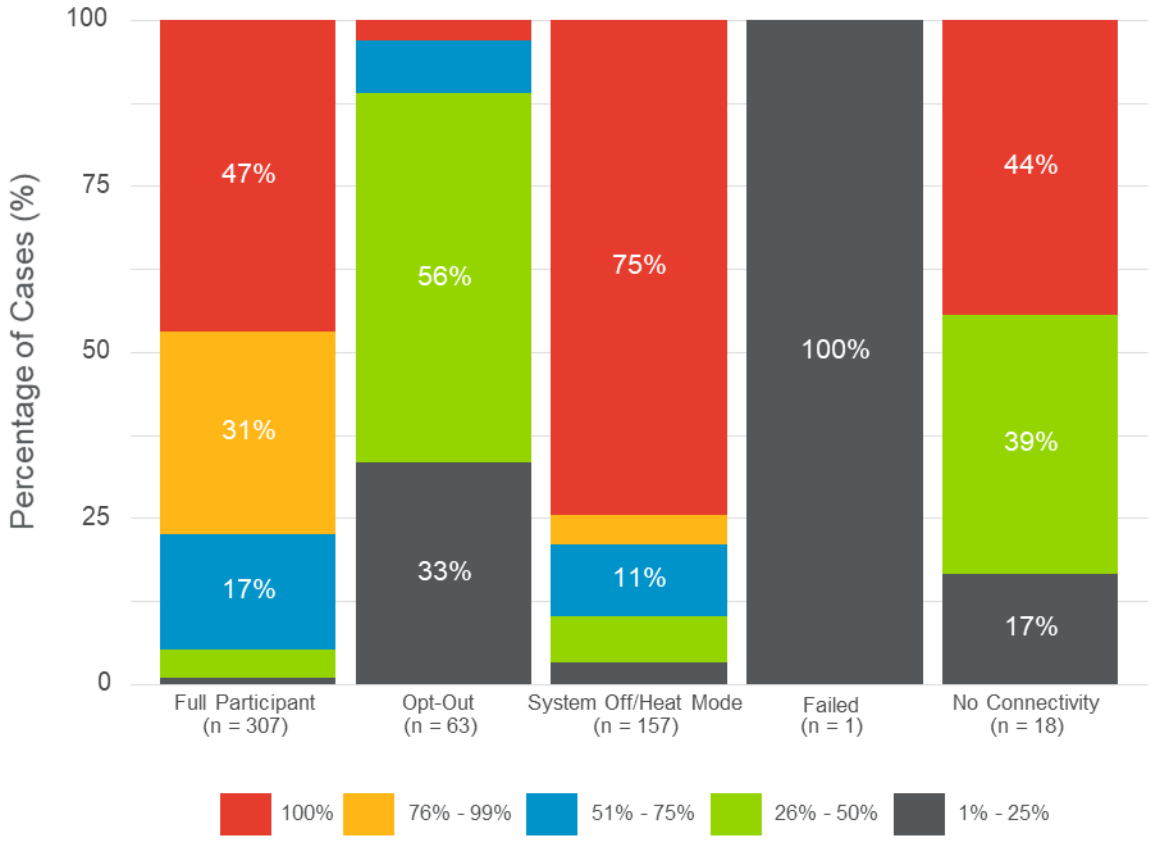
Figure 4-18. Serial Participation by Category (Unitil)



Note: *n* represents the total number of cases during the DR season for each participation status.
Source: Navigant analysis of EnergyHub data

To examine if event fatigue occurred throughout the season, Navigant analyzed participation by experimental design group (Figure 4-19). During the 2019 season, the PAs dispatched Group C for every event and alternated dispatching Group A and B (withholding one for each event to serve as the control group). As such, customers in Group C experienced twice as many events as those in Group A and B. Despite this disparity, average event participation was nearly identical across the three groups, indicating event fatigue did not impact event participation in the 2019 DR season.

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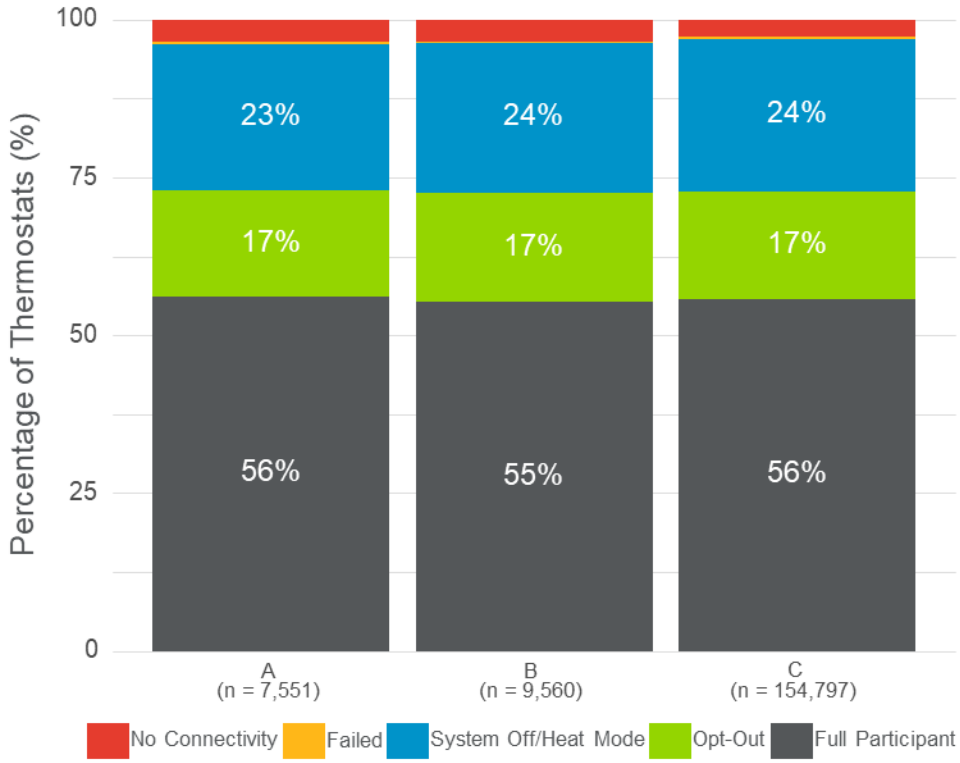
Figure 4-19. Participation by Experimental Design Group



Note: *n* represents the total instances of thermostat participation during the DR season for each group. Unitil was not part of the experimental design and is therefore not included in this chart.
Source: Navigant analysis of EnergyHub data

Navigant also explored whether event participation fatigue occurred during back-to-back events for participants in Group C (Figure 4-20). If event participation fatigue occurred, full participation would decrease after the first event day in a back-to-back sequence. In 2019, National Grid MA and Unitil MA had one 4-day sequence of events and three 2-day sequences while Eversource MA and CT had no back-to-back events. When examining participation across these event sequences, full participation never fell below the full participation rate of the first day in the sequence, indicating no event participation fatigue for back-to-back events.

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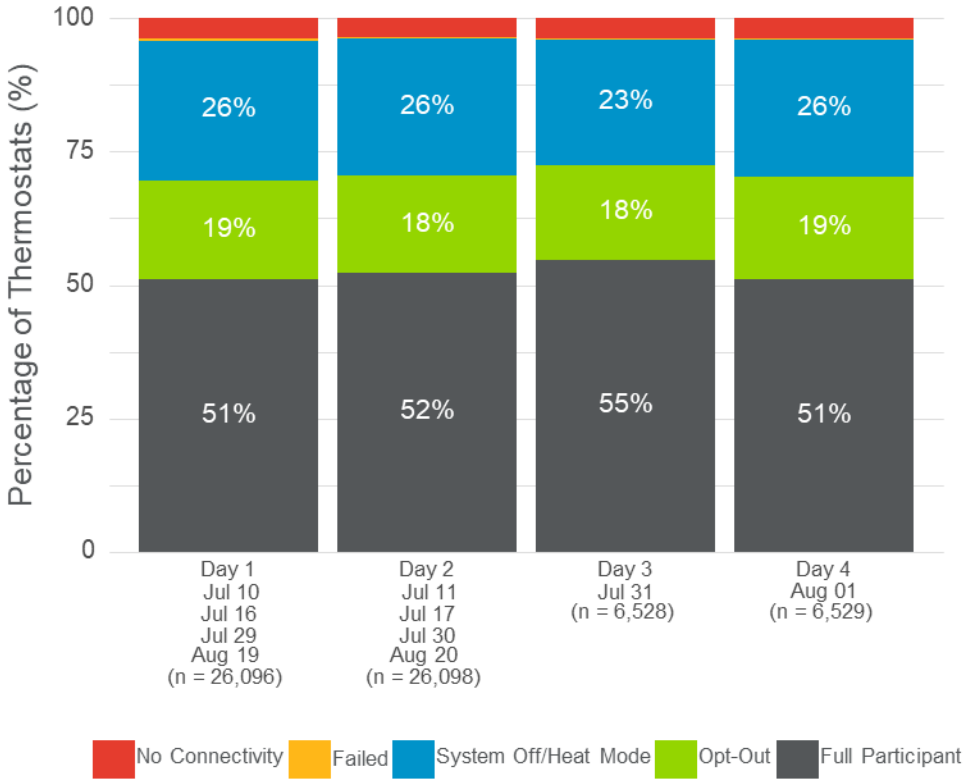
Figure 4-20. Consecutive Event Participation



Note: *n* represents the total instances of thermostat participation during the DR season for each day.
Source: Navigant analysis of EnergyHub data

4.3 Impact Analysis

Navigant estimated average demand and energy impacts during pre-cooling, event, and recovery hours as well as total demand savings by event for the 2019 program offering for Eversource MA, Eversource CT, National Grid MA. As a point of comparison, Navigant has included in this section the Unitil MA savings as calculated using the savings adjustment factor (described further in Section 4.4).

4.3.1 Key Findings

Key takeaways from the impact analysis include the following:

- **Eversource and National Grid had very similar average treatment effects for the 2019 season, 0.60 kW and 0.59 kW per thermostat, respectively.** Unitil's average treatment effect was lower, 0.38 kW per thermostat, which uses the savings adjustment factor described in Section 4.4.1 and EnergyHub's estimates of load shed.

- **As a percent of baseline usage, average demand savings were 58% and 59% for Eversource and National Grid, respectively.** For National Grid, this reduction in

cooling load is slightly higher than 2018 (likely due to the higher temperature setback during events), but consistent with the previous two implementation seasons.

- **Fully participating devices have average event savings across the 2019 season that are over 35% higher than the average across all dispatched participants.** Impacts for full participants show the technical potential of the offering. As opt-outs and other forms of non-participation are reduced, average and total event impacts should increase.

- **National Grid's average demand savings per event in 2019 was 0.59 kW, a decrease from the average savings found in 2018 (0.71 kW).** The lower savings likely stem from the later event times and the fewer number of event days exceeding 90°F in 2019 compared to 2018, which resulted in a lower baseline cooling load.

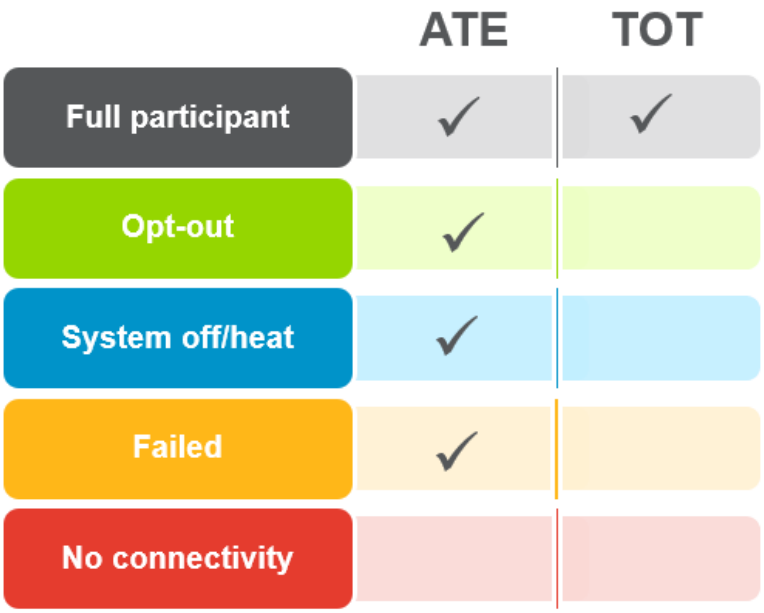
The remainder of this section elaborates on key findings for the following topics:

- Average impacts
- 2019 season savings

4.3.2 Average Impacts

Figure 4-21 shows the participation statuses included in the ATE versus the TOT. Navigant estimated the ATE per thermostat, which reflects the average event impact across all thermostats dispatched for an event, regardless of whether the thermostat opts-out, is in cooling mode, or has Wi-Fi connectivity.

Figure 4-21. Treatment Effects



Source: Navigant

Shown in Figure 4-22, the ATE for the three PAs across the 2019 season ranged from 0.38 to 0.60 kW per thermostat. Eversource and National Grid had very similar impact results during the 2019 season. Unitil's savings are notably lower than those of the other two PAs. Navigant did not evaluate Unitil's offering in 2019 due to low enrollment and therefore savings were calculated using the savings adjustment factor described in Section 4.4.1, which relies on EnergyHub's estimates of load shed. Due to low offering enrollment, Unitil's per-event savings were much more variable relative to the other PAs. Additionally, EnergyHub's estimated average load per device during events is lower for Unitil relative to the other PAs, resulting in a lower baseline and lower impacts. The lower average load is a result of the percent of devices cooling during an event. Relative precision for a typical event was +/- 9% at a 90% confidence level for both Eversource and National Grid, despite a smaller control group for Eversource. This likely stems from Eversource's higher rate of full participation rate – higher full participation reduces the noise around the event impact.

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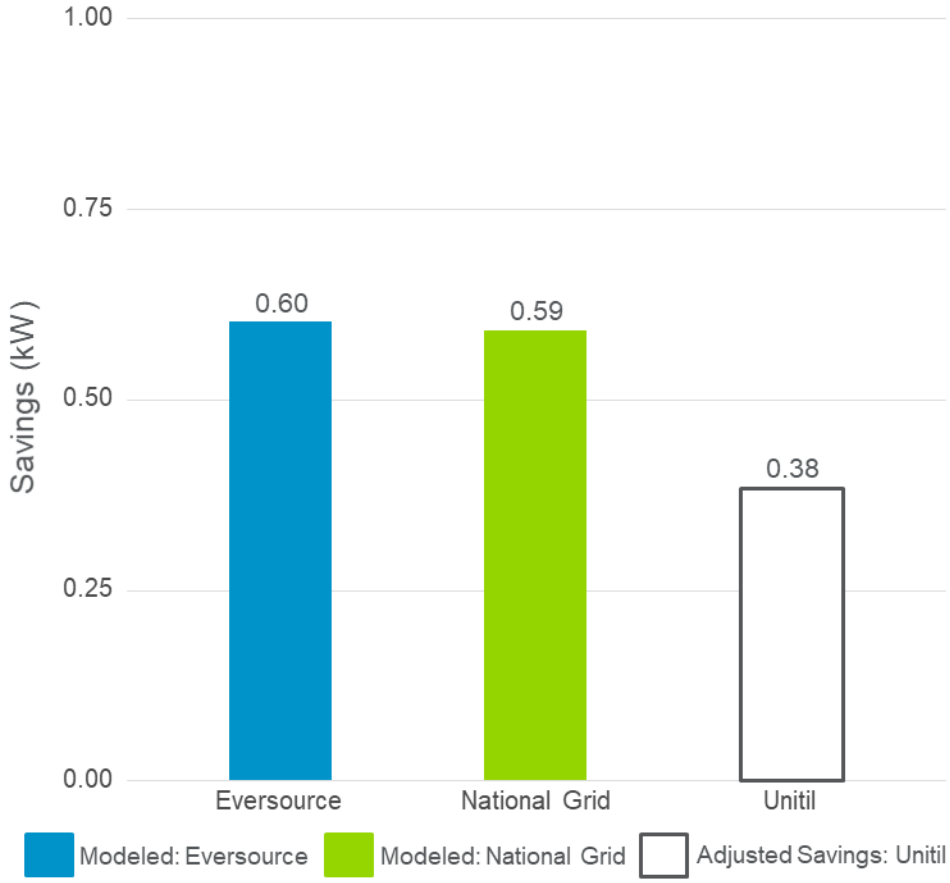
Figure 4-22. ATE per Thermostat by PA



Note: Adjusted savings are calculated using the savings adjustment factor (outlined in Section 4.4.1) on the vendor-reported savings.

Source: Navigant analysis of EnergyHub data

A yearly ATE comparison for National Grid is shown in Figure 4-23. Average demand savings per thermostat decreased from 0.71 kW to 0.59 kW, likely the result of a combination of factors:

- The 2019 DR season was cooler than 2018. There were 2 event days where the average high temperature was above 90°F (compared to 6 in 2018).
- Full participation rates were the highest in 2018 at 66%, compared to 53% in 2019.
- There were 6 new thermostat types introduced to the offering evaluation in 2019. These new types had lower full participation rates than old thermostat types (see Figure 4-15 from the Thermostat Usage Assessment).

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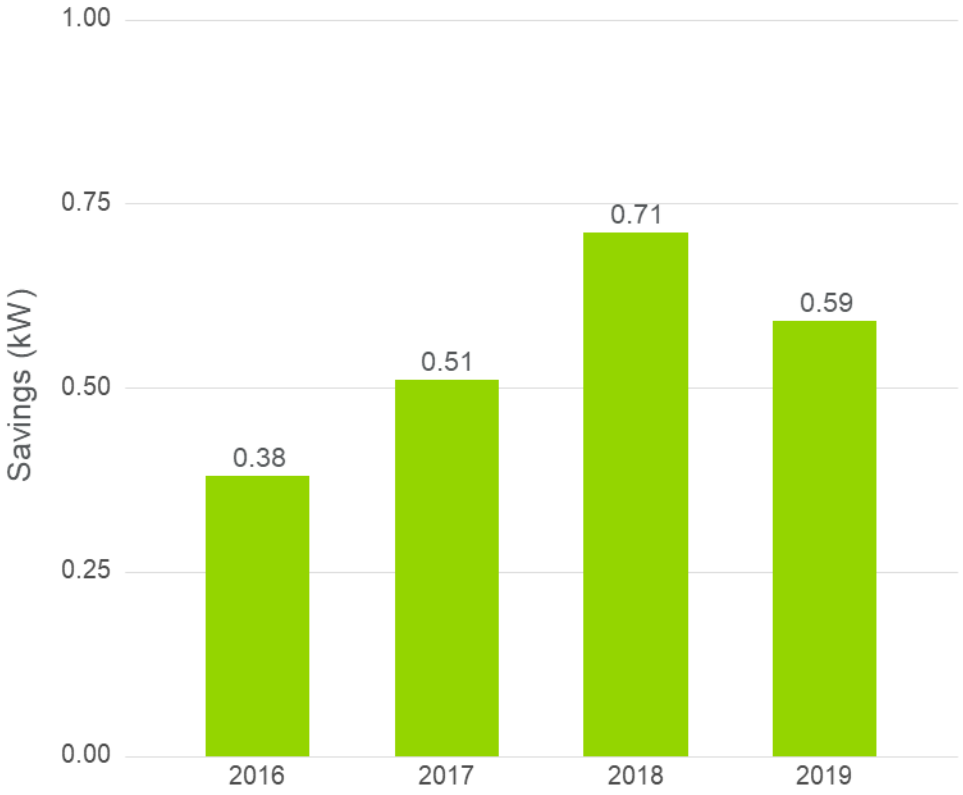
Figure 4-23. ATE per Thermostat by Year (National Grid)



Source: Navigant analysis of EnergyHub data

A key difference between National Grid's program implementation in 2019 and previous years was the thermostat setback during events. In 2019, the setback increased to 4 degrees from 3 degrees (the setback used in both 2017 and 2018). Navigant explored the impact of thermostat setback on average event impacts by comparing Eversource and National Grid impacts on shared event days where Eversource used a 3-degree setback. However, results were inconclusive due to differences in event timing, weather, and device participation (see Figure F-2 displays the average impacts (ATE) by event and PA. Lower average impacts are attributed to differences in temperature, and differences in the percent of full participation during each event. On August 8th and August 19th, Eversource and National Grid called events at the same time but with two different setbacks (3 degrees for Eversource and 4 degrees for National Grid). For the event on August 8th, National Grid had the higher average impact, while Eversource had the higher average impact on August 19th. With limited points of comparison and opposite results, it is inconclusive whether a higher setback produces larger average impacts.

Figure F-2 and Figure F-4 presents the TOT impacts by event, representing the impacts of full participants only (i.e., excluding thermostats that opt-out, where the AC system is in off or heat mode, and thermostats with connectivity or failure issues). The largest impacts are estimated on hotter event days when more cooling is occurring.

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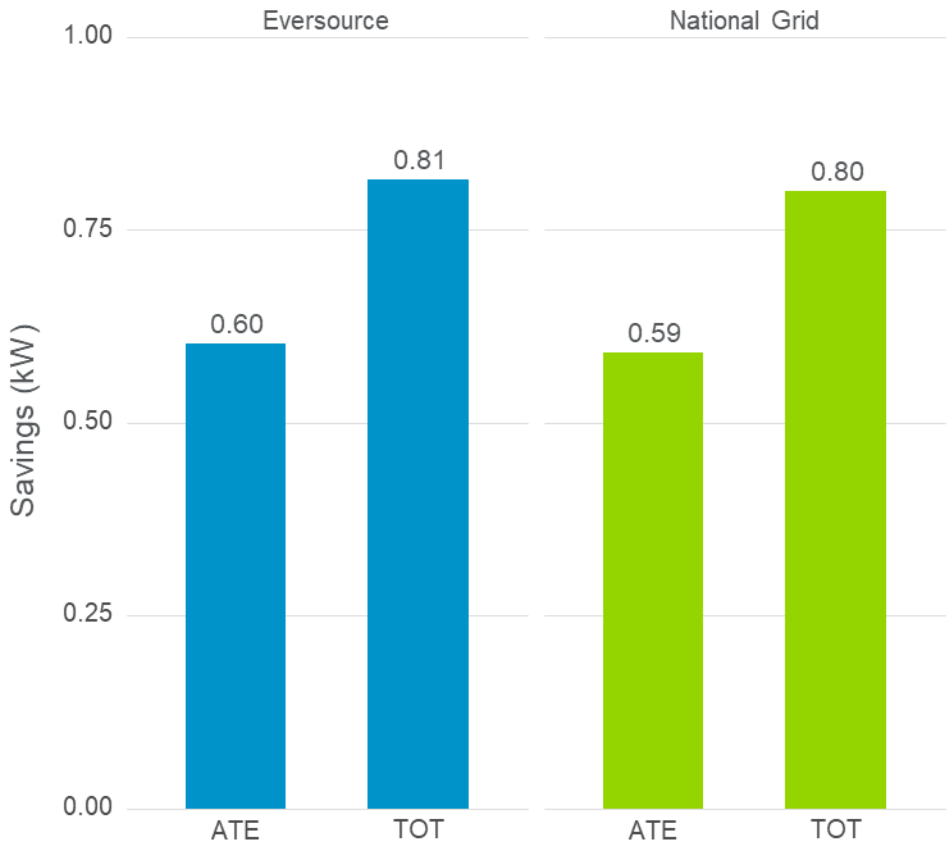
Figure F-4 in Appendix F). A second important difference was the timing of events. Events in 2017 and 2018 were called from 2 PM to 5 PM, while 2019 events were called from 3 PM to 6 PM or 4 PM to 7 PM. The later event times may have contributed to the lower event impacts, possibly through reduced AC load in the early evening hours as a result of lower solar insolation and lower outdoor temperatures later in the day.

Navigant also estimated the TOT per thermostat, which only includes thermostats in the full participant category. Figure 4-24 displays the TOT per thermostat impact by PA. Eversource and National Grid had very similar impact results, despite slight differences in the program designs. The average TOT demand savings per thermostat was 0.81 kW for Eversource and 0.80 kW for National Grid. However, as a percent of baseline load, the TOT savings was 70% for Eversource and 73% for National Gird (shown in Table 4-6). A year-over-year comparison of the TOT for National Grid can be found in Appendix F.

Figure 4-24. TOT per Thermostat by PA



Source: Navigant analysis of EnergyHub data

Table 4-6 displays the average impacts (ATE) and the full participation impacts (TOT) for each PA. Despite slight differences in program designs, Eversource and National Grid had very similar impact results (on average and for full participants).

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Table 4-6. ATE and TOT Summary

		Eversource	National Grid	Unitil
Average ATE	Savings per thermostat (kW)	0.60	0.59	0.38
	Percent Savings	58%	59%	-
	Baseline per thermostat (kW)[45]	1.03	1.01	-
Average TOT	Savings per thermostat (kW)	0.81	0.80	-
	Percent Savings	70%	73%	-
	Baseline per thermostat (kW)	1.17	1.09	-

Note: ATE includes thermostats in the full participant, opt-out, and system off/heat categories. TOT includes only full participants.

Source: Navigant analysis of EnergyHub Data

A year-over-year summary of average impacts (ATE) and full participation impacts (TOT) is presented in Table 4-7. Although the season ATE and TOT decreased in 2019 relative to 2018, the impacts as a percent of baseline cooling load increased. Cooler event day weather relative to 2018 resulted in a lower baseline load per thermostat. The year-over-year results also reflect changes in implementation:

- 2016: Lowest average impacts in the four years of implementation. National Grid called almost 30 events, and several were on cooler days with high temperatures in the low 70s. The setback was 2 degrees for ecobee and Honeywell devices, and 3 degrees for Nest. Only Honeywell and Nest had pre-cooling.

- 2017: Average impacts increased over 2016. National Grid called 11 events on hotter summer days, but none had high temperatures in the 90s. The setback was 3 degrees for all devices. Only Honeywell and Nest had pre-cooling.

- 2018: The highest average impacts across the four years. National Grid called 15 events on hotter summer days, 6 of which occurred on days where the high temperature exceeded 90. The setback was 3 degrees for all devices and all devices had pre-cooling.

[45] The baseline load is the counterfactual event period load as predicted by the regression model. The counterfactual load is largely predicted by the control group usage during events, with corrections for pre-existing differences between groups.

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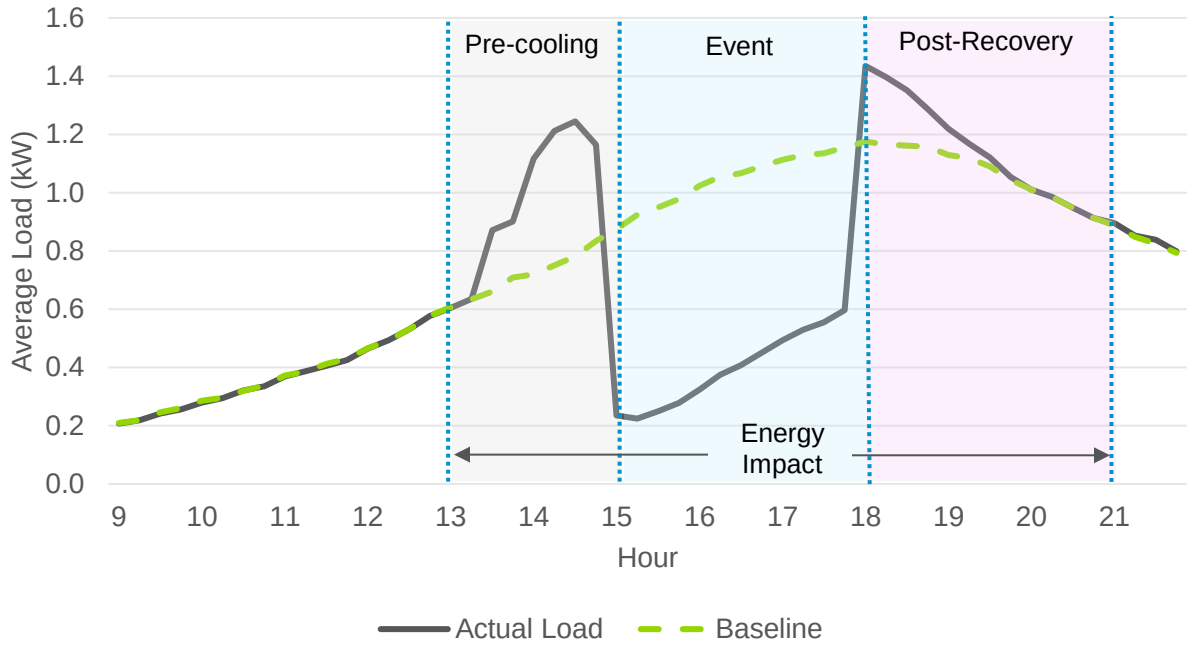
Table 4-7. ATE and TOT Summary by Year (National Grid)

		2016	2017	2018	2019
Average ATE	Savings per thermostat (kW)	0.39	0.51	0.71	0.59
	Percent Savings	45%	61%	56%	59%
	Baseline per thermostat (kW)	0.86	0.83	1.26	1.01
Average TOT	Savings per thermostat (kW)	0.50	0.69	0.91	0.80
	Percent Savings	60%	77%	71%	73%
	Baseline per thermostat (kW)	0.84	0.89	1.29	1.09

Note: ATE includes thermostats in the full participant, opt-out, and system off/heat categories. TOT includes only full participants.
Source: Navigant analysis of EnergyHub Data

In addition to event period impacts, Navigant estimate the demand impacts for the pre-cooling and post-event recovery periods. Navigant also reports total energy impacts as a result of the event, which show a collective reduction in energy usage across the pre-cooling, event, and recovery periods (i.e., a summation of the energy impacts across the three periods). These periods are shown in Figure 4-25.

Figure 4-25. Illustrative Event and Baseline Load and Associated Periods



Source: Navigant

Table 4-8 summarizes the average impacts during each period. Although pre-cooling impacts are larger for Eversource, this is a result of the shorter pre-cooling period relative to National Grid (60 minutes and 90 minutes, respectively). Ultimately, the energy savings are similar between the two PAs.

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Table 4-8. Average Period and Energy Impacts

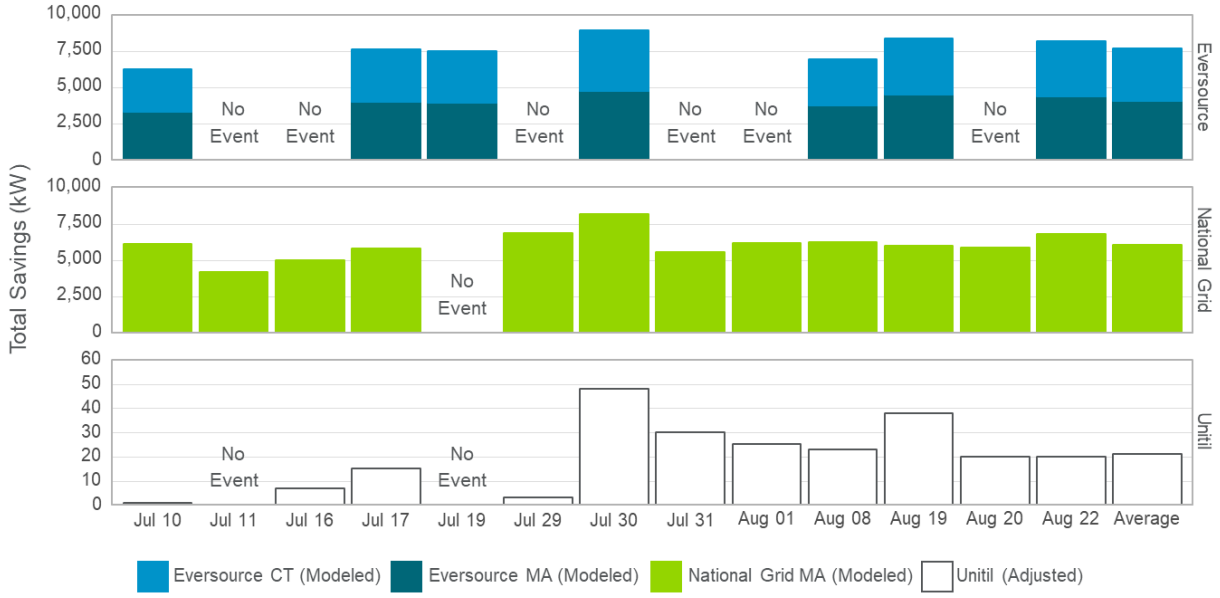
PA	Metric	Pre-cool	Event	Recovery	Energy
Eversource	Impact	0.44 kW	-0.60 kW	0.23 kW	-0.67 kWh
	Duration	1 hour	3 hours	3 hours	7 hours
National Grid	Impact	0.35 kW	-0.59 kW	0.21 kW	-0.62 kWh
	Duration	1.5 hours	3 hours	3 hours	7.5 hours

Source: Navigant analysis of EnergyHub Data

4.3.3 2019 Season Savings

Figure 4-26 presents the total demand savings for the residential Wi-Fi thermostat DLC offering by event for Eversource MA, Eversource CT, National Grid MA, and Unitil MA. The maximum kilowatt reduction occurred on July 30, 2019, which coincided with the 2018 ISO-NE system peak day. Savings accrue for each dispatched device on each event day. Devices withheld from an event in a control group do not accrue savings (unlike prior evaluations). Additional details on dispatched devices counts can be found in Appendix F.

Figure 4-26. Summary of 2019 Event Savings



Source: Navigant analysis of EnergyHub Data

Table 4-9 shows the estimated peak hour savings achieved by PA during the ISO-NE peak hour. The peak hour occurred on July 30, 2019 from 5 p.m. to 6 p.m.

Table 4-9. ISO-NE 2019 Peak Hour Savings

PA	Estimated Peak Hour Impact
Eversource CT	3,715 kW
Eversource MA	4,243 kW
National Grid	6,786 kW
Unitil	39 kW

Source: Navigant analysis of EnergyHub Data

Table 4-10 shows the summary of season impacts for the 2019 DR season. The table contains average and maximum impacts for the entire season, as well as energy savings.

Table 4-10. Summary of 2019 Season Savings[46]

	Eversource CT	Eversource MA	National Grid	Unitil
Average Demand Reduction per Event	3,572 kW	4,081 kW	6,031 kW	20 kW
Maximum Demand Reduction per Event	4,164 kW	4,756 kW	8,124 kW	48 kW
Average Energy Savings per Event	4,020 kWh	4,594 kWh	6,330 kWh	-

Source: Navigant analysis of EnergyHub Data

4.4 Ex Post Savings in 2019 and Future Years

This section describes the savings adjustment factors Navigant developed in order to facilitate the PAs' use of EnergyHub's estimates for claiming savings both in 2019 and going forward. Appendix G summarizes the key parameters needed for the particular tools utilized by the Massachusetts PAs for the purposes of claiming savings.

4.4.1 Savings Adjustment Factor

Navigant developed a savings adjustment factor to be applied to vendor-reported savings estimates by comparing the hourly evaluated impacts for National Grid in 2018 and 2019 and Eversource in 2019 to the hourly impacts estimated by the implementer, EnergyHub, where the average outdoor temperature was greater than 75 degrees, shown in Figure 4-27.

[46] The demand reductions only include the event period, while the energy savings include the pre-cooling, event, and post-recovery periods.

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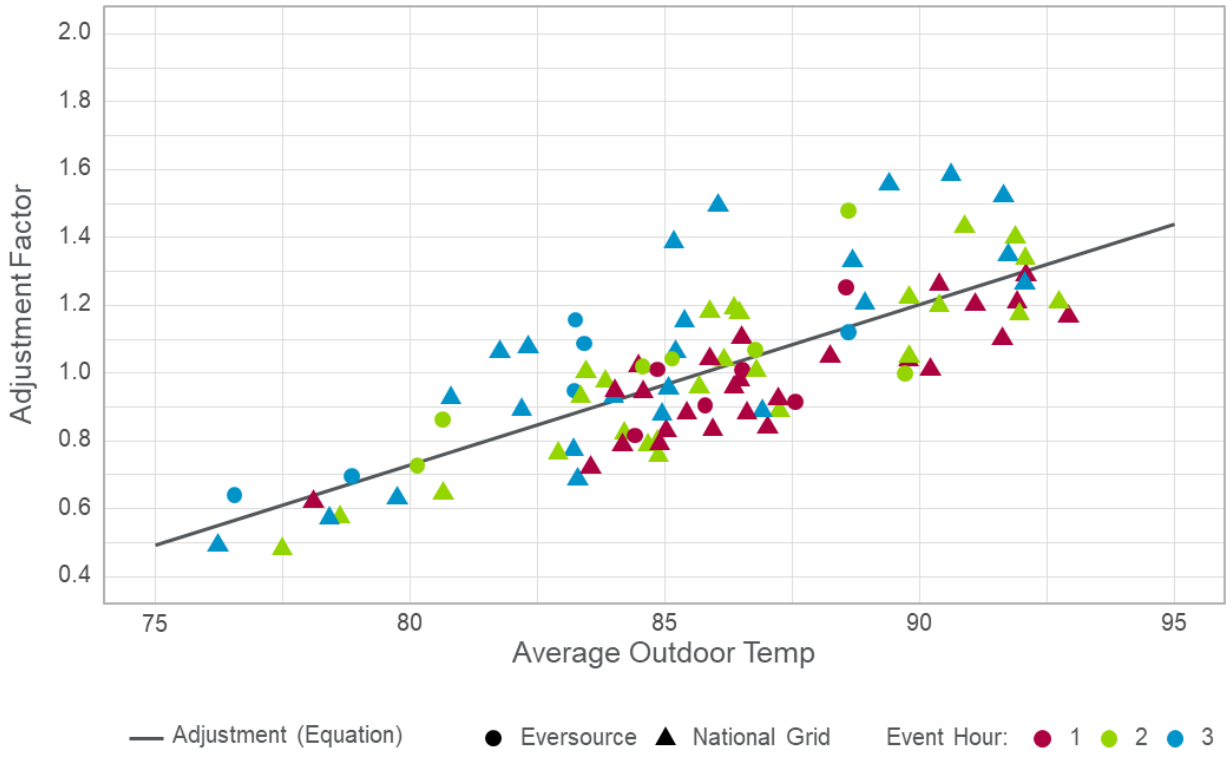
Figure 4-27. Hourly Event Impact Adjustment Factor



Source: Navigant analysis of 2018-2019 EnergyHub Data

Navigant found that the comparison had a positive correlation, indicating that EnergyHub was overestimating impacts for lower event temperatures and underestimating impacts for higher event temperatures. These biases and lower and higher temperatures stem from the baseline methodologies used by EnergyHub (ISO-NE and PJM[47]). These baselines rely on runtime from the previous non-event weekdays and use an adjustment window prior to the event to scale the baseline to day-of load. On hotter days, the shape of the baseline is often too flat, leading to underestimated impacts. An illustrative example of this is depicted in Figure 4-28. On cooler days, particularly ones where afternoon storms resulted in a sudden temperature drop, the baseline can be too high and can't adapt to the change in weather. Due to the correlation observed, Navigant recommends an adjustment factor equation where the adjustment factor is a function of hourly temperature.

[47] Each PA can select either the ISO-NE baseline or the PJM baseline when scheduling an event. These baselines rely on runtime in the previous non-event weekdays and use an adjustment window prior to the event to scale the baseline to day-of load.

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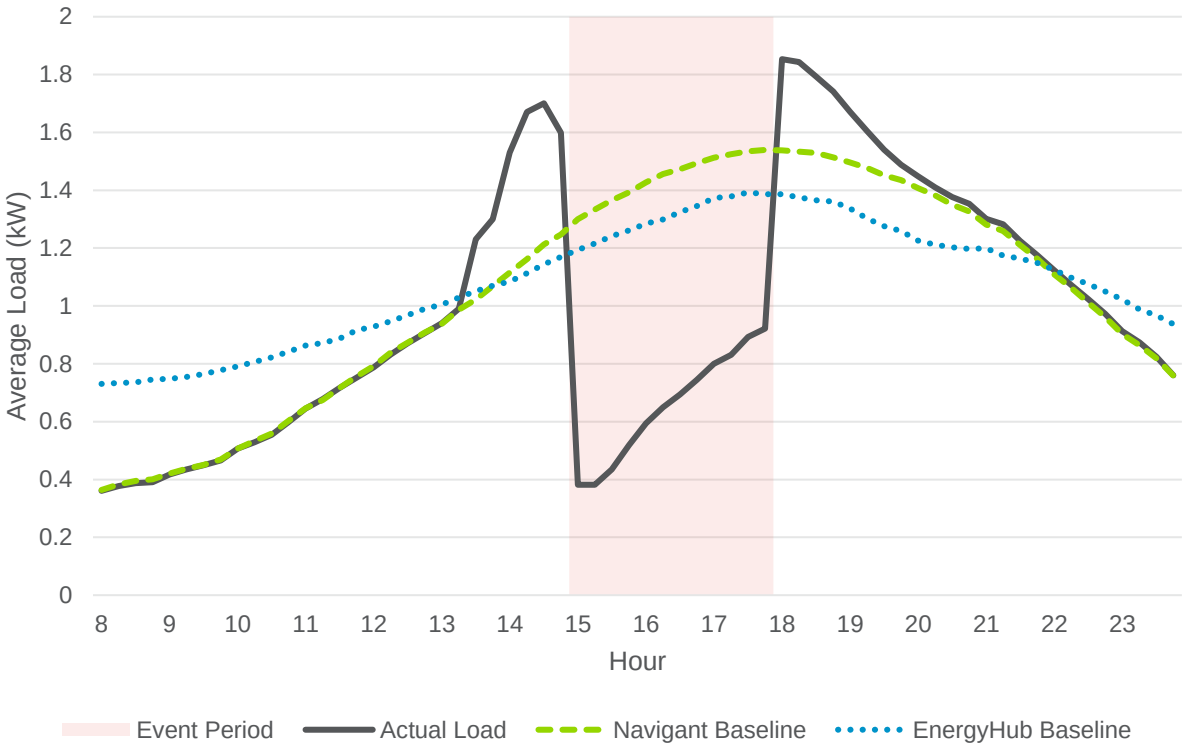
Figure 4-28. Illustrative Comparison of Baselines



Source: Navigant

Navigant compared the evaluated pre-cooling impacts to EnergyHub's impacts. As shown in shown in Figure 4-29, there was no strong correlation between outdoor air temperature and the resulting adjustment factor. For the pre-cooling hours, Navigant recommends a single average value.

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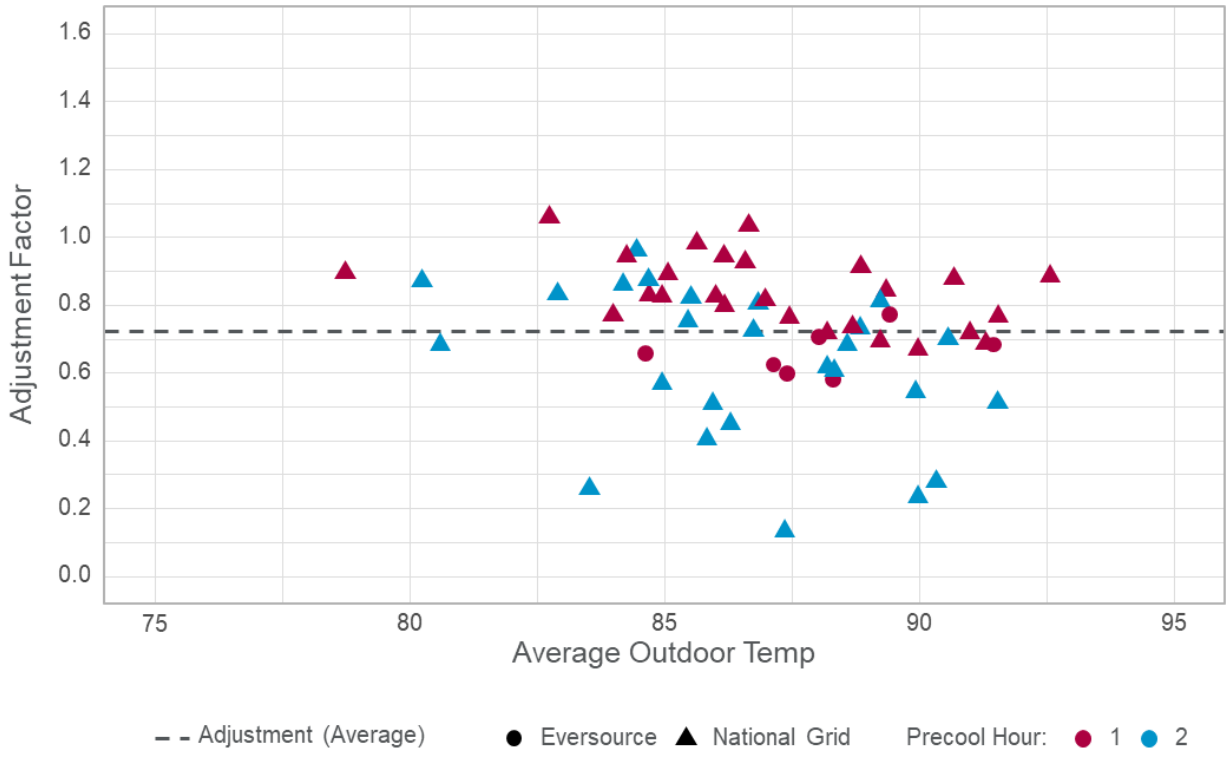
Figure 4-29. Hourly Pre-cooling Impact Adjustment Factor



Source: Navigant analysis of 2018-2019 EnergyHub Data

Navigant compared the evaluated post-event recovery impacts to EnergyHub's impacts. As shown in shown in Figure 4-30, similar to the pre-cooling hours, there was no strong correlation between outdoor air temperature and the resulting adjustment factor. For the post-event recovery hours (the 3 hours following the event period), Navigant also recommends a single average value.

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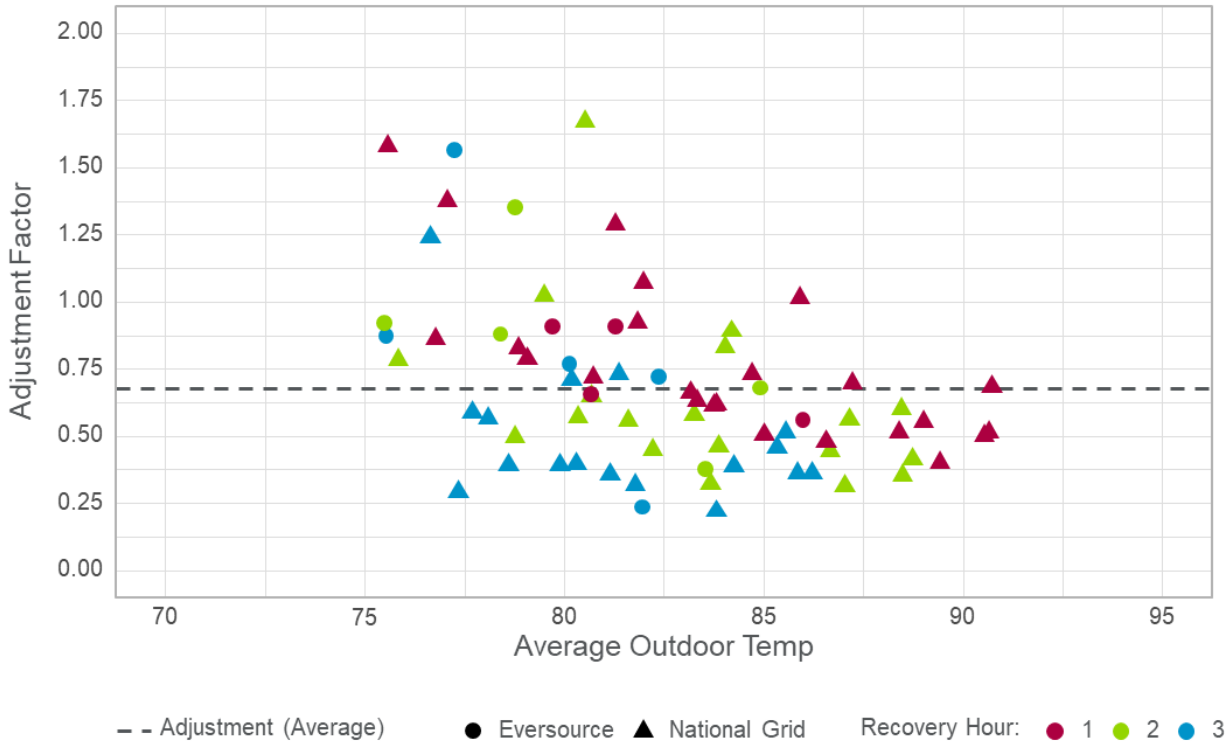
Figure 4-30. Hourly Recovery Impact Adjustment Factor



Source: Navigant analysis of 2018-2019 EnergyHub Data

Navigant's recommended savings adjustment factors are found in Table 4-11. For the pre-cooling and recovery periods, the hourly adjustment factor is a single value. The event period adjustment factor is an equation with a single input: the average outdoor temperature during the hour in question. The average outdoor temperature can be found in EnergyHub's "Load Intervals" file for each dispatched event. Using this input, the adjustment factor can be calculated for each individual event hour and applied to the "Load Difference" column.

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Table 4-11. Demand Savings Adjustment Factors

Period	Conditions	Hourly Load Adjustment Factor
Pre-cooling	Average Temperature ≥ 75°F 30 to 90 Minute Duration ISO-NE or PJM Baseline	0.72
Event	Average Temperature ≥ 75°F 3-Hour Duration ISO-NE or PJM Baseline	-3.06 + (0.05 x Average Temperature °F)
Recovery	Average Temperature ≥ 75°F ISO-NE or PJM Baseline	0.68

Source: Navigant

4.4.2 Ex Post Savings

Navigant recommends that all the PAs apply the savings adjustment factors to Energy Hub-reported savings to generate *ex post* savings values for the purposes of claiming savings in 2019 and in future years.[48]

[48] To claim savings from their Wi-Fi thermostat DLC offerings, Eversource MA, National Grid MA and Unitil MA must compile and enter necessary inputs into the MA Active Demand Reduction Benefit Cost Ratio model. As an intermediate step, the MA PAs must populate the DR Impact Factor Calculator tool developed by Synapse Energy Economics, Inc (Synapse). Key parameters needed for the Synapse tool and the ADR BCR model and the process for populating the Synapse tool are outlined in Appendix G.

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5. FINDINGS AND CONSIDERATIONS

This section identifies the key findings and considerations from the process and impact evaluation of the residential Wi-Fi thermostat DLC offerings of Eversource CT, Eversource MA, National Grid MA, and Unitil MA in 2019. Key findings appear in Table 5-1 through Table 5-3, and recommendations and considerations appear in Table 5-4.

Table 5-1. Key Findings – Customer Experience

Research Category	Findings
	Overall, 96% of thermostats that enrolled since September 30, 2018 remained enrolled through the end of the evaluated 2019 DR season. The rate of sustained enrollment for thermostats enrolled after September 30, 2018 was 97%, 94%, and 99% for Eversource, National Grid, and Unitil, respectively.
Participation over time	**The annualized rate at which thermostats leave the ConnectedSolutions offering ("annualized attrition") ranges from 5 to 11% per year.**[49] For National Grid, annual attrition ranges from 6% to 10% depending on the period of enrollment, reflecting National Grid's device management plan. For Eversource, attrition ranges from 10 to 14%, depending on the period of enrollment. However, for both Eversource and National Grid, implementation vendor transitions impact the ability to fully analyze the extent to which thermostats have left the programs over time. For Unitil, annualized attrition is 5%.
Overall Experience	**Across all PAs and cohorts, more than 85% of survey respondents reported that they are likely or very likely to participate again in the future.** Respondents were generally satisfied with event characteristics in 2019, including the number, length, and timing of events.
Motivations	**Bill savings is a perceived offering benefit.** Bill savings is the most commonly cited motivation for participating, including among returning National Grid customers. Although this offering achieved energy savings in 2019, the primary goal of the offering is to achieve peak demand reductions. As a result, any given participant may or may not experience bill savings by participating in the offering. The perception that participation will lead to bill savings may be a consequence of co-marketing the offering with Wi-Fi thermostat rebates.
Event notifications	**55% of respondents were satisfied with the mode of notification received.** Overall, approximately 75% of survey respondents reported receiving event notification, and 75% of these respondents received their preferred mode of notification.

[49] This includes thermostats associated with a customer that chooses to unenroll from the program as well as thermostats that are removed from the program by the PA or implementation vendor.

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Research Category	Findings
	About 20% of respondents would like more flexibility in terms of how they are notified of events. 25% of respondents *who reported receiving event notifications* would like to receive a different mode of event notification than what they received in 2019. Of these, a majority would like notifications by email.
	Overall 17% of respondents reported not receiving event notifications and 10% were unsure whether or not they received event notifications. 80% of Unitil and Eversource respondents reported receiving advance notifications for events while only about 62% of National Grid new participant respondents and 70% of National Grid returning participant respondents reported receiving advance notifications. The remaining participants either reported receiving no event notification or they were unsure whether or not they received notifications. Eversource and Unitil elected to send event notification emails to participants with device types that allowed this. National Grid elected not to send advance notification emails. For device types where email notification was an option the PAs could select, participants that received event notifications *only* through the thermostat provider's app had lower rates of event notification recall than those who also received an email. For respondents who reported not receiving any event notification, a majority would like to receive email notification, at a minimum.
Event awareness / comfort / behavior	**Approximately two-thirds of participants reported noticing temperature changes during events but only 40% reported ever opting out**. Most of those who reported having opted out stated that they did so only sometimes (30-40%) or rarely (50-65%). When looking at thermostat telemetry data, the percentage of devices that opted out at least once over the course of the season, and the frequency with which they opted out, is somewhat higher than what survey respondents reported (see section 4.2).[50,51] Notably, 16% of National Grid returning participants reported not knowing if they ever opted-out of an event. Relatedly, over 40% of survey respondents indicated they did not recall pre-cooling happening prior to events. In open-ended feedback, three respondents noted that it was too easy to override events inadvertently.
Program design elements	**Approximately 10% of survey respondents are interested in seeing changes to or the ability to customize offering design parameters.** Some survey respondents would like to see changes to or to be able to specify their preferences related to: pre-cooling temperature adjustment and/or duration (26), event duration and/or timing (16), event setpoint maximum (3). Three survey respondents would like to be able to opt back into the event after opting-out.

[50] The thermostat usage assessment (section 4.2) shows that 45% of Eversource devices, 54% of National Grid devices, and 43% of Unitil devices opted-out for at least one event during the 2019 season.

[51] The thermostat usage assessment shows that 47% and 45% of participants who opted of at least one event during the summer, for Eversource and National respectively, opted out of over half of events (see Section 4.2).

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Source: Navigant

Table 5-2. Key Findings – Thermostat Usage Assessment

Research Category	Findings
Full Participation	**2019 full participation rates exceeded 50% on average for each event and across the season.** Eversource MA and CT had the highest full participation at 60%, followed by Unitil MA at 56% and National Grid MA at 52%. The primary reason for devices not fully participating in events was not being in cooling mode.
Device Mode	**A significant number of devices were never in cooling mode for an event.** Over 60% of system off/heat mode issues for Eversource MA and CT, National Grid MA, and Unitil MA stem from devices that were in system off/heat mode for the entire season.
Connectivity	**Connectivity was a small issue overall during individual events for Eversource MA and CT, National Grid MA, and Unitil MA.** A large portion of connectivity issues stem from devices that were disconnected for the entire season.
Event Fatigue	**Participants exhibited no evidence of event participation fatigue (increased opt-out rates) due to back-to-back events or a higher event dispatch frequency.** Devices in the experimental design groups participated at similar rates regardless of the number of events for which they were dispatched.

Source: Navigant

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Table 5-3. Key Findings – Impact Analysis

Research Category	Findings
Average Treatment Effect	**Eversource and National Grid had very similar average treatment effects for the 2019 season, 0.60 kW and 0.59 kW per thermostat, respectively.** Unitil's average treatment effect was lower, 0.38 kW per thermostat, which uses the savings adjustment factor described in Section 4.4.1 and EnergyHub's estimates of load shed.
Average Treatment Effect - Percent Savings	**As a percent of baseline usage, average demand savings per event were 58% and 59% for Eversource and National Grid, respectively.** For National Grid, this reduction in cooling load is slightly higher than 2018, but consistent with the previous two implementation seasons.
Treatment Effect on the Treated	**Fully participating devices have average event savings that are over 35% higher than the average across all dispatched participants.** Larger impacts for full participants indicate the program can improve average and total event impacts if opt-outs and other forms of non-participation are reduced.
2019 vs. 2018 savings	**National Grid's average demand savings per event in 2019 was 0.59 kW, a decrease from the average savings found in 2018 (0.71 kW).** The lower savings likely stem from the later event times and the fewer number of event days exceeding 90°F in 2019 compared to 2018, which resulted in a lower baseline cooling load.

Source: Navigant

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Table 5-4. Recommendations and Considerations

Research Category	Recommendations and Considerations
Participation and Attrition	**Consideration 1:** Monitor attrition annually to identify changes in and causes of unenrollment and removal of devices from the offering. If possible, records of former participants should be maintained in the event of a change in implementation vendors.
	Recommendation 1: Unenroll thermostats from the offering that frequently opt out of events, do not have connectivity, and/or are consistently in a non-cooling mode. This will lower the costs of the Direct Load Control Offering and increase average savings per thermostat. In parallel, ensure that the enrollment tracking system allows for the tracking of unenrollment reasons related to the opt outs, connectivity and AC system mode behavior.
Program Messaging	**Consideration 2:** Clarify the messaging regarding the intent of offering by continuing to emphasize in all public-facing materials that the offering supports protecting the environment by lowering emissions and supports reliability of the electric system. Avoid language that suggests individual customers will save energy and/or money on electricity bills by participating in the offering.
Event Notifications	**Consideration 3:** During or after participants enroll, provide some "helpful program tips" including noting that, if participants would like to be notified of events through their thermostat app, they may need to adjust their phone settings in order to allow automated messages to be sent by their thermostat app when the app is not open. This is only applicable to thermostat types that provide event notification via the associated mobile app.
	Consideration 4: Give participants a few options to customize advance event notification preferences – method (email, thermostat app, or text) and timing (day-ahead or day-of) to the extent possible.
	Consideration 5: Provide a pop-up notification that asks participants who try to adjust their setpoint during events to confirm that they would like to override the event. Some thermostats already have this feature.
Pre-Cooling	**Consideration 6:** Continue pre-cooling to maximize event savings. Ensure that participants are aware that adjustments made during the pre-cooling period will prevent them from participating in the event (as applicable).

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Research Category	Recommendations and Considerations
	Recommendation 2: Include the count of all residential and non-residential devices and participants enrolled as of August 31 in the Massachusetts ADR BCR model. For 2019, the count of thermostats is 8,020, 11,503, and 70 for Eversource MA, National Grid MA, and Unitil, respectively. The count of participants is 5,158, 7,814, and 45 for Eversource MA, National Grid MA, and Unitil, respectively.
	Recommendation 3: Calculate ex-post savings by applying the savings adjustment factor to vendor-reported savings. Use ex-post savings for claiming savings in 2019 and in future years. For the event period, the savings adjustment factor is an equation based on average outdoor temperature: -3.06 + (0.05 x Avg Temp °F). For pre-cooling and recovery hours, the savings adjustment factors are constants, 0.72 and 0.68, respectively.
2019 and Future Savings	The adjustment factor can apply when the ISO-NE or PJM baseline is used, pre-cooling and event duration conditions are met, the assumed AC nameplate capacity continues to be 3.5 kW in the EnergyHub portal, and the average outdoor temperature is 75 degrees F or higher. When these conditions are not met, the savings adjustment factor does not apply.
	Consideration 7: Consider conducting an evaluation in the future if the offering undergoes vendor and/or algorithm changes as the current adjusted savings framework will no longer apply with significant changes to implementation.
	Consideration 8: Consider conducting an evaluation in the future if a DR season has back-to-back 95+ degree event days as current and past evaluations have not included such extreme event conditions.
	Consideration 9: Continue to test DR setbacks to explore whether the program can achieve higher savings per thermostat without resulting in participants opting out of events at higher rates.

Source: Navigant

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APPENDIX A. 2016-2019 NATIONAL GRID OFFERING DETAIL

Table A-1. 2016-2019 Offering Characteristics – National Grid

Offering Attribute	2016	2017	2018	2019
DR Platform	Whisker Labs (and Nest)	Whisker Labs (and Nest)	EnergyHub	EnergyHub
Thermostat Manufacturers	ecobee Honeywell Nest	ecobee Honeywell Nest	ecobee Honeywell Nest Alarm.com Lux Radio Thermostat Sensi Vivint	ecobee Honeywell Nest Alarm.com Lux Radio Thermostat Sensi Vivint
Enrollment Incentive	Yes	Yes	Yes	Yes
Annual Incentive	ecobee (>75% participation) Honeywell (>75% participation) Nest	ecobee (>75% participation) Honeywell (>75% participation) Nest	Annual incentive without a participation requirement	Annual incentive without a participation requirement
Event Dispatch Criteria	ecobee (>$49 MWh) Honeywell (>$49 MWh) Nest (>$63 MWh)	Same event dispatch criteria	Same event dispatch criteria	Same event dispatch criteria
Event Duration	2 to 4 hours	3 hours	3 hours	3 hours
Pre-cooling Adjustment	ecobee 0°F Honeywell 2°F Nest 2°F	ecobee 0°F Honeywell 2°F Nest 2°F	2°F for all	3°F for all
Event Adjustment	ecobee 2°F Honeywell 2°F Nest 3°F	3°F for all	3°F for all	4°F for all

Source: Navigant

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APPENDIX B. IMPACT ANALYSIS DATA MANAGEMENT

Devices or observations were removed using the following steps for event and non-event days. The results of data cleaning are shown in three tables below for National Grid, Eversource (Experimental Design) and Eversource (Within Subject Analysis), respectively. A shortened data cleaning approach was taken for Unitil and no devices were removed during the process.

1. **Devices in Experimental Design** – Starting with enrolled devices included in the experimental design

2. **No Reported Telemetry Data (Alarm, Vivint)** – Remove Alarm.com and Vivint GoControl devices which do not report any telemetry data

3. **No Reported Telemetry Data (Nest)** – Remove Nest devices that did not report telemetry data on the specified day due to a lack of connectivity

4. **Missing 100% of Data During Event*** – Remove device/date combo if 100% of data is missing during precool, event, and snapback intervals

5. **Missing 10% of Data During Precool, Event, or Snapback*** – Remove device/date combo if 10% of data is missing during precool, event, or snapback intervals

6. **Missing 10% of Data Between 8AM and 10PM** – Remove device/date combo if 10% of data is missing between 8AM and 10PM

7. **Remaining Steps** – Several additional QA/QC processes were incorporated. This includes:

    - **High Set Point** – Remove observations where the set point exceeds 100 degrees

    - **Missing Device ID** – Remove devices missing their device id

    - **Missing Utility Account Number** – Remove devices missing their utility account number

    - **Missing/Invalid Zip Codes** – Remove devices missing or invalid zip code

    - **Device Was Not Called But Should Have Been** – Remove device/date combo if device was not called for the event but should have been

    - **Device Was Called But Should Not Have Been** – Remove device/date combo if device was called for the event but should not have been

    - **Missing/Multiple Participation Statuses** – Remove device/date combo if device is missing a DR participation status or has multiple statuses assigned on the same event day

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Table B-1. Data Cleaning Results – National Grid

Step	Jul 10	Jul 11	Jul 16	Jul 17	Jul 29	Jul 30	Jul 31	Aug 1	Aug 8	Aug 19	Aug 20	Aug 22
Devices in Experimental Design	**8,511**	**8,486**	**8,510**	**8,497**	**8,524**	**8,512**	**8,526**	**8,516**	**8,539**	**8,541**	**8,549**	**8,542**
No Reported Telemetry Data (Alarm, Vivint)	1,322	1,322	1,322	1,322	1,324	1,324	1,324	1,324	1,326	1,328	1,328	1,328
No Reported Telemetry Data (Nest)	28	3	18	5	18	5	16	11	24	6	13	6
Missing 100% of Data During Precool, Event, or Snapback	164	159	164	164	178	175	173	170	183	181	184	180
Missing 10% of Data During Precool, Event, and Snapback	168	**731**	226	393	174	175	290	200	204	**968**	198	191
Missing 10% of Data Between 8AM and 10PM	29	11	24	28	35	20	63	17	21	7	38	30
Remaining Steps	10	4	10	6	9	10	6	9	8	2	8	8
Final Count in Group A	**793** 78%	**743** 73%	**794** 78%	**774** 76%	**799** 79%	**802** 79%	**783** 77%	**800** 79%	**801** 79%	**717** 71%	**810** 80%	**811** 80%
Final Count in Group B	**806** 81%	**740** 75%	**794** 80%	**771** 78%	**800** 81%	**800** 81%	**787** 79%	**799** 81%	**793** 80%	**718** 72%	**804** 81%	**799** 80%
Final Count in Group C	**5,191** 80%	**4,773** 74%	**5,158** 79%	**5,034** 78%	**5,187** 80%	**5,201** 80%	**5,084** 78%	**5,186** 80%	**5,179** 79%	**4,614** 71%	**5,166** 79%	**5,189** 79%

Source: Navigant analysis of EnergyHub data

Table B-2. Data Cleaning Results – Eversource (Experimental Design)

Step	Jul 30	Aug 8	Aug 19	Aug 22
Devices in Experimental Design	**12,148**	**12,154**	**12,188**	**12,172**
No Reported Telemetry Data (Alarm, Vivint)	1,638	1,638	1,638	1,638
No Reported Telemetry Data (Nest)	25	27	35	15
Missing 100% of Data During Precool, Event, or Snapback	64	79	75	77
Missing 10% of Data During Precool, Event, and Snapback	138	162	**489**	150
Missing 10% of Data Between 8AM and 10PM	32	16	18	16
Remaining Steps	0	0	1	1
Final Count in Group A	**430** 84%	**431** 84%	**416** 81%	**432** 85%
Final Count in Group B	**437** 82%	**440** 83%	**424** 79%	**441** 83%
Final Count in Group C	**9,384** 84%	**9,361** 84%	**9,092** 82%	**9,402** 84%

Source: Navigant analysis of EnergyHub data

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Table B-3. Eversource (Within Subject Analysis)

Step	Jul 2	Jul 3	Jul 5	Jul 10	Jul 12	Jul 15	Jul 16	Jul 17	Jul 19	Jul 29	Jul 31	Aug 1	Aug 20	Aug 21
Devices in Experimental Design	**9,315**	**9,573**	**10,159**	**10,890**	**11,408**	**11,693**	**11,845**	**11,965**	**12,100**	**12,088**	**12,121**	**12,120**	**12,147**	**12,147**
No Reported Telemetry Data (Alarm, Vivint)	1,392	1,418	1,453	1,563	1,577	1,582	1,618	1,624	1,638	1,638	1,638	1,638	1,638	1,638
No Reported Telemetry Data (Nest)*	-	-	-	40	-	-	-	22	39	-	-	-	-	-
Missing 100% of Data During Precool, Event, or Snapback*	-	-	-	51	-	-	-	51	56	-	-	-	-	-
Missing 10% of Data During Precool, Event, and Snapback*	-	-	-	127	-	-	-	199	264	-	-	-	-	-
Missing 10% of Data Between 8AM and 10PM	337	380	561	14	257	412	283	16	27	199	250	218	223	251
Remaining Steps	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Final Remaining Count	**7,586**	**7,775**	**8,145**	**9,095**	**9,574**	**9,699**	**9,944**	**10,053**	**10,076**	**10,251**	**10,233**	**10,264**	**10,286**	**10,258**

Source: Navigant analysis of EnergyHub data

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APPENDIX C. POST-SEASON SURVEY INSTRUMENT

C.1 Post-Season Survey

Table C-1. Survey Characteristics

Characteristics	Description
Statement of purpose	Gain an understanding of participants' comfort level and behavior during events, including their reasons for opting out of events. Investigate the primary motivations of participation in the offering and solicit feedback on how the offering design and delivery can be improved from the customer's perspective.
Qualified respondent	National Grid MA, Eversource MA, Eversource CT, and Unitil MA customers who were enrolled in the Connection Solutions offering for Wi-Fi thermostats in 2019 and who were called for at least one 2019 event.
Population size	National Grid MA returning participants National Grid MA new participants Eversource MA+CT participants Unitil MA participants
Target number of completes	National Grid MA returning participants: 70 National Grid MA new participants: 70 Eversource MA+CT participants: 70 Unitil MA participants: 70
Estimated survey length	10-15 minutes
Survey timeline	October 11th – October 21st
Survey mode	Online

Source: Navigant

Table C-2. Research Objectives

Research Objective	Survey Questions
Why are customers opting out?	Q10-12, 16-20
How many events are customers willing to participate before they become "fatigued" and opt-out at higher rates?	Q24-27
What length of event is considered acceptable?	Q24-27
How did customers typically use their ACs and Wi-Fi thermostats throughout the summer of 2019?	Q23-23d
Do customers rely on other appliances (e.g., portable AC, fans) to maintain comfort during DR events?	Q21

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Research Objective	Survey Questions
How likely are customers to continue to participate in the offering in the future?	Q28
What suggestions or recommendations do customers have related to offering improvement?	Q7-9, 15, 25-27 29-30

Source: Navigant

[SURVEY START]

C.1.1 Screener

1. Please complete the following sentence: *I enrolled one or more thermostats in the* **[PROGRAM_NAME]** *Program for…*

    a. My residence
    b. My business **[IF [PA_NAME] = Eversource and [SAMPLE_GROUP] = SMB, SKIP TO NON-RESIDENTIAL MODULE. IF [PA_NAME] = Eversource and [SAMPLE_GROUP] = Res, SKIP TO NON_RESIDENTIAL MODULE AND SHOW: "***Congratulations! Because you have a business account enrolled in the program, you qualify to receive an incentive of $50 for continuing with this survey. Please answer the remaining survey questions from the standpoint of your business.***" ELSE TERMINATE SURVEY AND SHOW: "***This survey is intended for residential customers who enrolled in the **[PROGRAM_NAME]** Program. Thank you for your time.***"]**
    c. Both my residence and business **[IF [PA_NAME] = Eversource and [SAMPLE_GROUP] = SMB, SKIP TO NON-RESIDENTIAL MODULE AND SHOW:** *"Please answer the remaining survey questions from the standpoint of your business."* **IF [PA_NAME] = Eversource and [SAMPLE_GROUP] = Res, SKIP TO NON-RESIDENTIAL MODULE AND SHOW:** *"Congratulations! Because you have a business account enrolled in the program, you qualify to receive an incentive of $50 for continuing with this survey. Please answer the remaining survey questions from the standpoint of your business."* **ELSE CONTINUE AND SHOW:** *"Please answer the remaining survey questions from the standpoint of your residence."]*
    d. I did not enroll a thermostat in the program **[TERMINATE SURVEY AND SHOW:** *This survey is intended for residential customers who enrolled in the* **[PROGRAM_NAME]** *Program. Thank you for your time.*]

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C.1.2 Motivation for Participation

[RANDOMIZE ORDER OF a–h RESPONSE OPTIONS]

2. How did you become aware of the **[PROGRAM_NAME]** Program? (Select all that apply)

   a. **[IF PA_STATE = MA]** MassSave Website
   b. **[IF PA_STATE = CT]** Energize CT Website
   c. **[PA_NAME]** Website
   d. Email from **[PA_NAME]**
   e. Email from thermostat provider
   f. In-app invitation from thermostat provider
   g. Social media
   h. Friends/family/neighbor
   i. Other (Please specify) **[OPEN ENDED]**
   j. Don't know

[RANDOMIZE ORDER OF a - e RESPONSE OPTIONS]

3. What was your motivation for participating in the **[PROGRAM_NAME]** Program in 2019? Select your first and second reasons for enrolling.

{RESPONSE OPTION ORDER TO BE RANDOMIZED FOR EACH RESPONDENT}	1st Reason	2nd Reason
a. Receive participation incentives		
b. Save money on our energy bills		
c. Reduce our environmental impact		
d. Reduce the need for additional power plants		
e. Support our community and/or state's energy initiatives		
f. Other		

3_a. Please tell us your "Other" motivation for enrolling in the **[PROGRAM_NAME]** Program in 2019. **[OPEN ENDED]**

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C.1.3 Awareness and Notification

4. The **[PROGRAM_NAME]** Program helps you earn incentives from **[PA_NAME]** for saving energy during periods of high energy demand (aka "**[EVENT_NAME]**s") while still keeping you comfortable. During a **[EVENT_NAME]**, the program adjusts the cooling of your central air conditioner by sending a signal to your Wi-Fi thermostat to allow the temperature to rise by a few degrees.

   This summer, about how many **[EVENT_NAME]**s do you remember occurring? (Please make your best estimate)

   a. Please enter the number of events: **[OPEN ENDED, NUMERIC]**
   b. Don't know

[IF Q4a = 0, SKIP TO Q28. ELSE CONTINUE]

5. During this past summer, did you receive ever advance notifications about the **[EVENT_NAME]**s?

   a. Yes
   b. No
   c. Don't know

5_a. After enrolling in the **[PROGRAM_NAME]** Program, did you receive an option to opt-out of advance notifications?

   a. Yes
   b. No
   c. Don't know

[IF Q5_a = a, CONTINUE. ELSE SKIP TO Q6]

5_b. Did you choose to opt-out of advance notifications?

   a. Yes
   b. No
   c. Don't Know

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[IF Q5_b = a, SKIP TO Q10. ELSE IF Q5 = b OR c, SKIP TO Q7. ELSE CONTINUE]

6. How were you notified in advance that a **[EVENT_NAME]** was going to occur? (Select all that apply)

    a. Email
    b. Thermostat app
    c. Other (Please specify) **[OPEN ENDED]**
    d. Don't know

7. In general, how would you prefer to be notified that a **[EVENT_NAME]** is going to occur? (Select all that apply)

    a. Email
    b. Thermostat app
    c. Other (Please specify) **[OPEN ENDED]**
    d. Don't know

8. In general, how much advance notice would you like before a **[EVENT_NAME]**?

    a. Don't need advance notice
    b. At least one hour
    c. At least four hours
    d. At least eight hours
    e. At least 24 hours
    f. Other (Please specify)
    g. Don't know

[IF Q5 = a, CONTINUE. ELSE SKIP TO Q10]

9. Are there ways that **[EVENT_NAME]** notification could be improved? **[OPEN-ENDED, OPTIONAL]**

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C.1.4 Comfort and Behavior During Events

10. This summer, for the **[EVENT_NAME]**s you can recall, how often were you or another family member at home during any part of the **[EVENT_NAME]**?

    a. Home for all **[EVENT_NAME]**s
    b. Home for most **[EVENT_NAME]**s
    c. Home for some **[EVENT_NAME]**s
    d. Never home during **[EVENT_NAME]**s
    e. Don't know

[IF Q10 = a, b, OR c, CONTINUE. ELSE SKIP TO Q16]

11. During the **[EVENT_NAME]**s you can recall, did you or another family member notice any changes to your home's indoor temperature?

    a. Yes
    b. No
    c. Don't know

[IF Q11 = a, CONTINUE. ELSE SKIP TO Q14]

12. During the **[EVENT_NAME]**s you can recall, using a scale of 1 to 5, where 1 means "Much less comfortable" and 5 means "Much more comfortable", how would you generally describe your comfort compared to typical afternoons with similar outdoor temperatures?

a. Much Less comfortable	b. Less comfortable	c. About the same	d. More comfortable	e. Much more comfortable	f. Don't Know
1	2	3	4	5	

13. Do you have any comments to provide about your household's comfort level during **[EVENT_NAME]**s**? [OPEN ENDED, OPTIONAL]**

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Pre-Cooling

14. Prior to **[EVENT_NAME]**s, do you recall the program "pre-cooling" your home (i.e., providing your home extra cooling prior to **[EVENT_NAME]** hours)?

    a. Yes
    b. No
    c. Don't know

[IF Q14 = a, CONTINUE. ELSE SKIP TO Q15a]

15. Do you have any feedback about the "pre-cooling" that occurred prior to **[EVENT_NAME]**s? **[OPEN ENDED, OPTIONAL]**

15a. Prior to **[EVENT_NAME]**s, did you ever take any actions to prepare for the **[EVENT_NAME]**?

    a. Yes (Please specify) **[OPEN ENDED]**
    b. No
    c. Don't Know

Opt-Out Behavior

16. On **[EVENT_NAME]** days, did you or a family member ever "opt-out" of a **[EVENT_NAME]** or override your thermostat setting to stop the program from adjusting your thermostat during the event?

    a. Yes
    b. No
    c. Don't know

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[IF Q16 = a, CONTINUE. OTHERWISE SKIP TO Q21]

16_a. Did you "opt-out" or override your thermostat setting before **[EVENT_NAME]**s or during the **[EVENT_NAME]**s? (Select all that apply)

a. I "opted-out" before the event.
b. I "opted-out" during the event.
c. Other (Please specify) **[OPEN-END]**
d. Don't know

17. How often would you say you chose to opt-out of a **[EVENT_NAME]** or override the scheduled event thermostat setting? Would you say…

a. Every **[EVENT_NAME]**
b. Most **[EVENT_NAME]**s
c. Some **[EVENT_NAME]**s
d. Rarely
e. Never
f. Unsure/Don't know

[IF Q16 = a AND Q17 <> e, CONTINUE. OTHERWISE SKIP TO Q21]

18. For what reason(s) did you opt-out or override the scheduled **[EVENT_NAME]** thermostat setting? (Select all that apply)

a. Didn't want my home to get warmer during the event
b. Didn't want my home to get cooler during the pre-cooling period prior to the event
c. Was unsure about what was happening to my thermostat setting
d. Was uncomfortable with the temperature in my home
e. Had guests/visitors over
f. Other (Please specify) **[OPEN ENDED]**
g. Don't know

19. Using a scale of 1 to 5, where 1 means "Very Difficult or Confusing" and 5 means "Very Easy", how easy was it to opt-out of or override **[EVENT_NAME]**s?

a. Very Difficult or Confusing	b.	c. Neutral	d.	e. Very Easy	f. Don't Know
1	2	3	4	5	

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[IF Q19 = a-b (1-2), CONTINUE ELSE SKIP TO Q21]

20. What issues did you encounter when trying to opt-out of or override scheduled **[EVENT_NAME]**s? **[OPEN ENDED]**

Other Actions

[IF Q10 = a, b, OR c, CONTINUE. ELSE SKIP TO Q23]

21. During an **[EVENT_NAME]**, did you ever rely on other appliances (*e.g.,* fans or room air-conditioners) to maintain comfort?

    a. Yes (Please specify) **[OPEN ENDED]**
    b. No
    c. Don't Know

22. Did you or other members of your family ever take any actions to reduce your electricity use during **[EVENT_NAME]**s (apart from allowing your thermostat setpoint to be adjusted)?

    a. Yes (Please specify) **[OPEN ENDED]**
    b. No
    c. Don't know

C.1.5 General Thermostat and AC Usage Behavior

23. How did you typically use your thermostat throughout the summer?

    a. Set a temperature schedule for the whole summer (i.e., specify different temperatures for different times of day or days of the week)
    b. Only turn AC on when hot/humid
    c. Set the thermostat to maintain one temperature setpoint (regardless of time of day or day of week) for the whole summer
    d. Other (Please specify) **[OPEN ENDED]**
    e. Don't know

[If Q23 = b, CONTINUE. ELSE SKIP TO Q23b]

23a. Above what *indoor* temperature do you typically turn your air conditioning on? Please enter a temperature in degrees F. **[ENTER NUMERIC]**

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23b. Now we'd like to understand the frequency with which you adjusted your Wi-Fi thermostat's setting or schedule (either up or down) on days when there was no **[EVENT_NAME]** this summer. Would you say it was…

a. More than once a day
b. Once a day
c. A few times per week
d. Once or twice monthly
e. Once or twice over the whole summer
f. Not at all
g. Other (Please specify) **[OPEN ENDED]**
h. Don't know

[IF Q23b = f, SKIP TO Q23d. ELSE CONTINUE]

23c. We'd also like to understand whether the frequency with which you adjusted your Wi-Fi thermostat's setting or schedule was different on **[EVENT_NAME]** days compared to other days. Would you say you adjusted your home's temperature…

a. More on **[EVENT_NAME]** days than on other days
b. Less on **[EVENT_NAME]** days than on other days
c. About the same amount regardless of whether it was a **[EVENT_NAME]** day or not
d. Don't know

23d. When no family member is at home, which of the following best describes the way you use your air conditioner?

a. The thermostat is set to one temperature at all times and I do not use home/away assist or eco mode functions.
b. I always have the air conditioner follow a schedule that raises the temperature setpoint during the hours that there is typically no one home and I do not use home/away assist or eco mode functions.
c. My thermostat senses that no one is home and adjusts the temperature setpoint accordingly (i.e., using home/assist or eco mode).
d. Depending on the weather, I sometimes raise the temperature setpoint or turn the air conditioner off.
e. When no family member is home, my air conditioner is turned off.
f. Other (Please specify) **[OPEN ENDED]**

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C.1.6 Program Satisfaction

24. On a scale of 1 through 5, where 1 is "Very dissatisfied" and 5 is "Very satisfied", how would you rate your satisfaction with the following aspects of the **[PROGRAM_NAME]** program?

	a. Very Dissatisfied	b.	c. Neutral	d.	e. Very Satisfied	f. Don't know
	1	2	3	4	5	
24a. Number of [EVENT_NAME]s during the 2019 summer season						
24b. Length of [EVENT_NAME]s						
24c. Timing of [EVENT_NAME]s (i.e., the period of time during which the [EVENT_NAME]s occurred)						

[Q24a = a OR b CONTINUE. ELSE SKIP TO Q26]

25. What changes to the number of **[EVENT_NAME]**s would you recommend? **[OPEN ENDED]**

[Q24b = a OR b, CONTINUE. ELSE SKIP TO Q27]

26. What changes to the length of **[EVENT_NAME]**s would you recommend? **[OPEN ENDED]**

[Q24c = a OR b, CONTINUE. ELSE SKIP TO Q28]

27. What changes to the timing of **[EVENT_NAME]**s would you recommend? **[OPEN ENDED]**

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28. In future summers, how likely would you be to participate in the **[PROGRAM_NAME]** Program, on a scale of 1-5, where 1 is “Very Unlikely” and 5 is “Very Likely”?

a. Very Unlikely	b.	c.	d.	e. Very Likely	f. Don’t Know
1	2	3	4	5	

[IF Q28 = a OR b, CONTINUE. OTHERWISE SKIP TO Q30]

29. What change(s) to the **[PROGRAM_NAME]** Program would encourage you to continue participating?

    a. Please enter your recommended change **[OPEN ENDED]**
    b. None

[IF Q28 = c - f, CONTINUE. OTHERWISE SKIP TO Q31]

30. What recommendations would you make to help improve the **[PROGRAM_NAME]** Program going forward?

    a. Please enter your recommended change **[OPEN ENDED]**
    b. None

31. We have reached the end of the survey. Do you have any additional comments regarding the **[PROGRAM_NAME]** Program?

    a. Please enter any additional comments you have regarding the program. **[OPEN ENDED]**
    b. None

32. Thank you for taking the time to fill out this survey for the **[PROGRAM_NAME]** Program! Please provide your email address so we may email you a $10 Amazon eGift Card.

    a. Email: **[OPEN ENDED]**
    b. I prefer not to provide my email address

[SURVEY CLOSE] Thank you for completing the survey!

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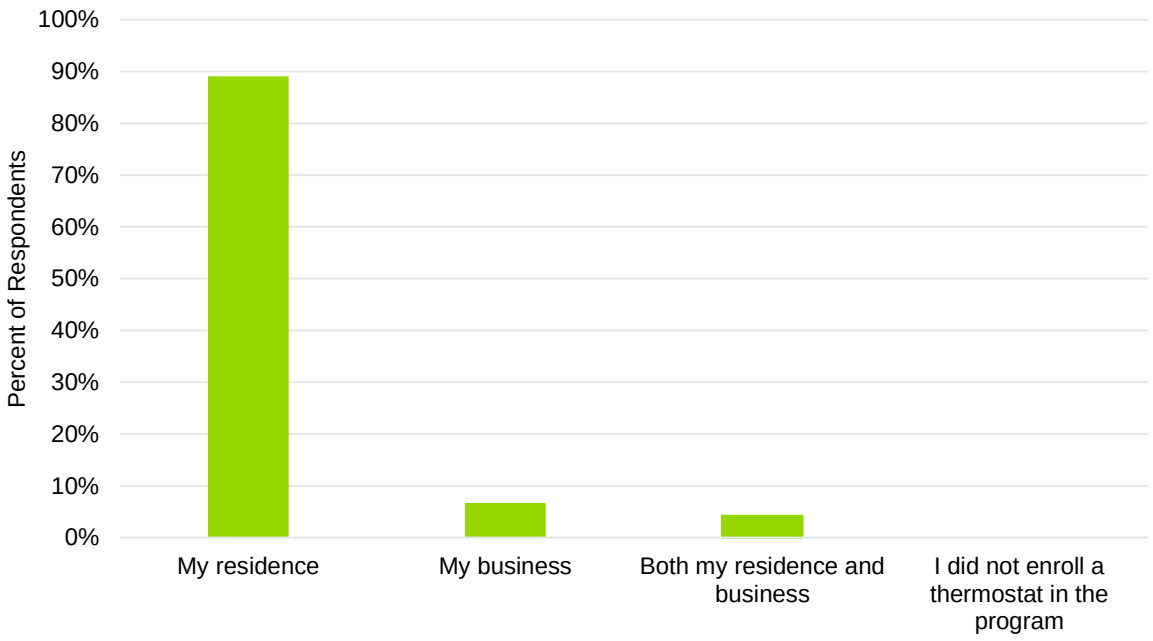
APPENDIX D. FULL SURVEY RESULTS

D.1 Eversource

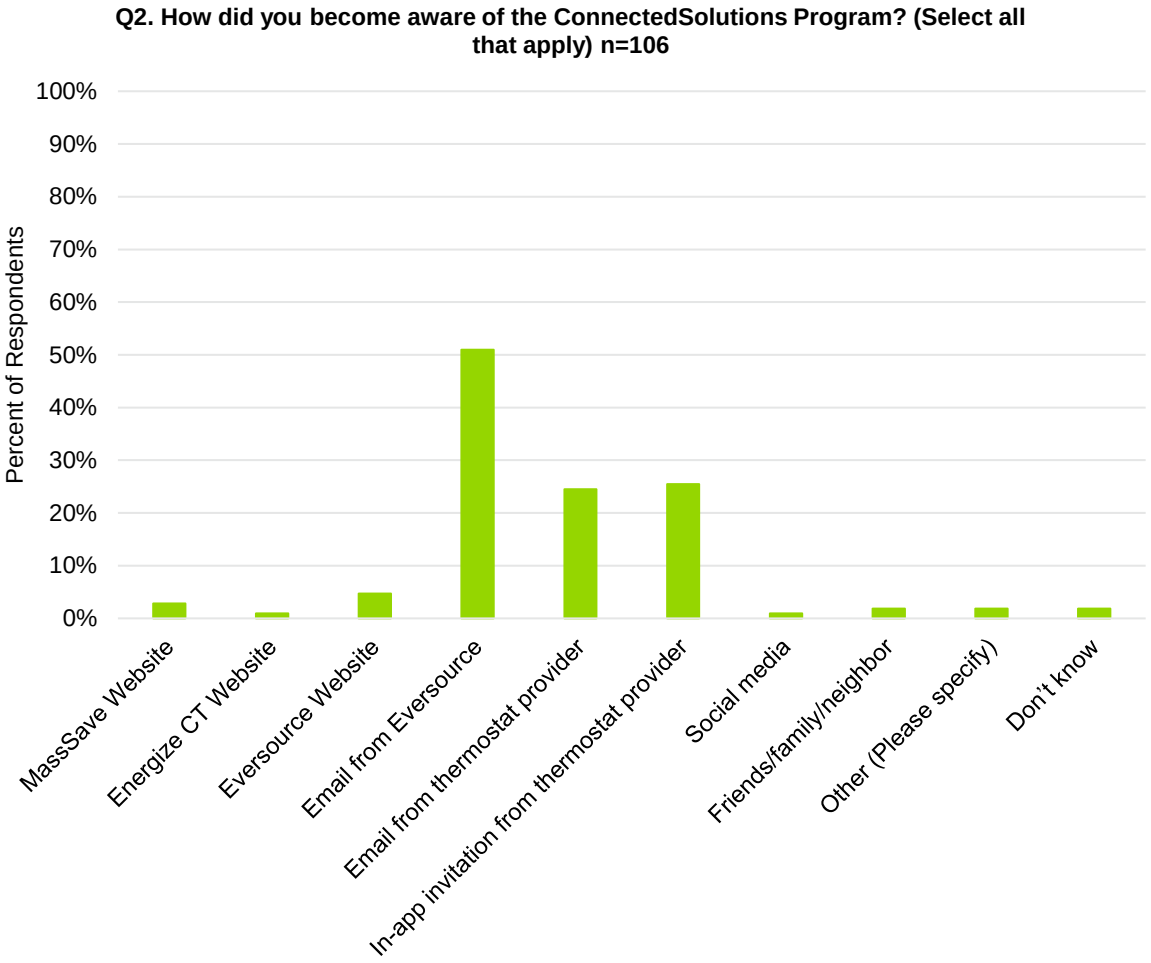
D.1.1 Screening

Q1. Please complete the following sentence: I enrolled one or more thermostats in the ConnectedSolutions Program for… n=119



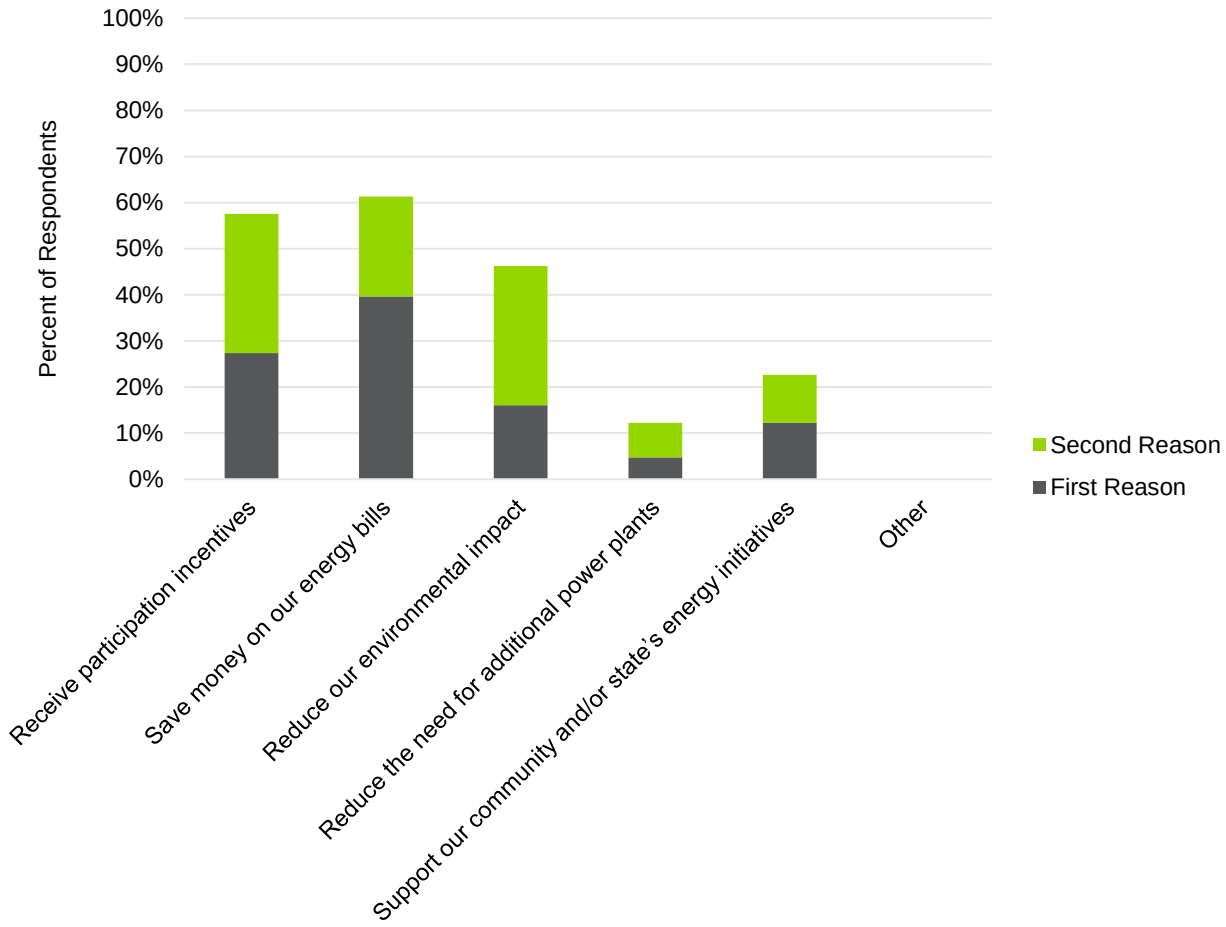
Source: Navigant analysis of online survey data

D.1.2 Motivations



Source: Navigant analysis of online survey data

Q3. What was your motivation for participating in the ConnectedSolutions Program in 2019? Select your first and second reasons for enrolling. n=106



Source: Navigant analysis of online survey data

3_a. For what OTHER reasons did you enroll in the program?

No responses.

Source: Navigant analysis of online survey data

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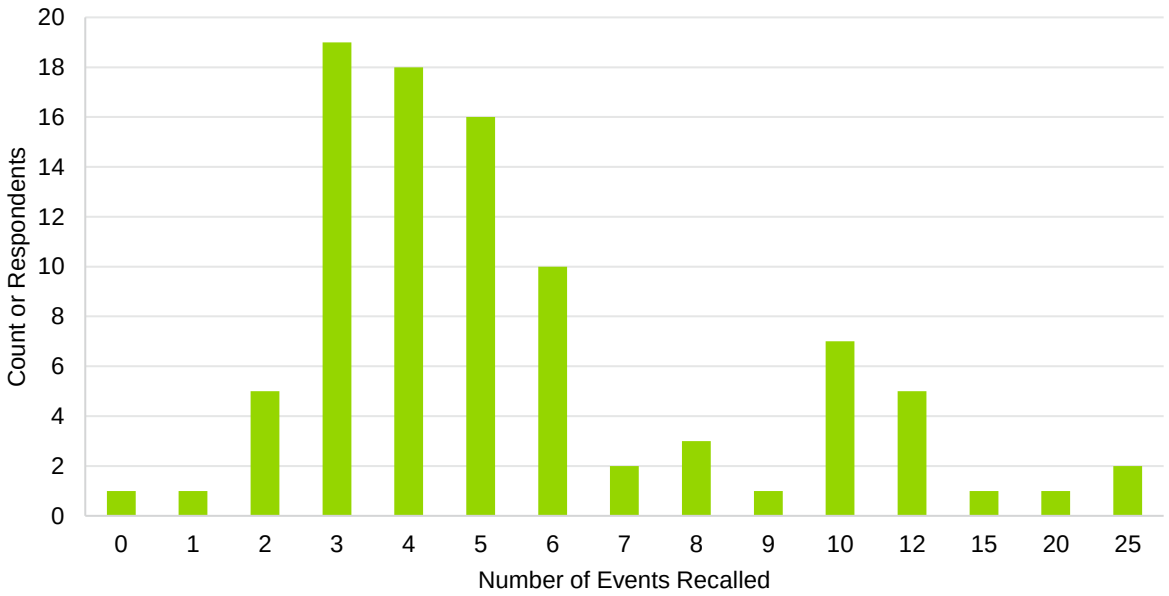
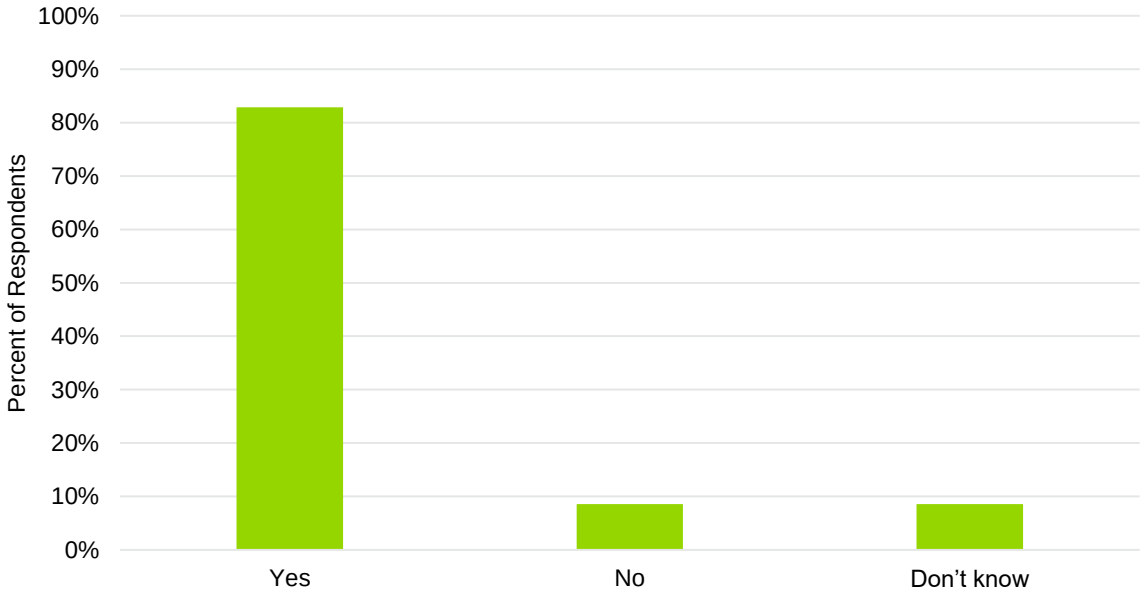
D.1.3 Awareness and Notification

Q4. This summer, about how many events do you remember occurring since enrolling in the program? n=106



Source: Navigant analysis of online survey data

Q5. During this past summer, did you ever receive advance notifications about the events? n=105



Source: Navigant analysis of online survey data

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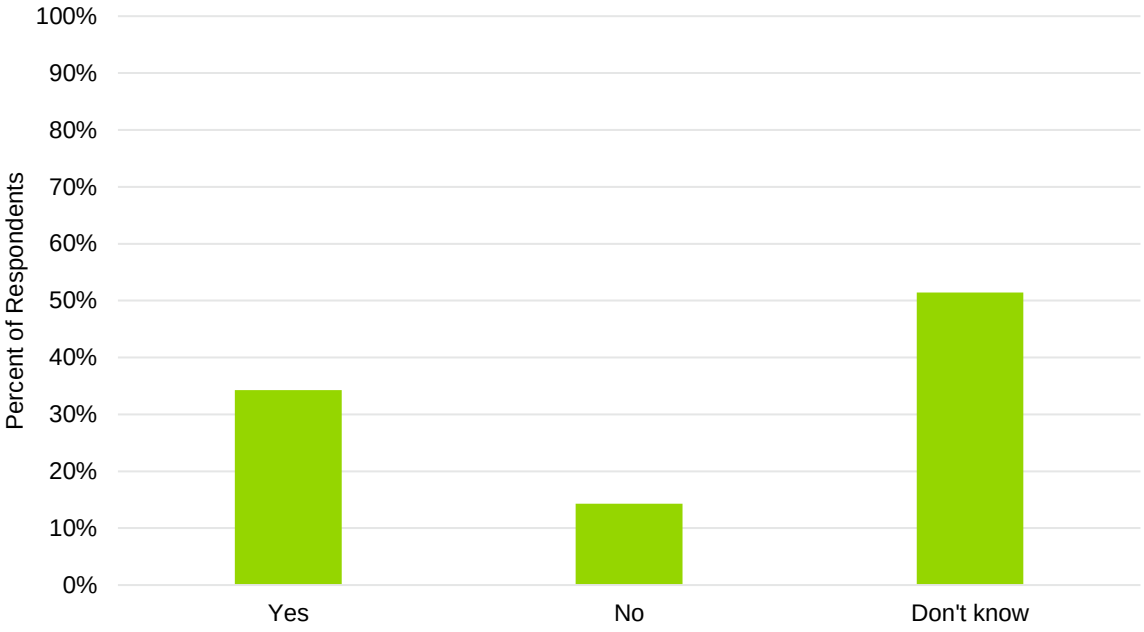
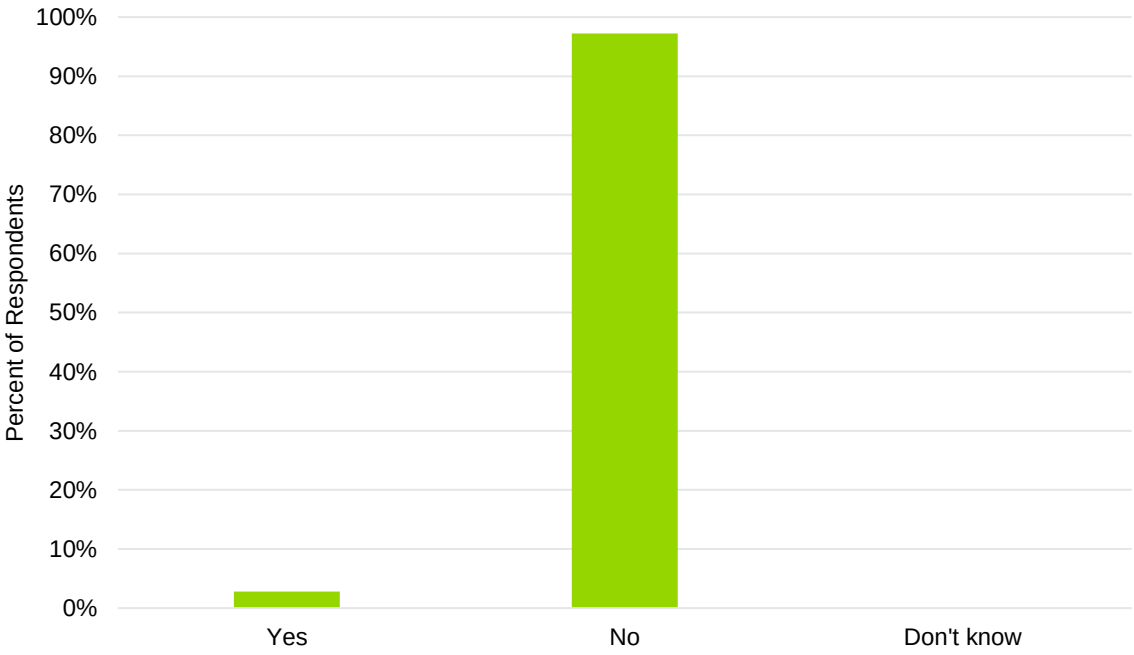
Q5_a. After enrolling in the ConnectedSolutions Program, did you receive an option to opt-out of advance notifications? n=105



Source: Navigant analysis of online survey data

Q5_b. Did you choose to opt-out of advance notifications? n=36



Source: Navigant analysis of online survey data

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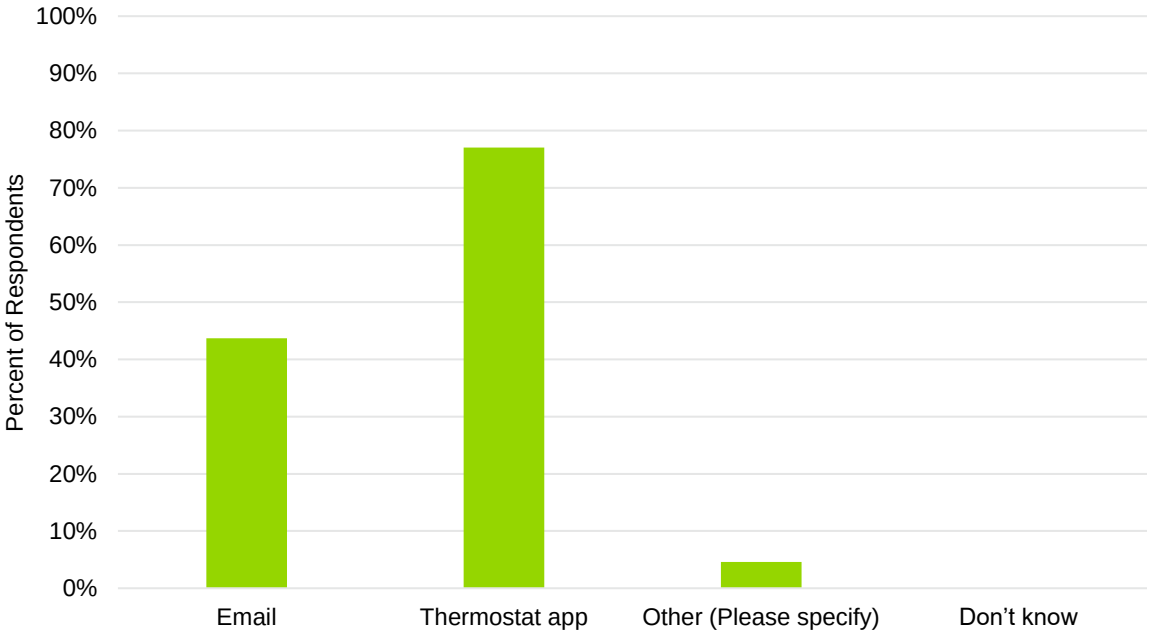
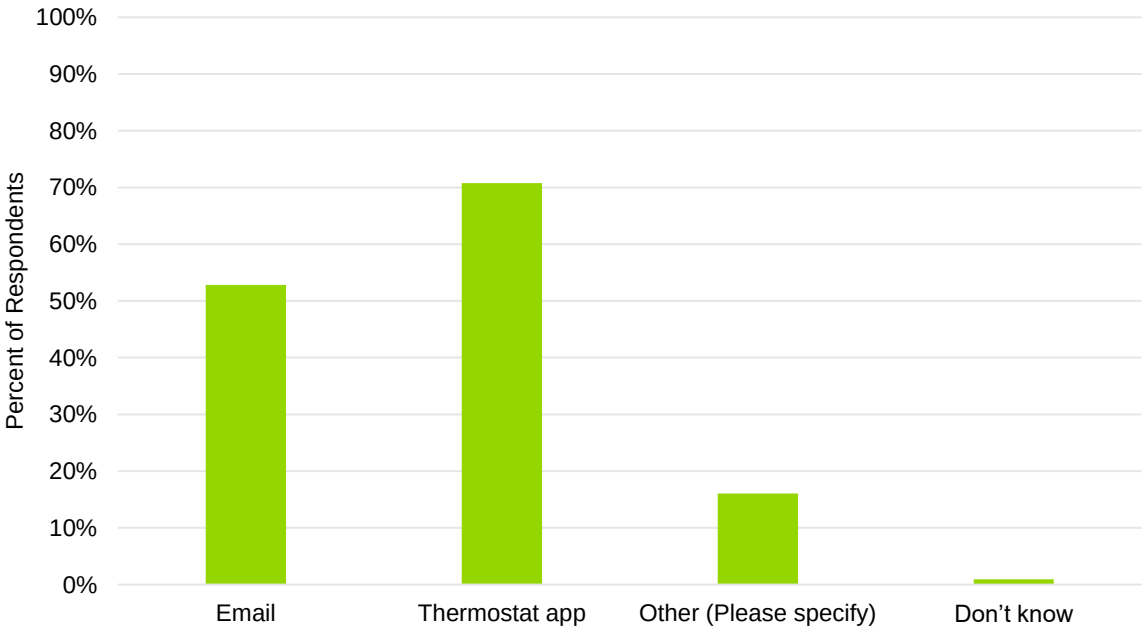
Q6. How were you notified in advance that a event was going to occur? (Select all that apply) n=87



*Customer verbatims were summarized in the report, as appropriate.

Source: Navigant analysis of online survey data

Q7. In general, how would you prefer to be notified that an event is going to occur? (Select all that apply) n=106



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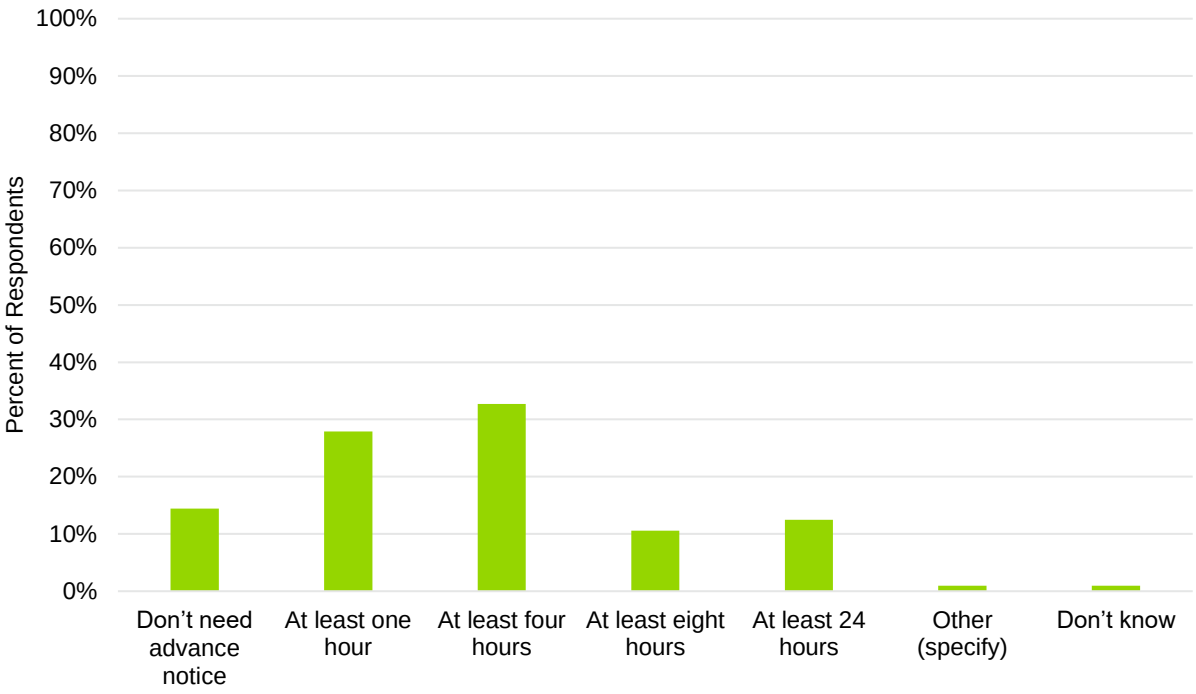
*Customer verbatims were summarized in the report, as appropriate.

Source: Navigant analysis of online survey data

Q8. In general, how much advance notice would you like before an event? n=104



*Customer verbatims were summarized in the report, as appropriate.

Source: Navigant analysis of online survey data

Q9. Are there ways that event notification could be improved? (optional) n=44

Customer verbatims were summarized in the report, as appropriate.

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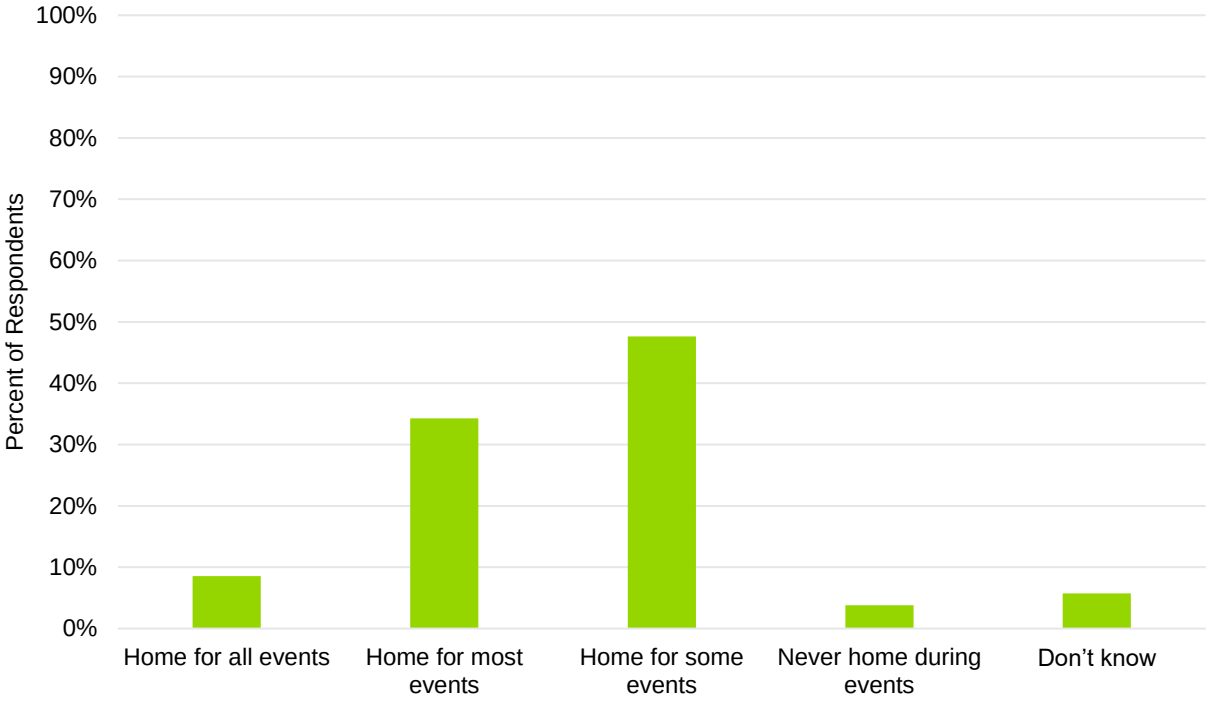
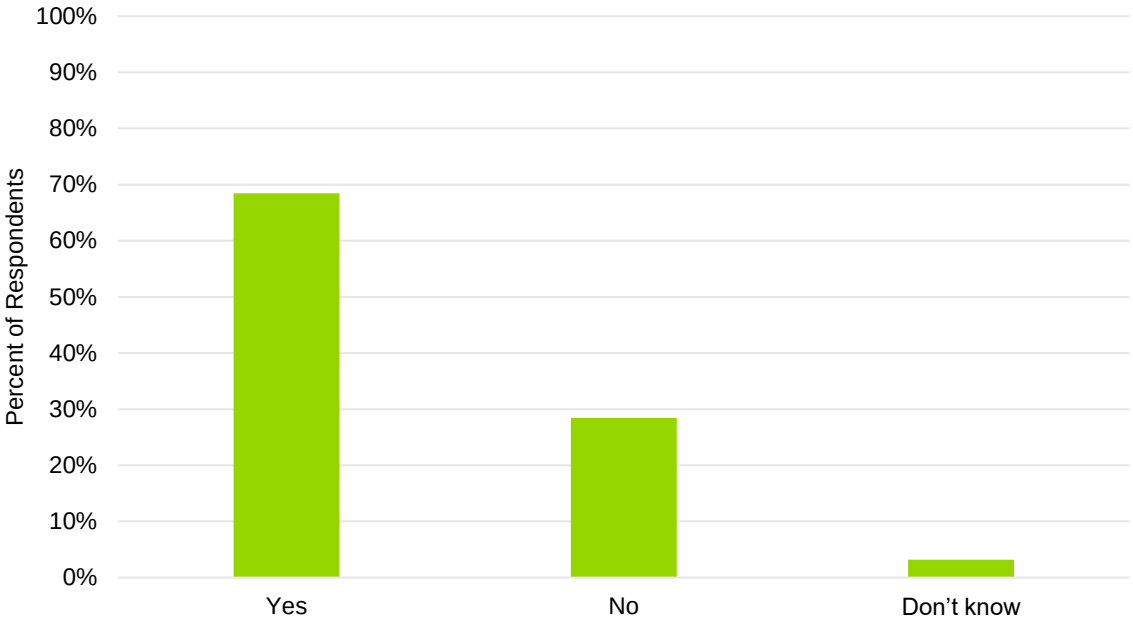
D.1.4 Comfort and Behavior During Events

Q10. This summer, for the events you can recall, how often were you or another family member at home during any part of the event? n=105



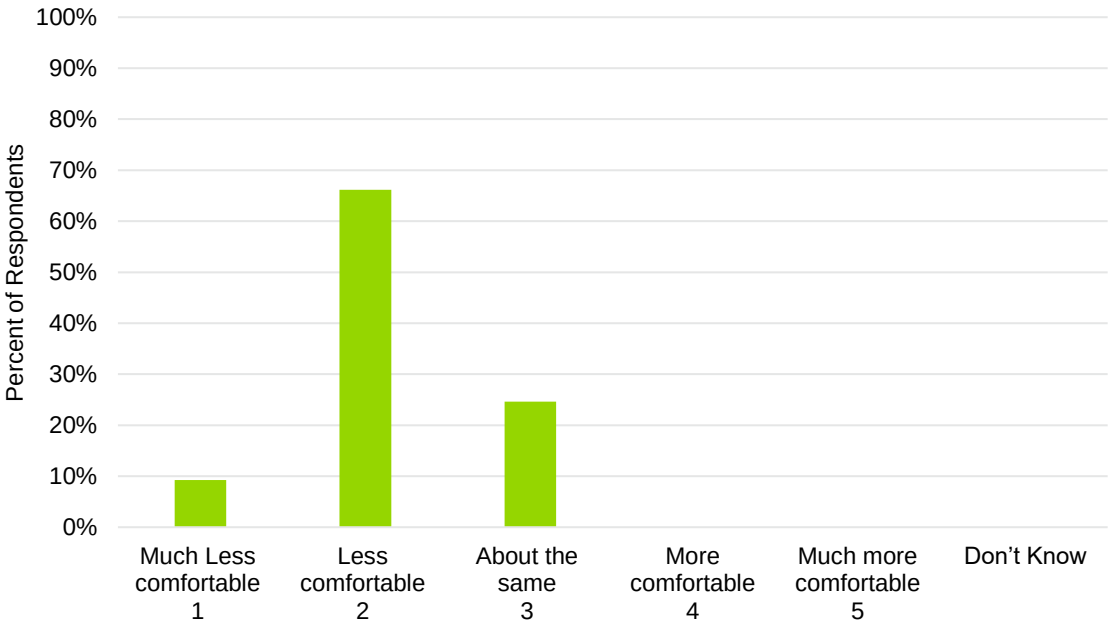
Source: Navigant analysis of online survey data

Q11. During the events you can recall, did you or another family member notice any changes to your home's indoor temperature? n=95



Source: Navigant analysis of online survey data

Q12. During the events you can recall, using a scale of 1 to 5, where 1 means "Much less comfortable" and 5 means "Much more comfortable", how would you generally describe your comfort compared to typical afternoons with similar outdoor temperatures? n=65



Source: Navigant analysis of online survey data

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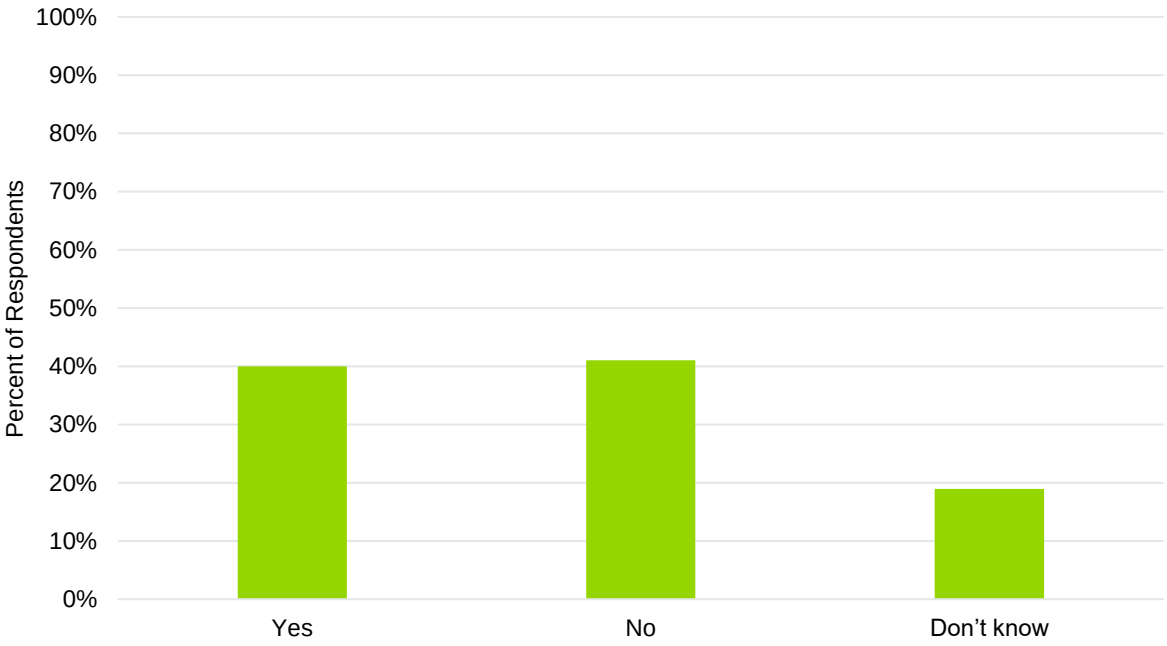
Q13. Do you have any comments to provide about your household's comfort level during events? (optional) n=34

Customer verbatims were summarized in the report, as appropriate.

Q14. Prior to events, do you recall the program "pre-cooling" your home (i.e., providing your home extra cooling prior to event hours)? n=95

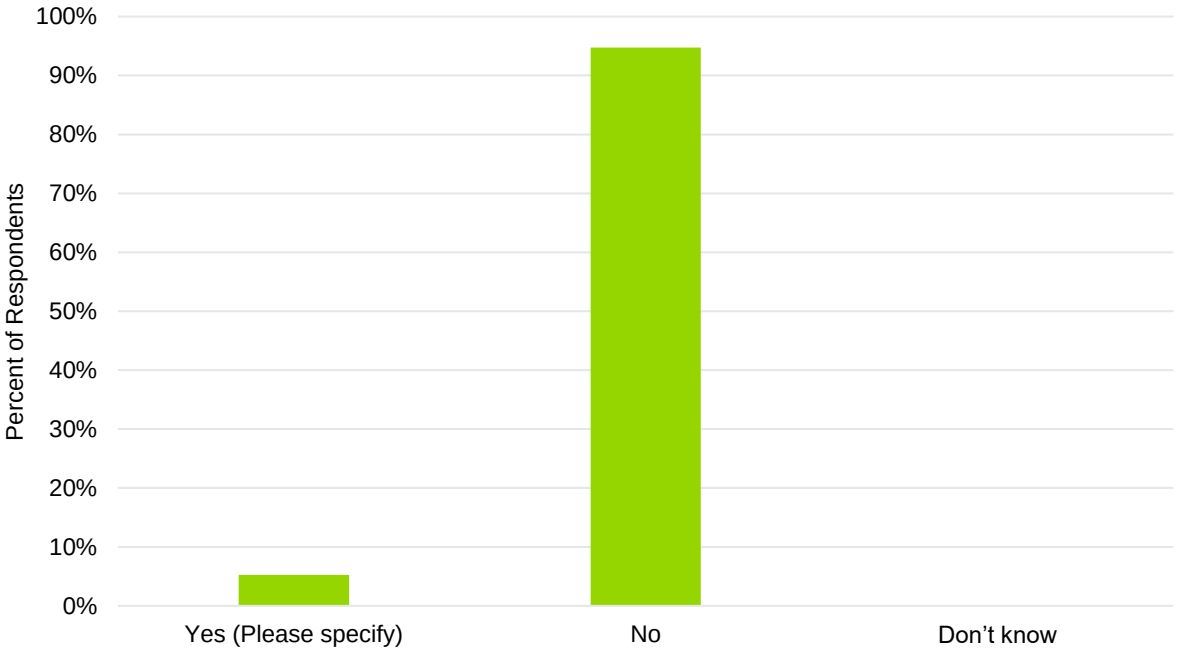


Source: Navigant analysis of online survey data

Q15. Do you have any feedback about the "pre-cooling" that occurred prior to events? (optional) n=26

Customer verbatims were summarized in the report, as appropriate.

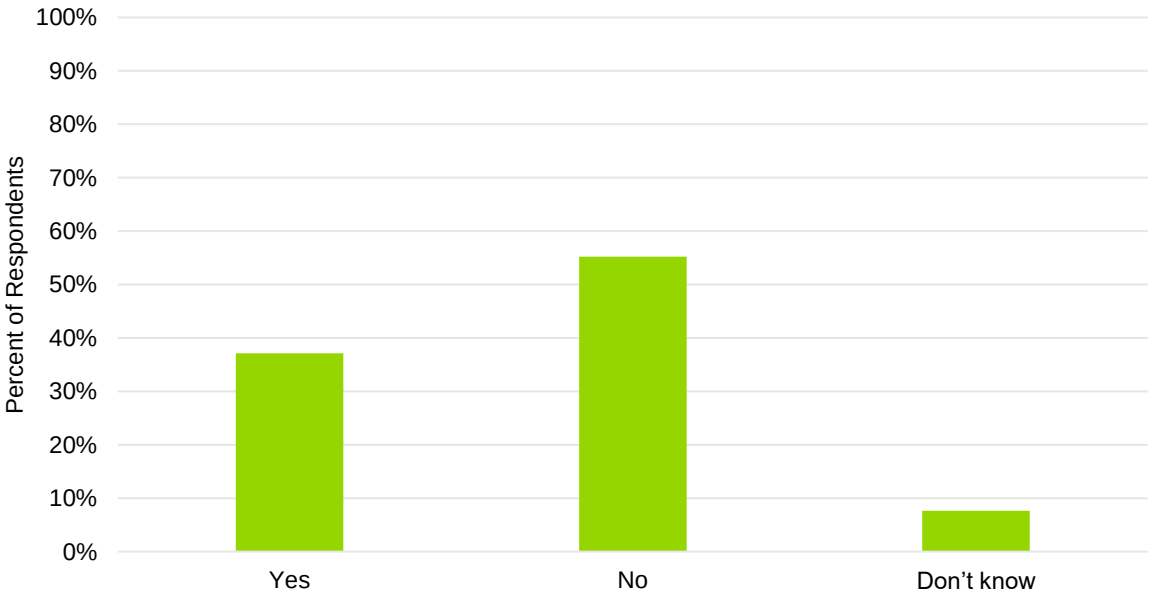
Q15_a. Prior to events, did you ever take any actions to prepare for the event? n=95



*Customer verbatims were summarized in the report, as appropriate.

Source: Navigant analysis of online survey data

Q16. On event days, did you or a family member ever "opt-out" of a event or override your thermostat setting to stop the program from adjusting your thermostat during the event? n=105



Source: Navigant analysis of online survey data

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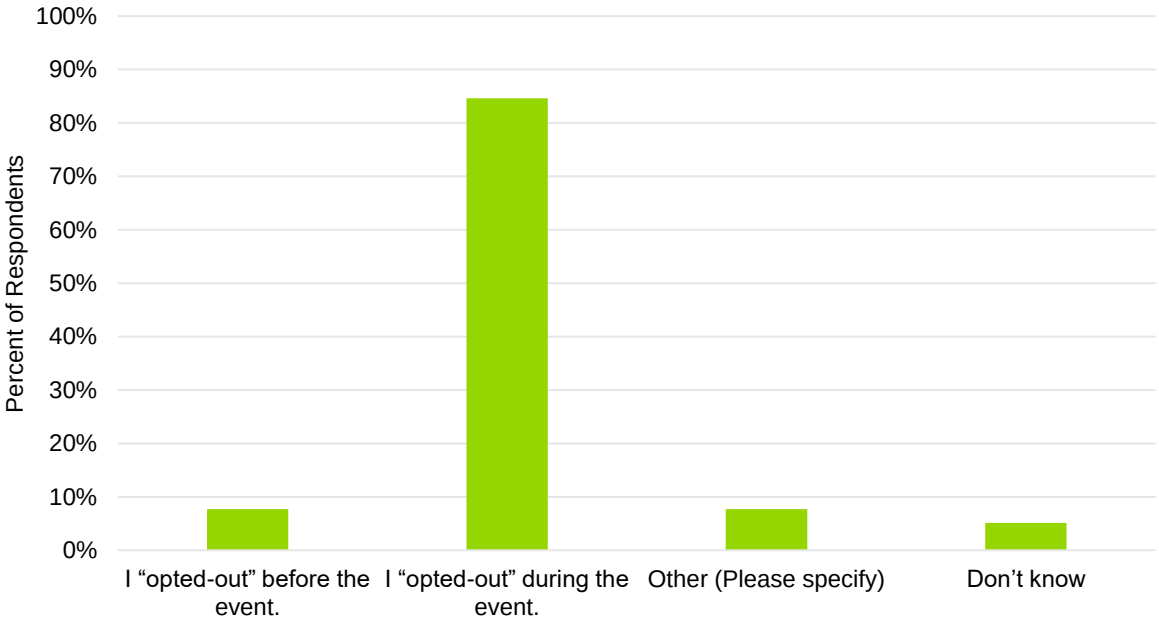
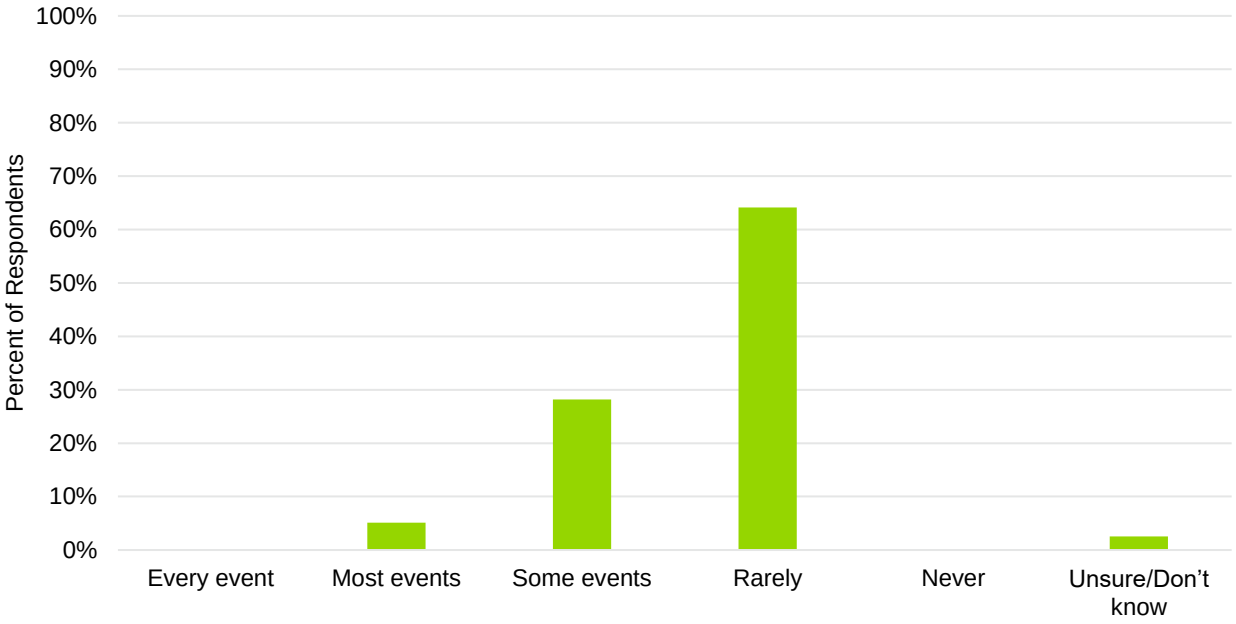
Q16_a. Did you "opt-out" or override your thermostat setting before events or during the event? (Select all that apply) n=39



*Customer verbatims were summarized in the report, as appropriate.

Source: Navigant analysis of online survey data

Q17. How often would you say you chose to opt-out of an event or override the scheduled event thermostat setting? Would you say… n=39



Source: Navigant analysis of online survey data

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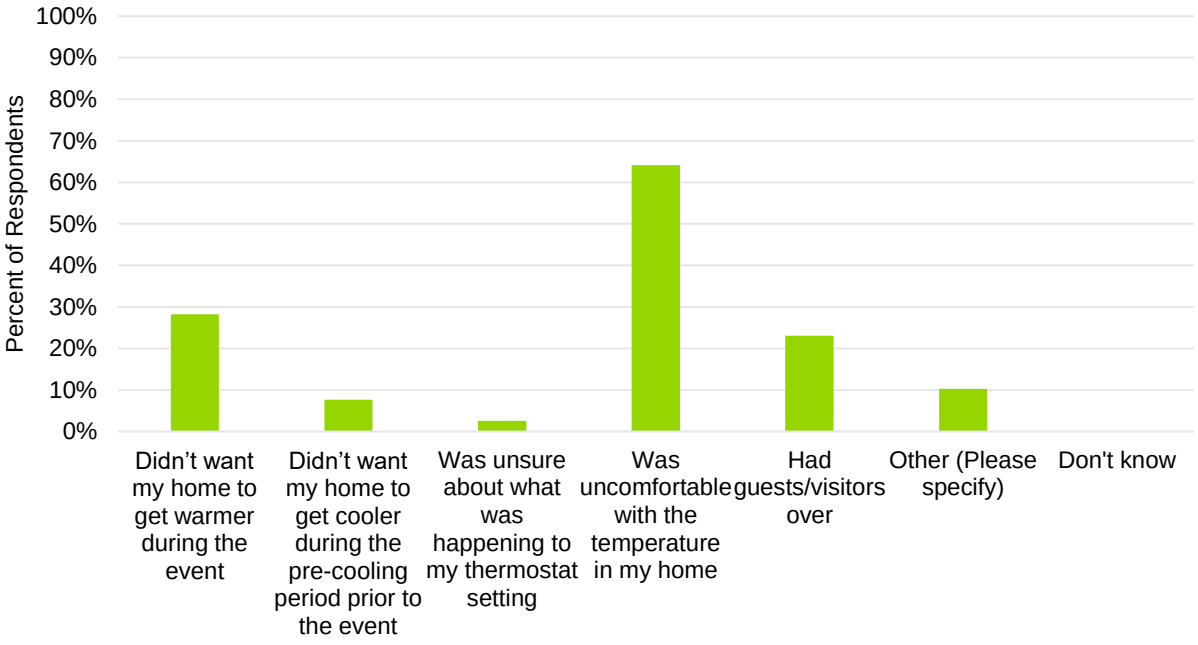
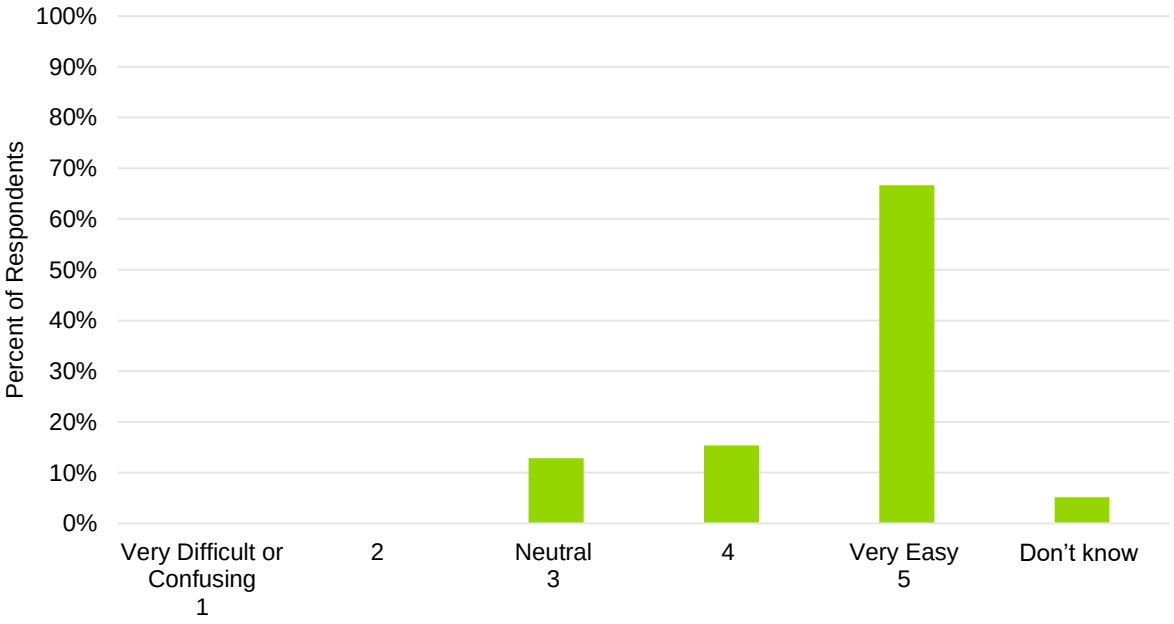
Q18. For what reason(s) did you opt-out or override the scheduled event thermostat setting? (Select all that apply) n=39



*Customer verbatims were summarized in the report, as appropriate.

Source: Navigant analysis of online survey data

Q19. Using a scale of 1 to 5, where 1 means "Very Difficult or Confusing" and 5 means "Very Easy", how easy was it to opt-out of or override events? n=39



Source: Navigant analysis of online survey data

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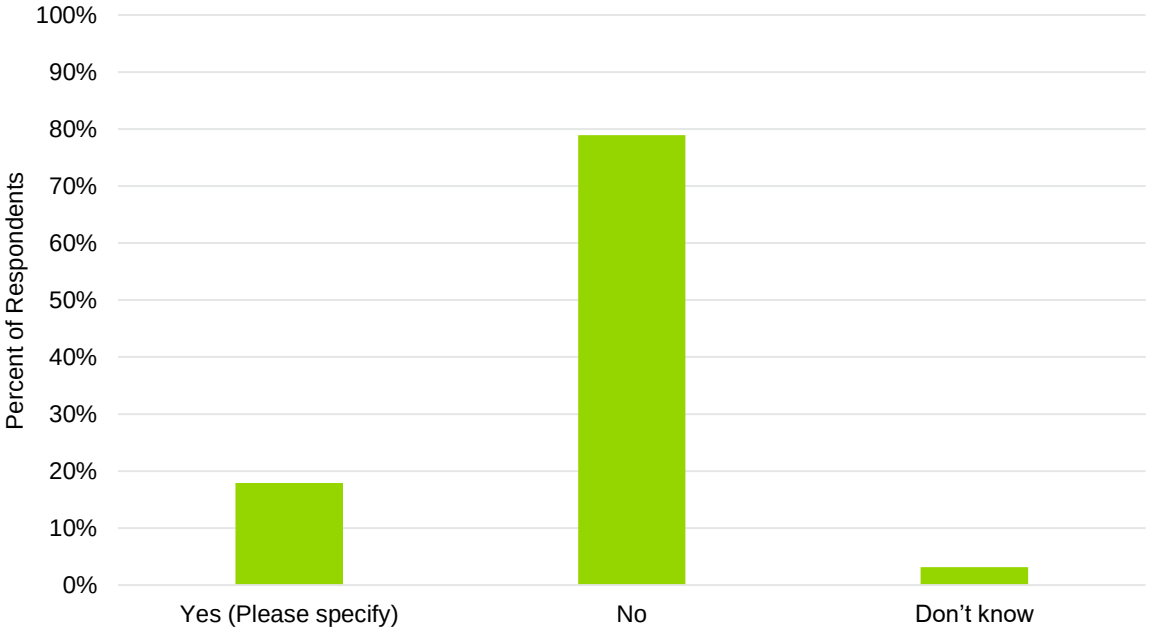
Q20. What issues did you encounter when trying to opt-out of or override a scheduled event? n=0

No responses.

D.1.5 General Thermostat and AC Usage Behavior

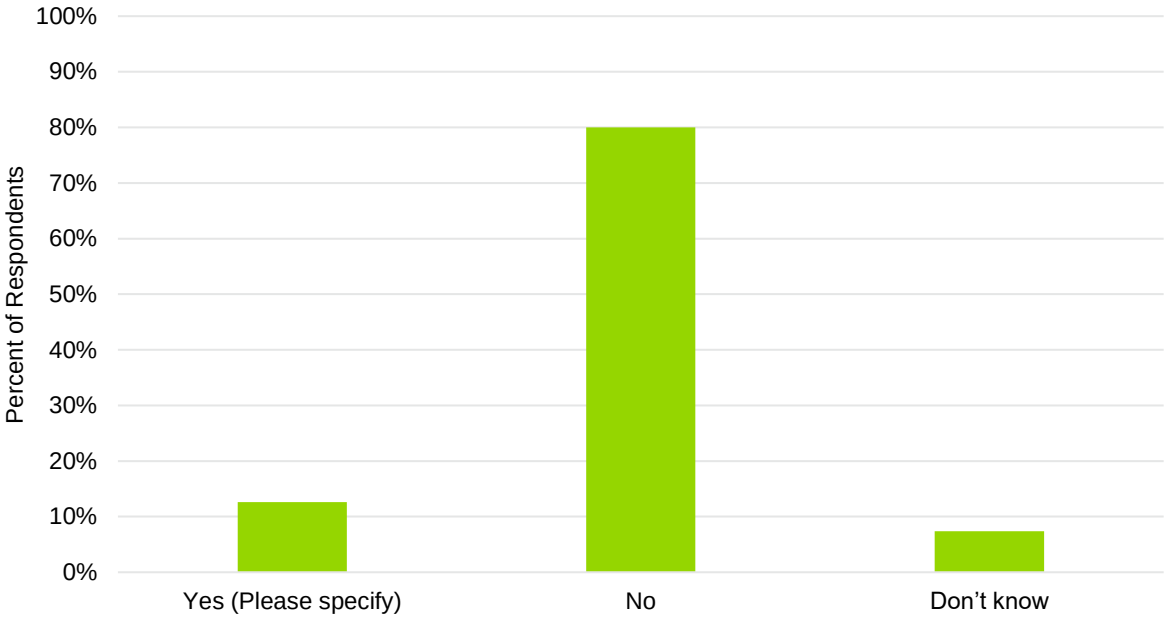
Q21. During an event, did you ever rely on other appliances (e.g., fans or room air-conditioners) to maintain comfort? n=95



*Customer verbatims were summarized in the report, as appropriate.

Source: Navigant analysis of online survey data

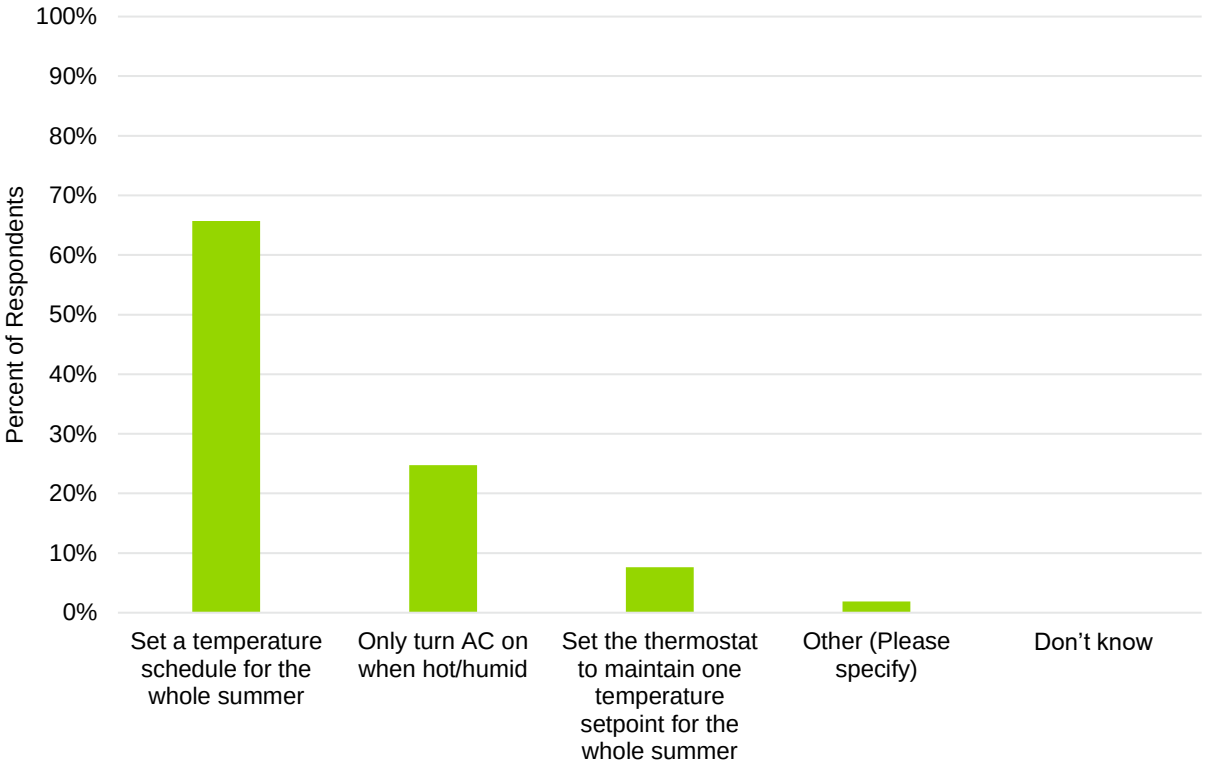
Q22. Did you or other members of your family ever take any actions to reduce your electricity use during events? n=95



*Customer verbatims were summarized in the report, as appropriate.

Source: Navigant analysis of online survey data

Q23. How did you typically use your thermostat throughout the summer? n=105



*Customer verbatims were summarized in the report, as appropriate.

Source: Navigant analysis of online survey data

Q23_a. Above what indoor temperature do you typically turn your air conditioning on? n=26

Customer verbatims were summarized in the report, as appropriate.

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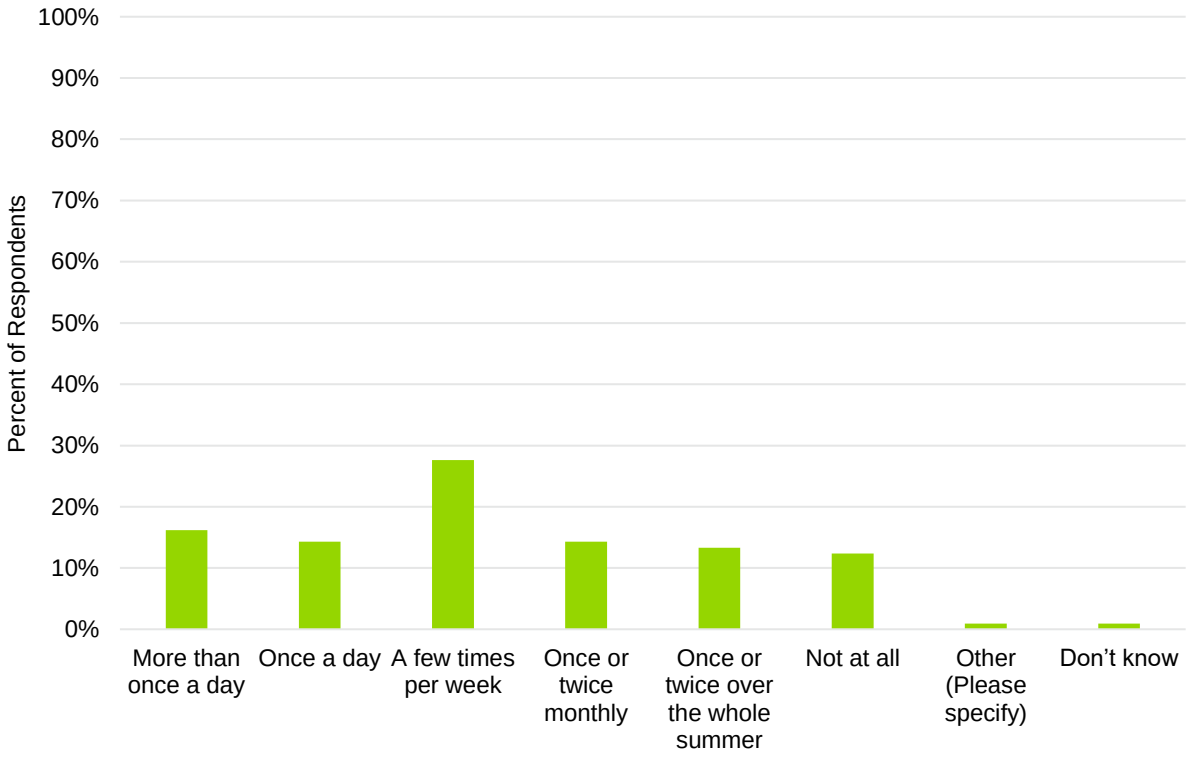
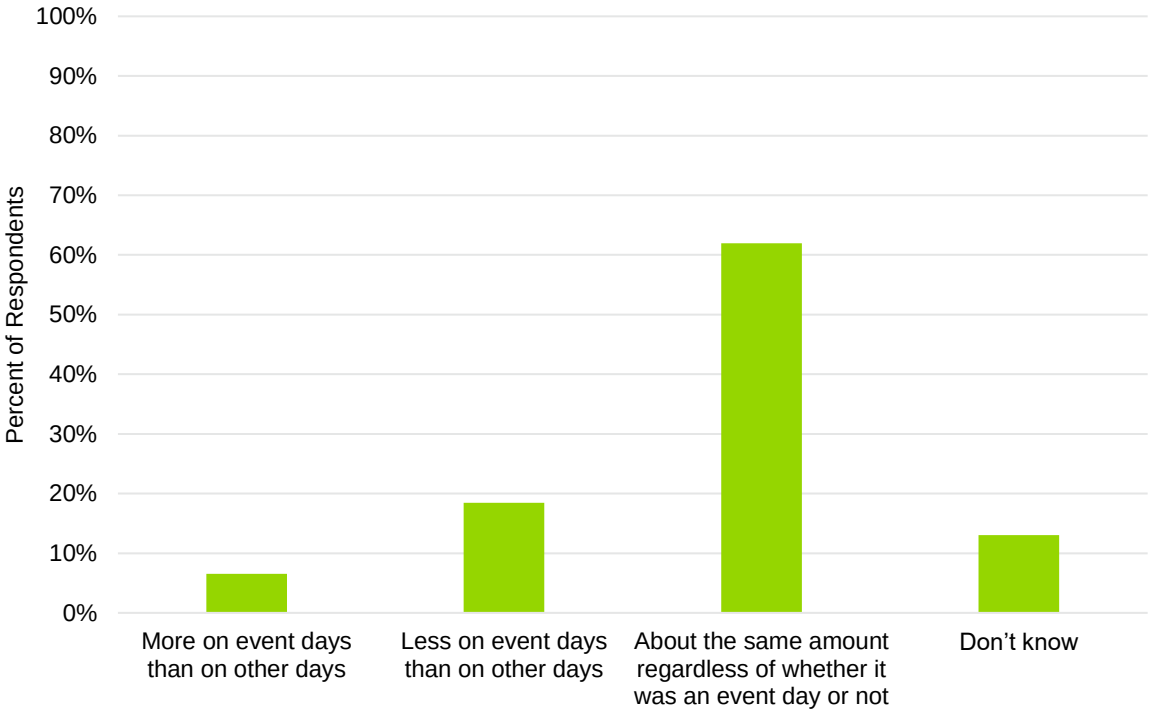
Q23_b. Now we'd like to understand the frequency with which you adjusted your Wi-Fi thermostat's setting or schedule (either up or down) on days when there was no event this summer. Would you say it was… n=105



*Customer verbatims were summarized in the report, as appropriate.

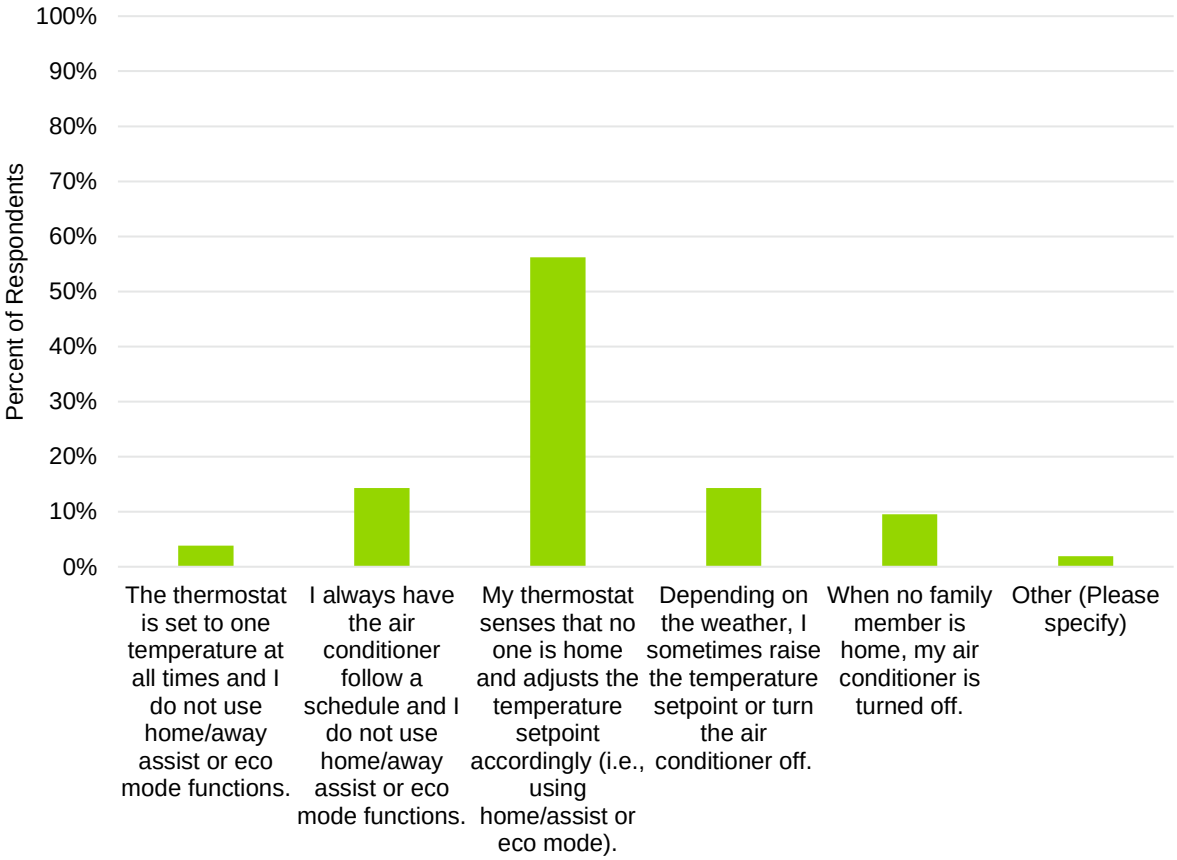
Source: Navigant analysis of online survey data

Q23_c. We'd also like to understand whether the frequency with which you adjusted your Wi-Fi thermostat's setting or schedule was different on event days compared to other days. Would you say you adjusted your home's temperature… n=92



Source: Navigant analysis of online survey data

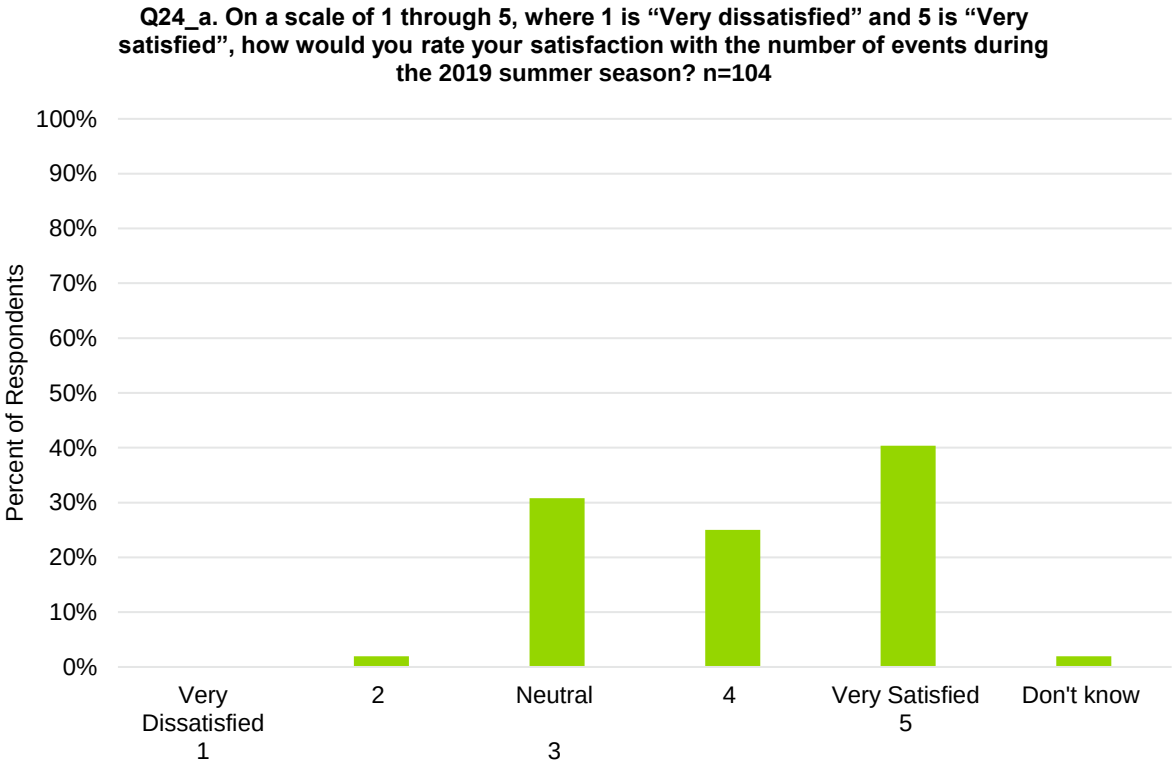
Q23_d. When no family member is at home, which of the following best describes the way you use your air conditioner? n=105



*Customer verbatims were summarized in the report, as appropriate.

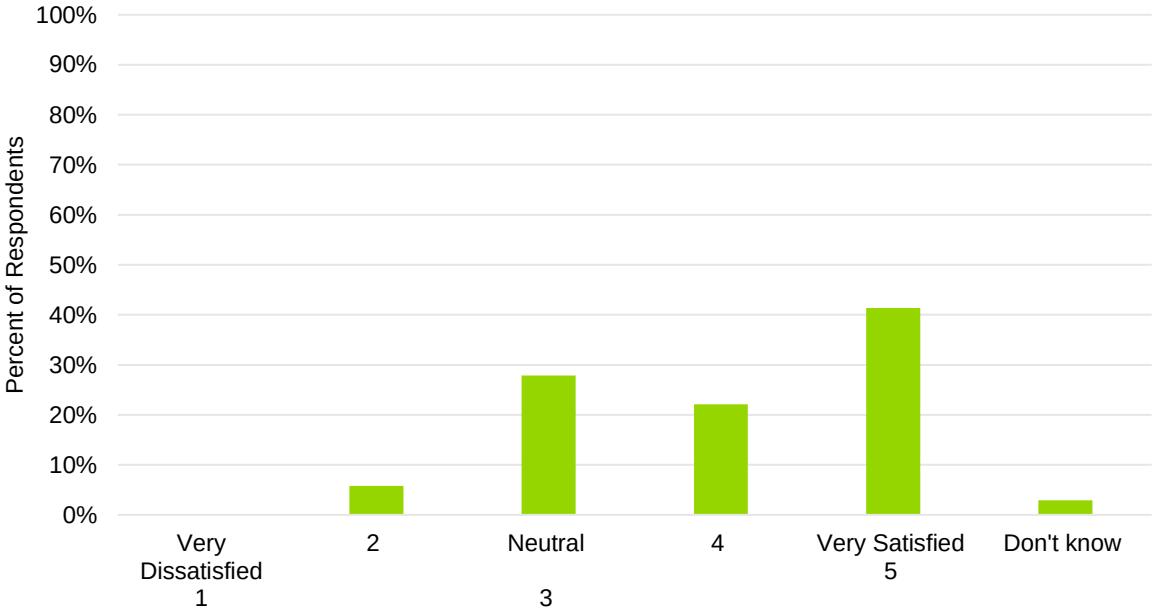
Source: Navigant analysis of online survey data

D.1.6 Program Satisfaction



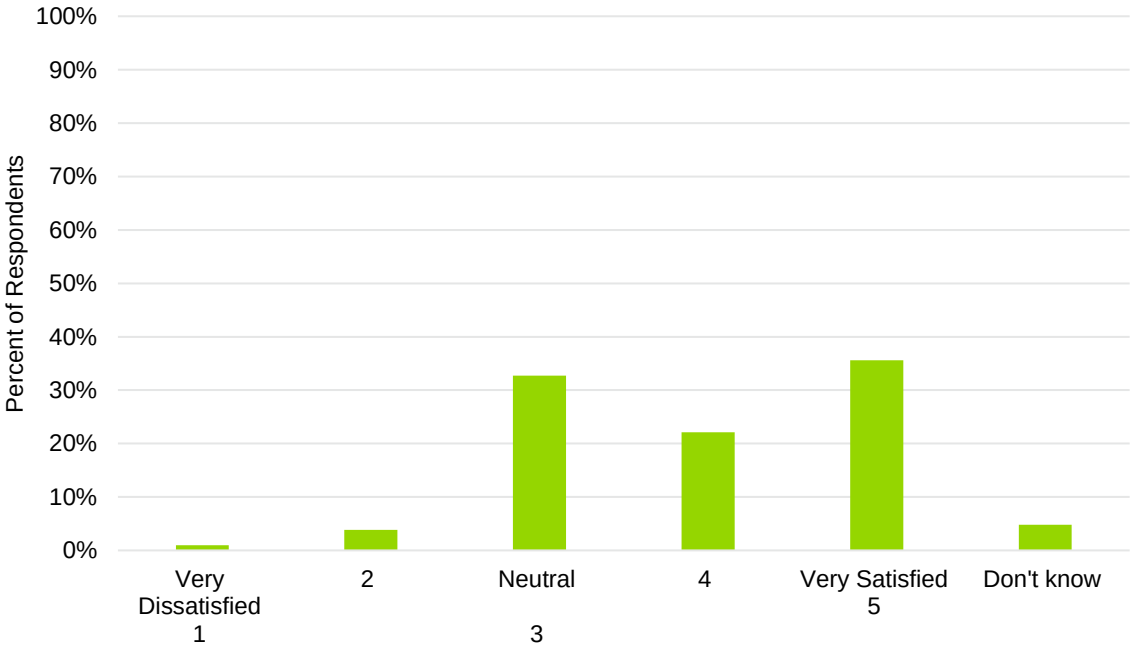
Source: Navigant analysis of online survey data

Q24_b. On a scale of 1 through 5, where 1 is "Very dissatisfied" and 5 is "Very satisfied", how would you rate your satisfaction with the length of events during the 2019 summer season?



Source: Navigant analysis of online survey data

Q24_c. On a scale of 1 through 5, where 1 is "Very dissatisfied" and 5 is "Very satisfied", how would you rate your satisfaction with the timing of events during the 2019 summer season?



Source: Navigant analysis of online survey data

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Q25. What changes to the number of events would you recommend? n=2

Customer verbatims were summarized in the report, as appropriate.

Q26. What changes to the length of events would you recommend? n=6

Customer verbatims were summarized in the report, as appropriate.

Q27. What changes to the timing of events would you recommend? n=5

Customer verbatims were summarized in the report, as appropriate.

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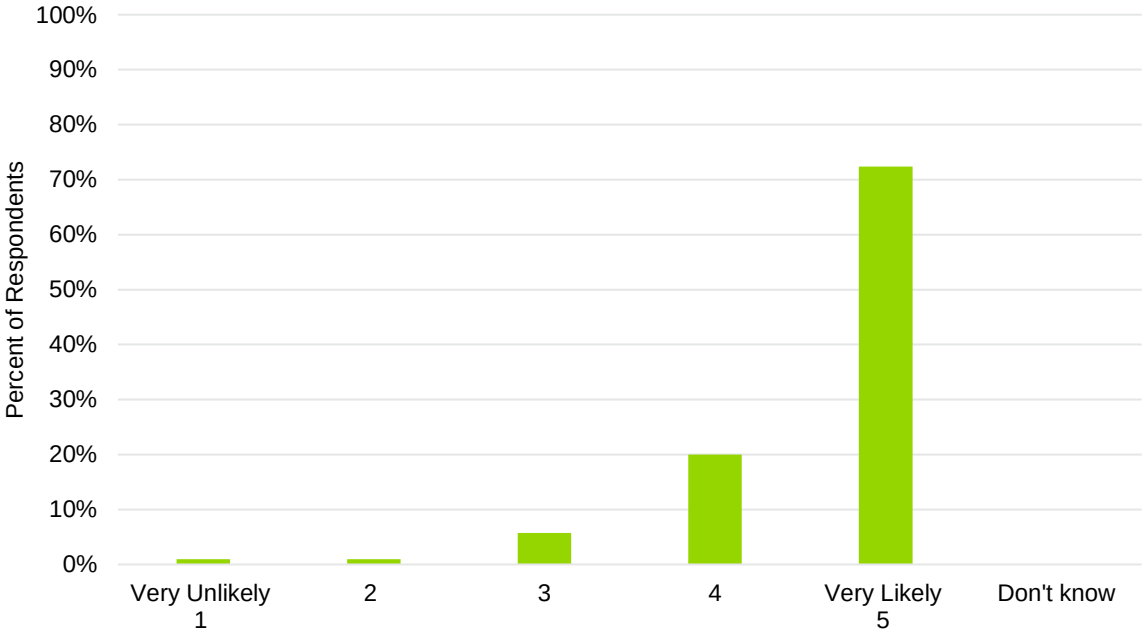
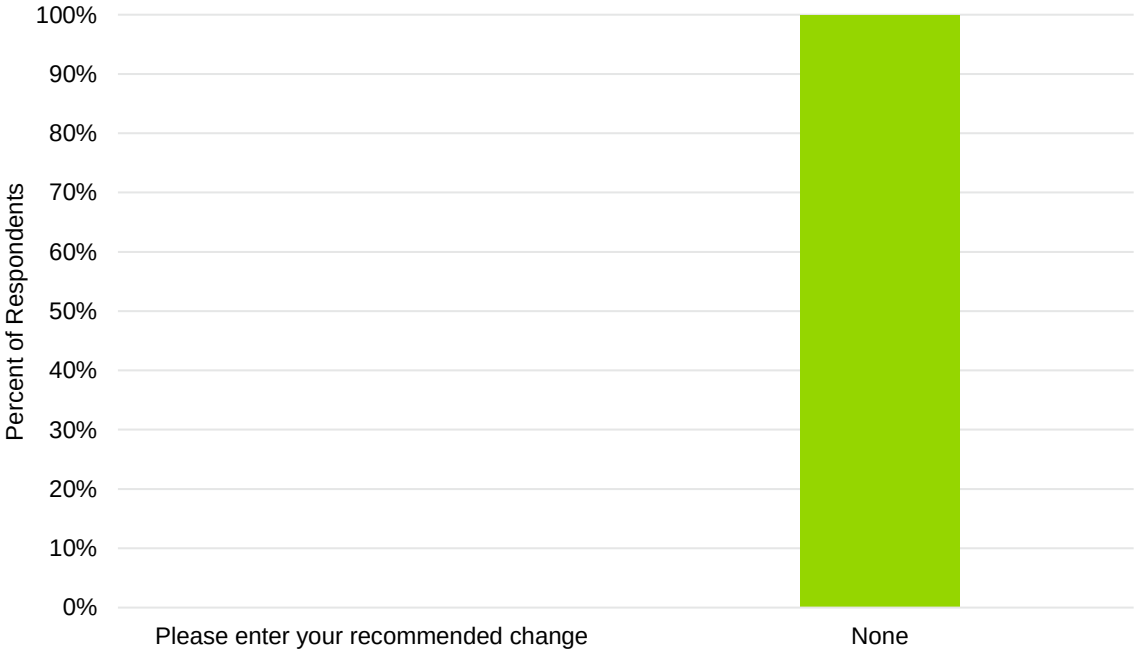
Q28. In future summers, how likely would you be to participate in the ConnectedSolutions Program, on a scale of 1-5, where 1 is "Very Unlikely" and 5 is "Very Likely"? n=105



Source: Navigant analysis of online survey data

Q29. What change(s) to the ConnectedSolutions Program would encourage you to continue participating? n=2



Source: Navigant analysis of online survey data

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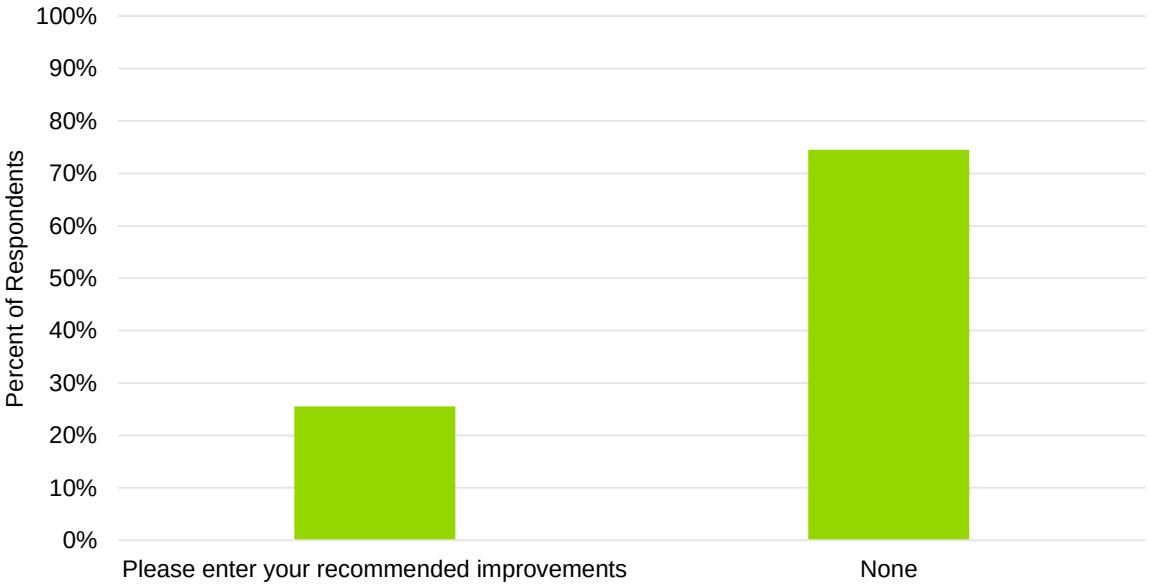
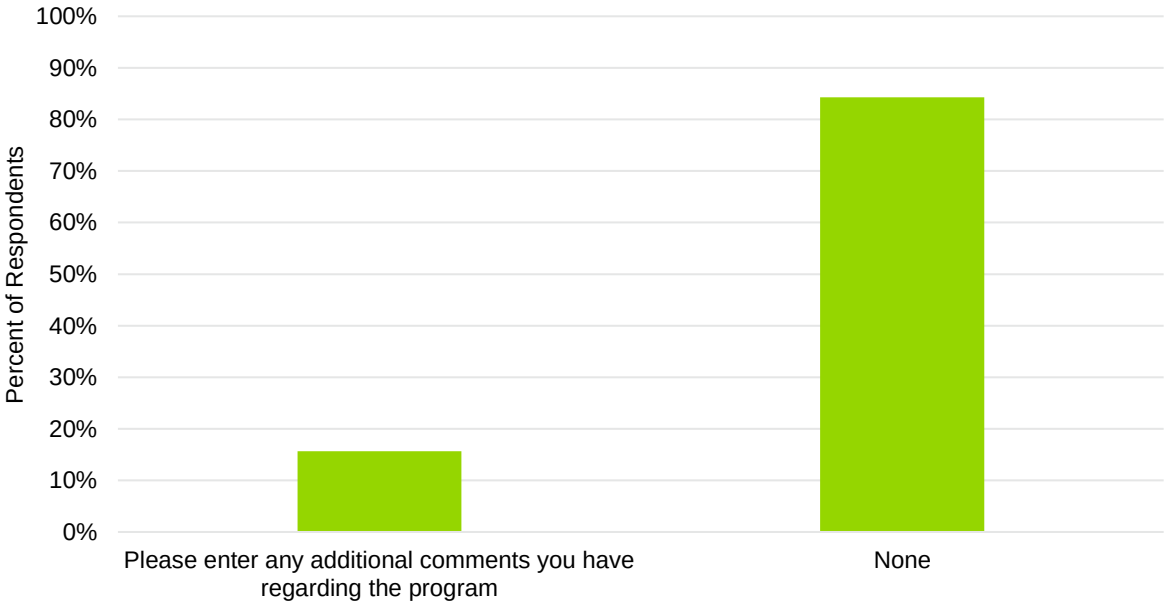
Q30. What recommendations would you make to help improve the ConnectedSolutions Program going forward? n=98



*Customer verbatims were summarized in the report, as appropriate.

Source: Navigant analysis of online survey data

Q31. We have reached the end of the survey. Do you have any additional comments regarding the ConnectedSolutions Program? n=102



*Customer verbatims were summarized in the report, as appropriate.

Source: Navigant analysis of online survey data

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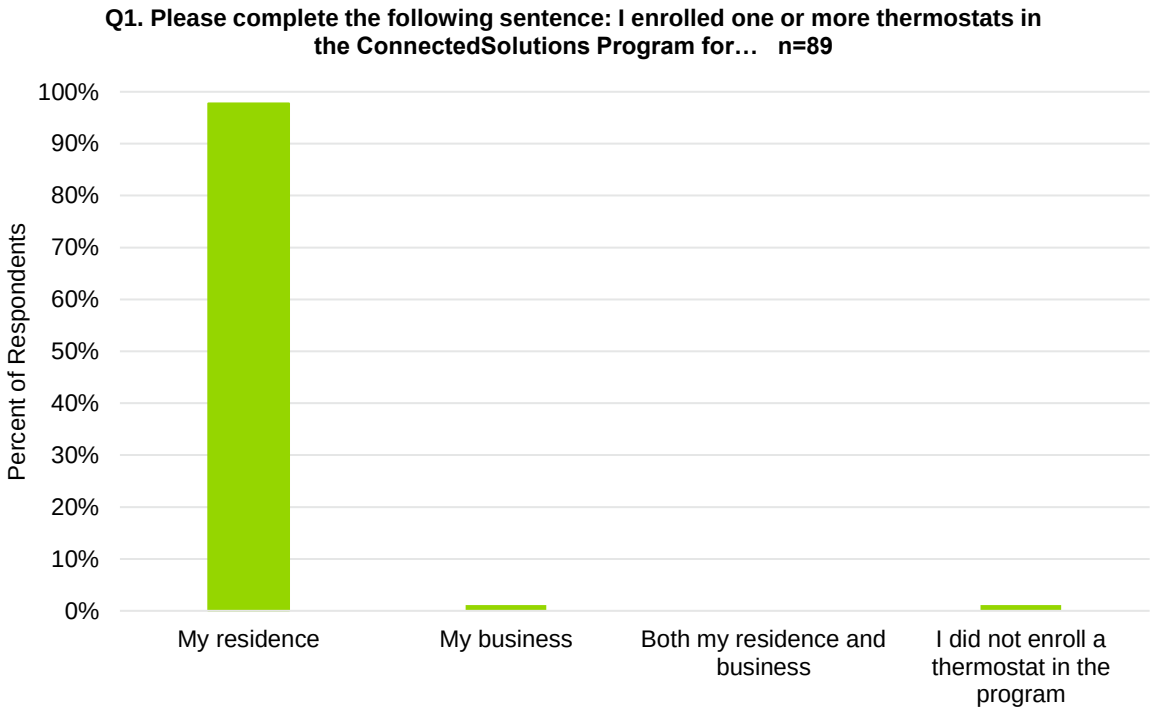
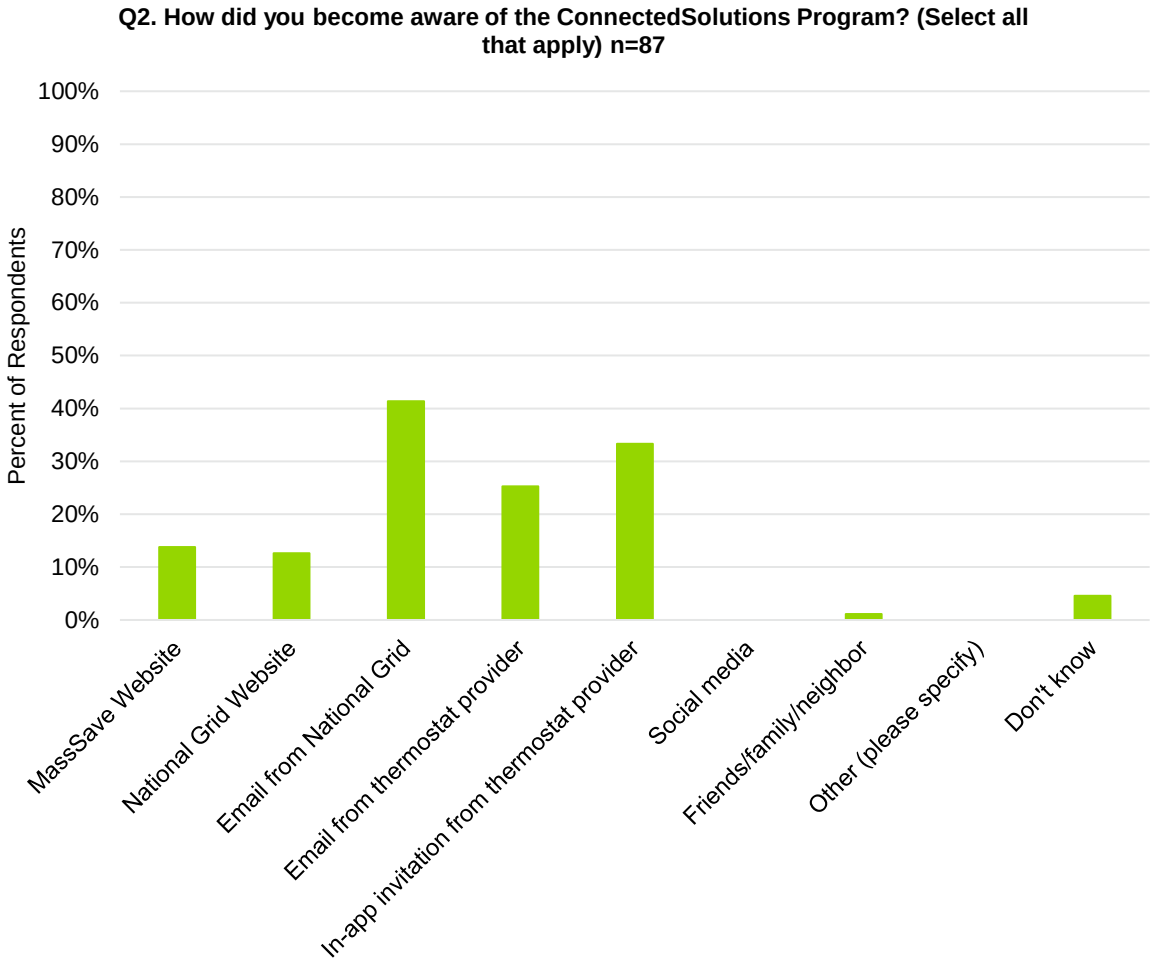
D.2 National Grid (New Customers)

D.2.1 Screening



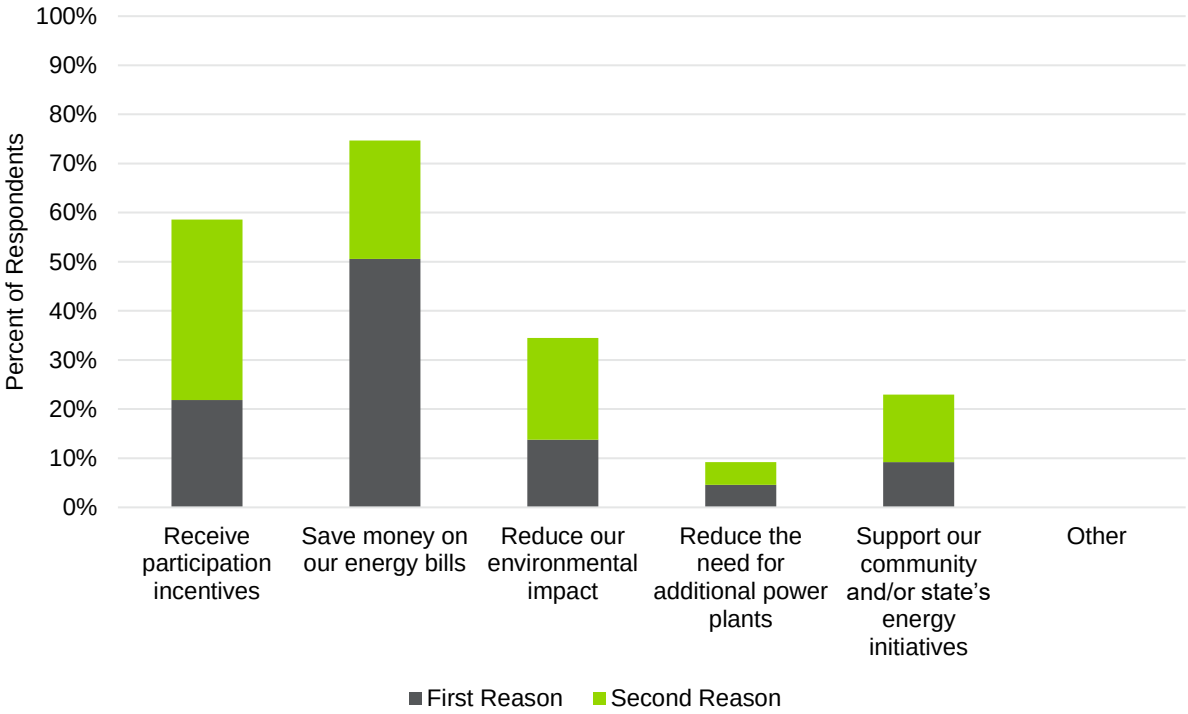
Source: Navigant analysis of online survey data

D.2.2 Motivations



Source: Navigant analysis of online survey data

Q3. What was your motivation for participating in the ConnectedSolutions Program in 2019? n=87



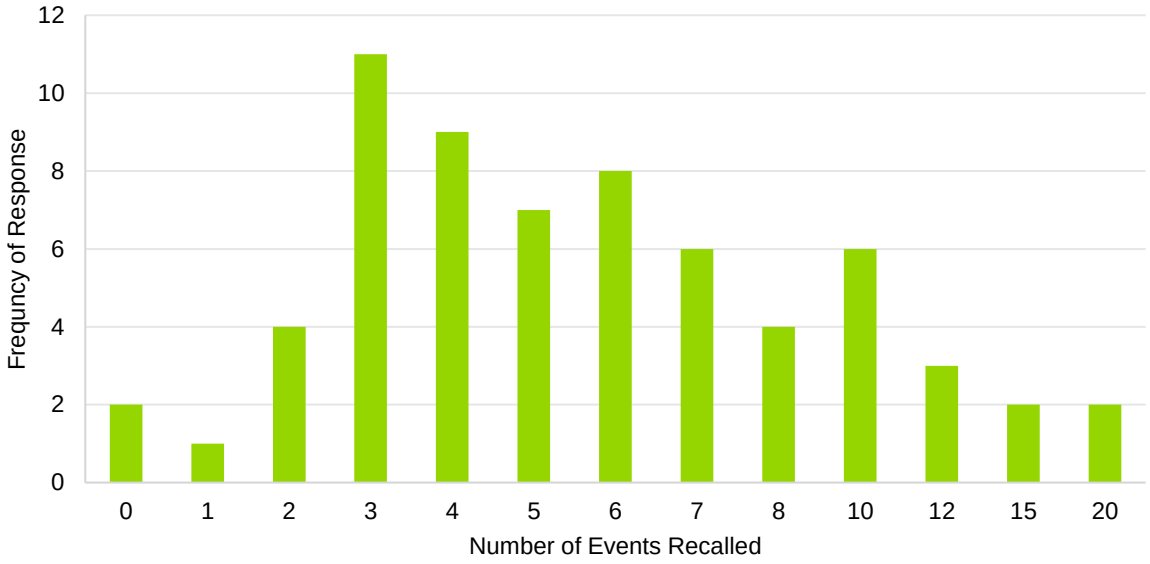
Source: Navigant analysis of online survey data

Q3_a. For what OTHER reasons did you enroll in the program? n=0

No responses.

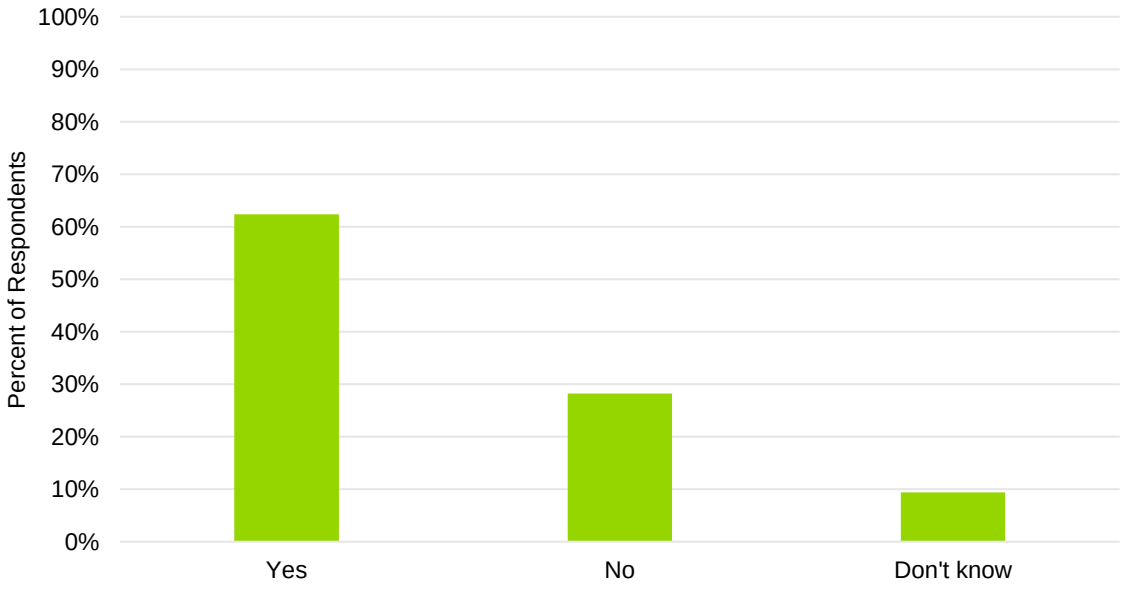
D.2.3 Awareness and Notification

Q4. This summer, about how many events do you remember occurring since enrolling in the program? (Please make your best estimate) n=87



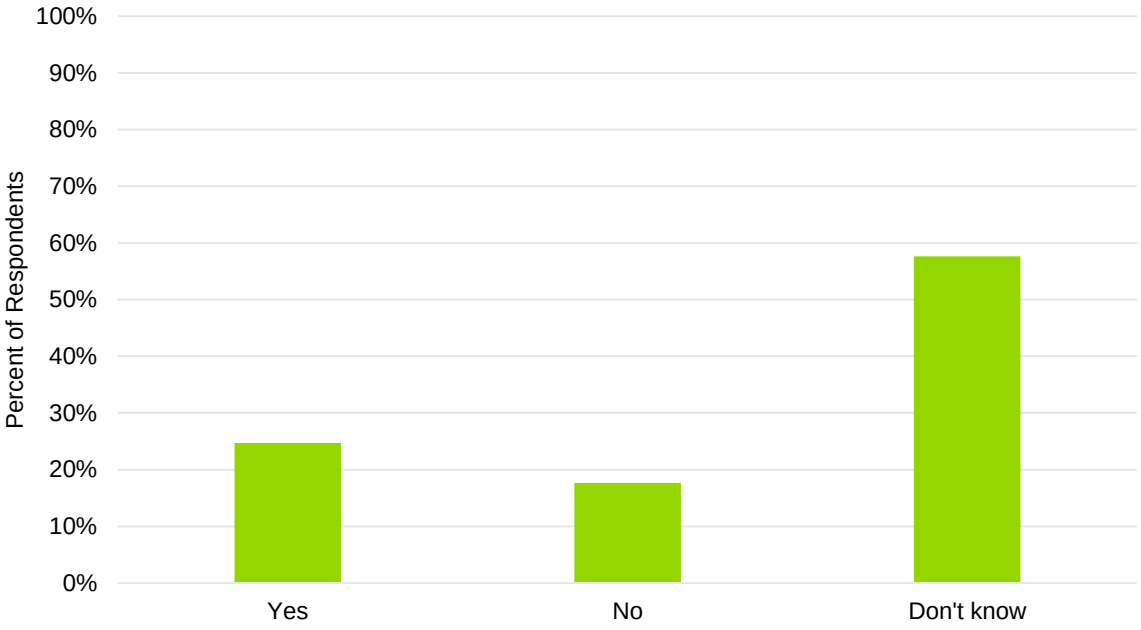
Source: Navigant analysis of online survey data

Q5. During this past summer, did you receive ever advance notifications about the events? n=85



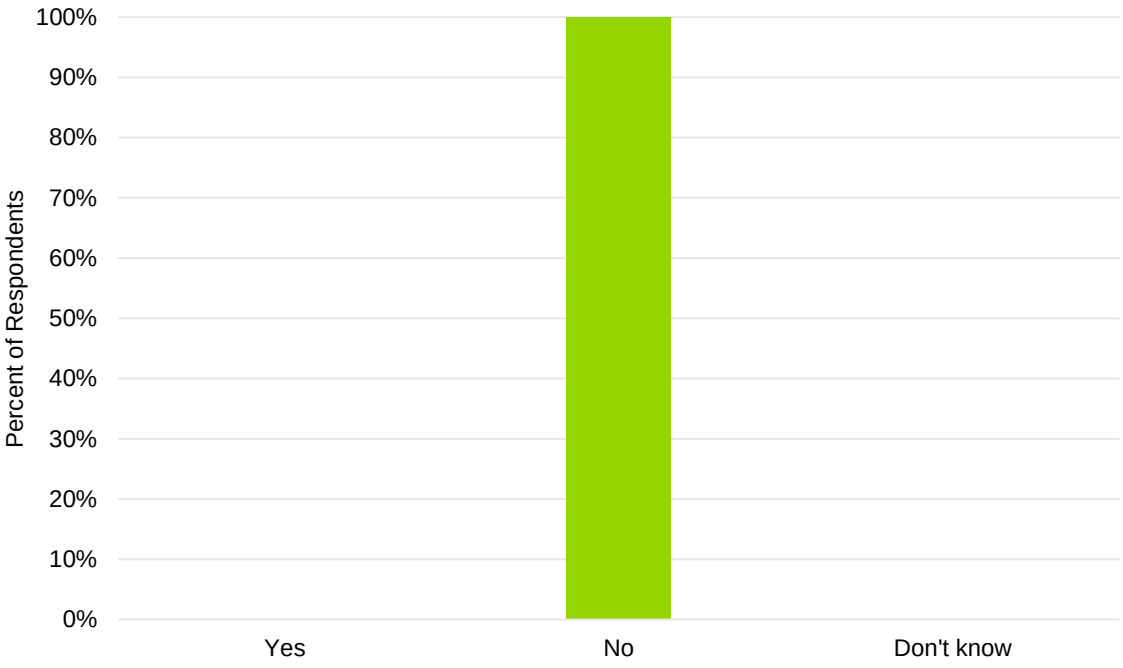
Source: Navigant analysis of online survey data

Q5_a. After enrolling in the ConnectedSolutions Program, did you receive an option to opt-out of advance notifications? n=85



Source: Navigant analysis of online survey data

Q5_b. Did you choose to opt-out of advance notifications? n=21



Source: Navigant analysis of online survey data

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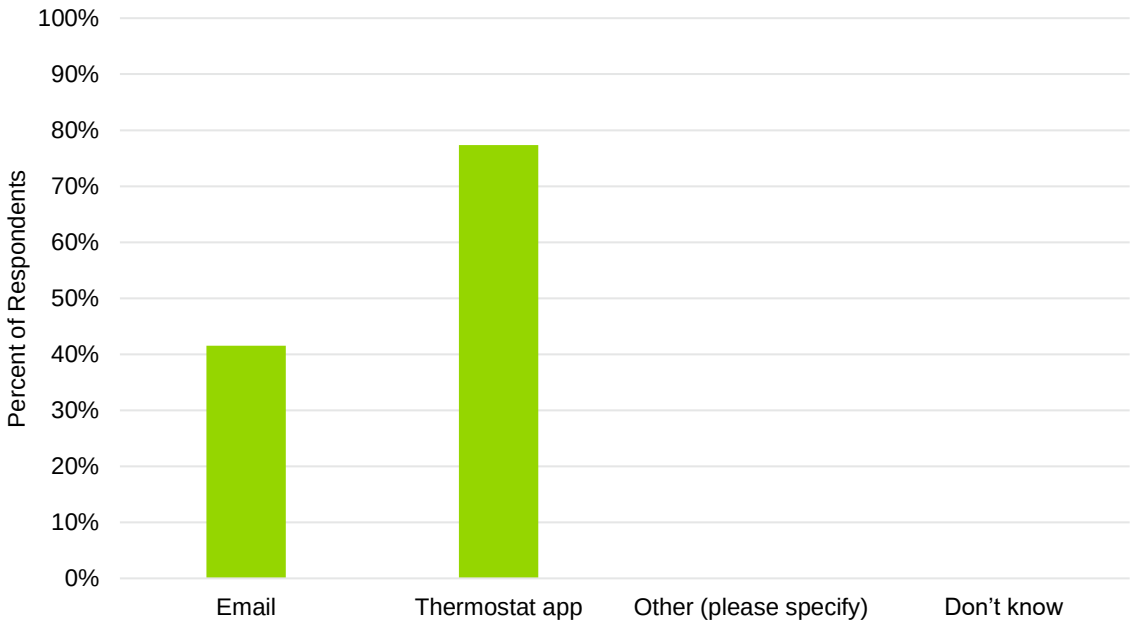
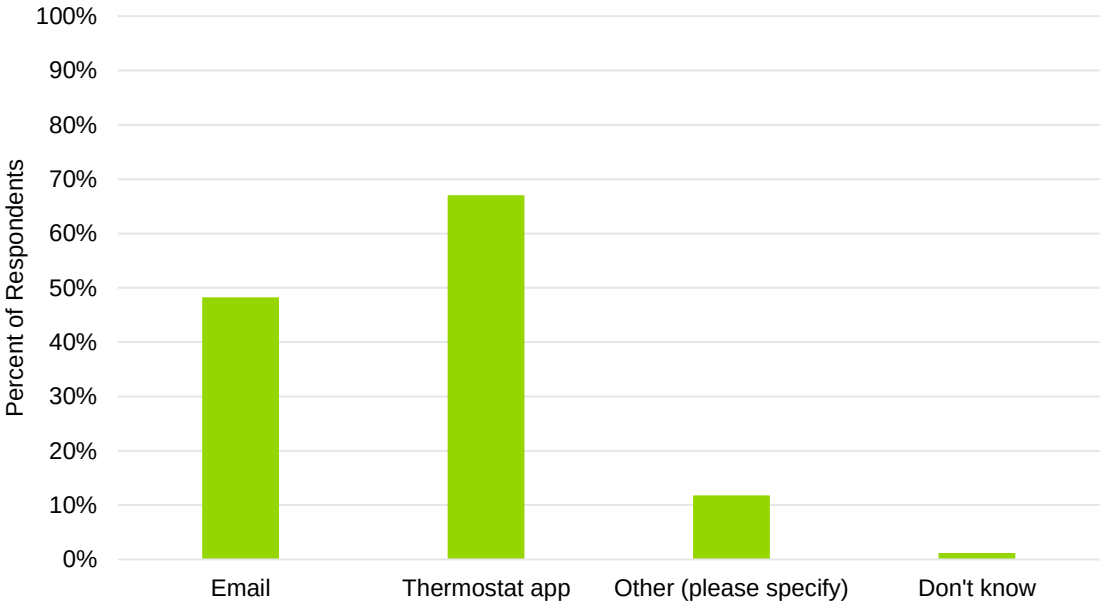
Q6. How were you notified in advance that an event was going to occur? (Select all that apply) n=53



Source: Navigant analysis of online survey data

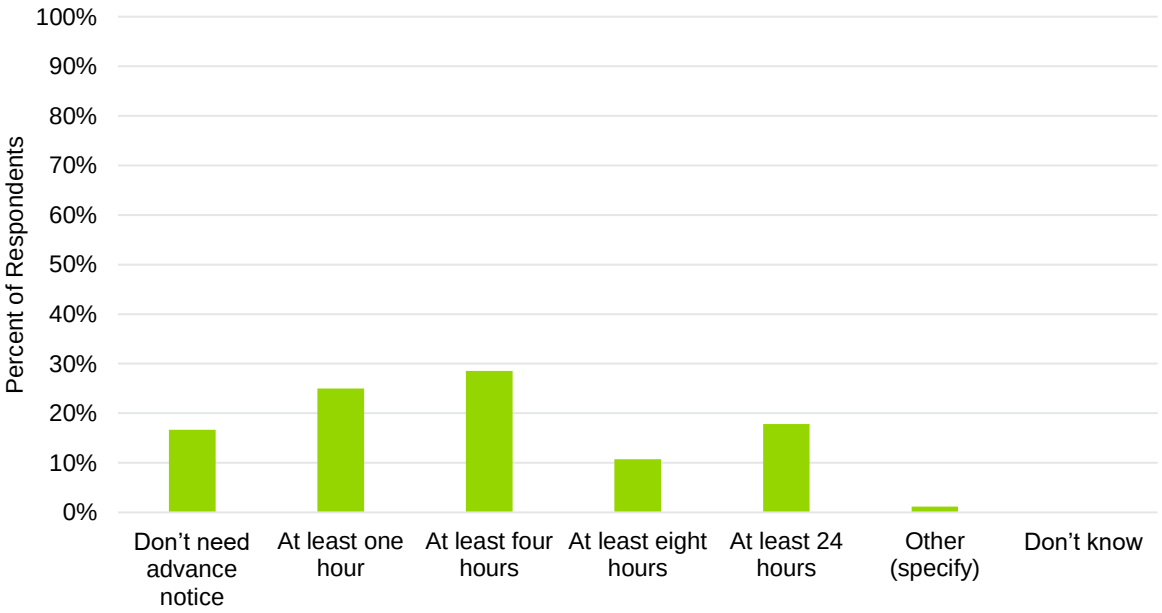
Q7. In general, how would you prefer to be notified that an event is going to occur? (Select all that apply) n=85



*Customer verbatims were summarized in the report, as appropriate.

Source: Navigant analysis of online survey data

Q8. In general, how much advance notice would you like before an event? n=84



*Customer verbatims were summarized in the report, as appropriate.

Source: Navigant analysis of online survey data

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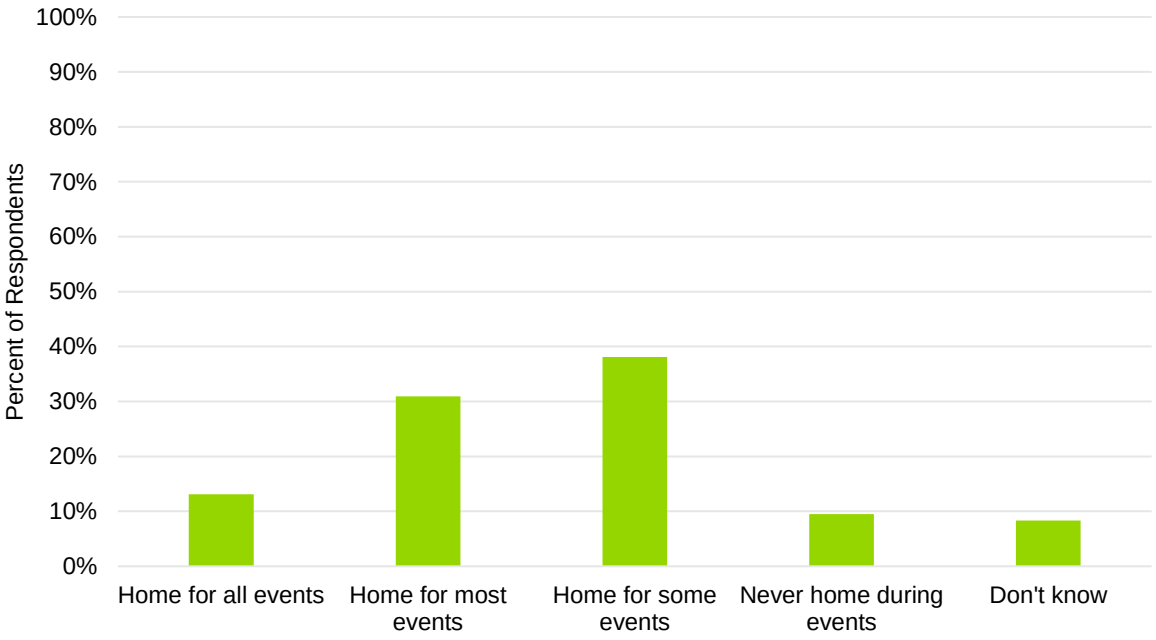
Q9. Are there ways that event notification could be improved? (optional) n=27

Customer verbatims were summarized in the report, as appropriate.

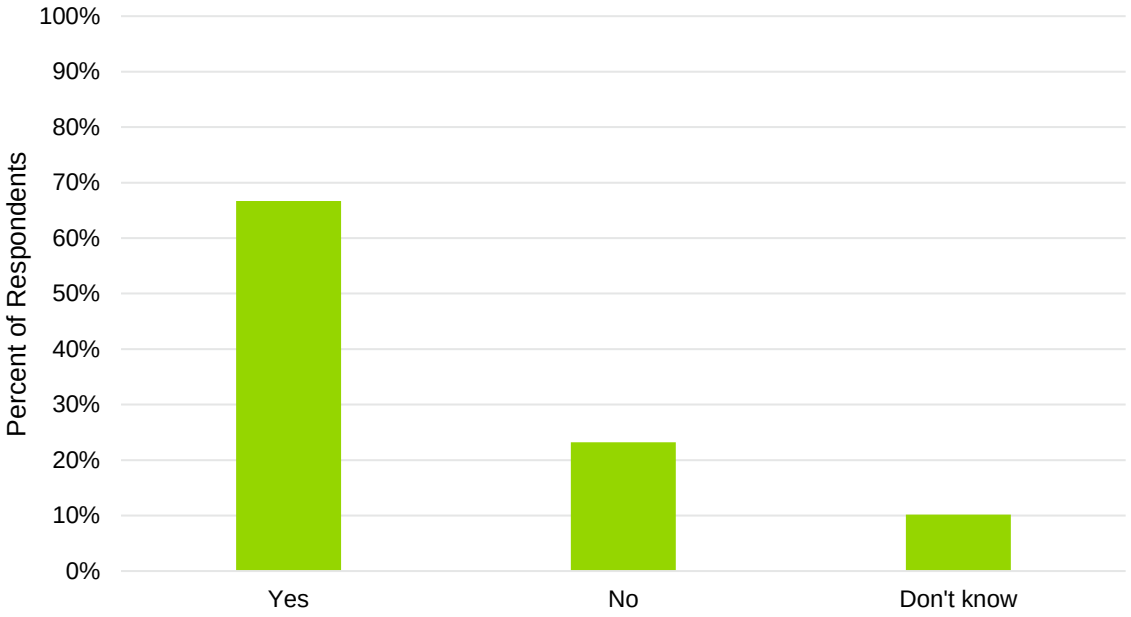
D.2.4 Comfort and Behavior During Events

Q10. This summer, for the events you can recall, how often were you or another family member at home during any part of the event? n=84



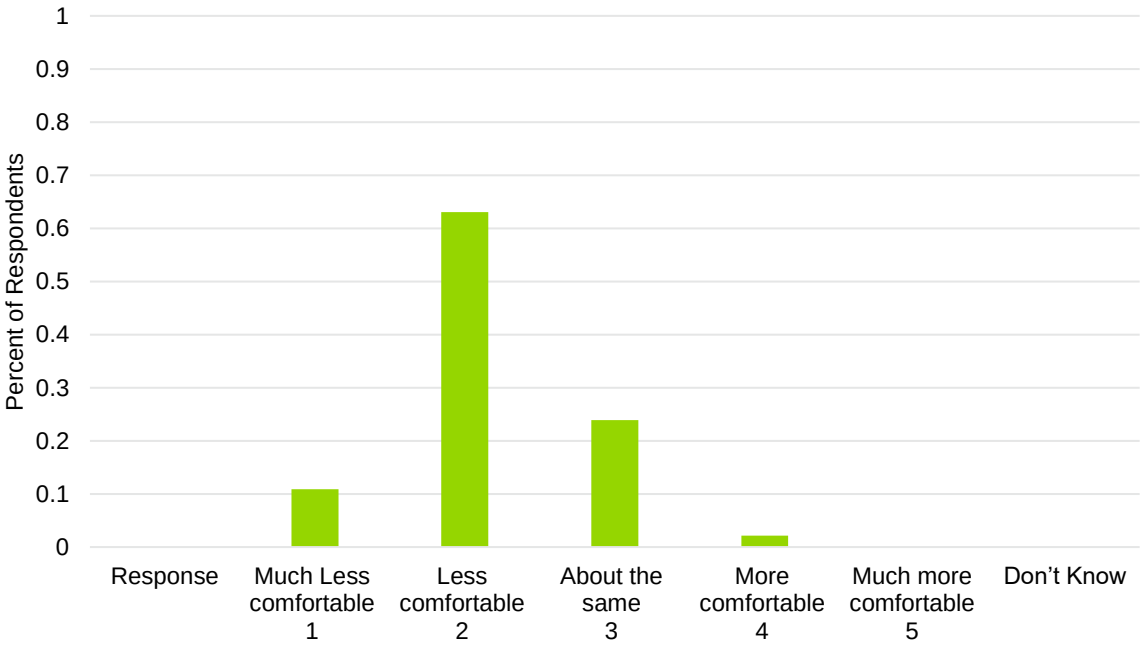
Source: Navigant analysis of online survey data

Q11. During the events you can recall, did you or another family member notice any changes to your home's indoor temperature? n=69



Source: Navigant analysis of online survey data

Q12. During the events you can recall, using a scale of 1 to 5, where 1 means "Much less comfortable" and 5 means "Much more comfortable", how would you generally describe your comfort compared to typical afternoons with similar outdoor temperatures? n=89



Source: Navigant analysis of online survey data

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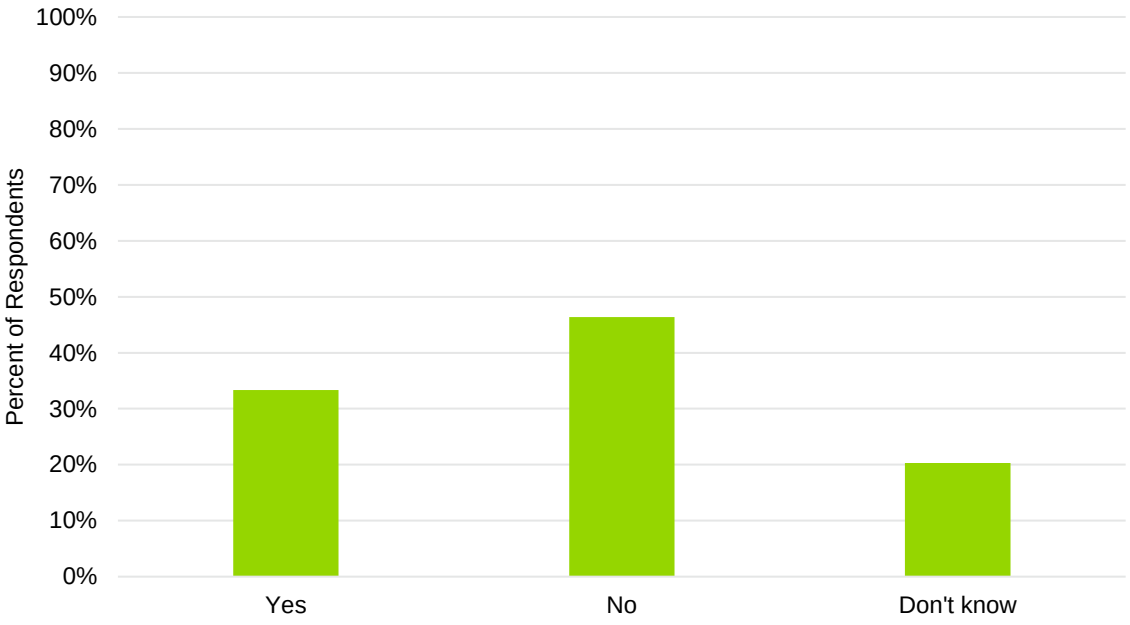
Q13. Do you have any comments to provide about your household's comfort level during events? (optional) n=21

Customer verbatims were summarized in the report, as appropriate.

Q14. Prior to events, do you recall the program "pre-cooling" your home (i.e., providing your home extra cooling prior to event hours)? n=69

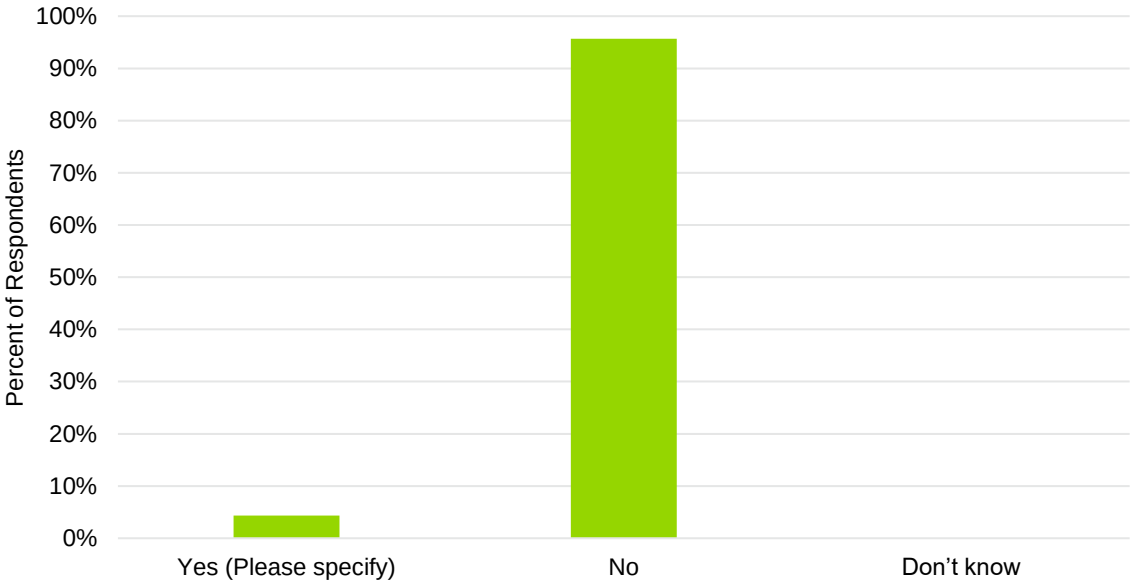


Source: Navigant analysis of online survey data

Q15. Do you have any feedback about the "pre-cooling" that occurred prior to events? (optional) n=

Customer verbatims were summarized in the report, as appropriate.

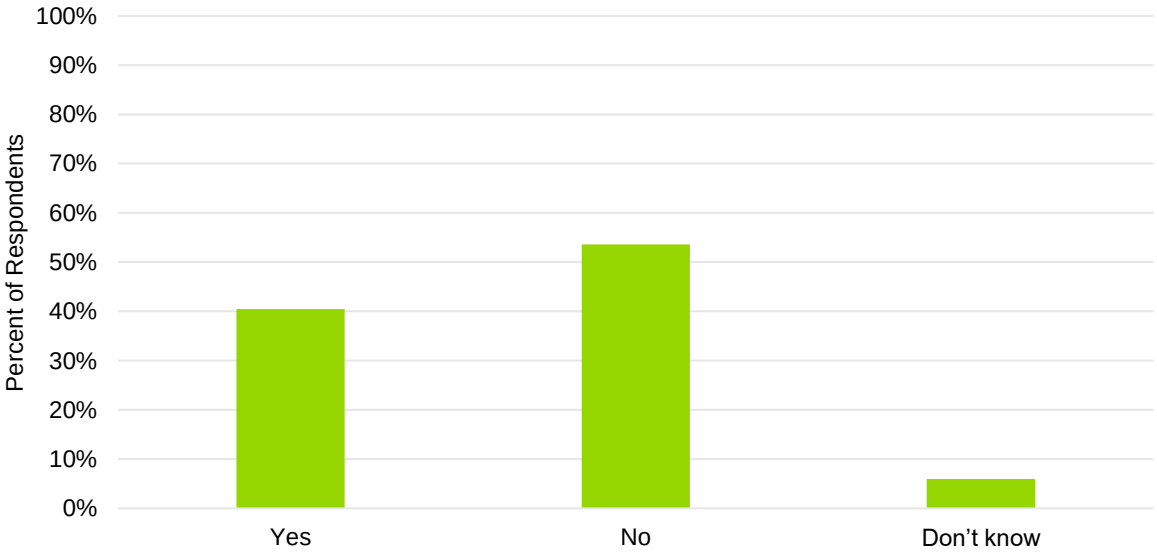
Q15_a. Prior to events, did you ever take any actions to prepare for the event? n=69



*Customer verbatims were summarized in the report, as appropriate.

Source: Navigant analysis of online survey data

Q16. On event days, did you or a family member ever "opt-out" of a event or override your thermostat setting to stop the program from adjusting your thermostat during the event? n=84



Source: Navigant analysis of online survey data

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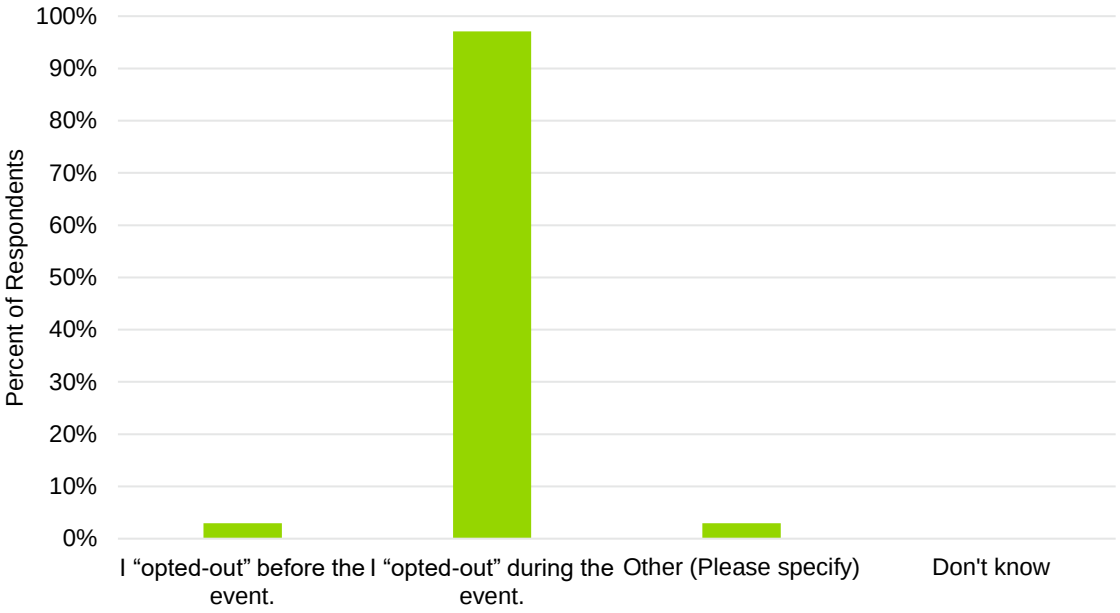
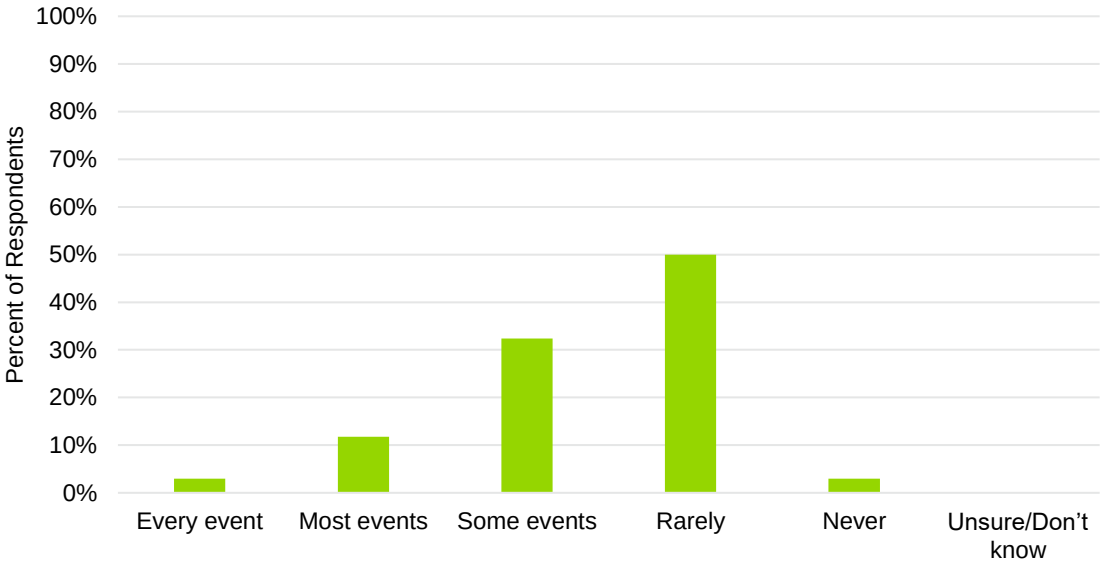
Q16_a. Did you "opt-out" or override your thermostat setting before events or during the events? (Select all that apply) n=34



*Customer verbatims were summarized in the report, as appropriate.

Source: Navigant analysis of online survey data

Q17. How often would you say you chose to opt-out of a event or override the scheduled event thermostat setting? Would you say… n=34



Source: Navigant analysis of online survey data

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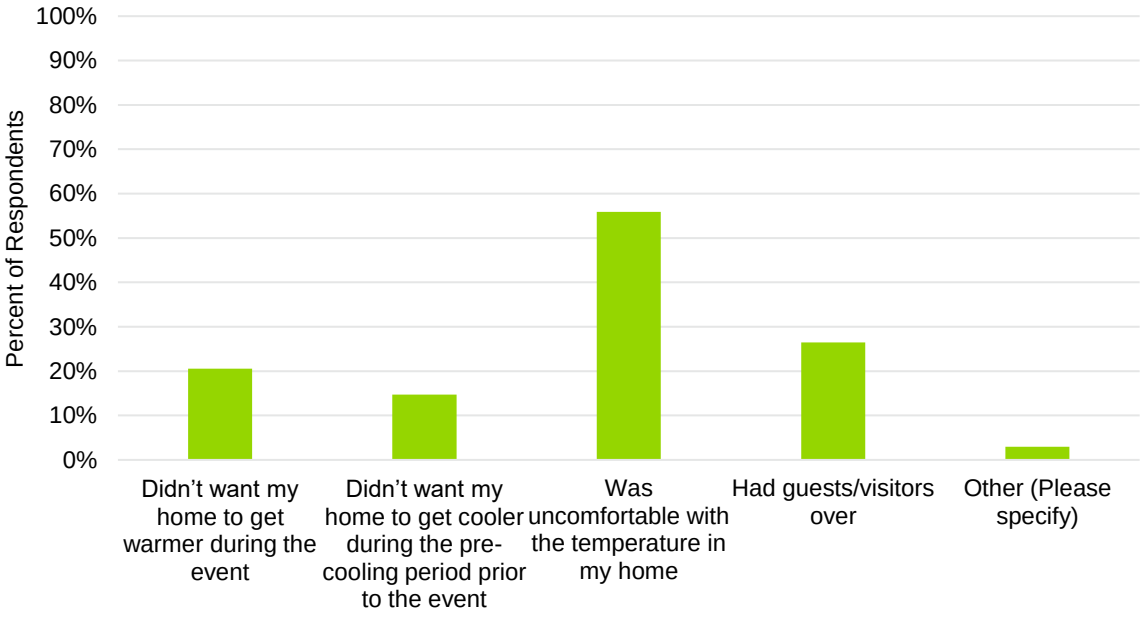
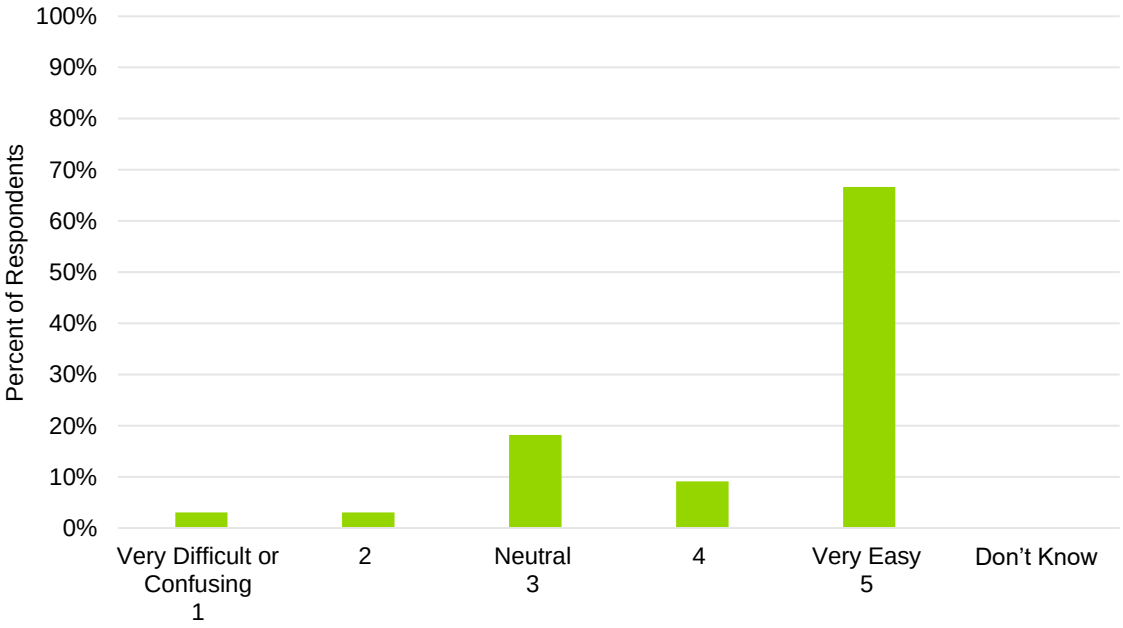
Q18. For what reason(s) did you opt-out or override the scheduled event thermostat setting? (Select all that apply) n=34



*Customer verbatims were summarized in the report, as appropriate.

Source: Navigant analysis of online survey data

Q19. Using a scale of 1 to 5, where 1 means "Very Difficult or Confusing" and 5 means "Very Easy", how easy was it to opt-out of or override events? n=33



Source: Navigant analysis of online survey data

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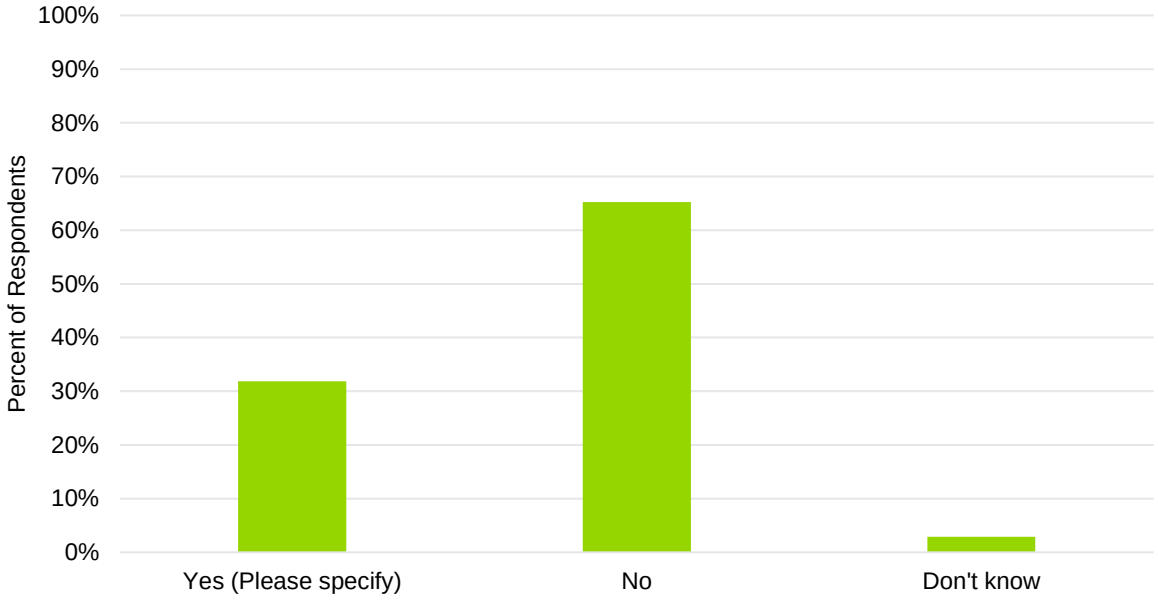
Q20. What issues did you encounter when trying to opt-out of or override a scheduled event? n=2

Customer verbatims were summarized in the report, as appropriate.

D.2.5 General Thermostat and AC Usage Behavior

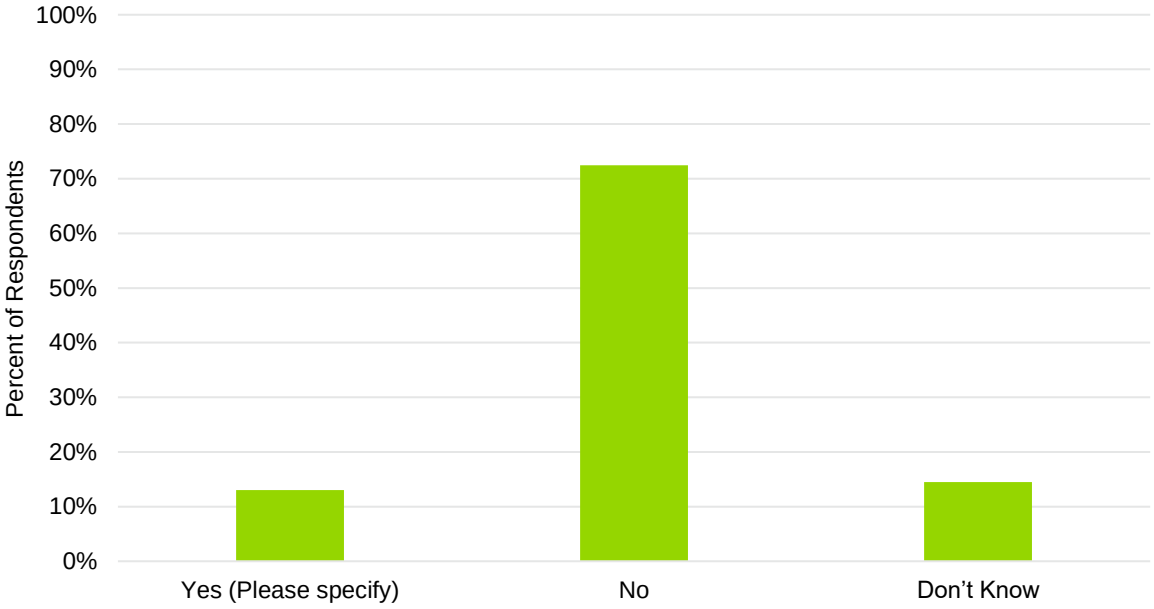
Q21. During an event, did you ever rely on other appliances (e.g., fans or room air-conditioners) to maintain comfort? n=69



*Customer verbatims were summarized in the report, as appropriate.

Source: Navigant analysis of online survey data

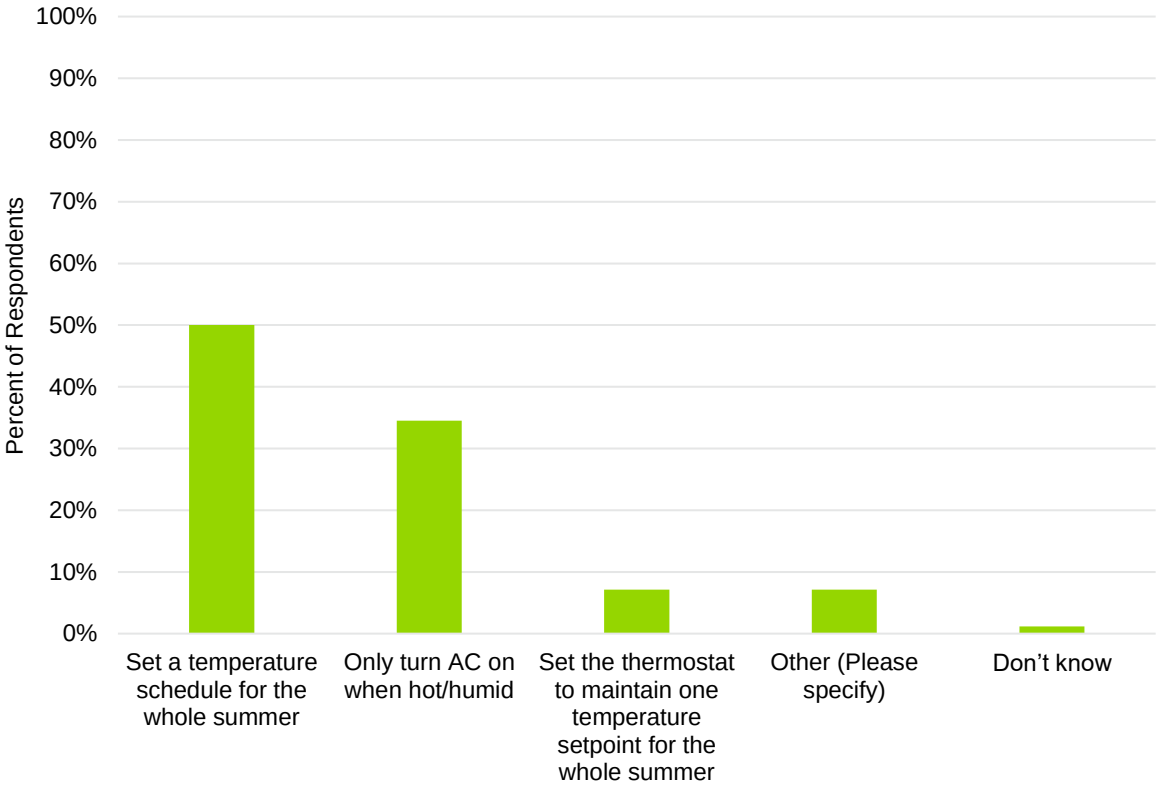
Q22. Did you or other members of your family ever take any actions to reduce your electricity use during events (apart from allowing your thermostat setpoint to be adjusted)? n=69



*Customer verbatims were summarized in the report, as appropriate.

Source: Navigant analysis of online survey data

Q23. How did you typically use your thermostat throughout the summer? n=84

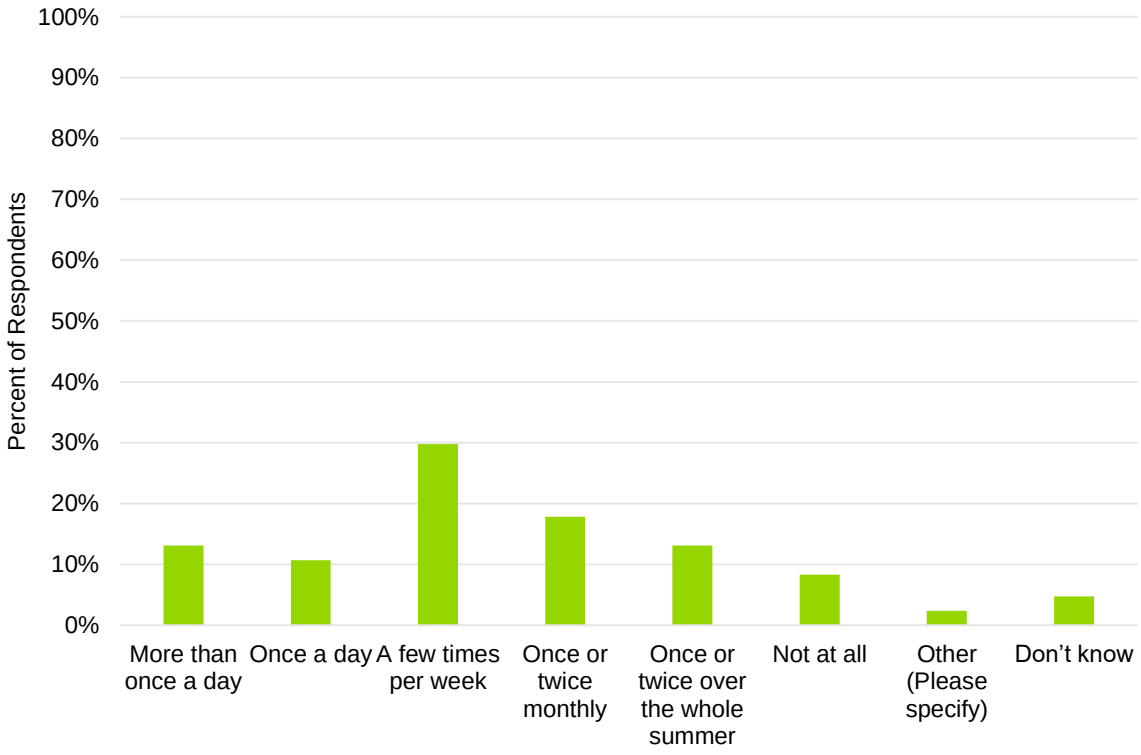


Source: Navigant analysis of online survey data

Q23_a. Above what indoor temperature do you typically turn your air conditioning on? Please enter a temperature in degrees F. n=29

Customer verbatims were summarized in the report, as appropriate.

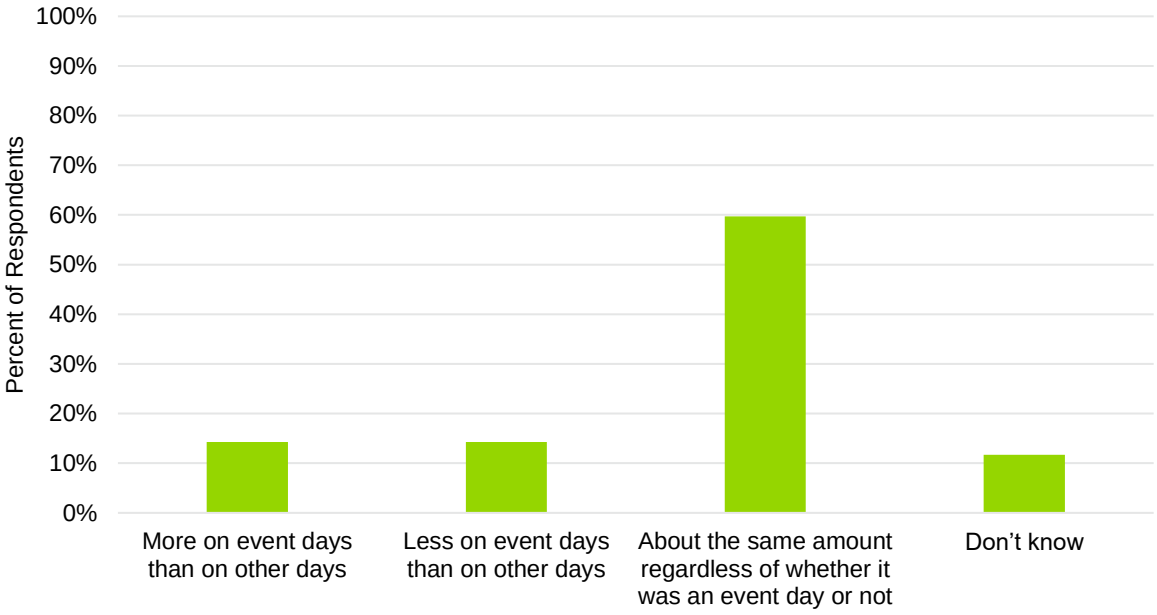
Q23_b. Now we'd like to understand the frequency with which you adjusted your Wi-Fi thermostat's setting or schedule (either up or down) on days when there was no event this summer. Would you say it was… n=84



*Customer verbatims were summarized in the report, as appropriate.

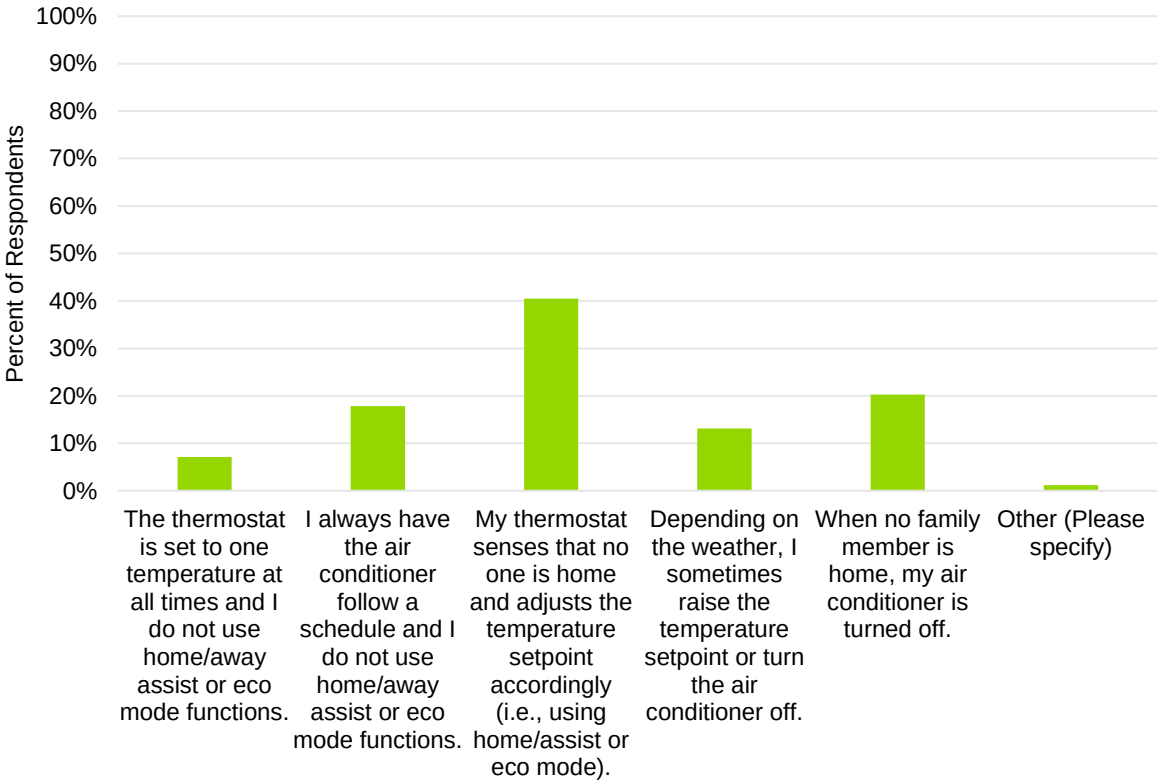
Source: Navigant analysis of online survey data

Q23_c. We'd also like to understand whether the frequency with which you adjusted your Wi-Fi thermostat's setting or schedule was different on event days compared to other days. Would you say you adjusted your home's temperature… n=77



Source: Navigant analysis of online survey data

Q23_d. When no family member is at home, which of the following best describes the way you use your air conditioner? n=84

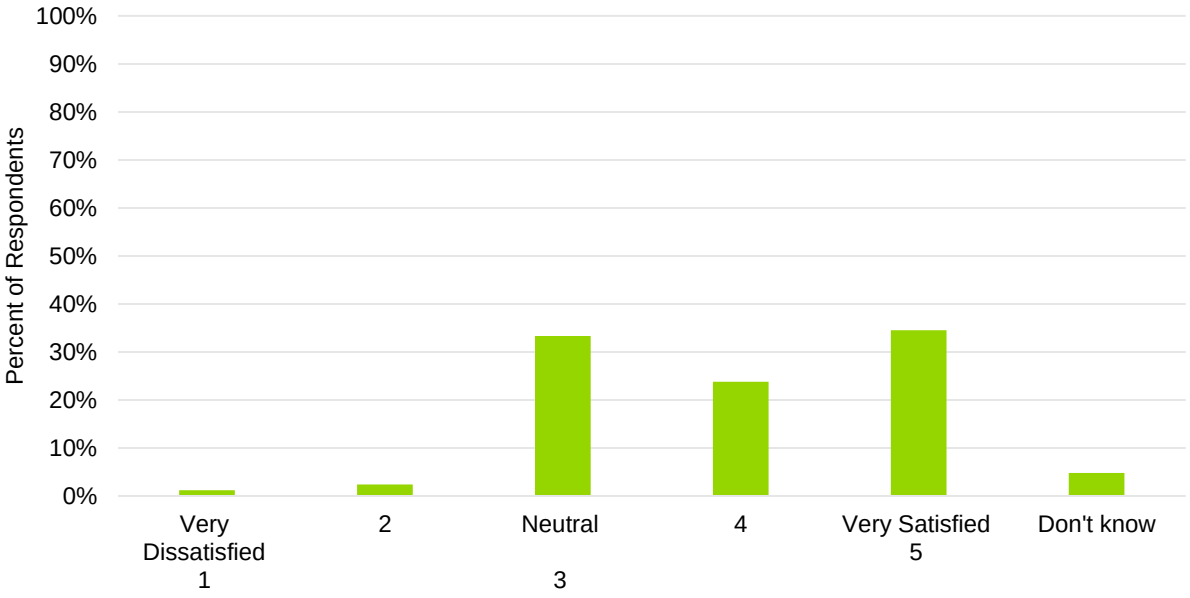


*Customer verbatims were summarized in the report, as appropriate.

Source: Navigant analysis of online survey data

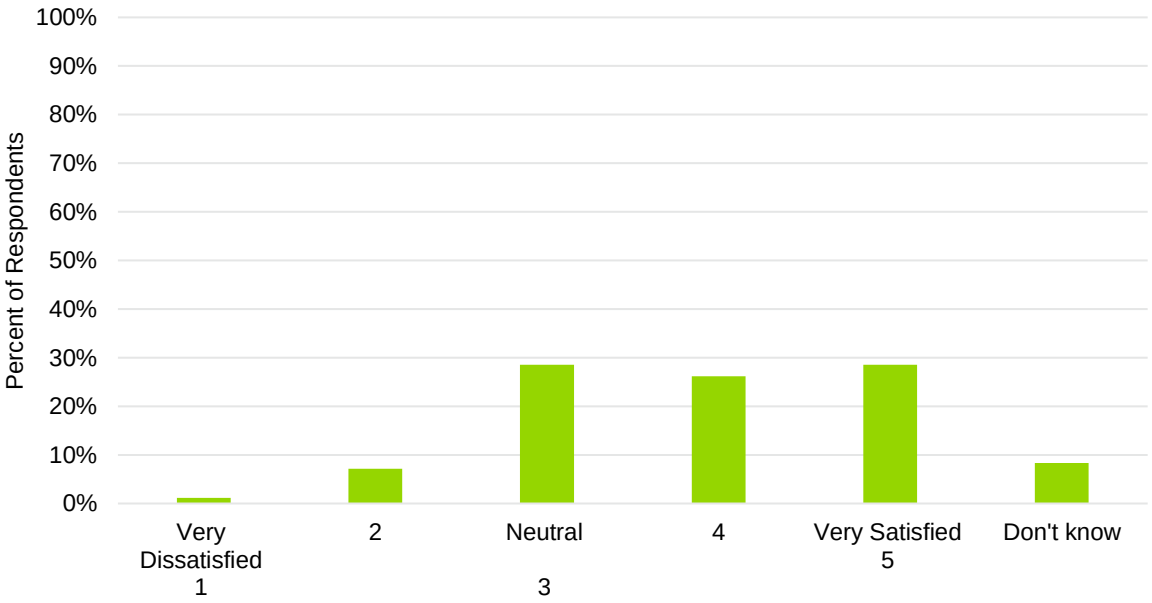
D.2.6 Program Satisfaction

Q24_a. On a scale of 1 through 5, where 1 is "Very dissatisfied" and 5 is "Very satisfied", how would you rate your satisfaction with the number of events during the 2019 summer season? n=84



Source: Navigant analysis of online survey data

Q24_b. On a scale of 1 through 5, where 1 is "Very dissatisfied" and 5 is "Very satisfied", how would you rate your satisfaction with the length of events during the 2019 summer season? n=84



Source: Navigant analysis of online survey data

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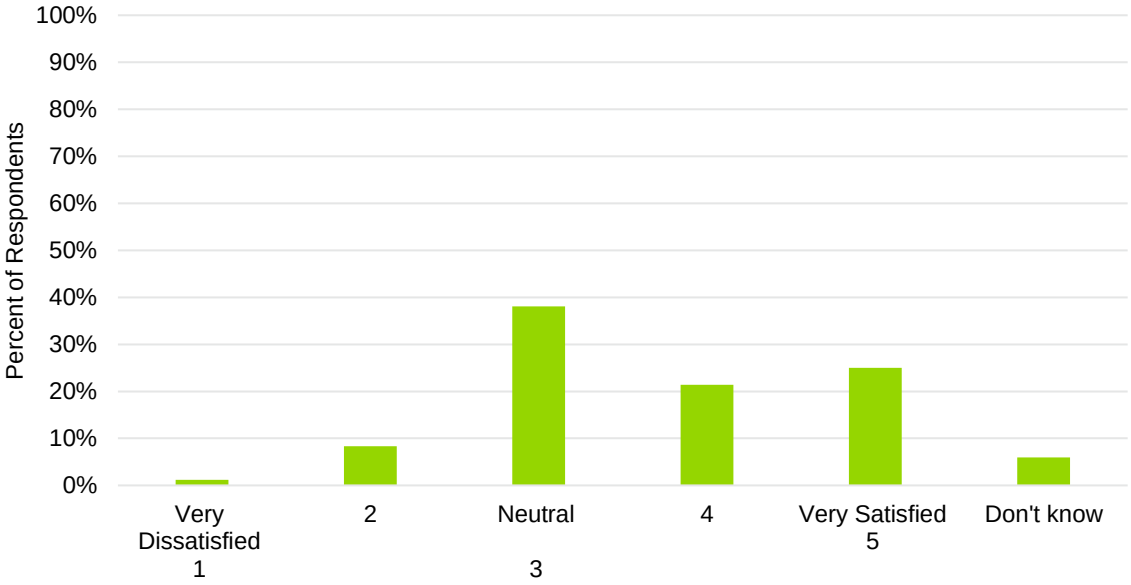
Q24_c. On a scale of 1 through 5, where 1 is "Very dissatisfied" and 5 is "Very satisfied", how would you rate your satisfaction with the timing of events during the 2019 summer season? n=84



Source: Navigant analysis of online survey data

Q25. What changes to the number of events would you recommend? n=3

Customer verbatims were summarized in the report, as appropriate.

Q26. What changes to the length of events would you recommend? n=7

Customer verbatims were summarized in the report, as appropriate.

Q27. What changes to the timing of events would you recommend? n=8

Customer verbatims were summarized in the report, as appropriate.

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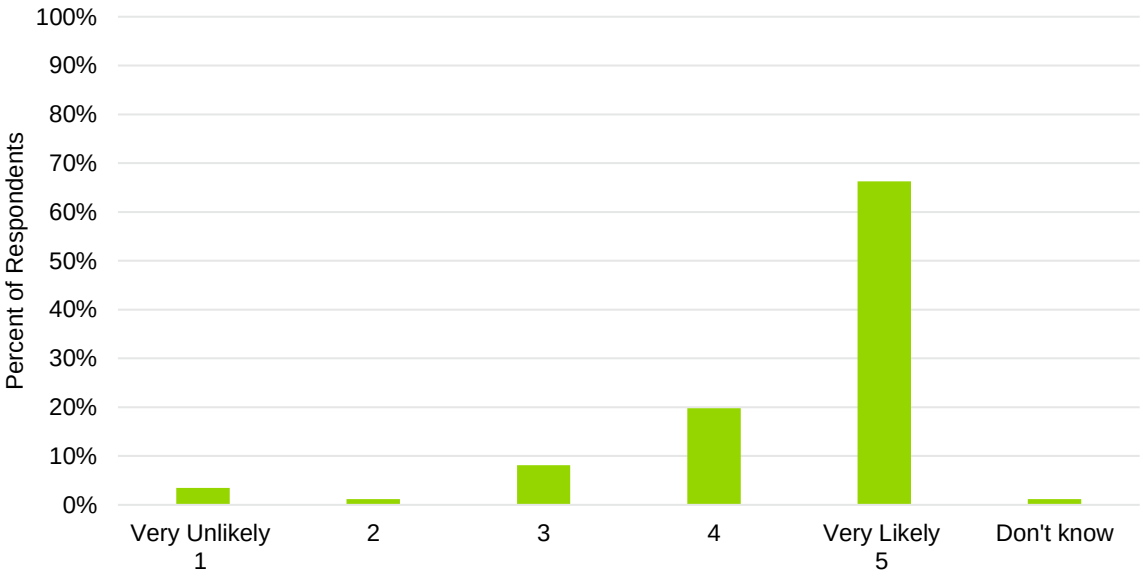
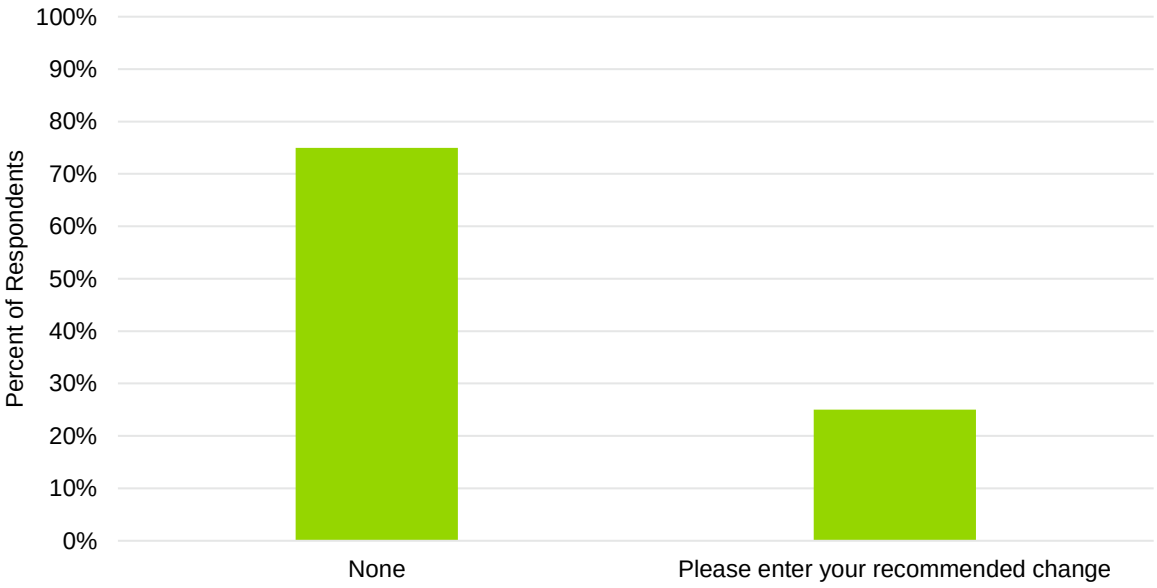
Q28. In future summers, how likely would you be to participate in the ConnectedSolutions Program, on a scale of 1-5, where 1 is "Very Unlikely" and 5 is "Very Likely"? n=86



Source: Navigant analysis of online survey data

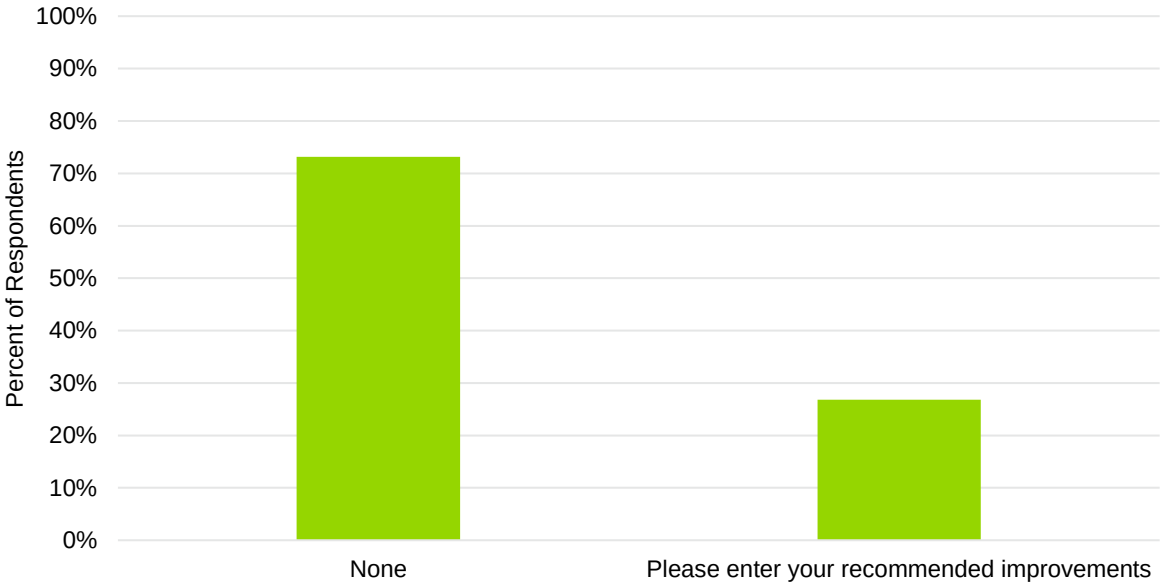
Q29. What change(s) to the ConnectedSolutions Program would encourage you to continue participating? n=4



*Customer verbatims were summarized in the report, as appropriate.

Source: Navigant analysis of online survey data

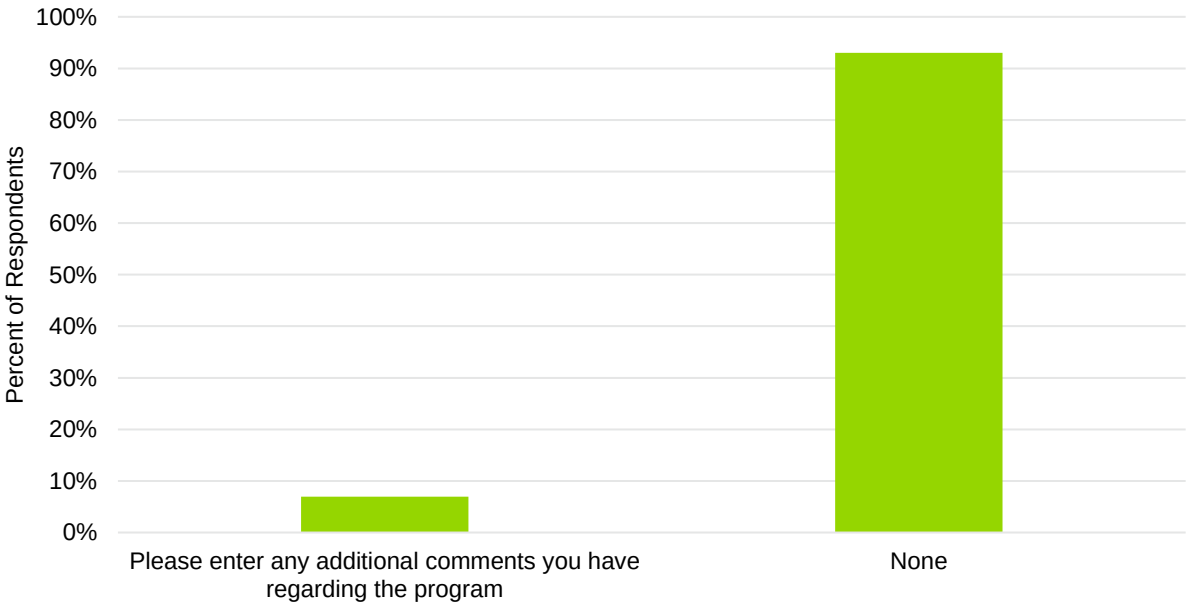
Q30. What recommendations would you make to help improve the ConnectedSolutions Program going forward? n=82



*Customer verbatims were summarized in the report, as appropriate.

Source: Navigant analysis of online survey data

Q31. Do you have any additional comments regarding the ConnectedSolutions Program? n=86



*Customer verbatims were summarized in the report, as appropriate.

Source: Navigant analysis of online survey data

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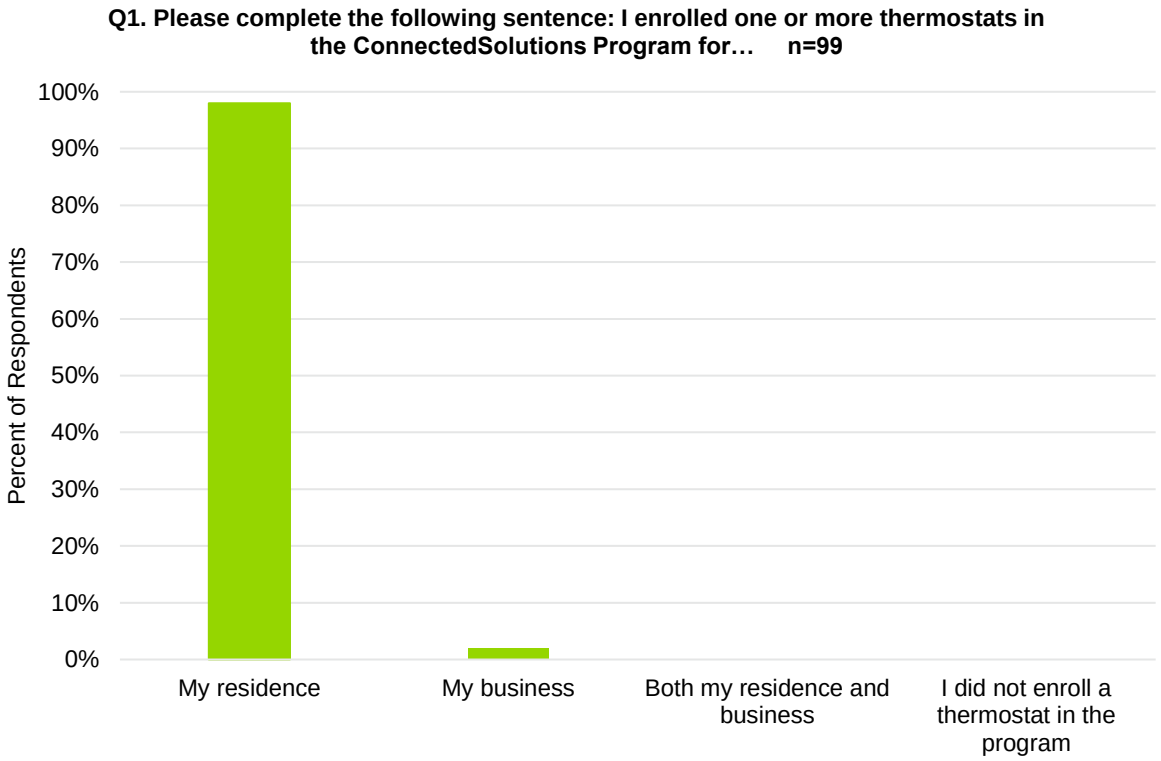
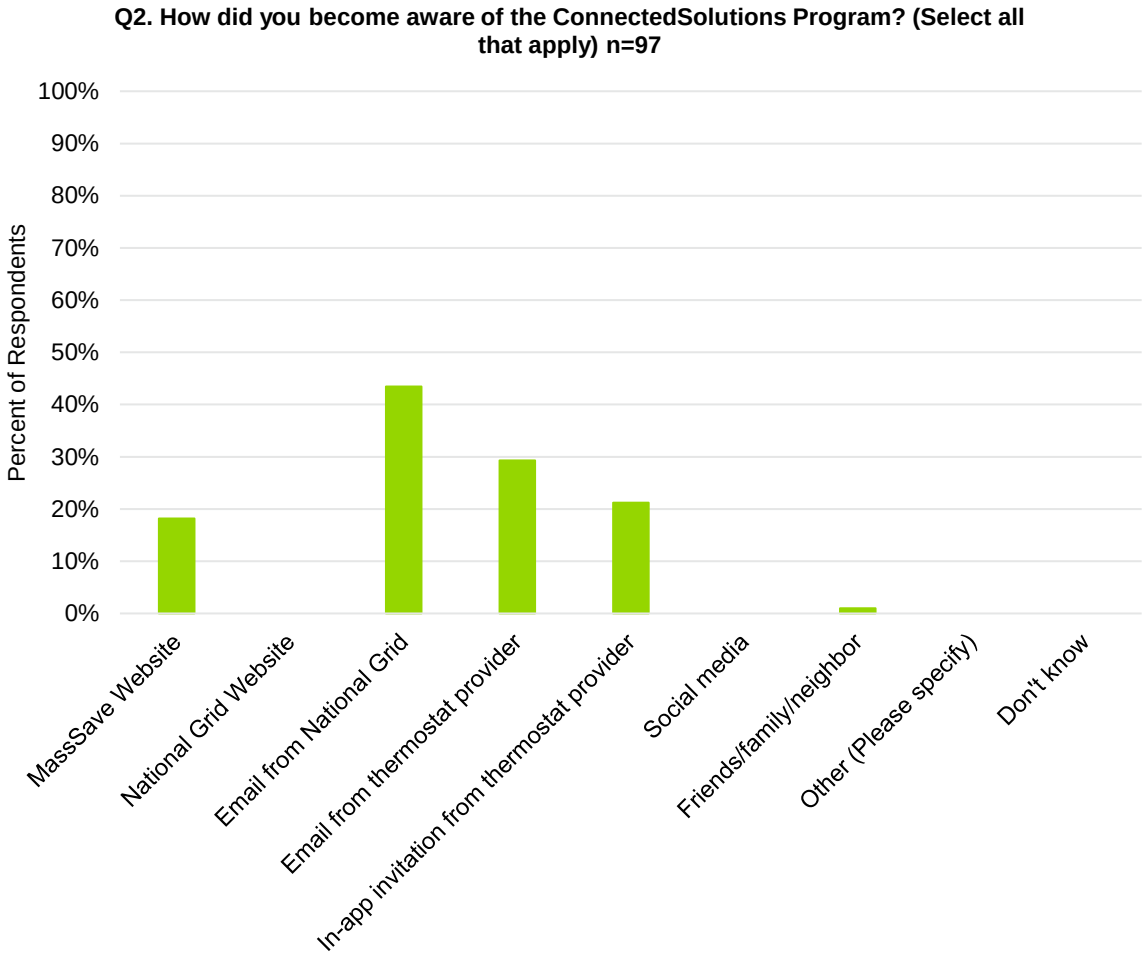
D.3 National Grid (Returning Customers)

D.3.1 Screening



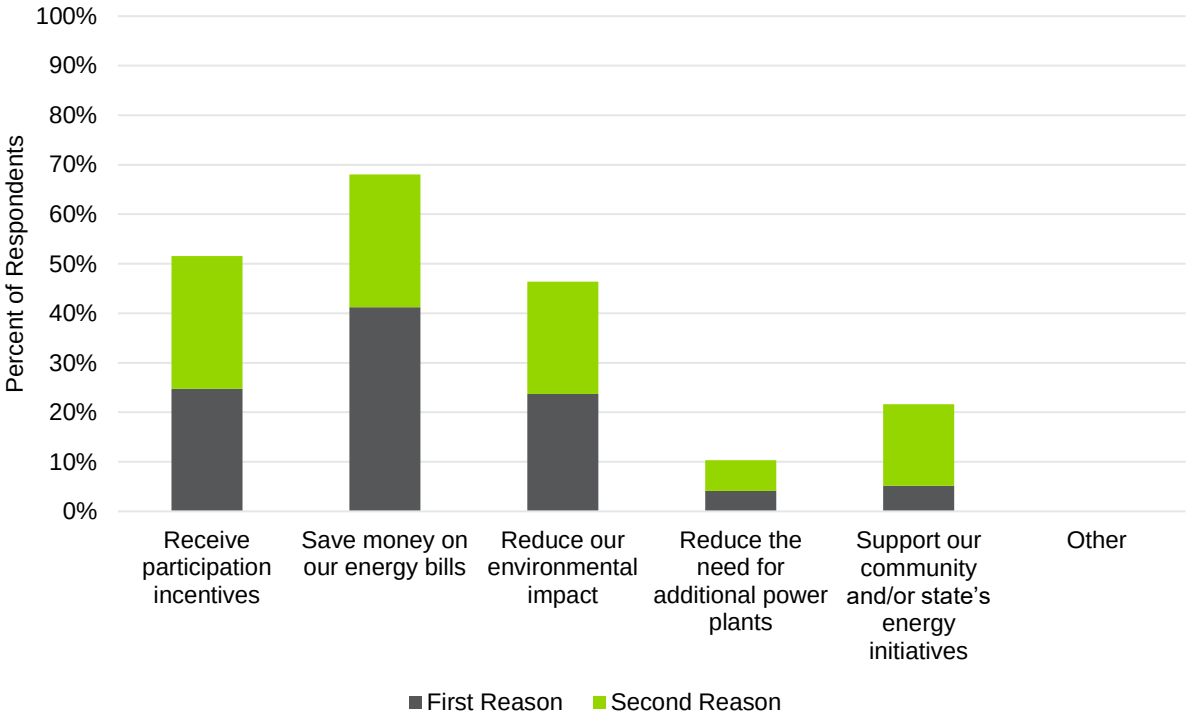
Source: Navigant analysis of online survey data

D.3.2 Motivations



Source: Navigant analysis of online survey data

Q3. What was your motivation for participating in the ConnectedSolutions Program in 2019? n=97



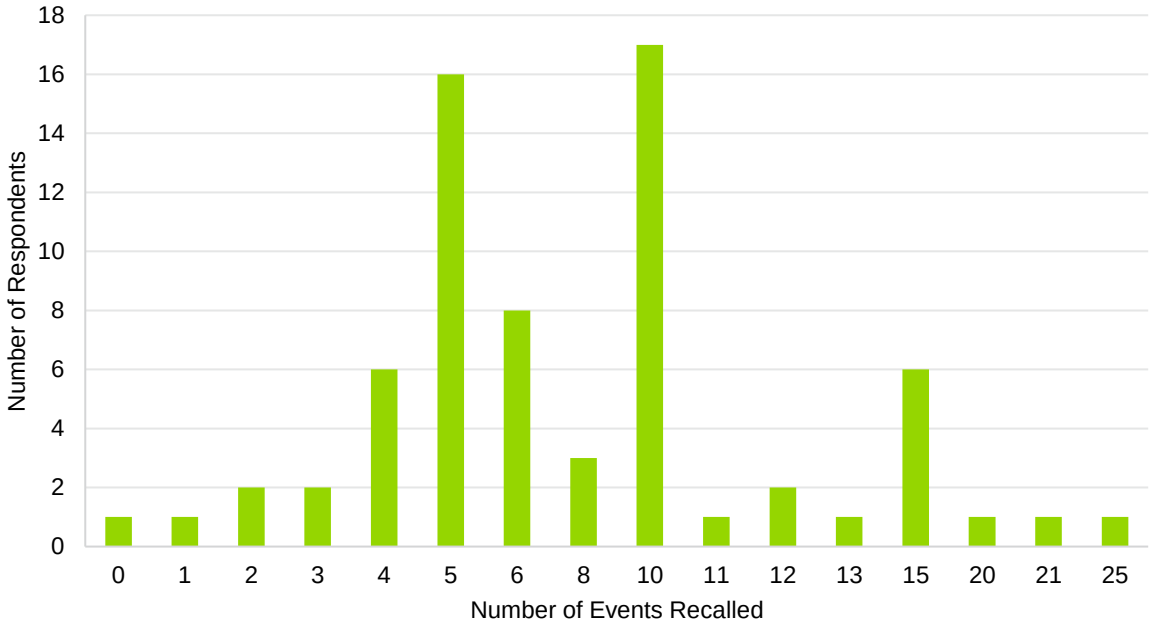
Source: Navigant analysis of online survey data

Q3_a. For what OTHER reasons did you enroll in the program?

No responses.

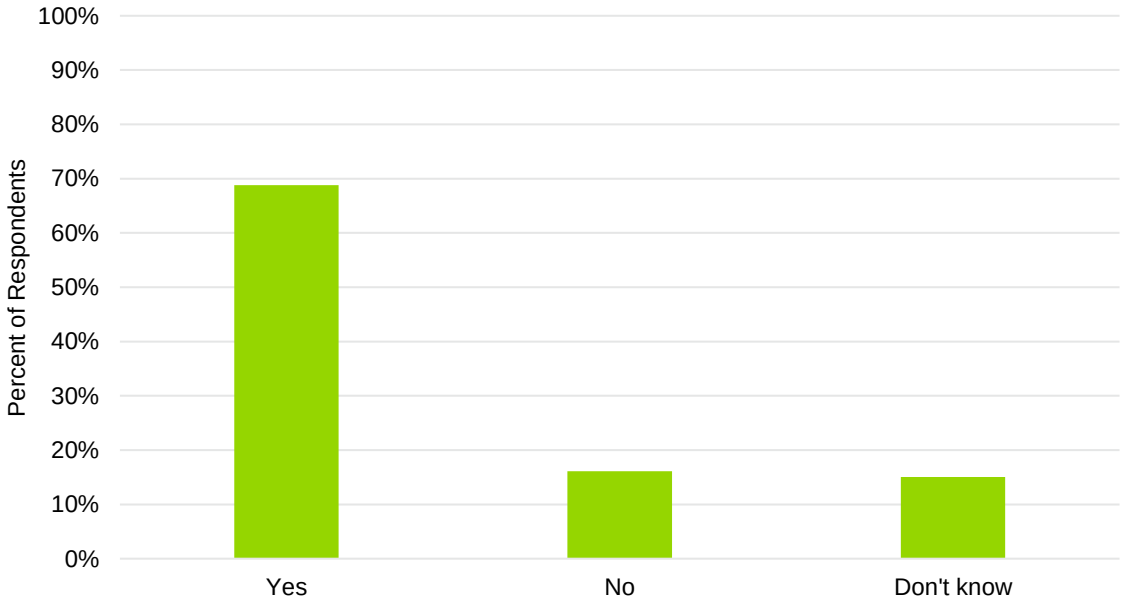
D.3.3 Awareness and Notification

Q4. This summer, about how many events do you remember occurring since enrolling in the program? (Please make your best estimate) n=95



Source: Navigant analysis of online survey data

Q5. During this past summer, did you receive ever advance notifications about the events? n=93



Source: Navigant analysis of online survey data

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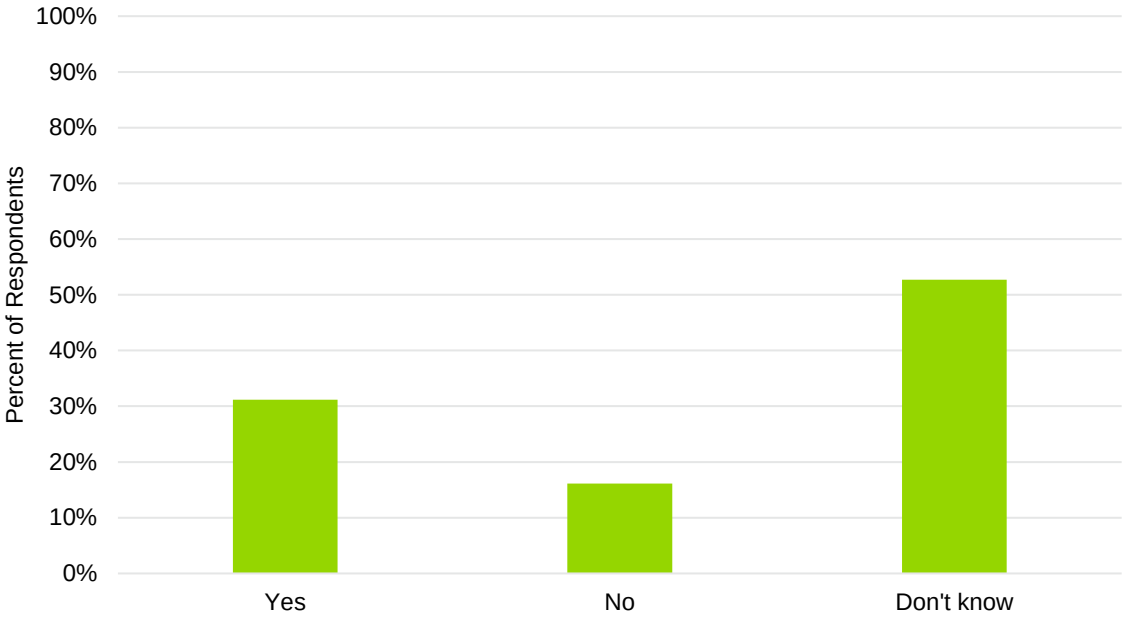
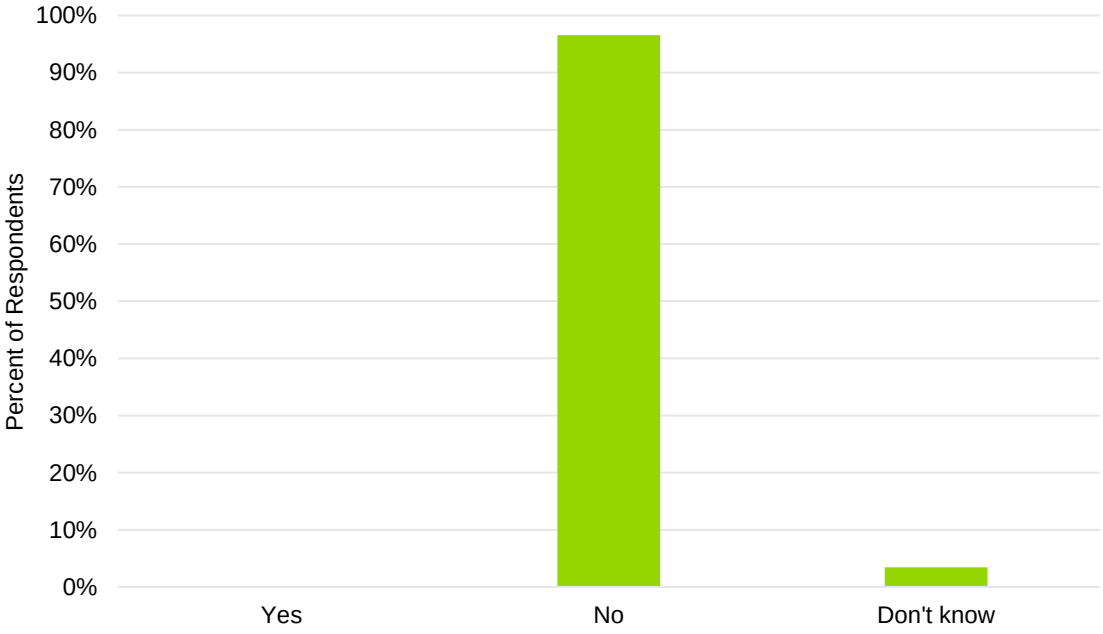
Q5_a. After enrolling in the ConnectedSolutions Program, did you receive an option to opt-out of advance notifications? n=93



Source: Navigant analysis of online survey data

Q5_b. Did you choose to opt-out of advance notifications? n=29



Source: Navigant analysis of online survey data

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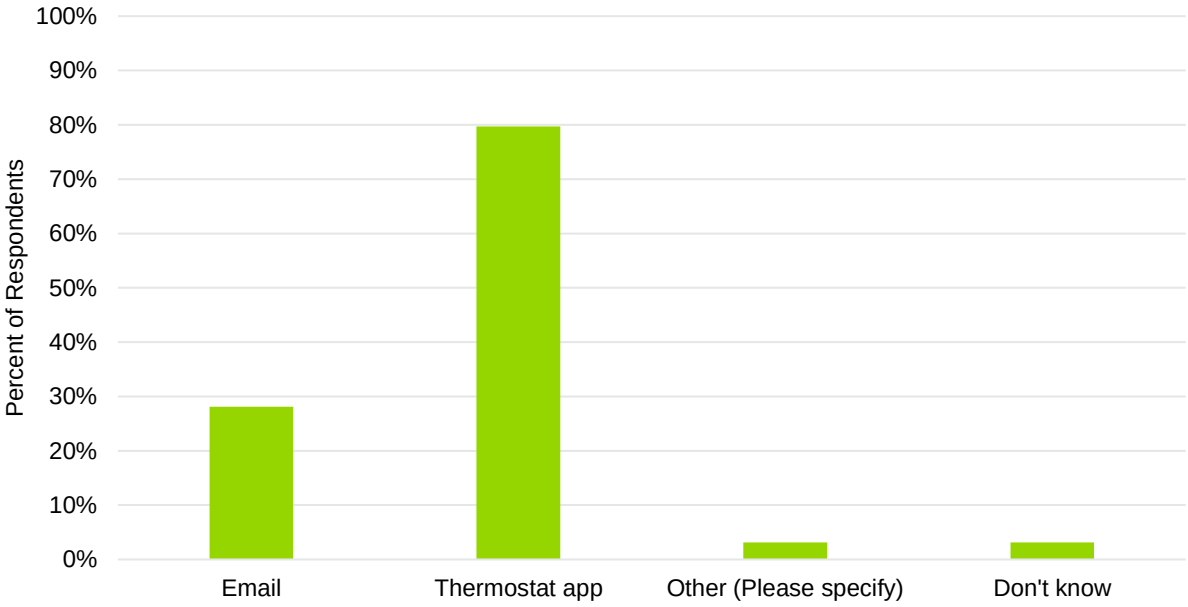
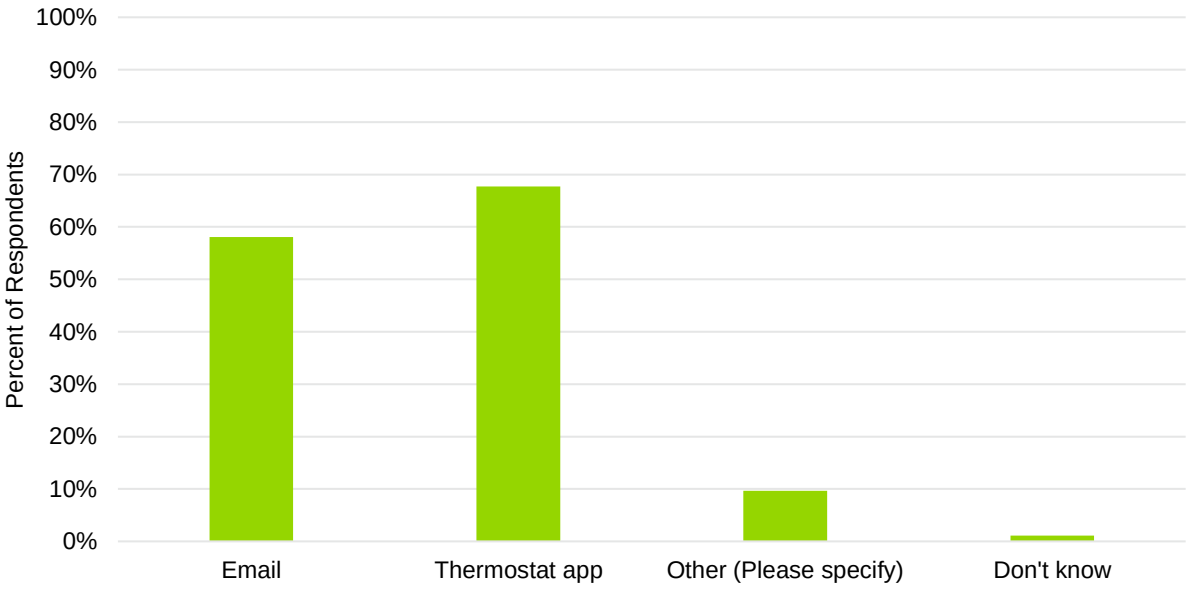
Q6. How were you notified in advance that an event was going to occur? (Select all that apply) n=64



*Customer verbatims were summarized in the report, as appropriate.

Source: Navigant analysis of online survey data

Q7. In general, how would you prefer to be notified that a event is going to occur? (Select all that apply) n=93



*Customer verbatims were summarized in the report, as appropriate.

Source: Navigant analysis of online survey data

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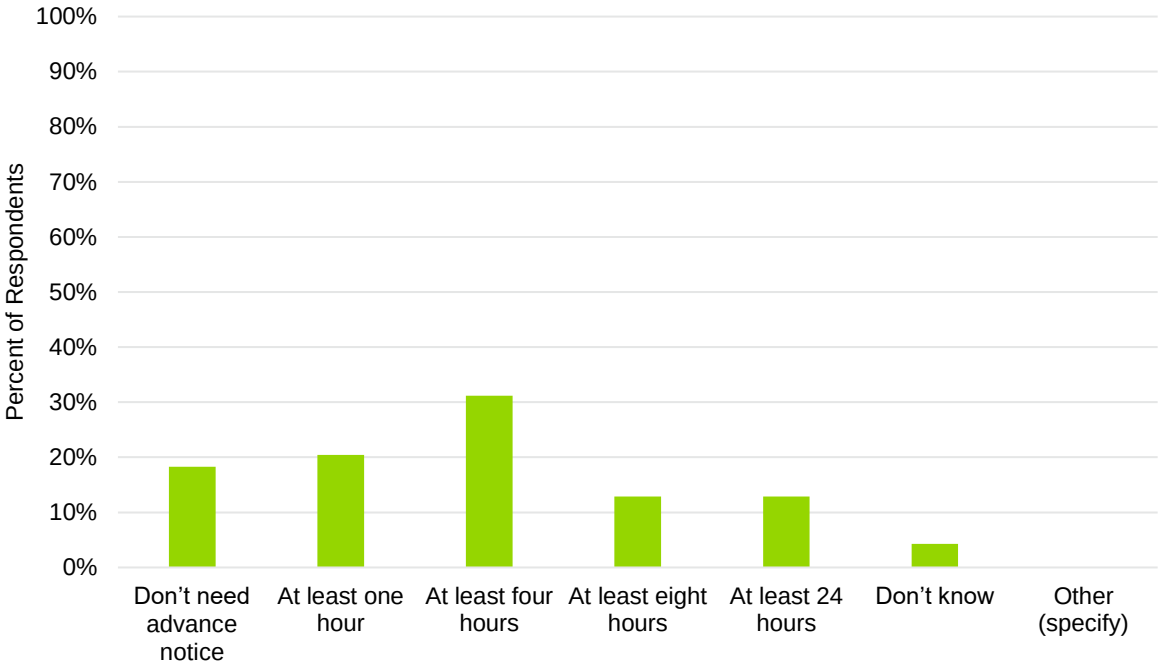
Q8. In general, how much advance notice would you like before an event? n=93



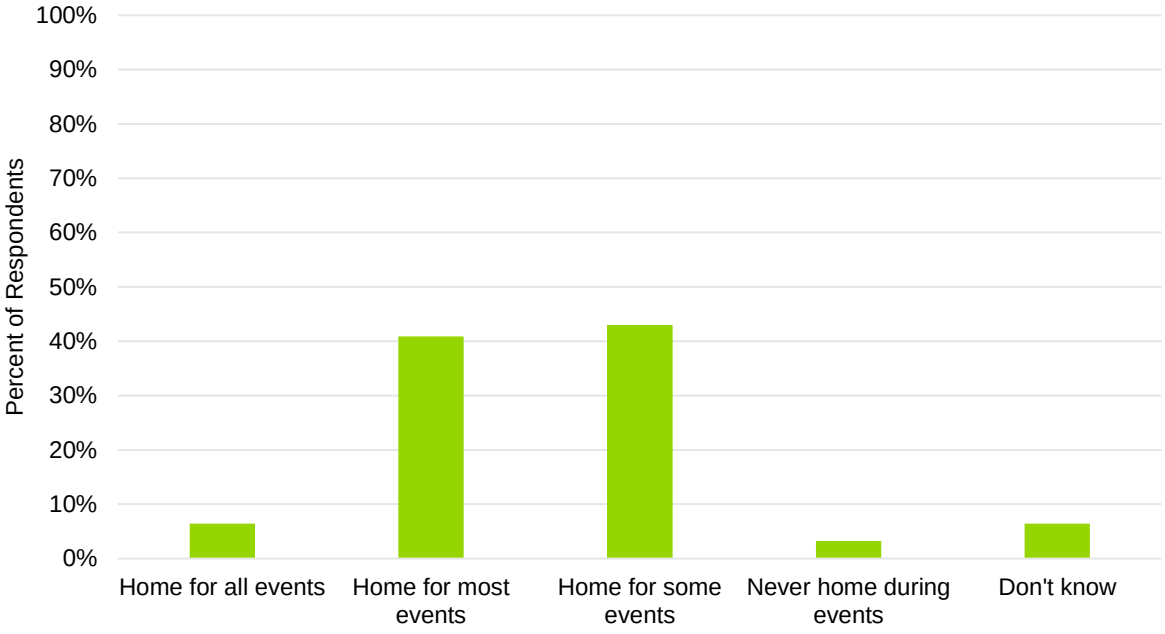
Source: Navigant analysis of online survey data

Q9. Are there ways that event notification could be improved? (optional) n=34

Customer verbatims were summarized in the report, as appropriate.

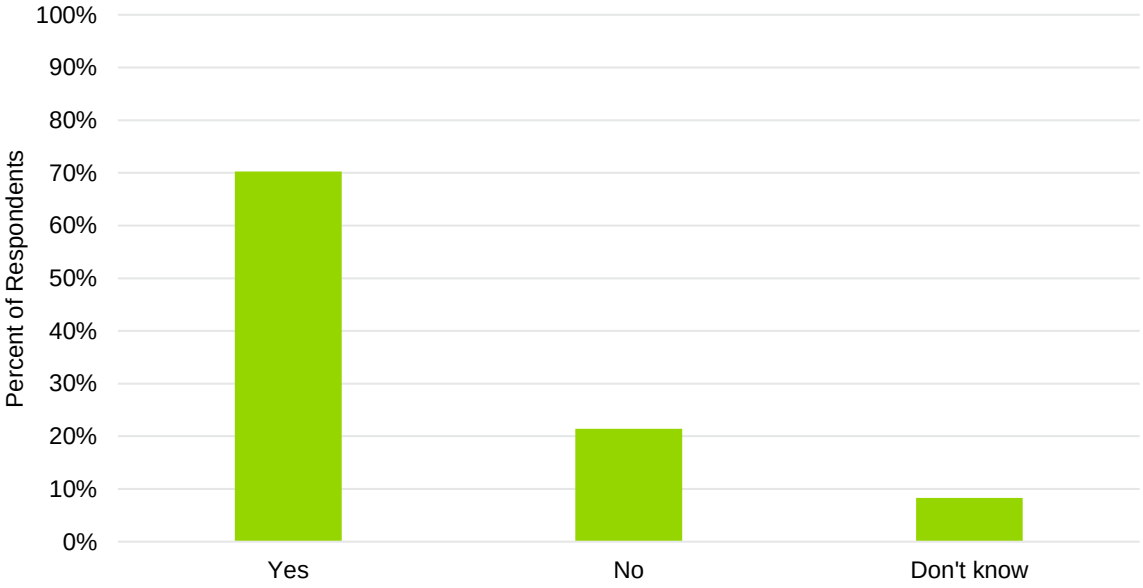
D.3.4 Comfort and Behavior During Events

Q10. This summer, for the events you can recall, how often were you or another family member at home during any part of the events? n=93



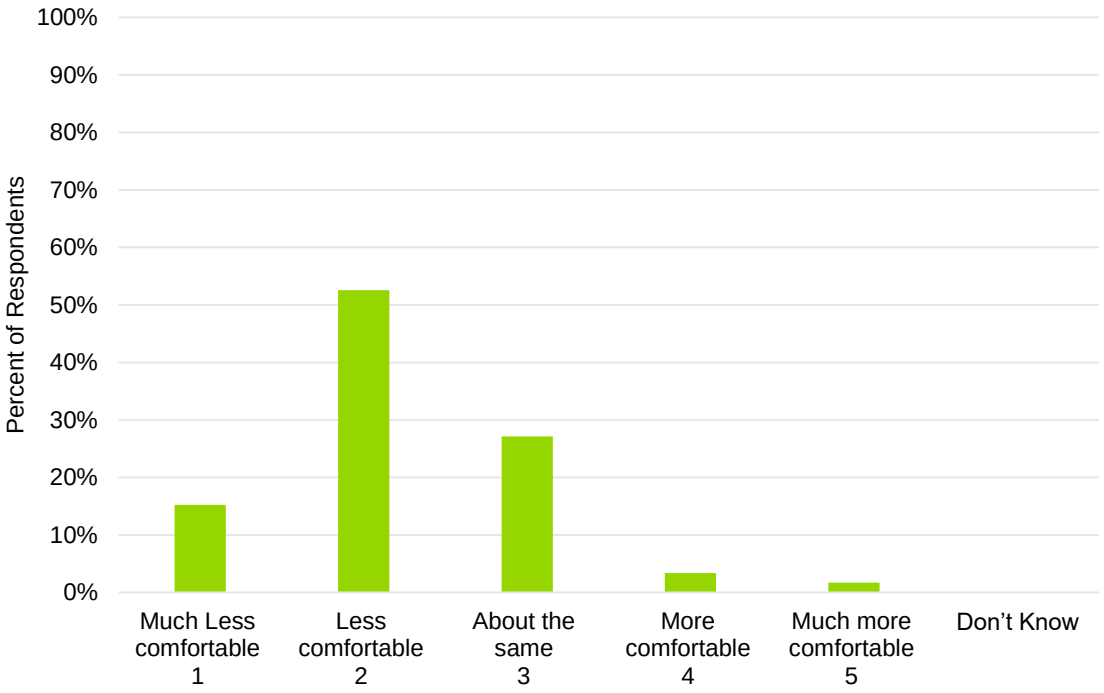
Source: Navigant analysis of online survey data

Q11. During the events you can recall, did you or another family member notice any changes to your home's indoor temperature? n=84



Source: Navigant analysis of online survey data

Q12. During the events you can recall, using a scale of 1 to 5, where 1 means "Much less comfortable" and 5 means "Much more comfortable", how would you generally describe your comfort compared to typical afternoons with similar outdoor temperatures? n=59

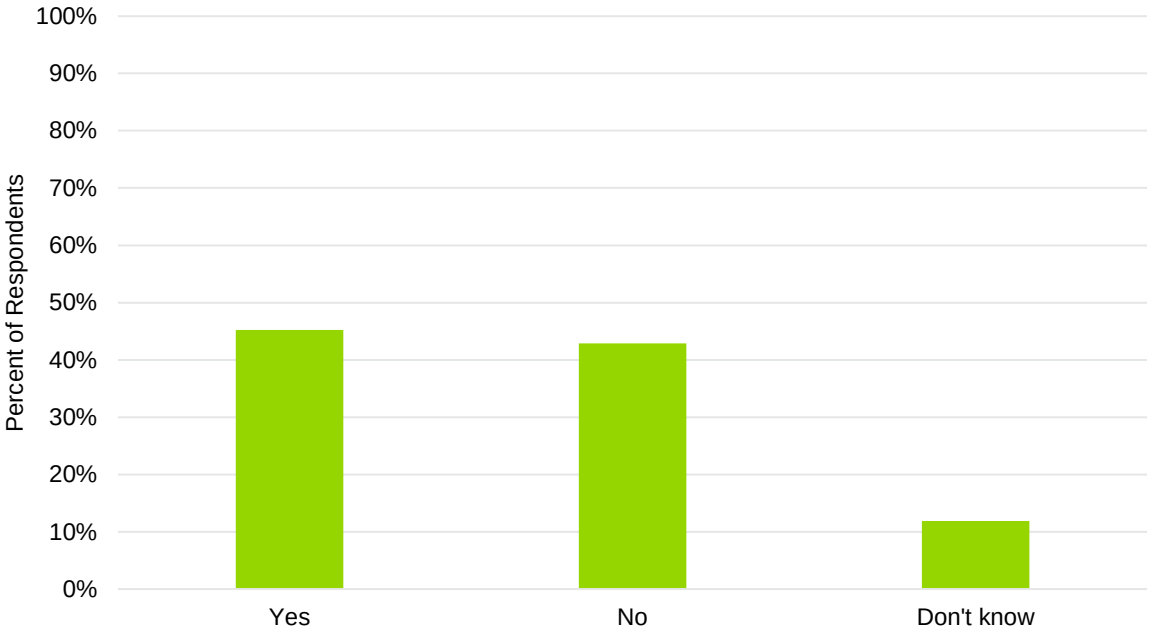


Source: Navigant analysis of online survey data

Q13. Do you have any comments to provide about your household's comfort level during events? (optional) n=37

Customer verbatims were summarized in the report, as appropriate.

Q14. Prior to events, do you recall the program "pre-cooling" your home (i.e., providing your home extra cooling prior to event hours)? n=84



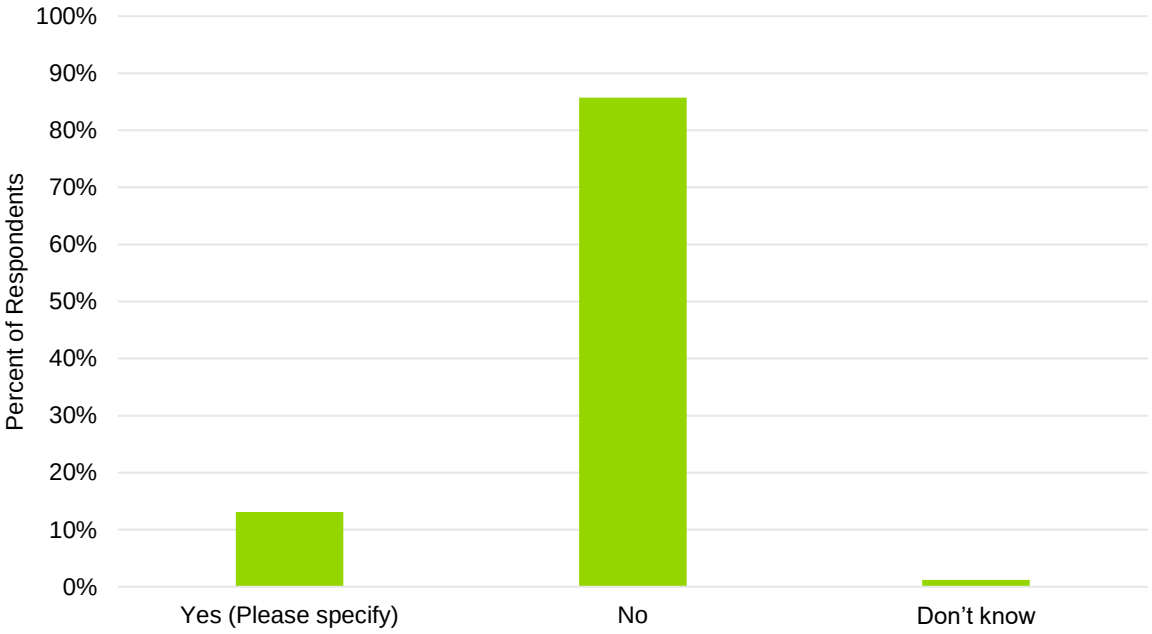
Source: Navigant analysis of online survey data

Q15. Do you have any feedback about the "pre-cooling" that occurred prior to events? (optional) n=24

Customer verbatims were summarized in the report, as appropriate.

Source: Navigant analysis of online survey data

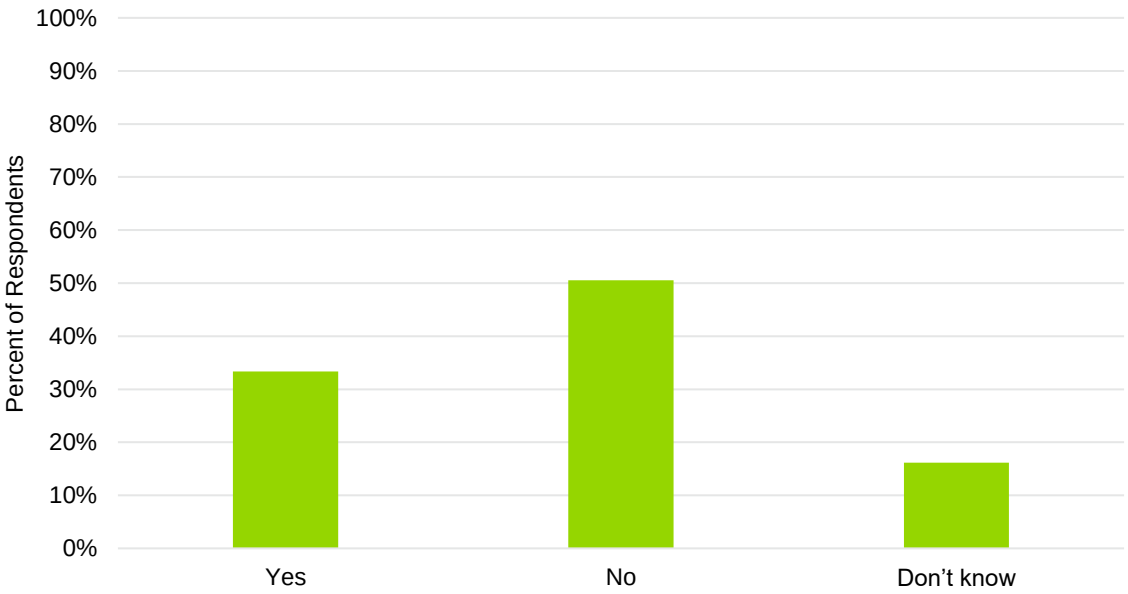
Q15_a. Prior to events, did you ever take any actions to prepare for the event? n=84



*Customer verbatims were summarized in the report, as appropriate.

Source: Navigant analysis of online survey data

Q16. On event days, did you or a family member ever "opt-out" of an event or override your thermostat setting to stop the program from adjusting your thermostat during the event? n=93



Source: Navigant analysis of online survey data

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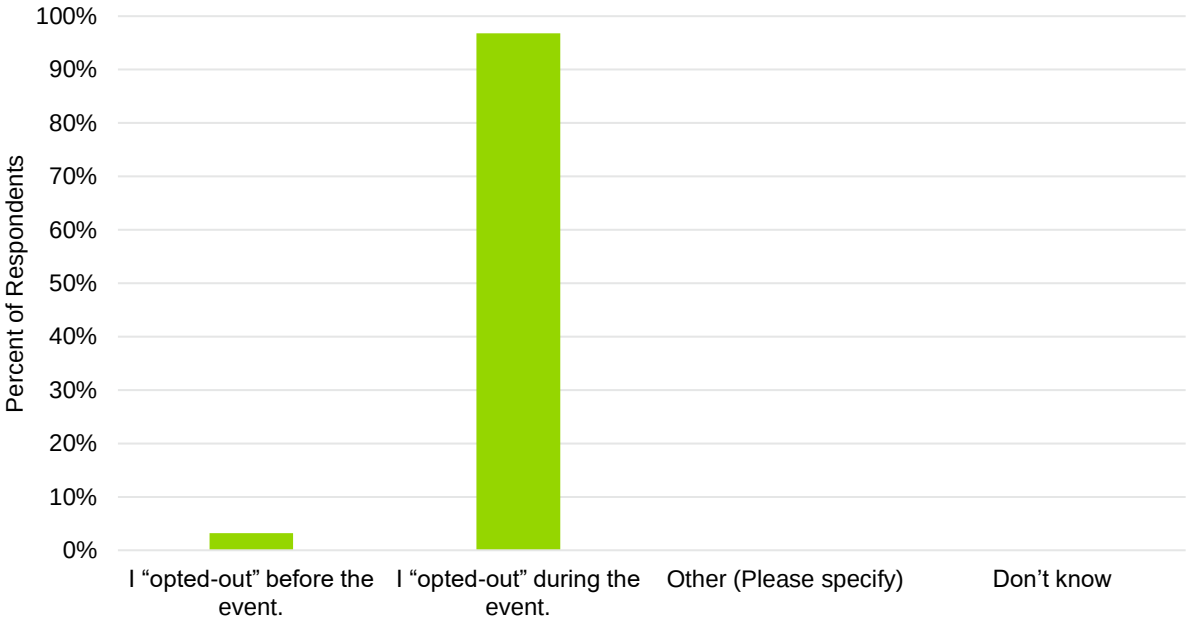
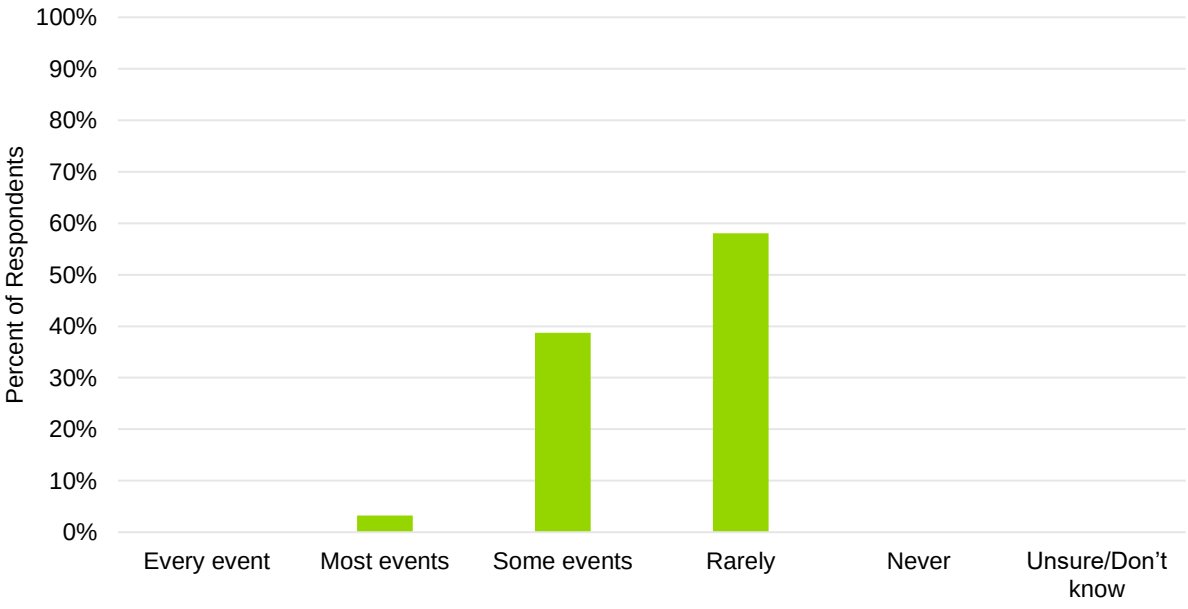
Q16_a. Did you "opt-out" or override your thermostat setting before events or during the events? (Select all that apply) n=31



Source: Navigant analysis of online survey data

Q17. How often would you say you chose to opt-out of an event or override the scheduled event thermostat setting? Would you say… n=31



Source: Navigant analysis of online survey data

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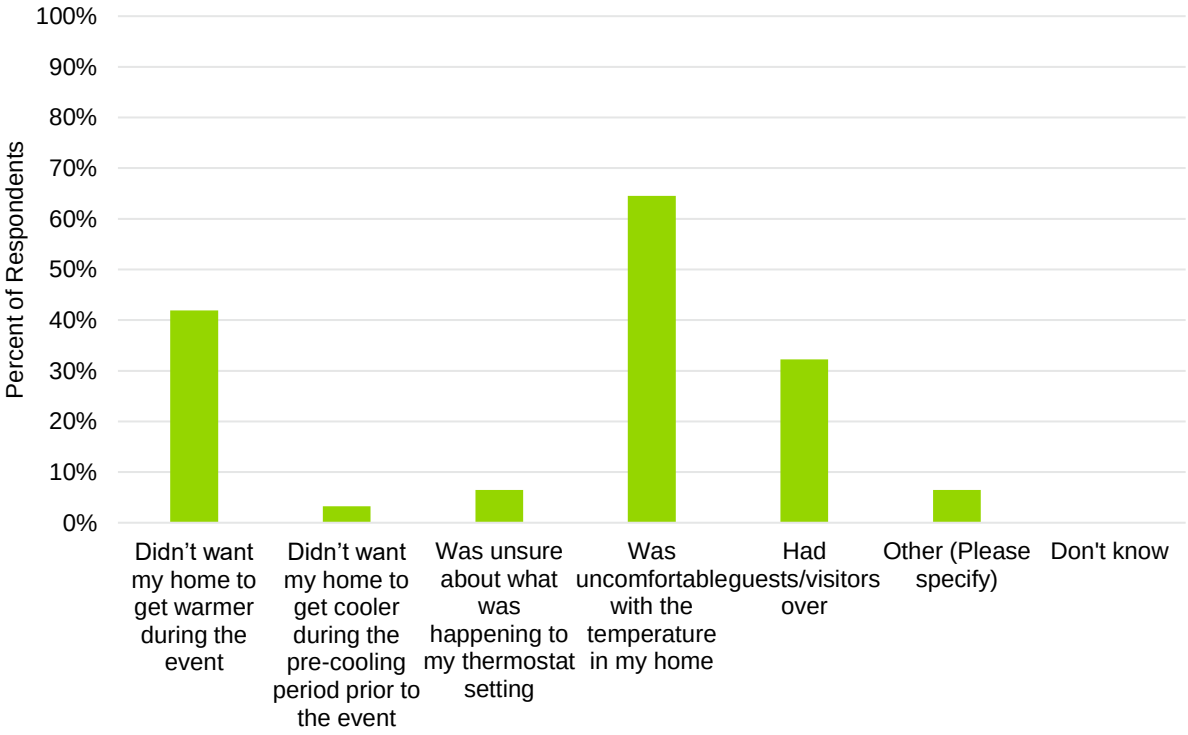
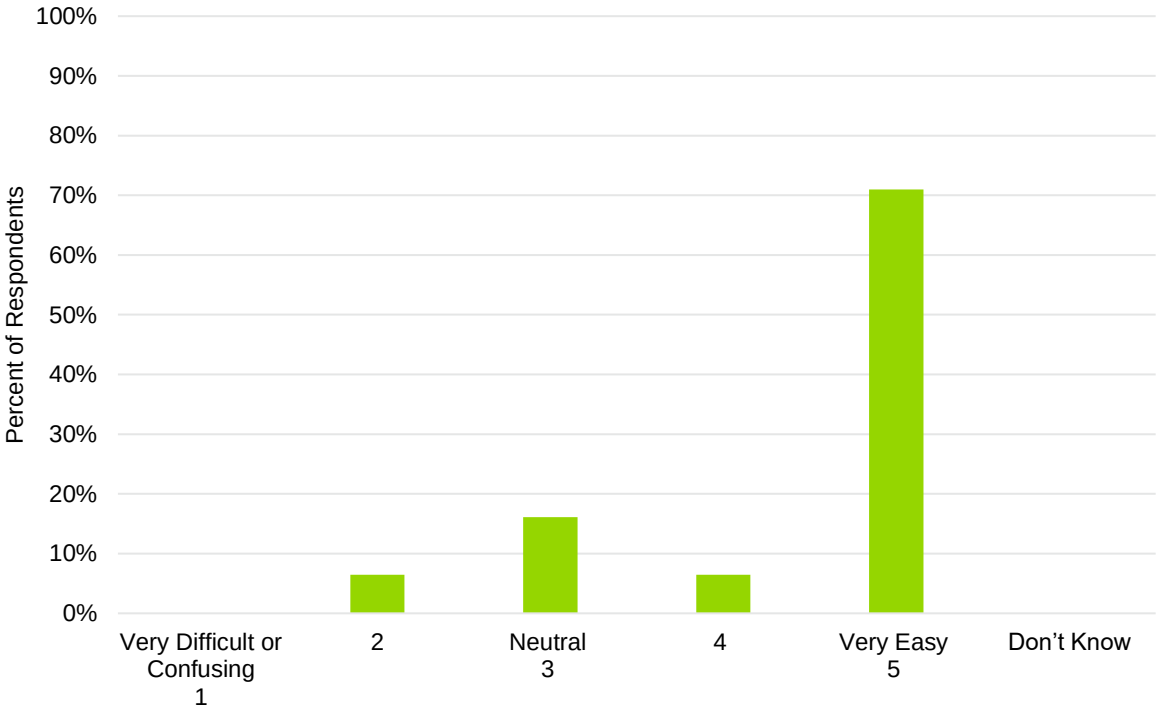
Q18. For what reason(s) did you opt-out or override the scheduled event thermostat setting? (Select all that apply) n=31



*Customer verbatims were summarized in the report, as appropriate.

Source: Navigant analysis of online survey data

Q19. Using a scale of 1 to 5, where 1 means "Very Difficult or Confusing" and 5 means "Very Easy", how easy was it to opt-out of or override events? n=31



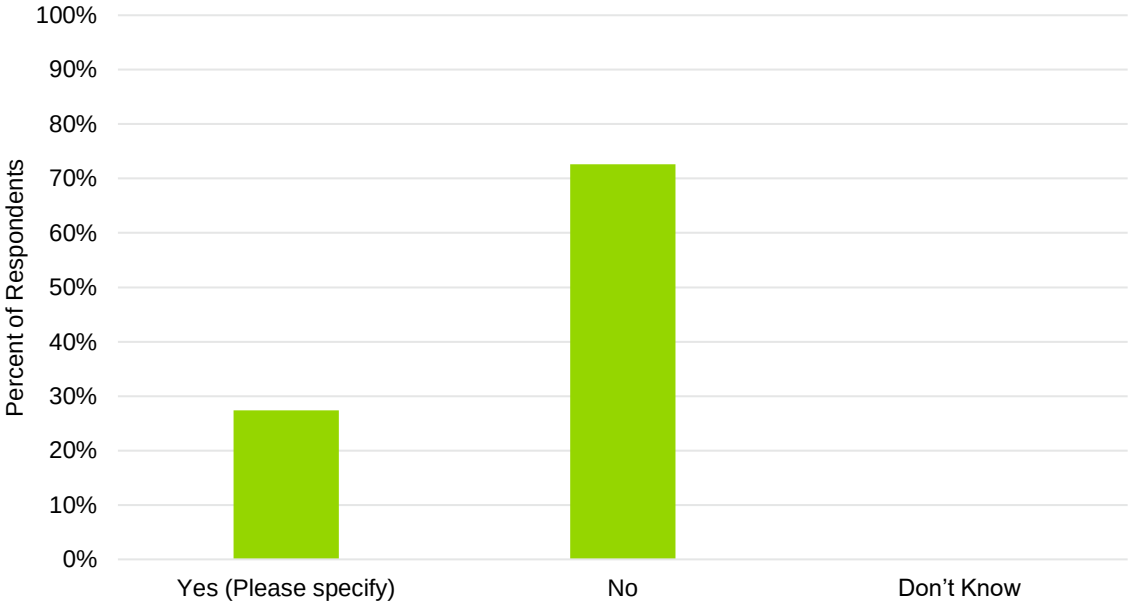
Source: Navigant analysis of online survey data

Q20. What issues did you encounter when trying to opt-out of or override a scheduled event? n=2

Customer verbatims were summarized in the report, as appropriate.

D.3.5 General Thermostat and AC Usage Behavior

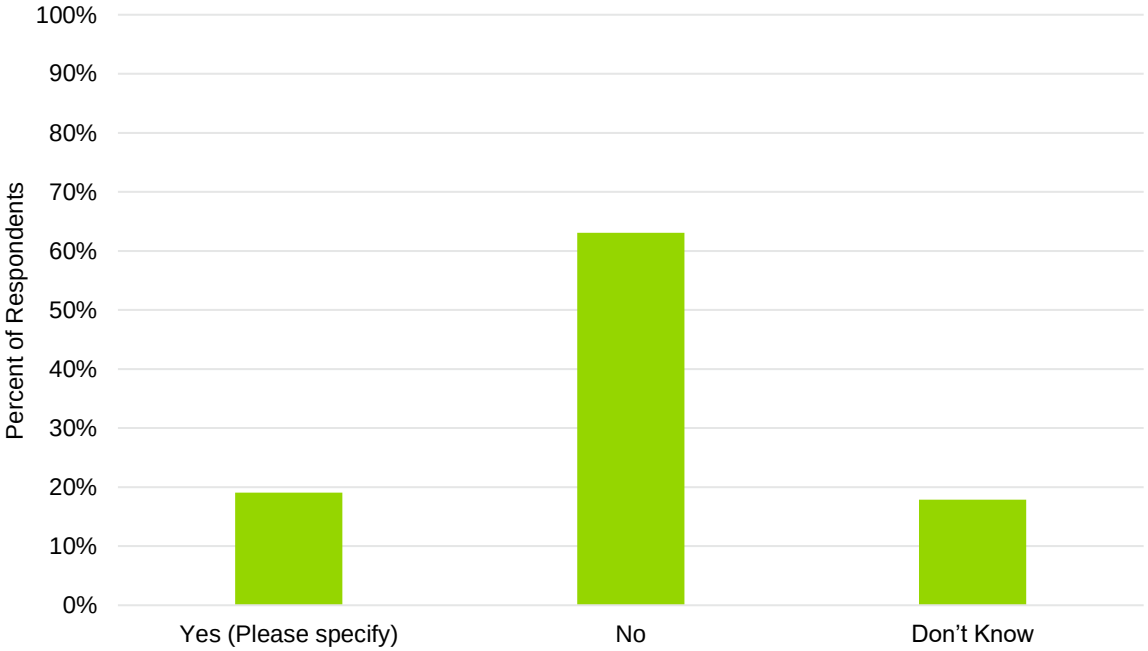
Q21. During an event, did you ever rely on other appliances (e.g., fans or room air-conditioners) to maintain comfort? n=84



*Customer verbatims were summarized in the report, as appropriate.

Source: Navigant analysis of online survey data

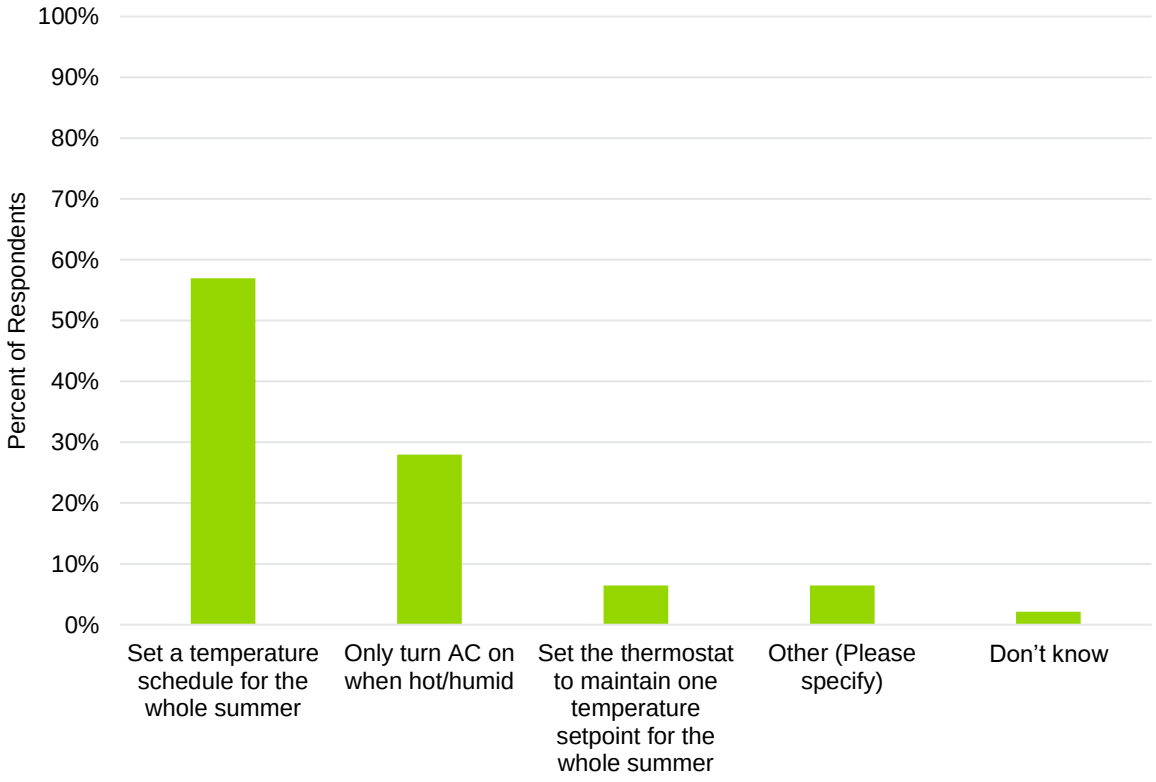
Q22. Did you or other members of your family ever take any actions to reduce your electricity use during events (apart from allowing your thermostat setpoint to be adjusted)? n=84



*Customer verbatims were summarized in the report, as appropriate.

Source: Navigant analysis of online survey data

Q23. How did you typically use your thermostat throughout the summer? n=93



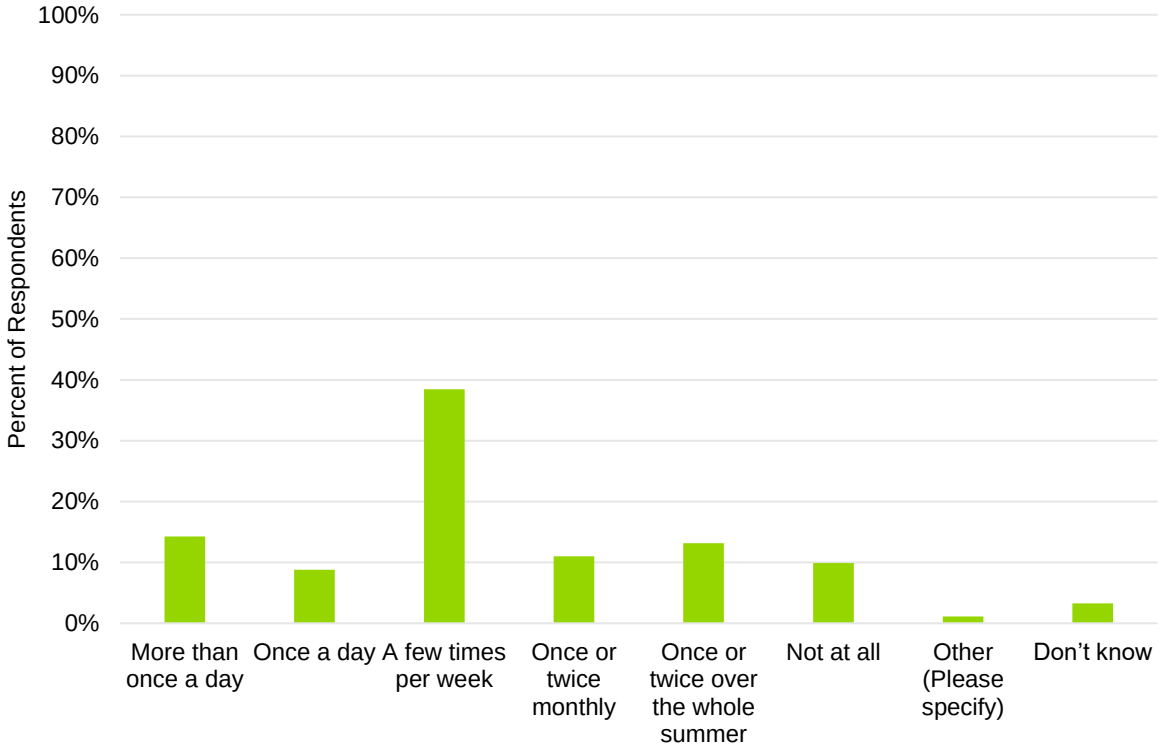
*Customer verbatims were summarized in the report, as appropriate.

Source: Navigant analysis of online survey data

Q23_a. Above what indoor temperature do you typically turn your air conditioning on? n=25

Customer verbatims were summarized in the report, as appropriate.

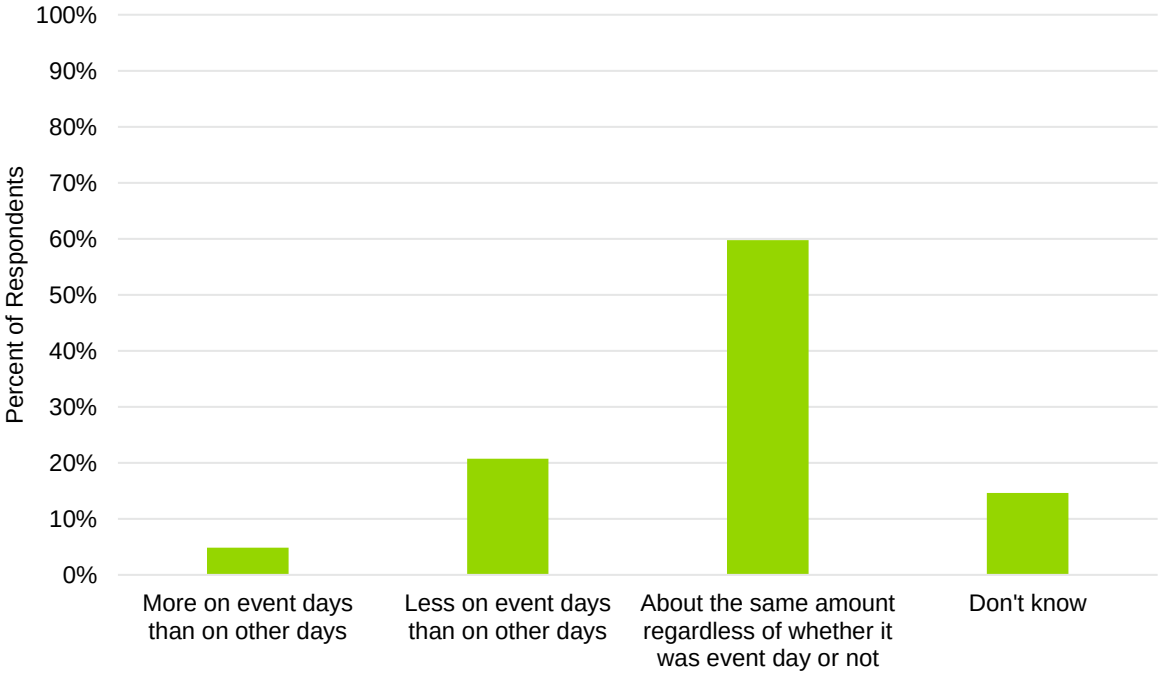
Q23_b. Now we'd like to understand the frequency with which you adjusted your Wi-Fi thermostat's setting or schedule (either up or down) on days when there was no event this summer. Would you say it was… n=91



*Customer verbatims were summarized in the report, as appropriate.

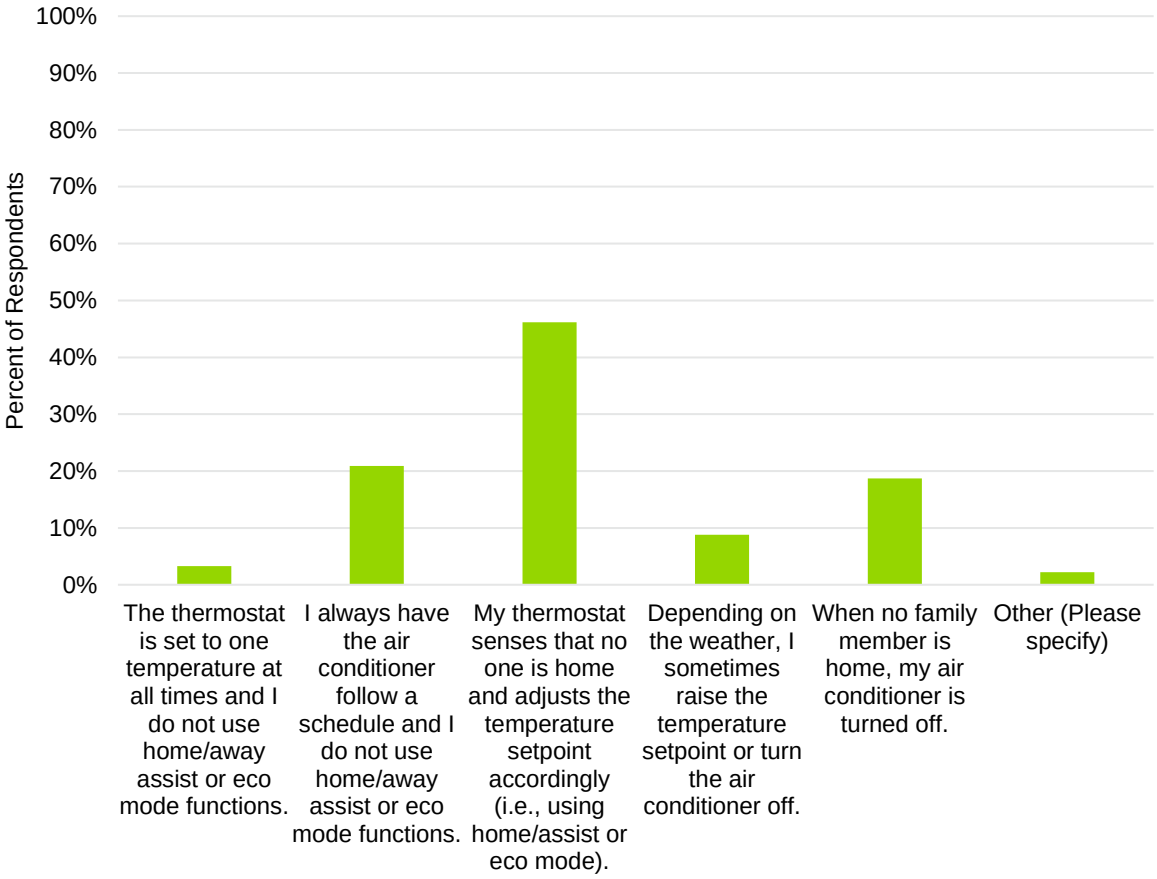
Source: Navigant analysis of online survey data

Q23_c. We'd also like to understand whether the frequency with which you adjusted your Wi-Fi thermostat's setting or schedule was different on event days compared to other days. Would you say you adjusted your home's temperature… n=82



Source: Navigant analysis of online survey data

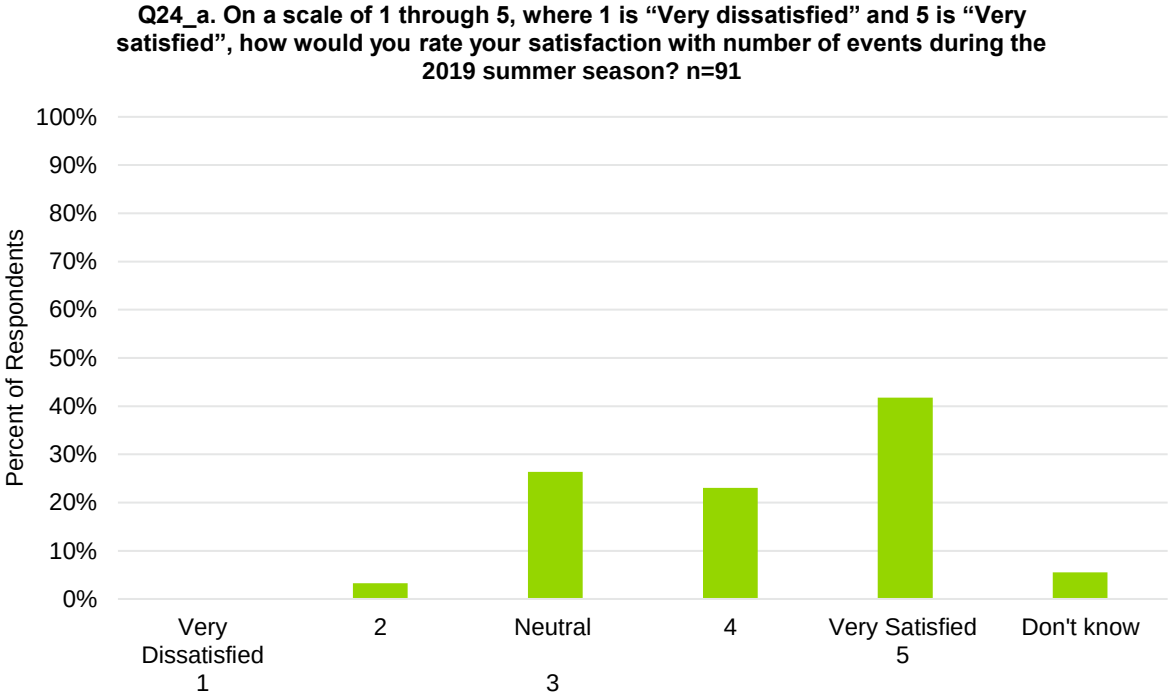
Q23_d. When no family member is at home, which of the following best describes the way you use your air conditioner? n=91



*Customer verbatims were summarized in the report, as appropriate.

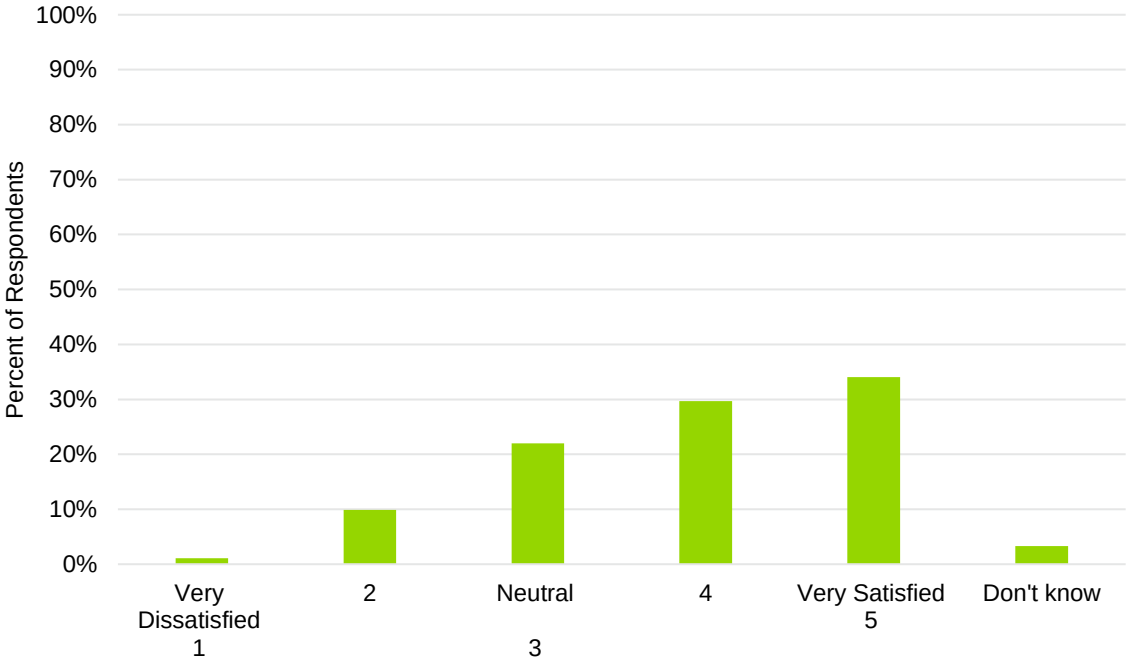
Source: Navigant analysis of online survey data

D.3.6 Program Satisfaction



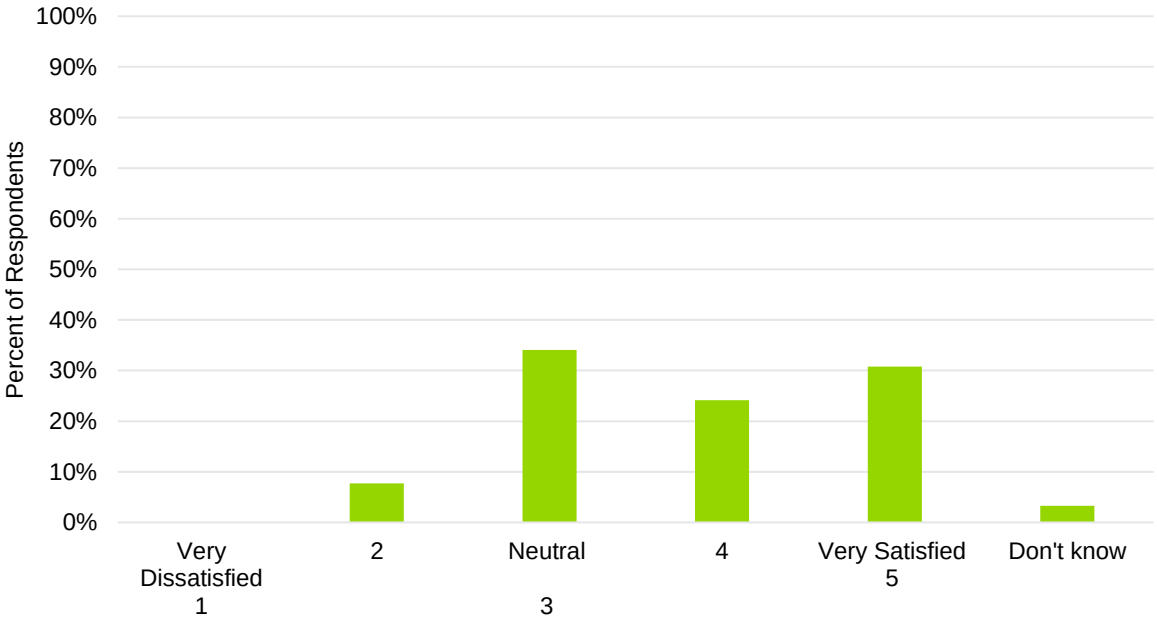
Source: Navigant analysis of online survey data

Q24_b. On a scale of 1 through 5, where 1 is "Very dissatisfied" and 5 is "Very satisfied", how would you rate your satisfaction with the length of events during the 2019 summer season? n=91



Source: Navigant analysis of online survey data

Q24_c. On a scale of 1 through 5, where 1 is "Very dissatisfied" and 5 is "Very satisfied", how would you rate your satisfaction with the timing of events during the 2019 summer season? n=91



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Source: Navigant analysis of online survey data

Q25. What changes to the number of events would you recommend? n=3

Customer verbatims were summarized in the report, as appropriate.

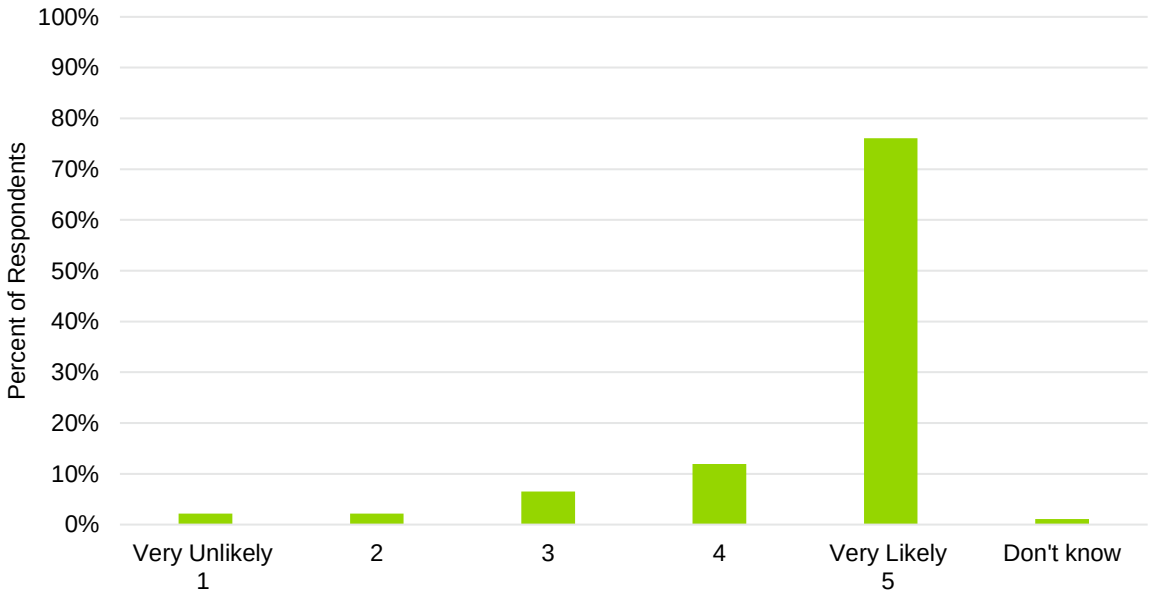
Q26. What changes to the length of events would you recommend? n=10

Customer verbatims were summarized in the report, as appropriate.

Q27. What changes to the timing of events would you recommend? n=7

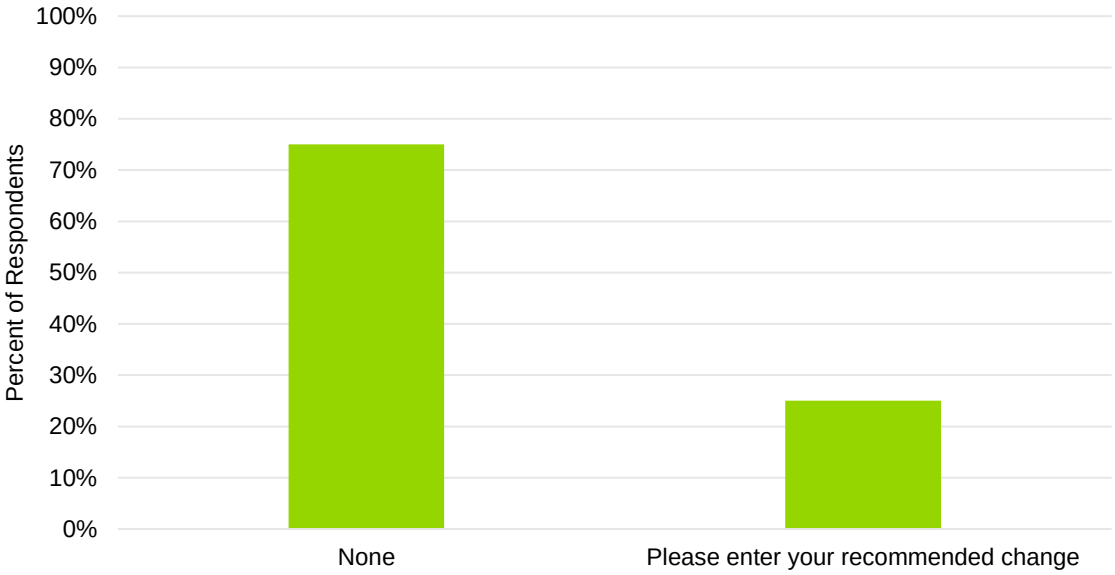
Customer verbatims were summarized in the report, as appropriate.

Q28. In future summers, how likely would you be to participate in the ConnectedSolutions Program, on a scale of 1-5, where 1 is "Very Unlikely" and 5 is "Very Likely"? n=92



Source: Navigant analysis of online survey data

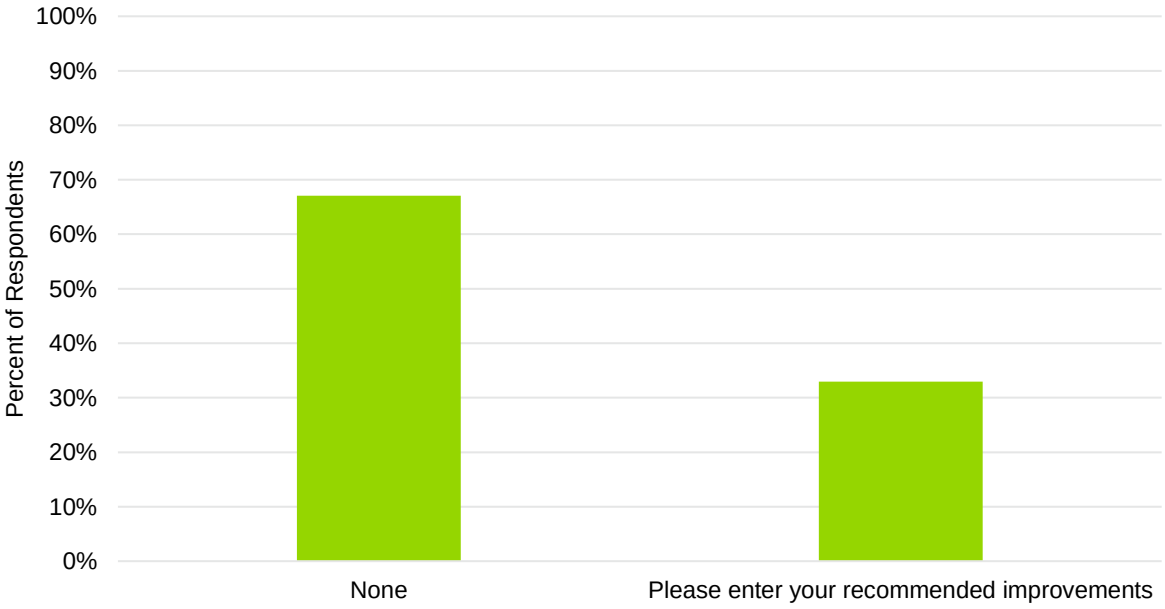
Q29. What change(s) to the ConnectedSolutions Program would encourage you to continue participating? n=4



*Customer verbatims were summarized in the report, as appropriate.

Source: Navigant analysis of online survey data

Q30. What recommendations would you make to help improve the ConnectedSolutions Program going forward? n=88



*Customer verbatims were summarized in the report, as appropriate.

Source: Navigant analysis of online survey data

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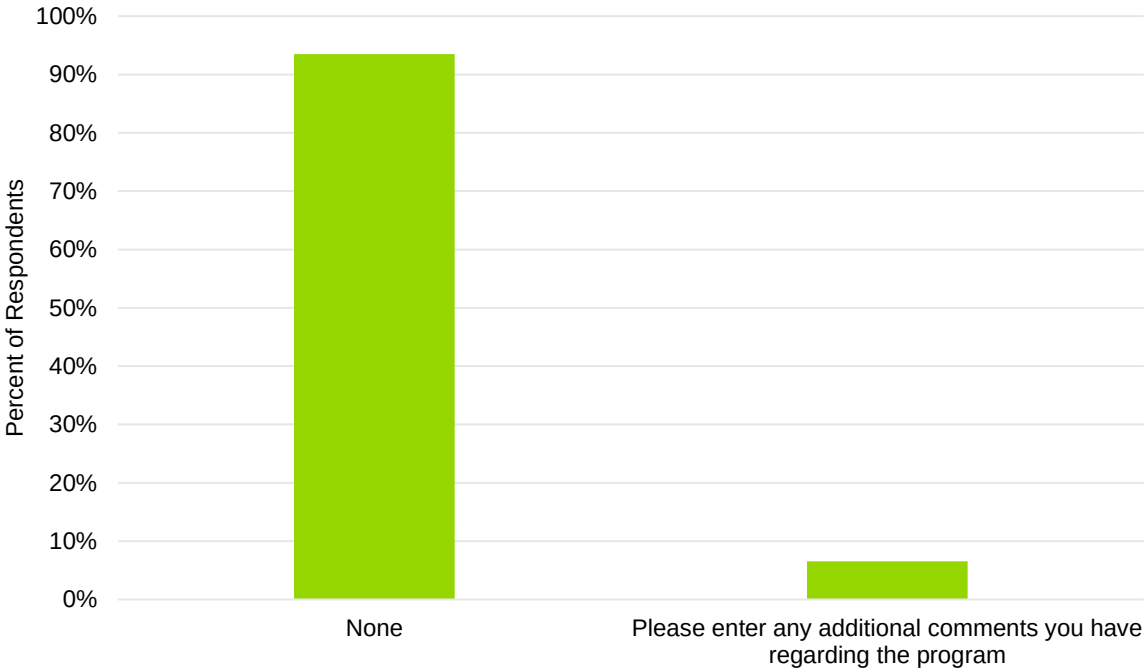
Q31. We have reached the end of the survey. Do you have any additional comments regarding the ConnectedSolutions Program? n=92

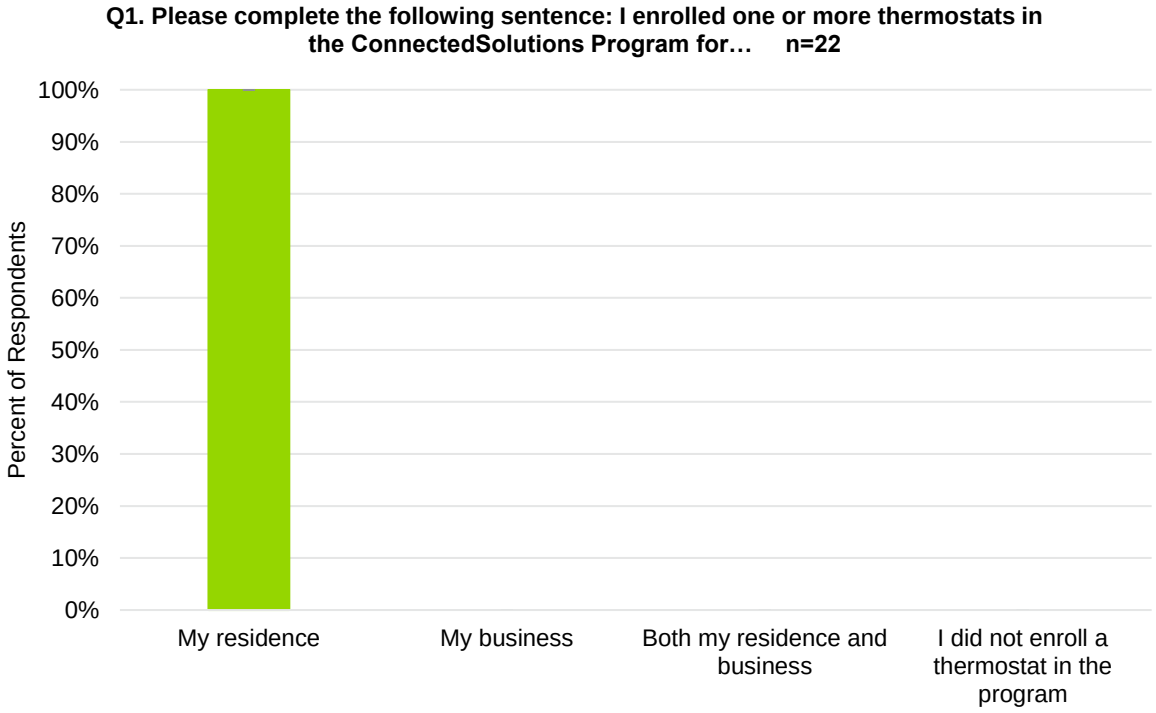


*Customer verbatims were summarized in the report, as appropriate.

Source: Navigant analysis of online survey data

D.4 Unitil

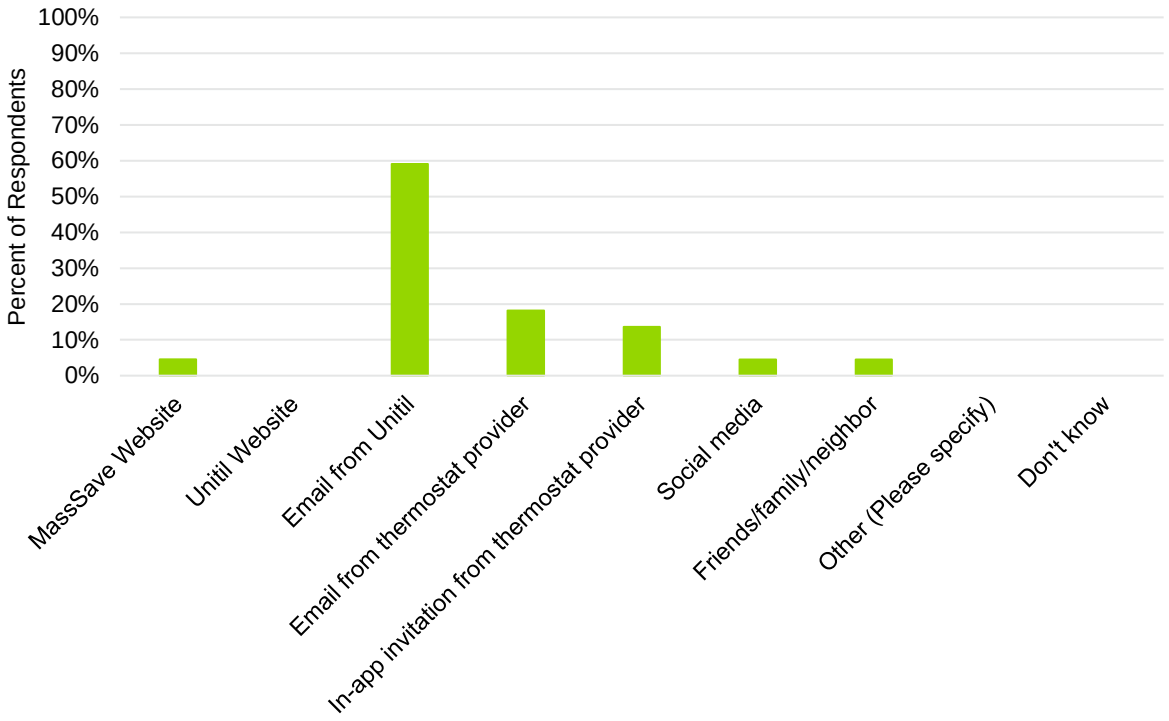
D.4.1 Screening



Source: Navigant analysis of online survey data

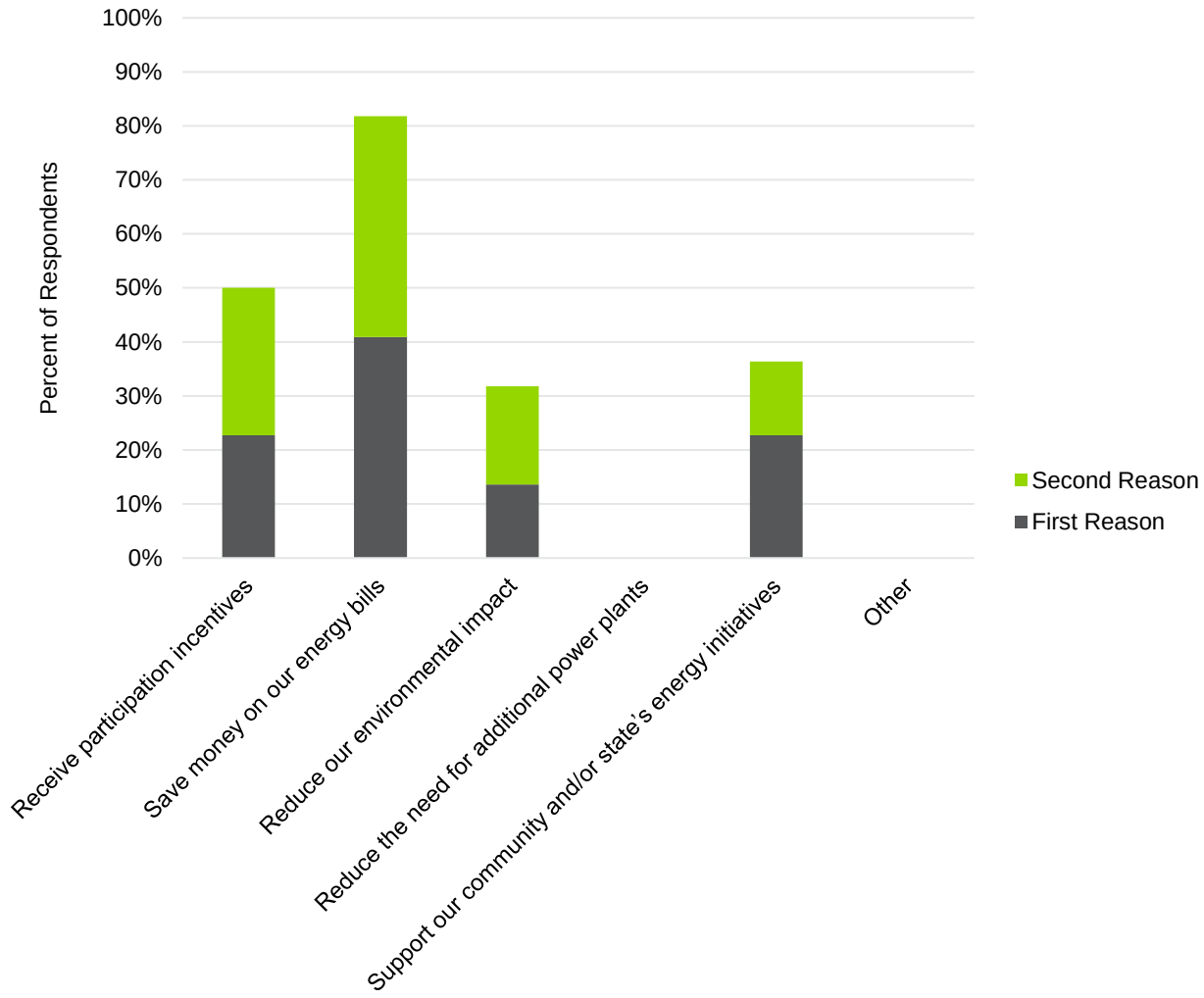
D.4.2 Motivations

Q2. How did you become aware of the ConnectedSolutions Program? (Select all that apply) n=22



Source: Navigant analysis of online survey data

Q3. What was your motivation for participating in the ConnectedSolutions Program in 2019? Select your first and second reasons for enrolling. n=22

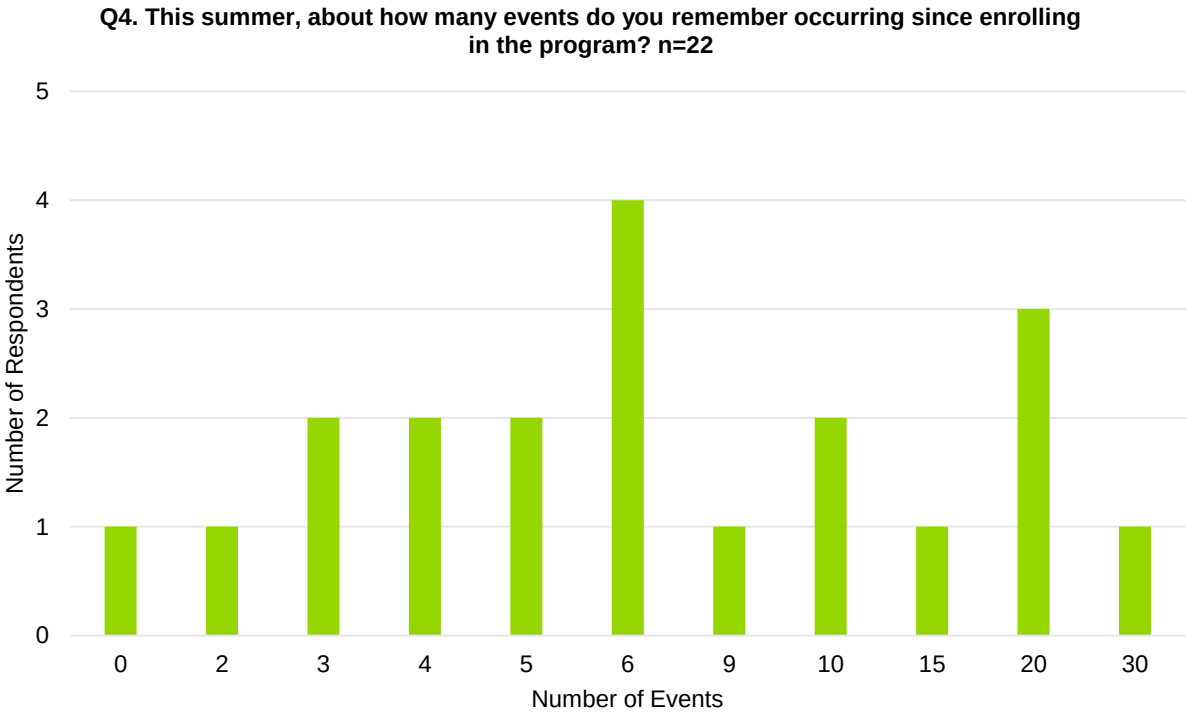


Source: Navigant analysis of online survey data

Q3_a. For what OTHER reasons did you enroll in the program? n=0

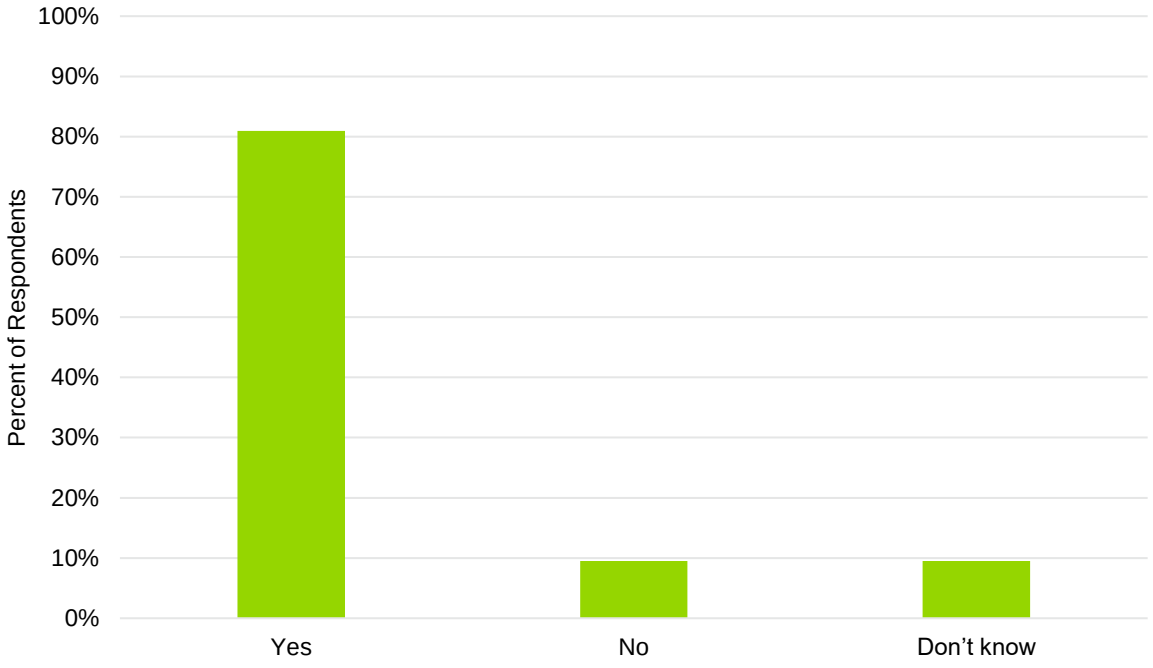
No responses.

D.4.3 Awareness and Notification



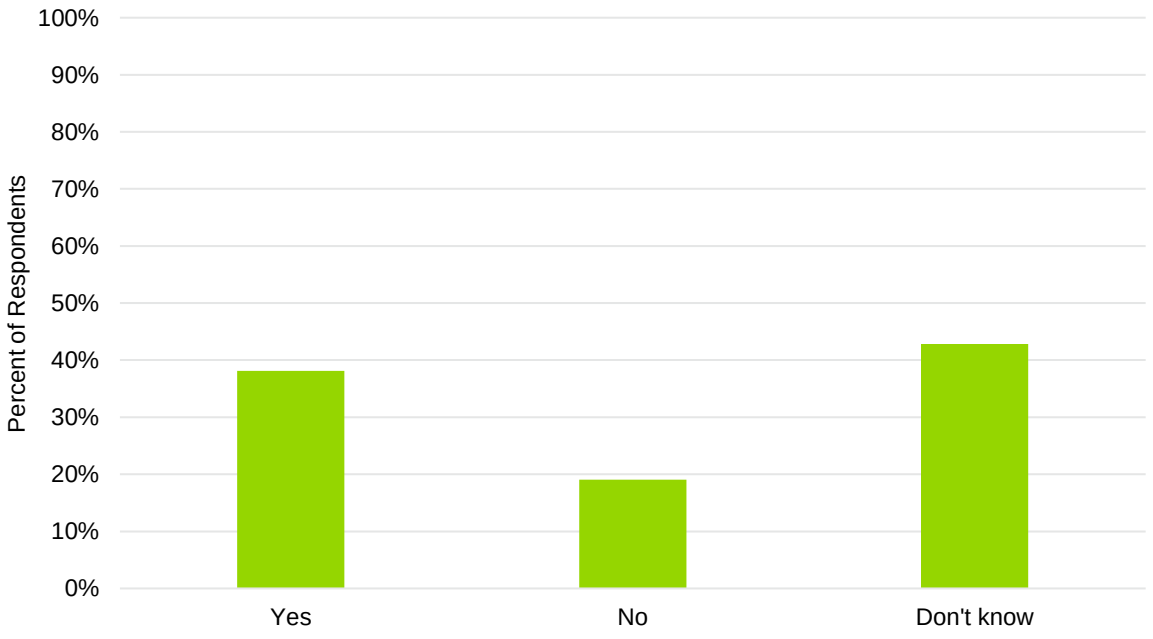
Source: Navigant analysis of online survey data

Q5. During this past summer, did you ever receive advance notifications about the events? n=21



Source: Navigant analysis of online survey data

Q5_a. After enrolling in the ConnectedSolutions Program, did you receive an option to opt-out of advance notifications? n=21



Source: Navigant analysis of online survey data

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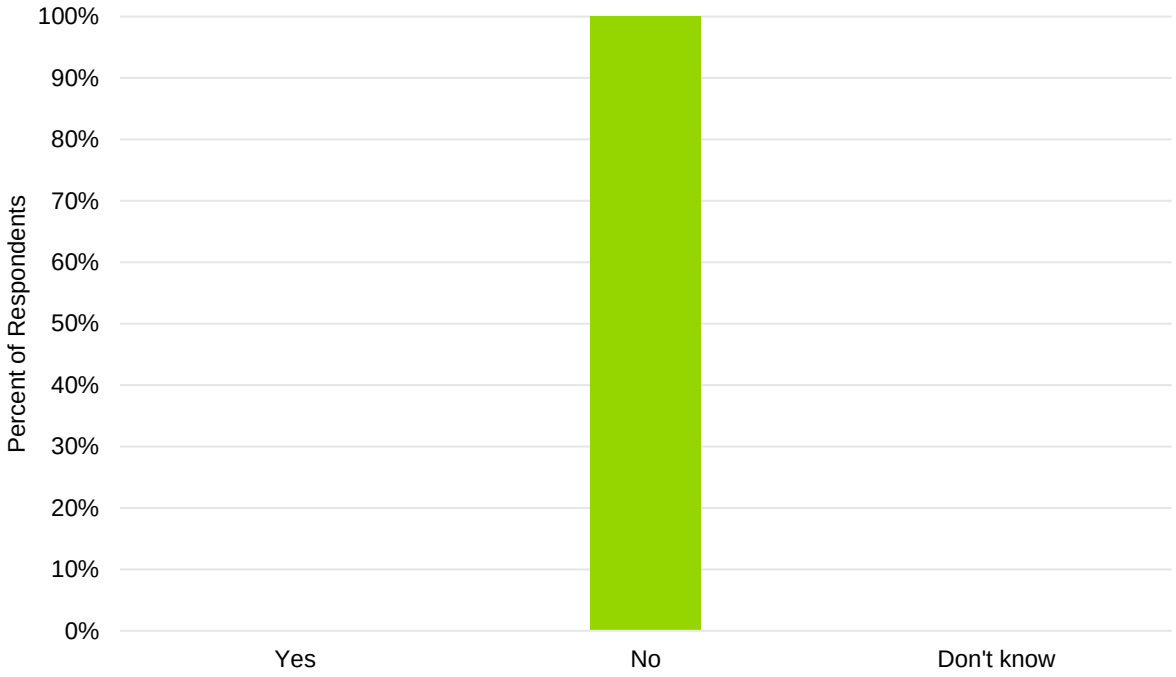
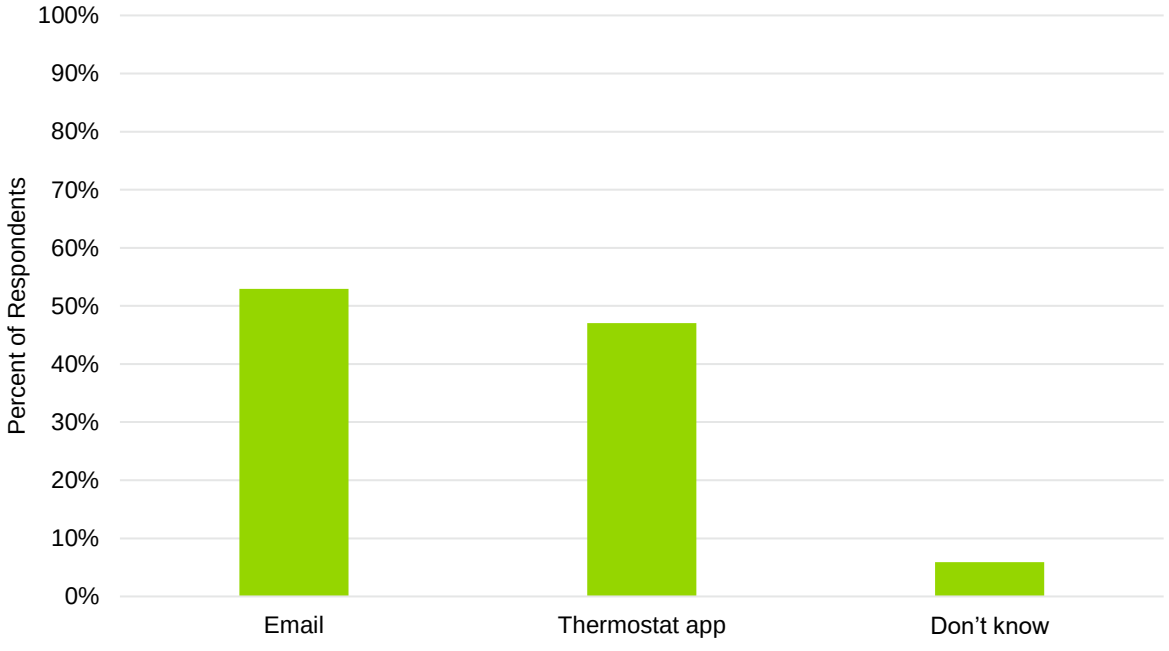
Q5_b. Did you choose to opt-out of advance notifications? n=8



Source: Navigant analysis of online survey data

Q6. How were you notified in advance that an event was going to occur? (Select all that apply) n=17



Source: Navigant analysis of online survey data

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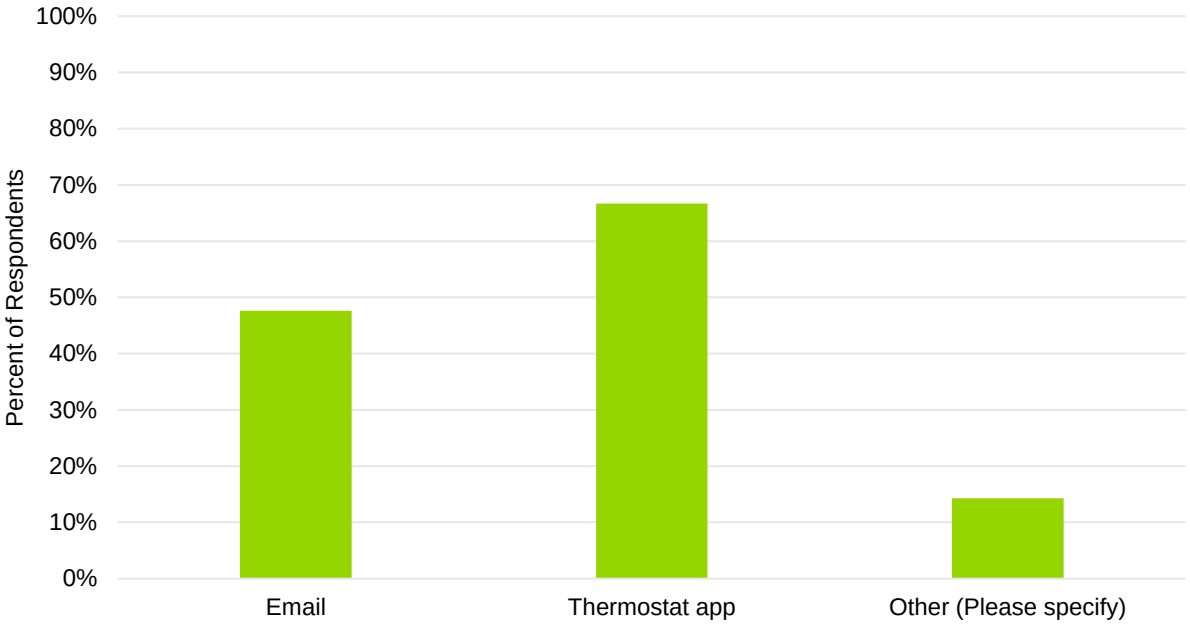
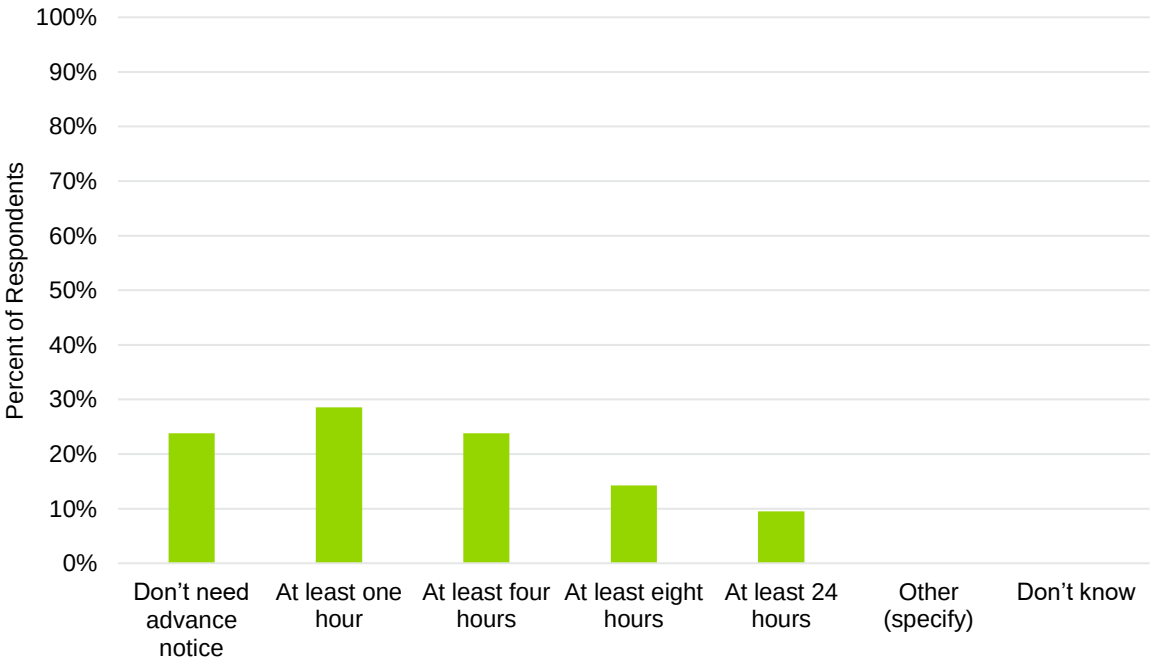
Q7. In general, how would you prefer to be notified that an event is going to occur? (Select all that apply) n=21



*Customer verbatims were summarized in the report, as appropriate.

Source: Navigant analysis of online survey data

Q8. In general, how much advance notice would you like before an event? n=21



Source: Navigant analysis of online survey data

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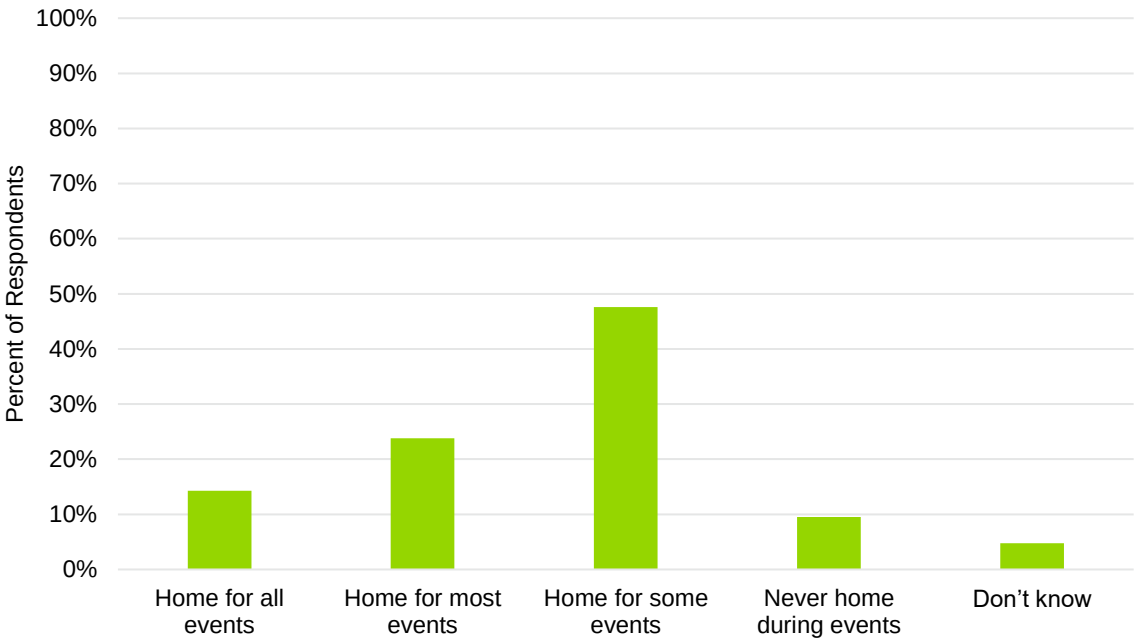
Q9. Are there ways that event notification could be improved? (optional) n=22

Customer verbatims were summarized in the report, as appropriate.

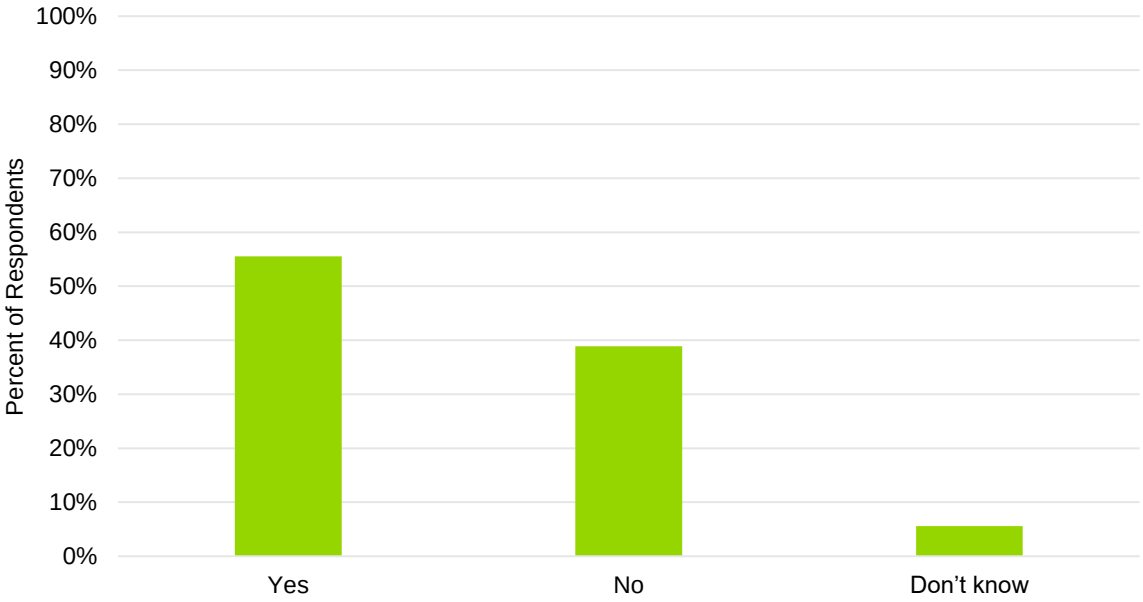
D.4.4 Comfort and Behavior During Events

Q10. This summer, for the events you can recall, how often were you or another family member at home during any part of the event? n=21



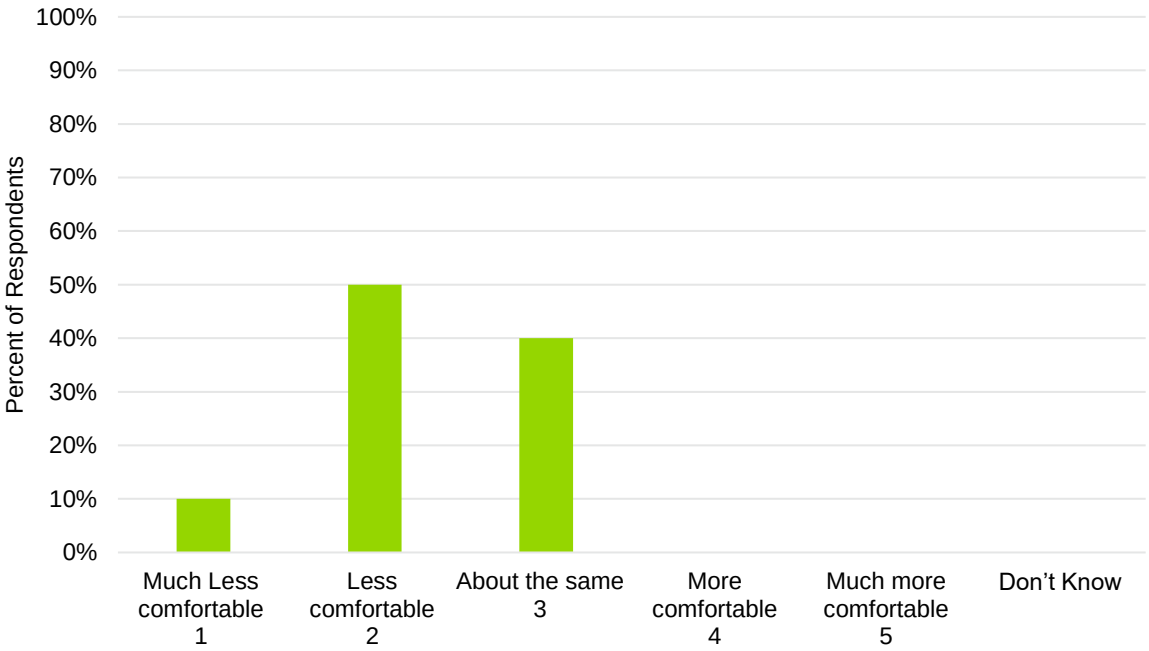
Source: Navigant analysis of online survey data

Q11. During the evens you can recall, did you or another family member notice any changes to your home's indoor temperature? n=18



Source: Navigant analysis of online survey data

Q12. During evens you can recall, using a scale of 1 to 5, where 1 means "Much less comfortable" and 5 means "Much more comfortable", how would you generally describe your comfort compared to typical afternoons with similar outdoor temperatures? n=10



Source: Navigant analysis of online survey data

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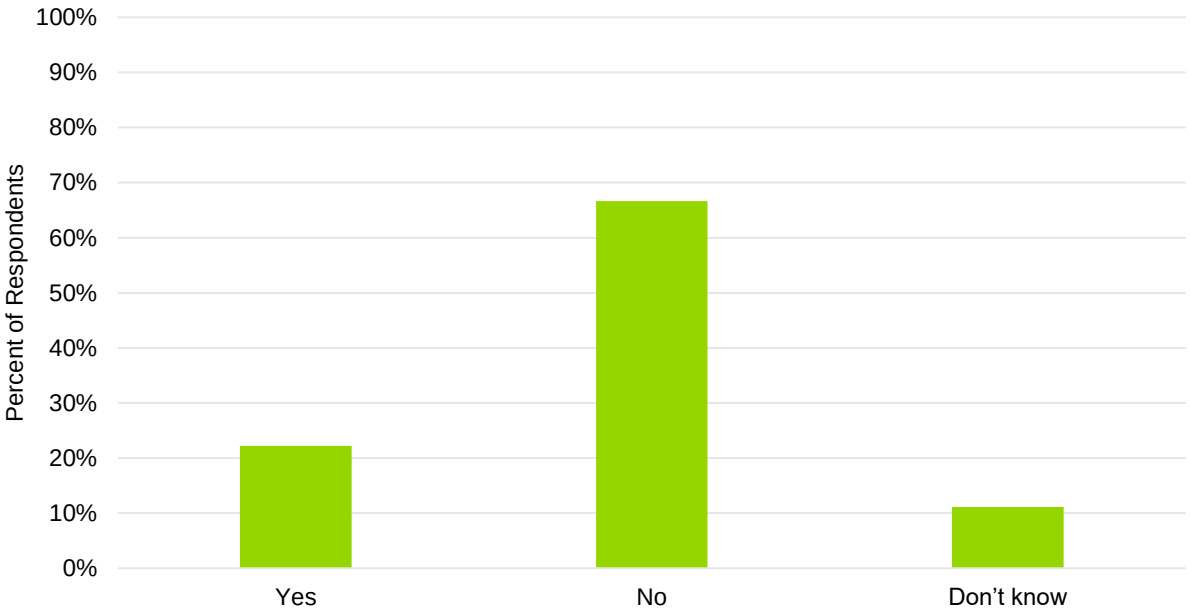
Q13. Do you have any comments to provide about your household's comfort level during events? (optional) n=7

Customer verbatims were summarized in the report, as appropriate.

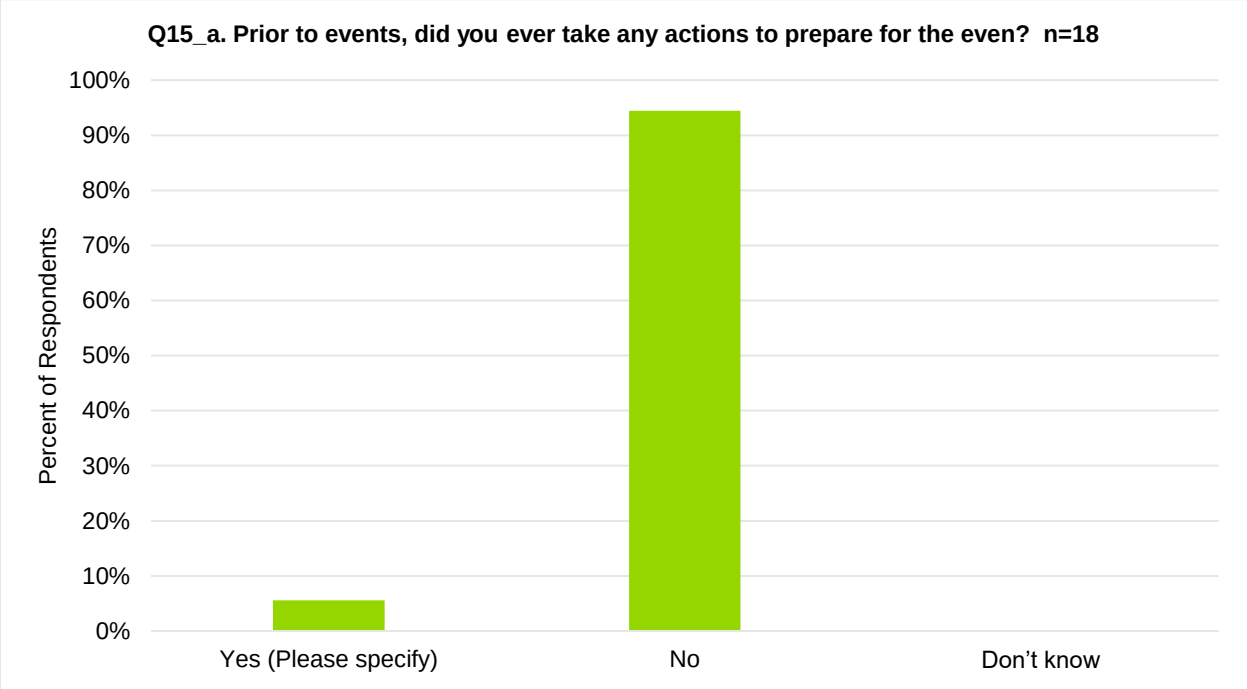
Q14. Prior to events, do you recall the program "pre-cooling" your home? n=18



Source: Navigant analysis of online survey data

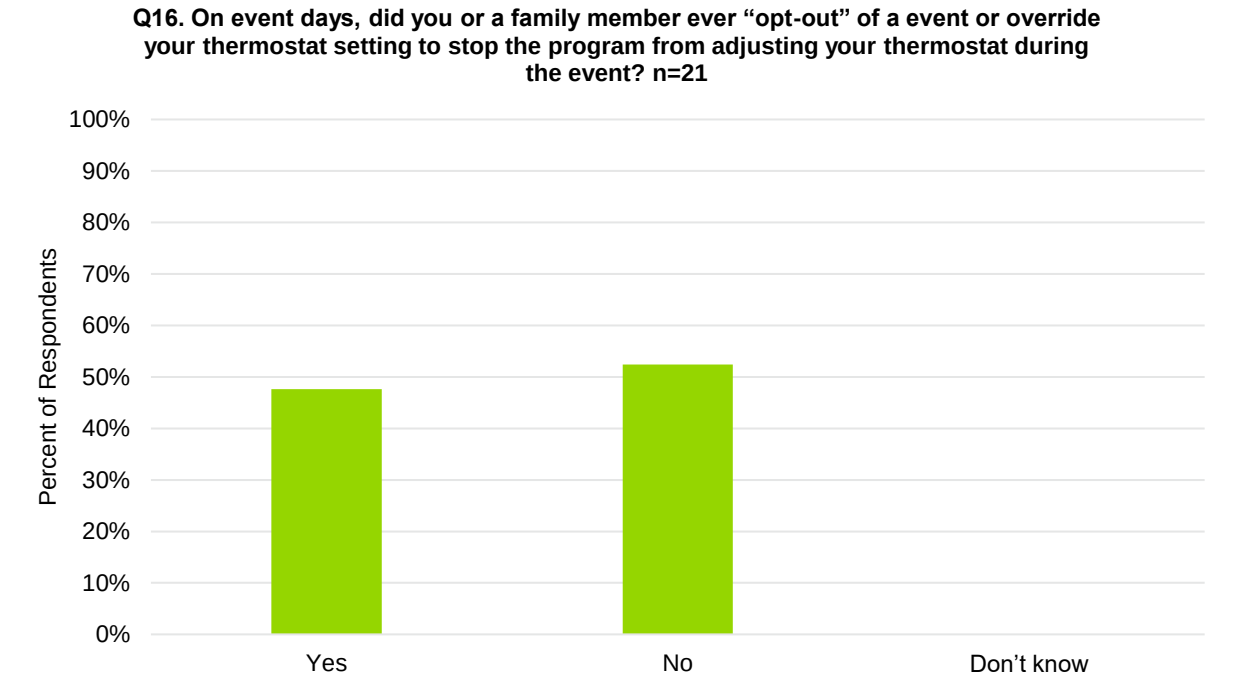
Q15. Do you have any feedback about the "pre-cooling" that occurred prior to events? (optional) n=3

Customer verbatims were summarized in the report, as appropriate.



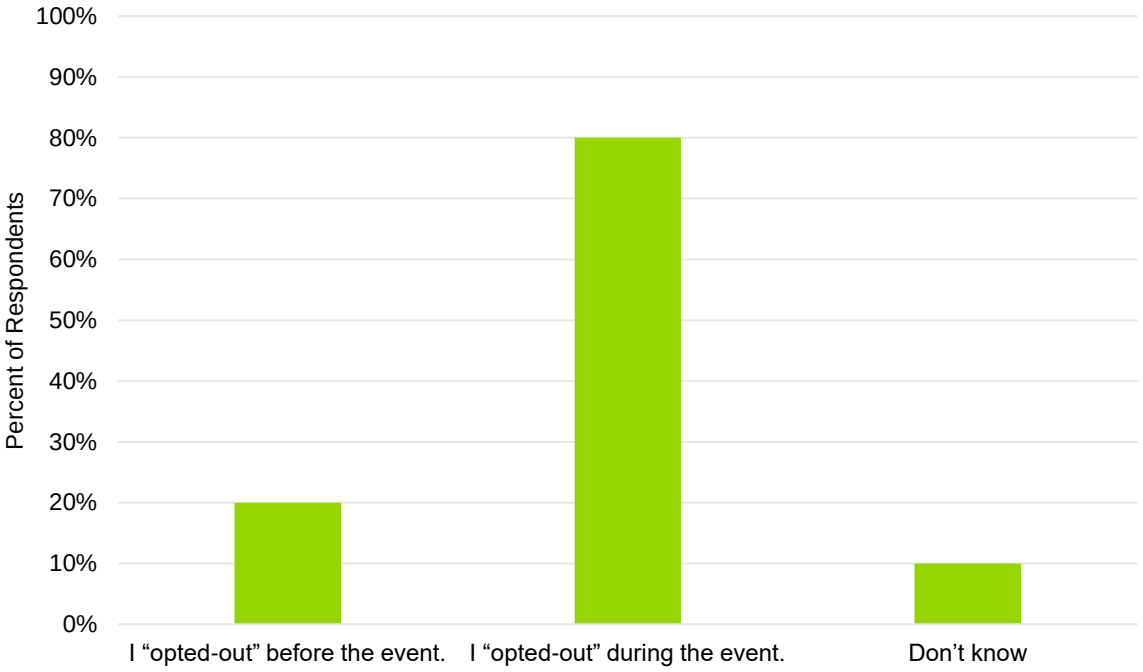
*Customer verbatims were summarized in the report, as appropriate.

Source: Navigant analysis of online survey data



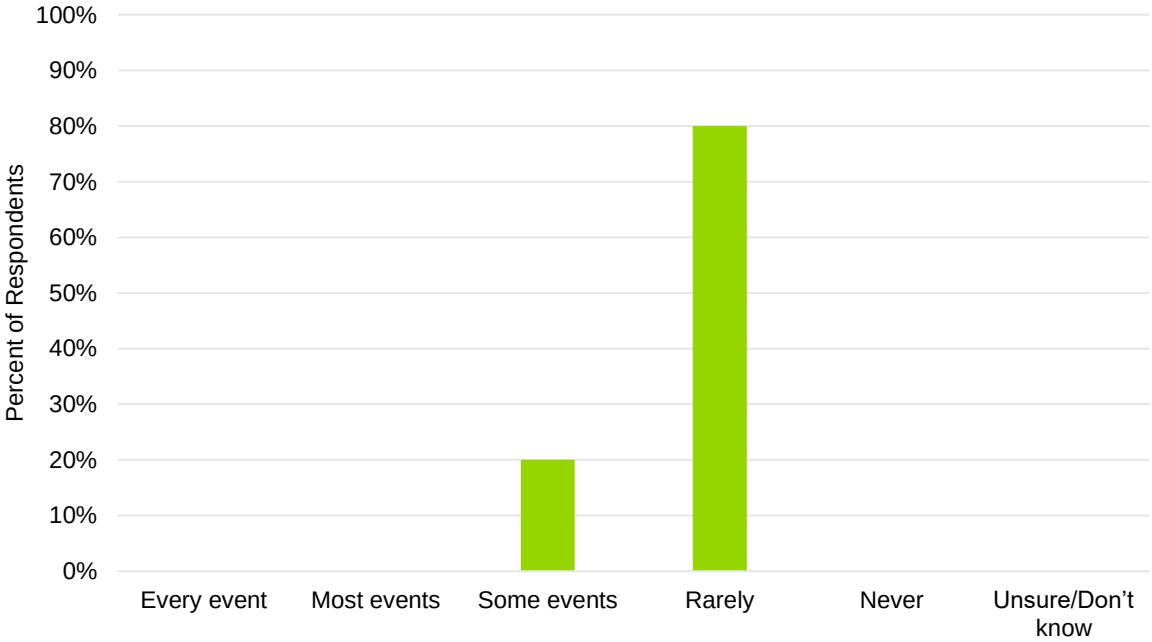
Source: Navigant analysis of online survey data

16_a. Did you "opt-out" or override your thermostat setting before events or during the events? (Select all that apply) n=10



Source: Navigant analysis of online survey data

Q17. How often would you say you chose to opt-out of a event or override the scheduled event thermostat setting? Would you say… n=10



Source: Navigant analysis of online survey data

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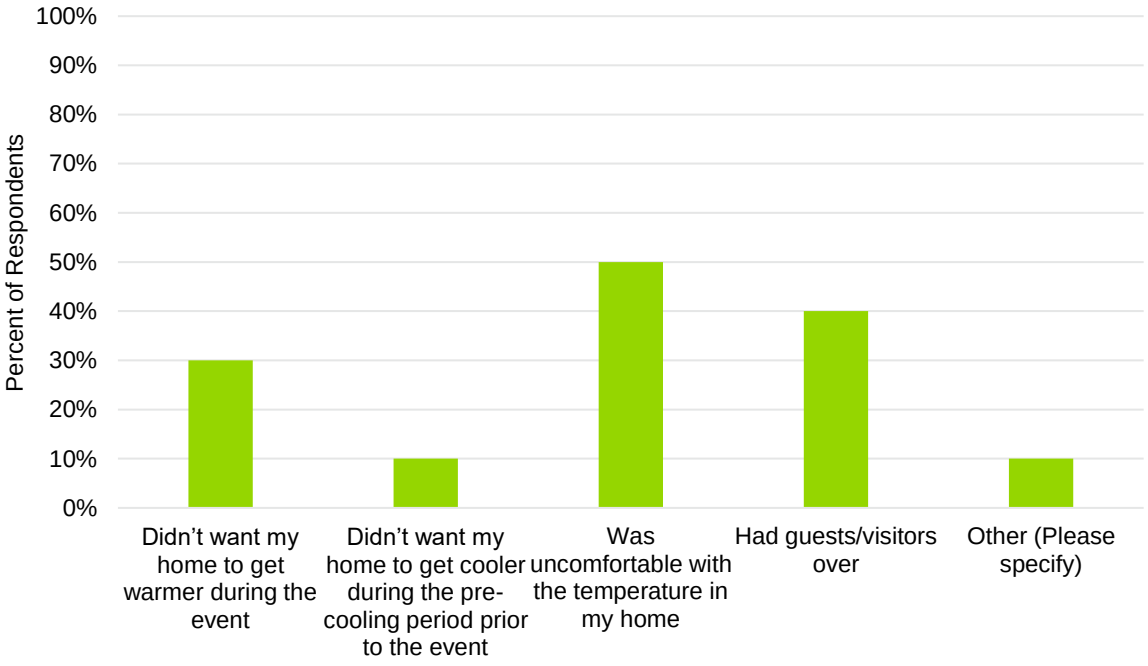
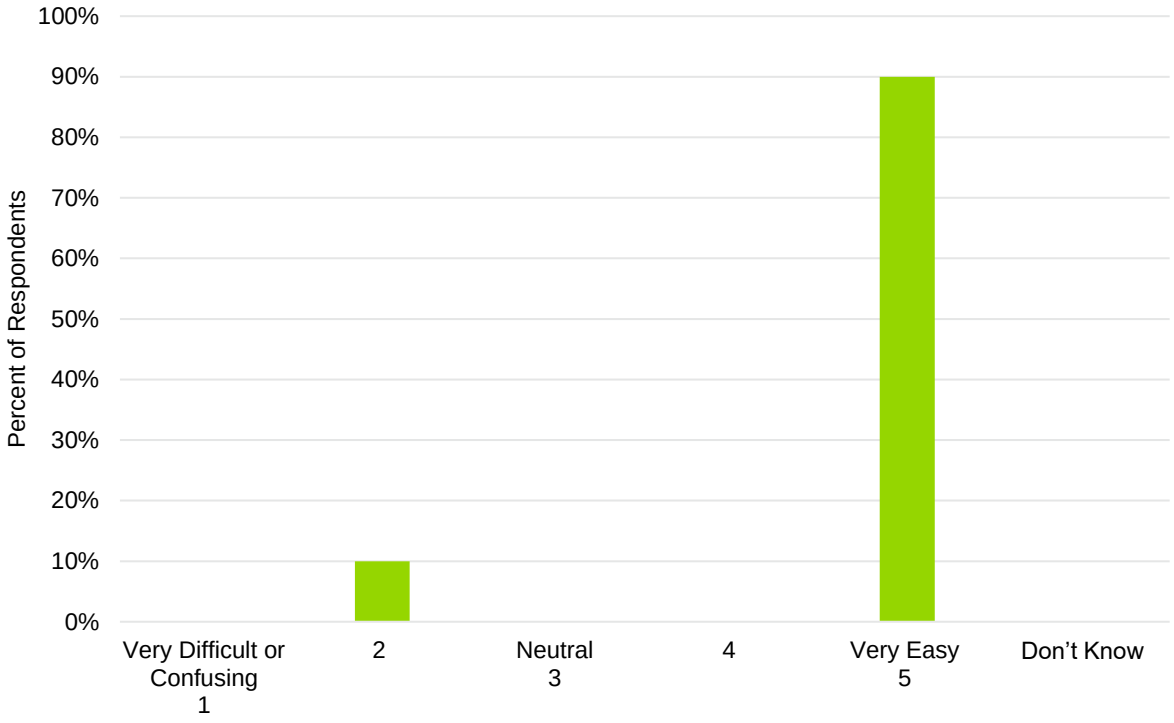
Q18. For what reason(s) did you opt-out or override the scheduled event thermostat setting? (Select all that apply) n=10



Source: Navigant analysis of online survey data

19. Using a scale of 1 to 5, where 1 means "Very Difficult or Confusing" and 5 means "Very Easy", how easy was it to opt-out of or override events? n=10



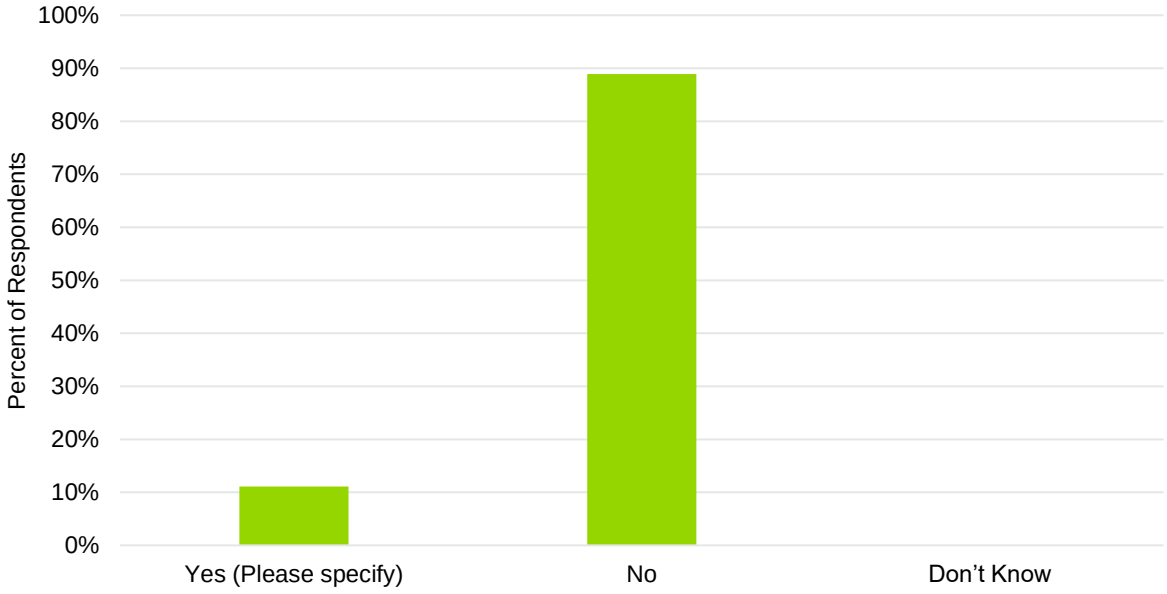
Source: Navigant analysis of online survey data

Q20. What issues did you encounter when trying to opt-out of or override a scheduled event? n=1

Customer verbatims were summarized in the report, as appropriate.

D.4.5 General Thermostat and AC Usage Behavior

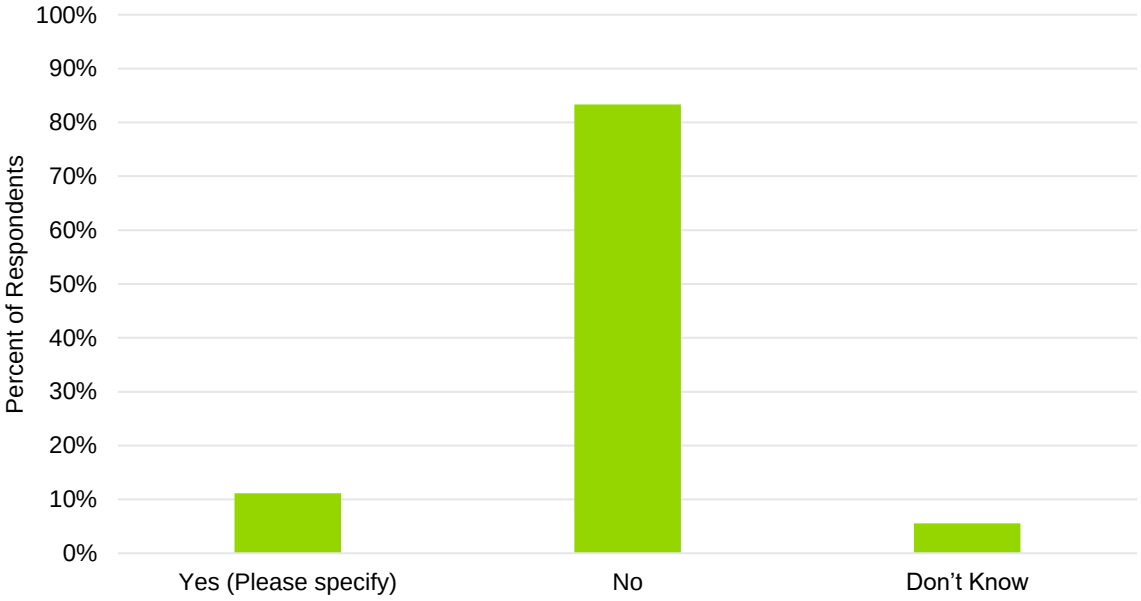
Q21. During an event, did you ever rely on other appliances (e.g., fans or room air-conditioners) to maintain comfort? n=18



*Customer verbatims were summarized in the report, as appropriate.

Source: Navigant analysis of online survey data

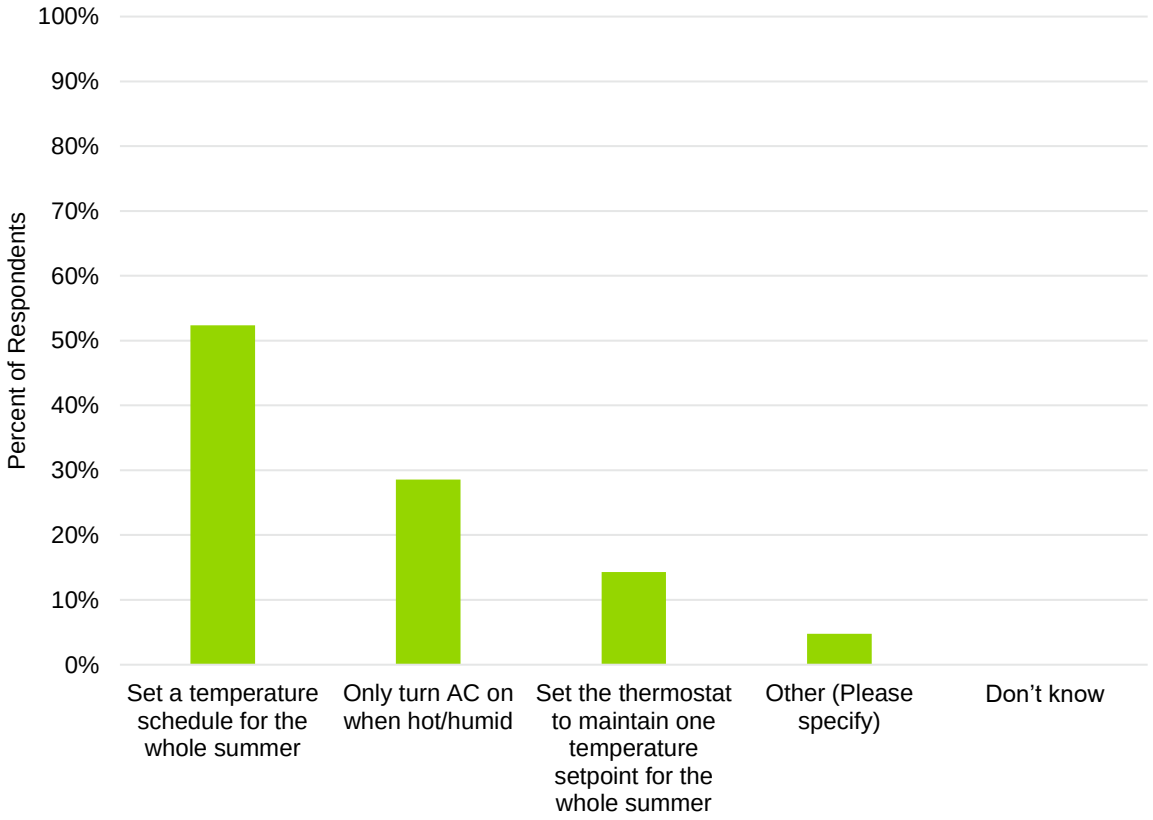
Q22. Did you or other members of your family ever take any actions to reduce your electricity use during events (apart from allowing your thermostat setpoint to be adjusted)? n=18



*Customer verbatims were summarized in the report, as appropriate.

Source: Navigant analysis of online survey data

Q23. How did you typically use your thermostat throughout the summer? n=21



*Customer verbatims were summarized in the report, as appropriate.

Source: Navigant analysis of online survey data

Q23_a. Above what indoor temperature do you typically turn your air conditioning on? n=6

Customer verbatims were summarized in the report, as appropriate.

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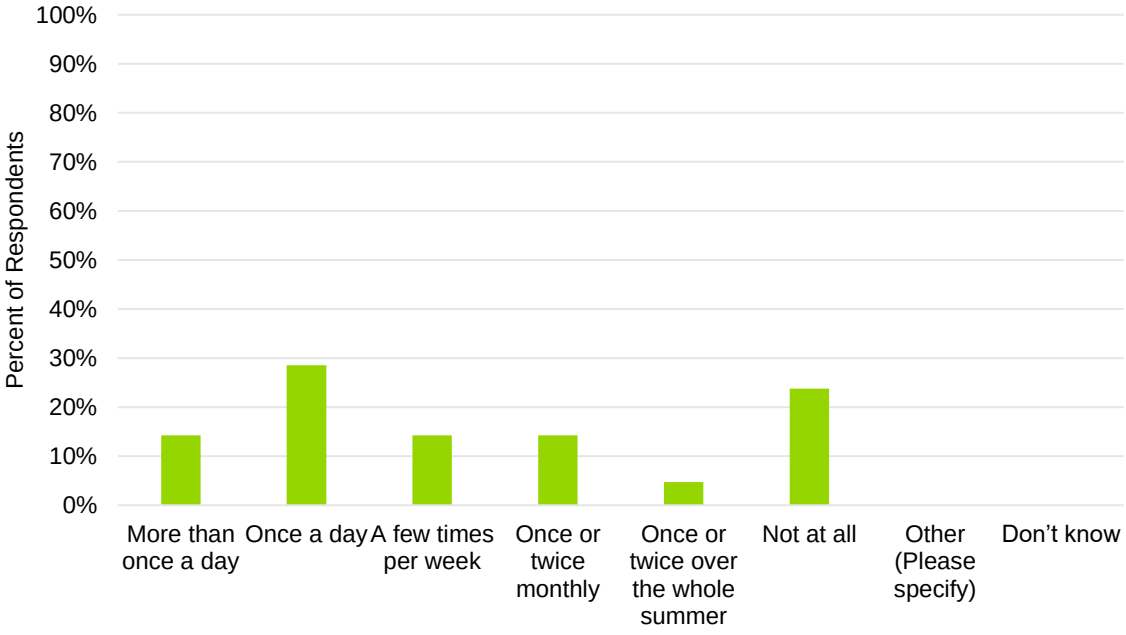
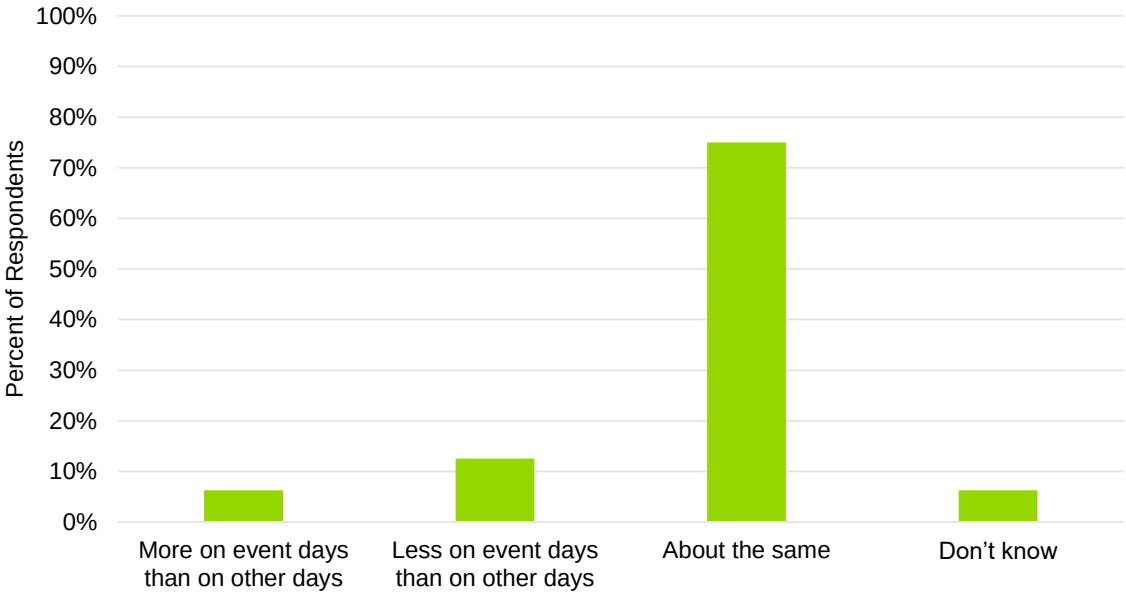
Q23_b. Now we'd like to understand the frequency with which you adjusted your Wi-Fi thermostat's setting or schedule (either up or down) on days when there was no event this summer. Would you say it was… n=21



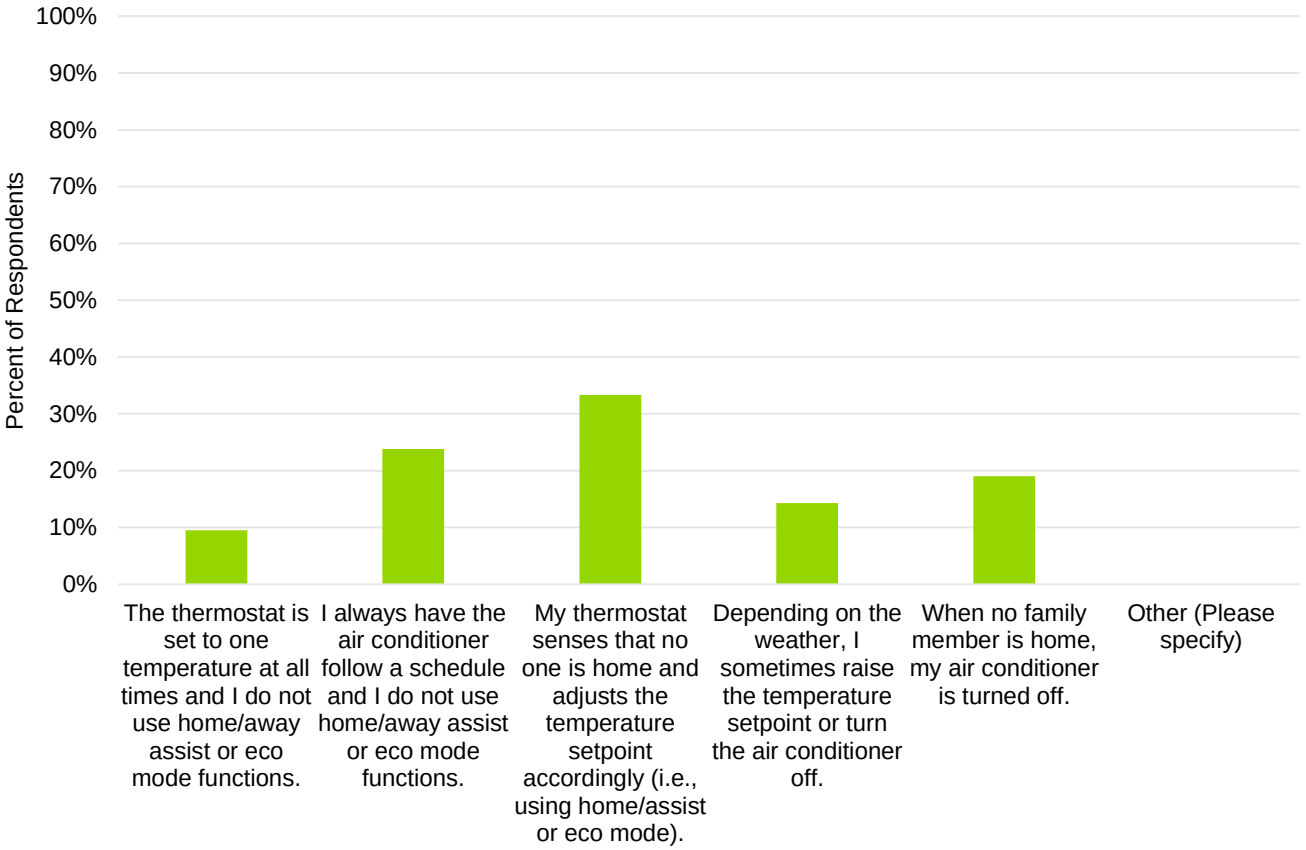
Source: Navigant analysis of online survey data

Q23_c. We'd also like to understand whether the frequency with which you adjusted your Wi-Fi thermostat's setting or schedule was different on event days compared to other days. Would you say you adjusted your home's temperature… n=16



Source: Navigant analysis of online survey data

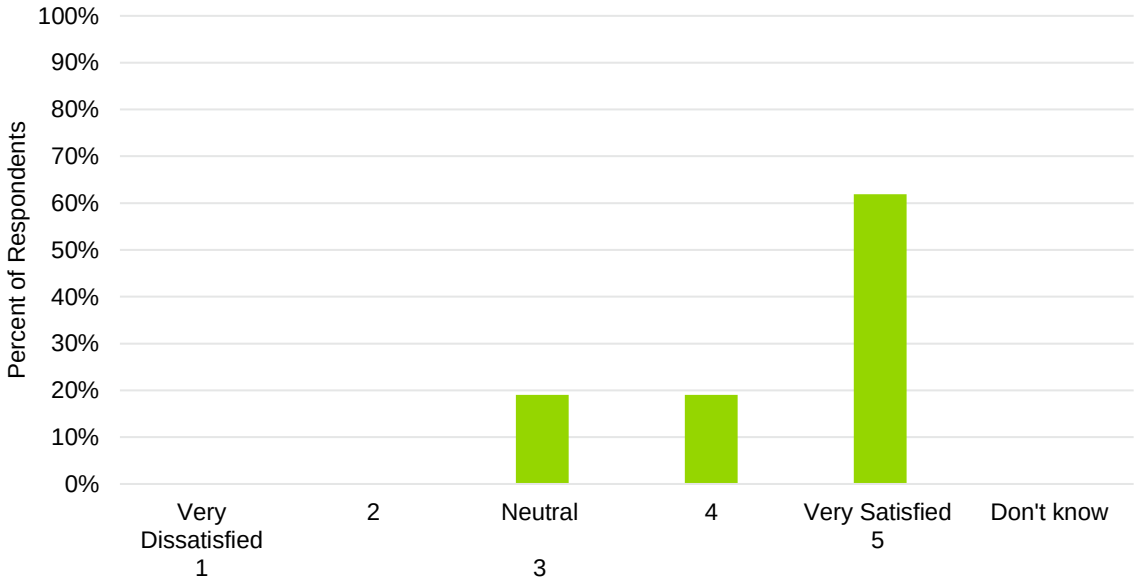
Q23_d. When no family member is at home, which of the following best describes the way you use your air conditioner? n=21



Source: Navigant analysis of online survey data

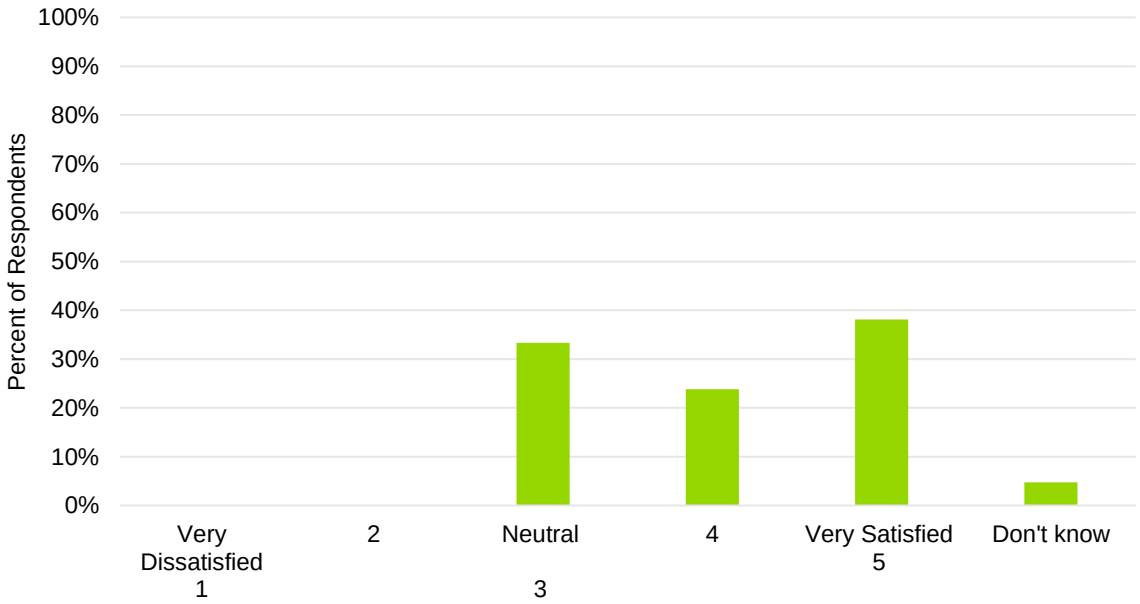
D.4.6 Program Satisfaction

Q24_a. On a scale of 1 through 5, where 1 is "Very dissatisfied" and 5 is "Very satisfied", how would you rate your satisfaction with the number of events during the 2019 summer season? n=21



Source: Navigant analysis of online survey data

Q24_b. On a scale of 1 through 5, where 1 is "Very dissatisfied" and 5 is "Very satisfied", how would you rate your satisfaction with the length of events during the 2019 summer season? n=21



Source: Navigant analysis of online survey data

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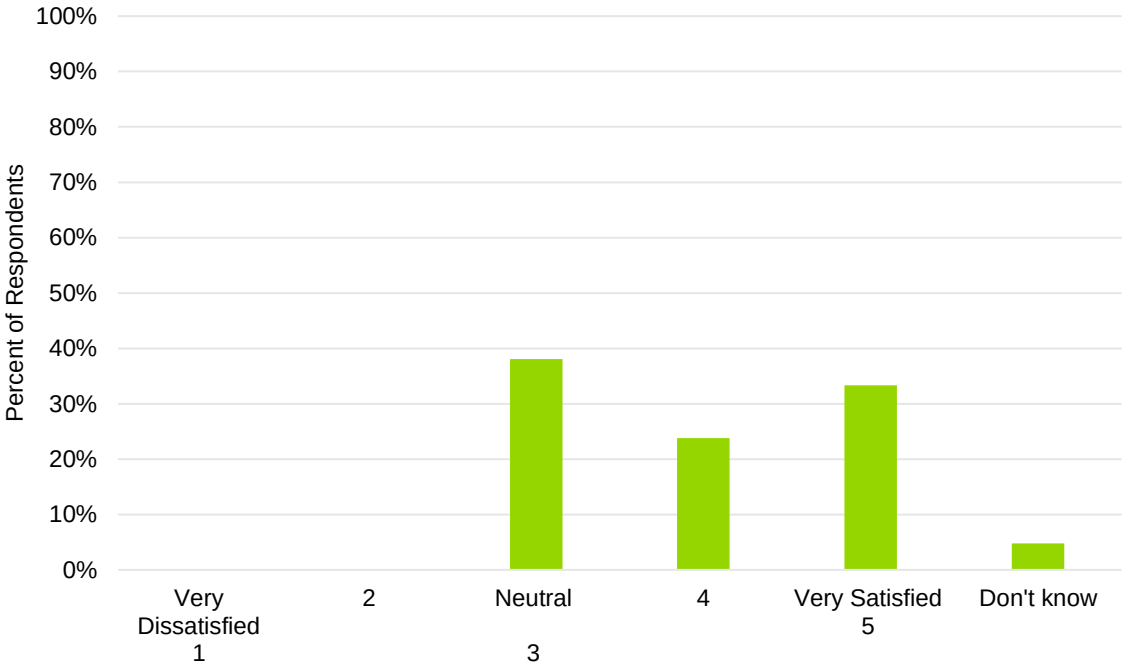
24_c. On a scale of 1 through 5, where 1 is "Very dissatisfied" and 5 is "Very satisfied", how would you rate your satisfaction with the timing of events? n=21



Source: Navigant analysis of online survey data

Q25. What changes to the number of events would you recommend? n=0

No response.

Q26. What changes to the length of events would you recommend? n=0

No response.

Q27. What changes to the timing of events would you recommend? n=0

No response.

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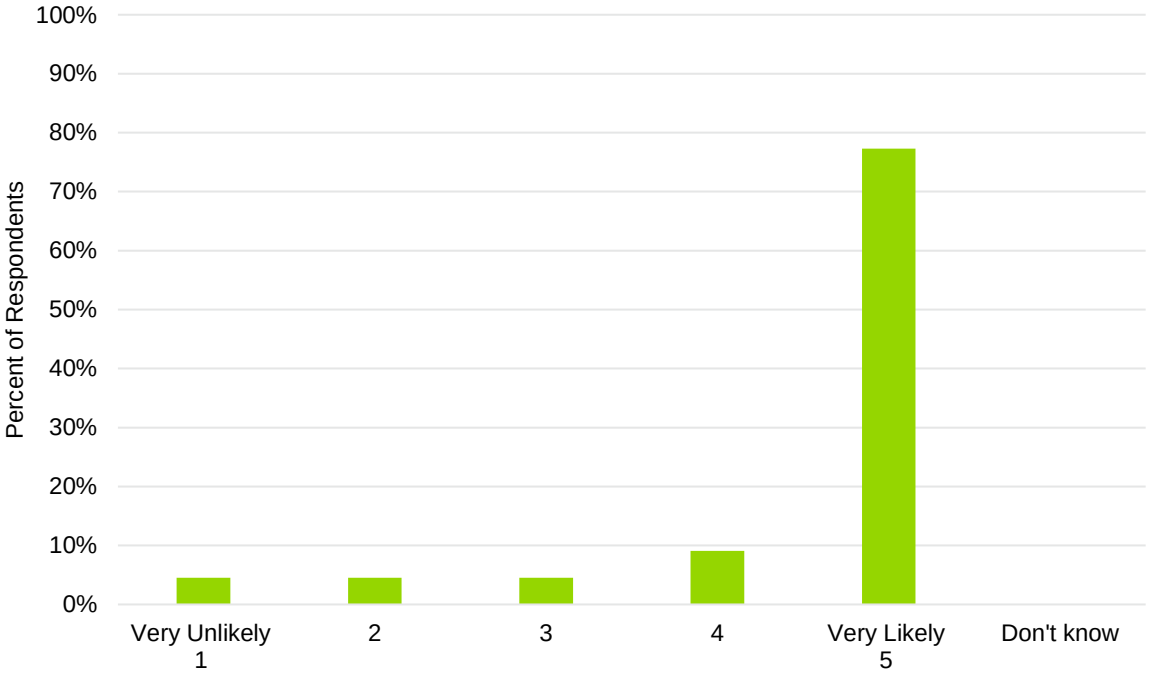
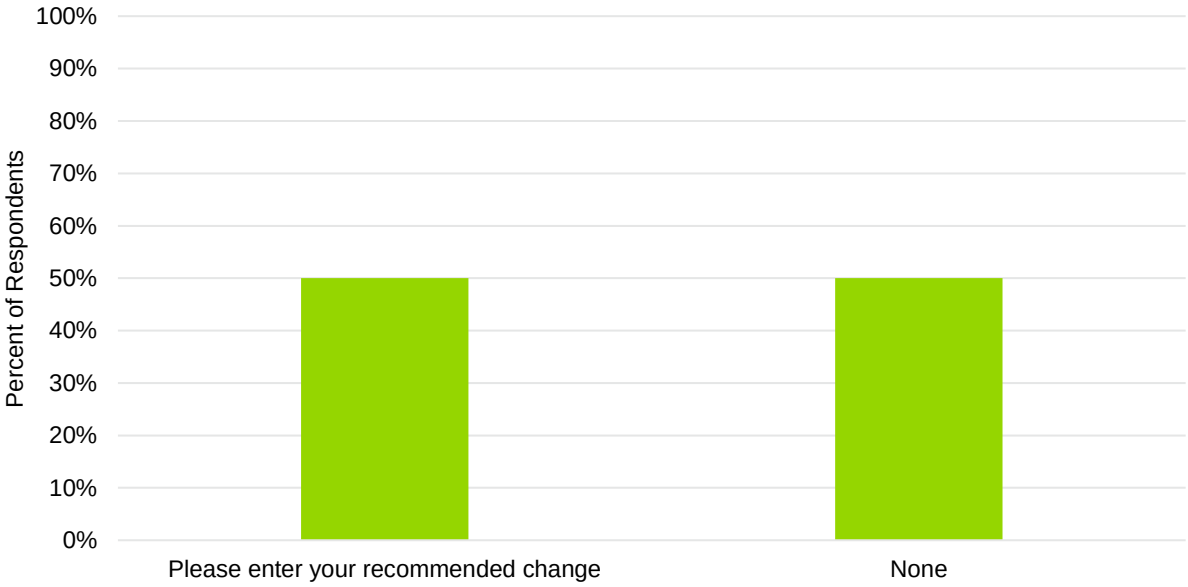
Q28. In future summers, how likely would you be to participate in the ConnectedSolutions Program, on a scale of 1-5, where 1 is "Very Unlikely" and 5 is "Very Likely"? n=22



Source: Navigant analysis of online survey data

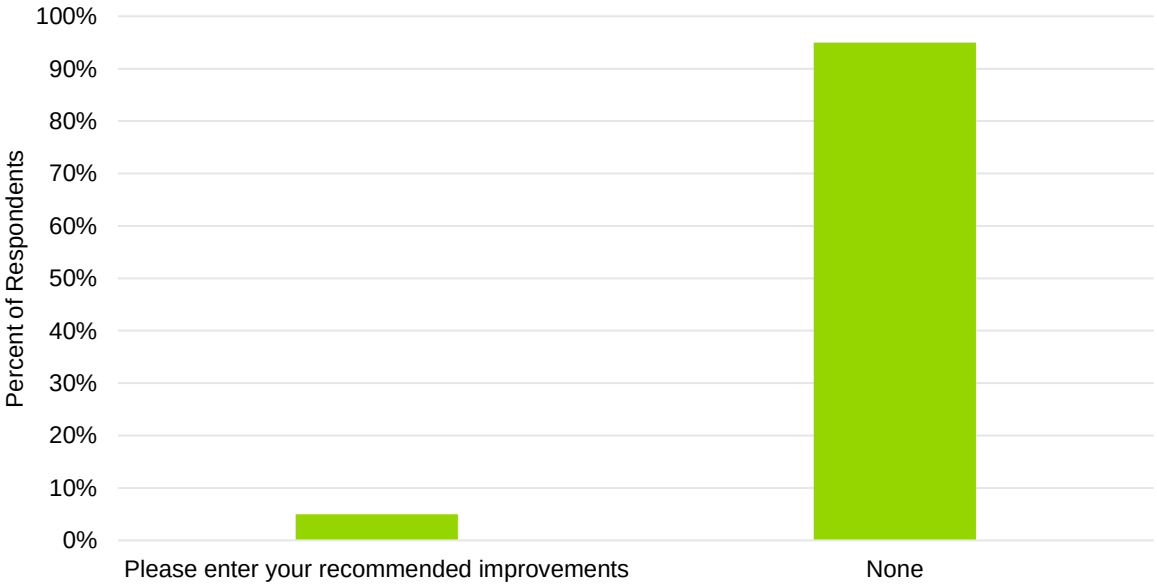
Q29. What change(s) to the ConnectedSolutions Program would encourage you to continue participating? n=2



*Customer verbatims were summarized in the report, as appropriate.

Source: Navigant analysis of online survey data

Q30. What recommendations would you make to help improve the ConnectedSolutions Program going forward? n=20



*Customer verbatims were summarized in the report, as appropriate.

Source: Navigant analysis of online survey data

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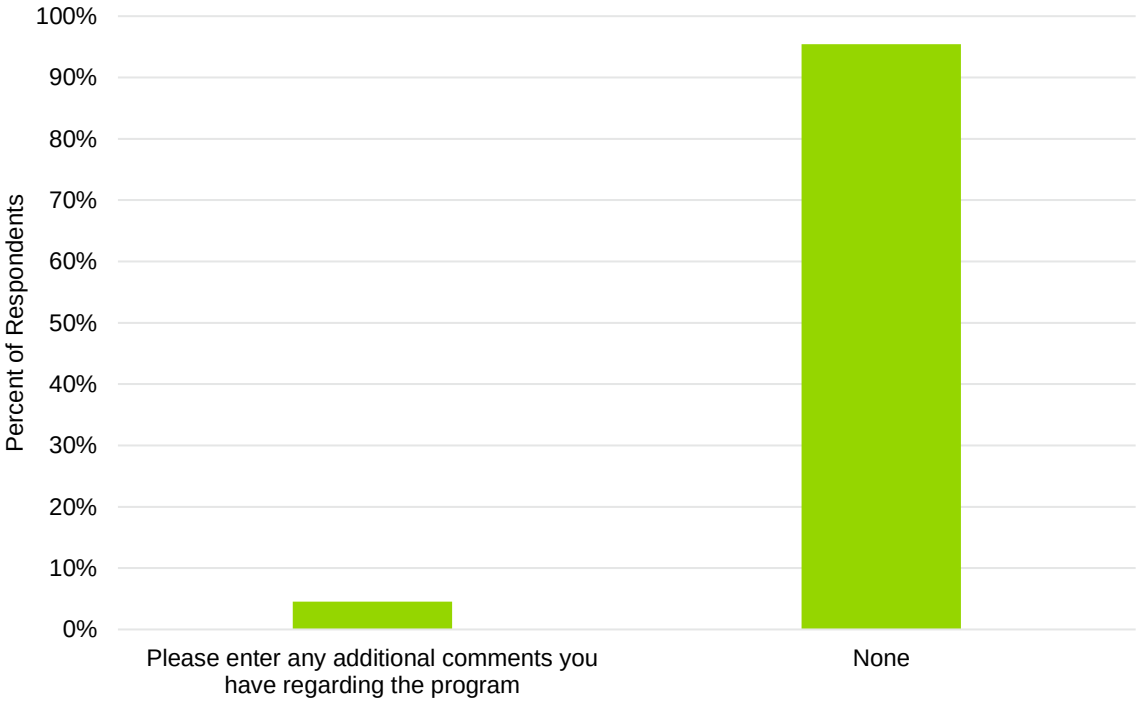
Q31. We have reached the end of the survey. Do you have any additional comments regarding the ConnectedSolutions Program? n=22



*Customer verbatims were summarized in the report, as appropriate.

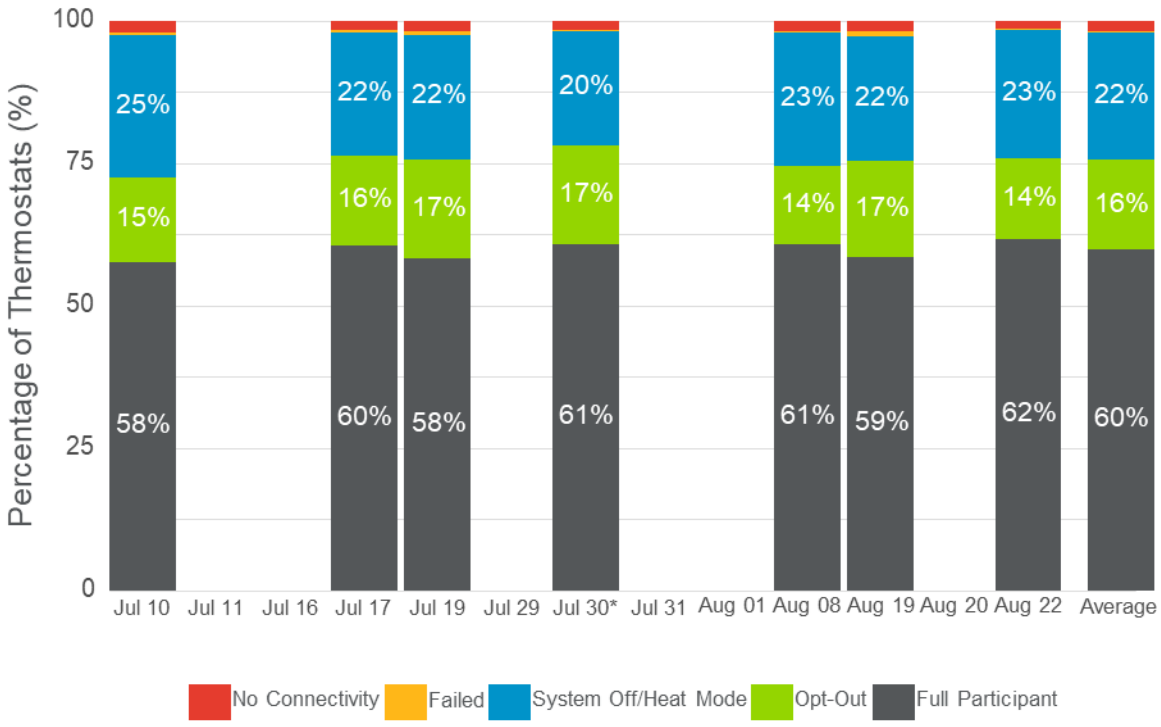
Source: Navigant analysis of online survey data

APPENDIX E. PARTICIPATION PER EVENT

In section 4.2, Navigant provided the average participation across the DR season by PA. This section provides the average participation by event.

Figure E-1 displays participation by event for Eversource during the 2019 DR season. Failure and connectivity issues were minimal throughout the summer. Full participation rates generally stayed in the mid to upper fifties to lower sixties, averaging 60%. The first event on July 10 had the lowest rate of full participation (58%) and the highest rate of thermostats in system off or heat mode (25%). The higher percentage of thermostats in the wrong mode may be attributable to cooler weather preceding the first event. Opt-out rates ranged from 14% to 17%, averaging 16% across the season.

Figure E-1. Average Participation by Event (Eversource)



Source: Navigant analysis of EnergyHub data

Figure E-2Figure E-1 displays participation by event for National Grid during the 2019 DR season. Failure and connectivity issues were minimal throughout the summer, although rates of no connectivity were higher than Eversource. Full participation rates stayed in the lower fifties, averaging 52%. The first event on July 10 had the highest rate of thermostats in system off or heat mode (29%). Similar to Eversource, the higher percentage of thermostats in the wrong mode may be attributable to cooler weather preceding the first event. Opt-out rates ranged from 15% to 21%, averaging 18% across the season, which was slightly higher than Eversource. The higher opt-out rates may be attributable to the larger temperature setback (Eversource used a

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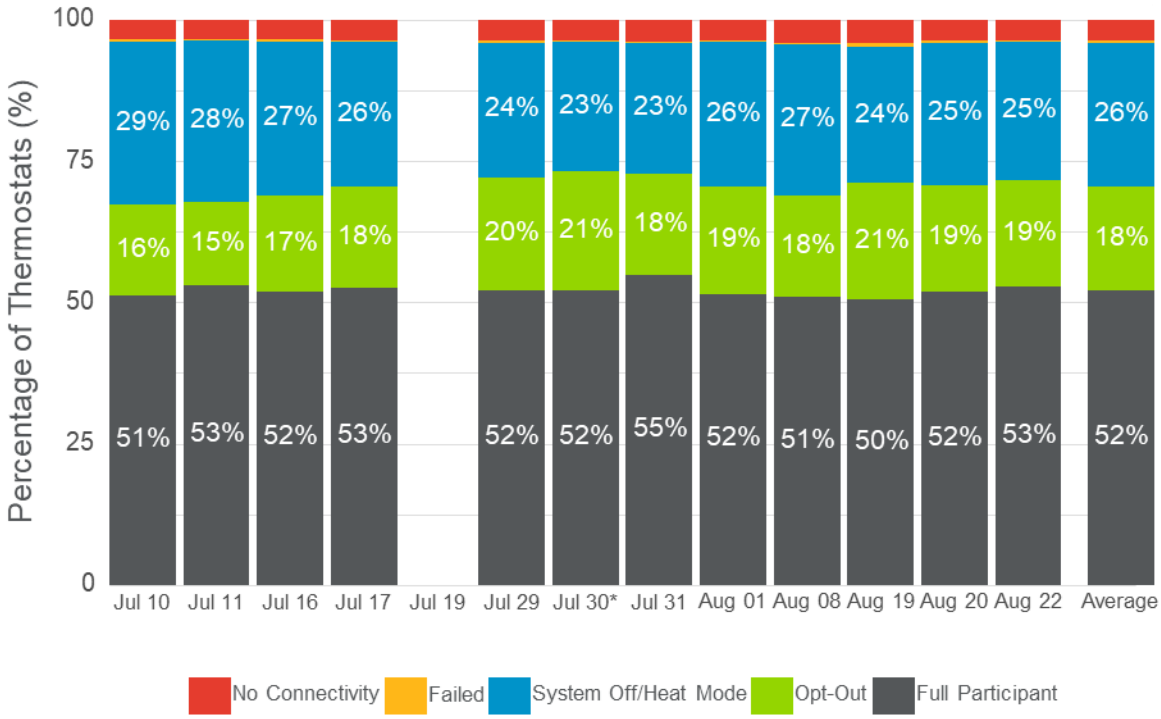
3-degree setback for four of their seven events, whereas National Grid used a 4 degree setback for the entire season).

Figure E-2. Average Participation by Event (National Grid)



Source: Navigant analysis of EnergyHub data

Figure E-3 displays participation by event for Unitil during the 2019 DR season. Like the other two PAs, failure and connectivity issues were minimal throughout the summer. Full participation rates were in the fifties for most of the season, averaging 56%. Low enrollment for the first few events contributed to the large variation in participation through the end of July. Unitil had the highest average rate of thermostats in off or heat mode (29%) and the lowest average opt-out rate (12%).

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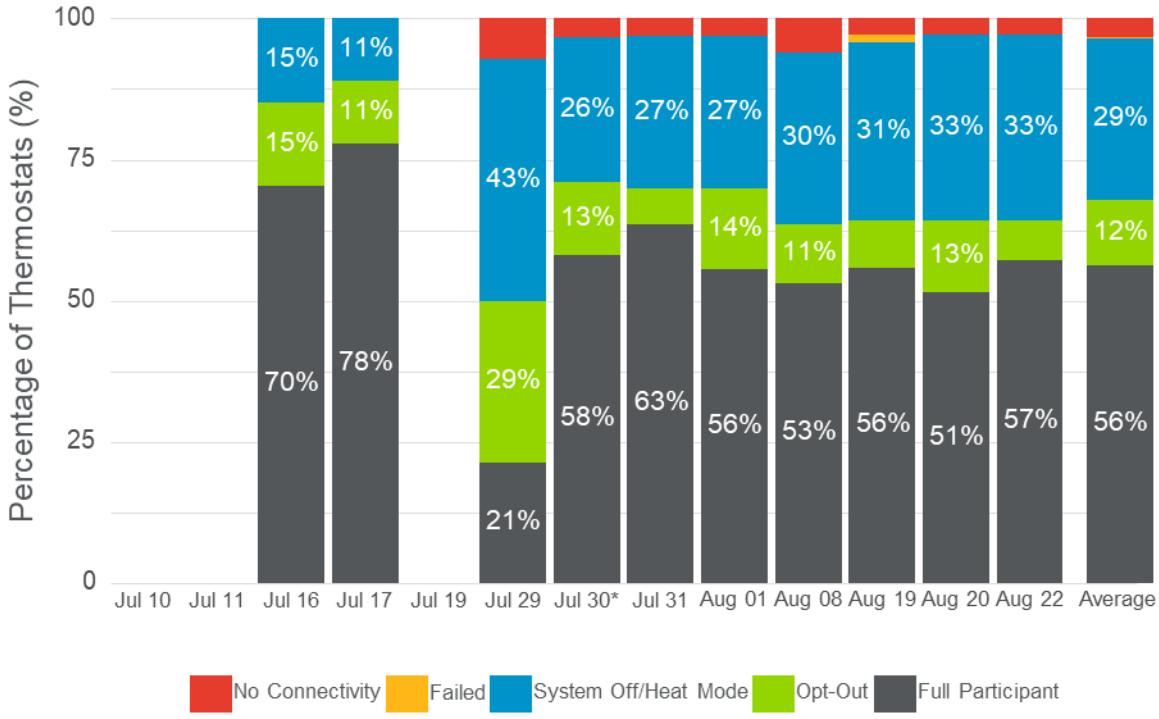
Figure E-3. Average Participation by Event (Unitil)

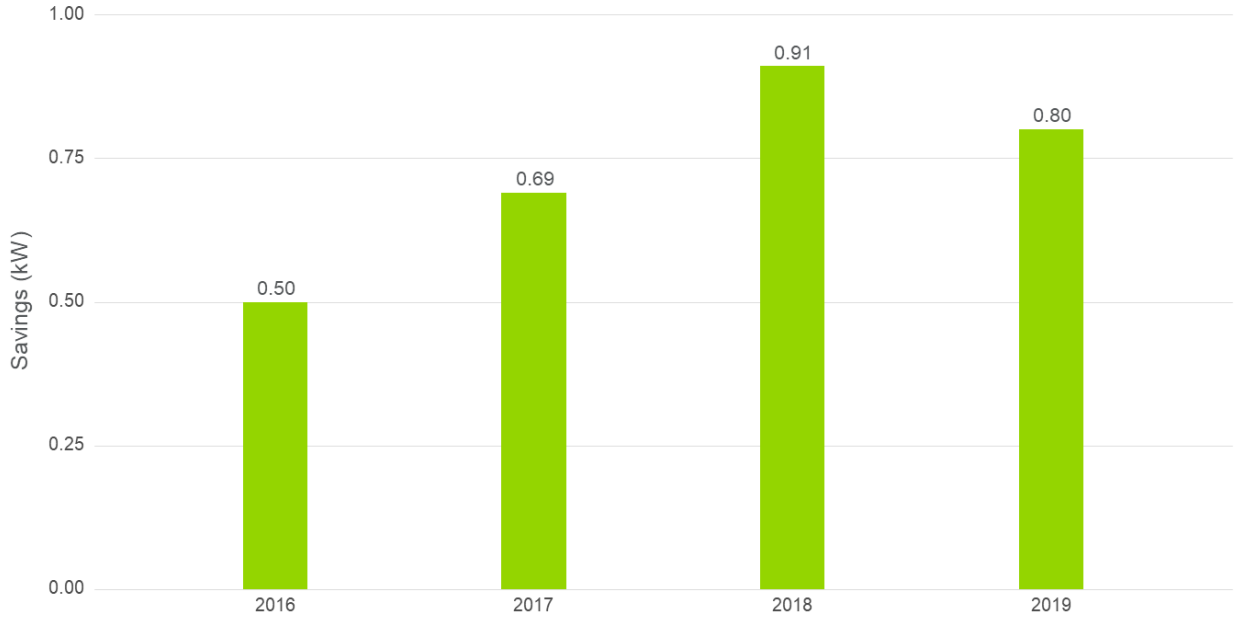


Source: Navigant analysis of EnergyHub data

APPENDIX F. ADDITIONAL IMPACT ANALYSIS FIGURES

Figure F-1 displays the TOT per thermostat impact across each year for National Grid devices. The average TOT demand savings per thermostat was 0.80 kW in 2019, a decrease from 2018. Despite the setback increase, event days in 2019 were cooler and occurred later in the day, resulting in a lower baseline load and lower impacts for full participants.

Figure F-1. TOT per Thermostat by Year (National Grid)



Source: Navigant analysis of EnergyHub data

Figure F-2 displays the average impacts (ATE) by event and PA. Lower average impacts are attributed to differences in temperature, and differences in the percent of full participation during each event. On August 8th and August 19th, Eversource and National Grid called events at the same time but with two different setbacks (3 degrees for Eversource and 4 degrees for National Grid). For the event on August 8th, National Grid had the higher average impact, while Eversource had the higher average impact on August 19th. With limited points of comparison and opposite results, it is inconclusive whether a higher setback produces larger average impacts.

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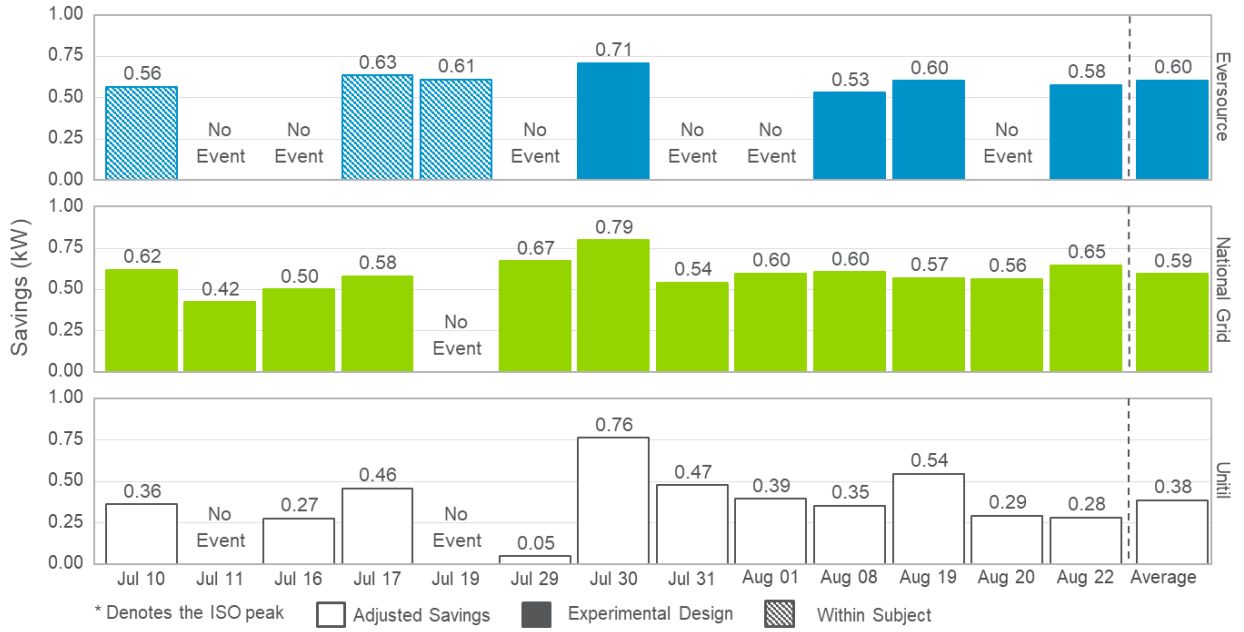
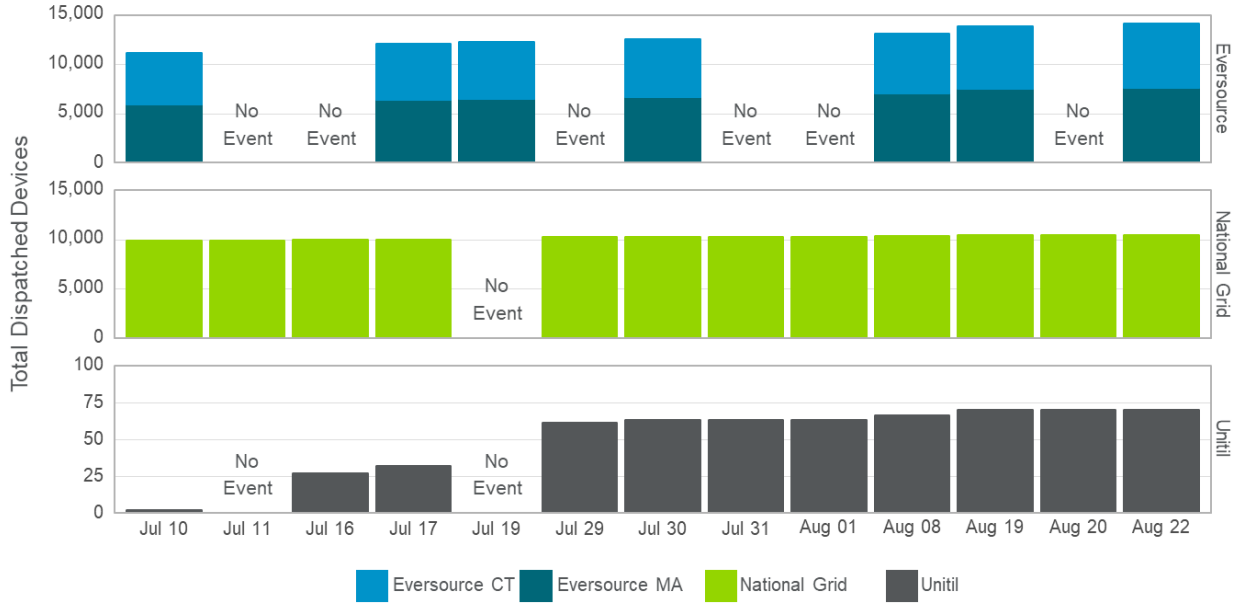
Figure F-2. ATE per Thermostat by Event



Source: Navigant analysis of EnergyHub data

Figure F-3 shows the total count of dispatched devices by event and PA. These counts are used to scale the ATE per event to calculate total savings in Section 4.3.3.

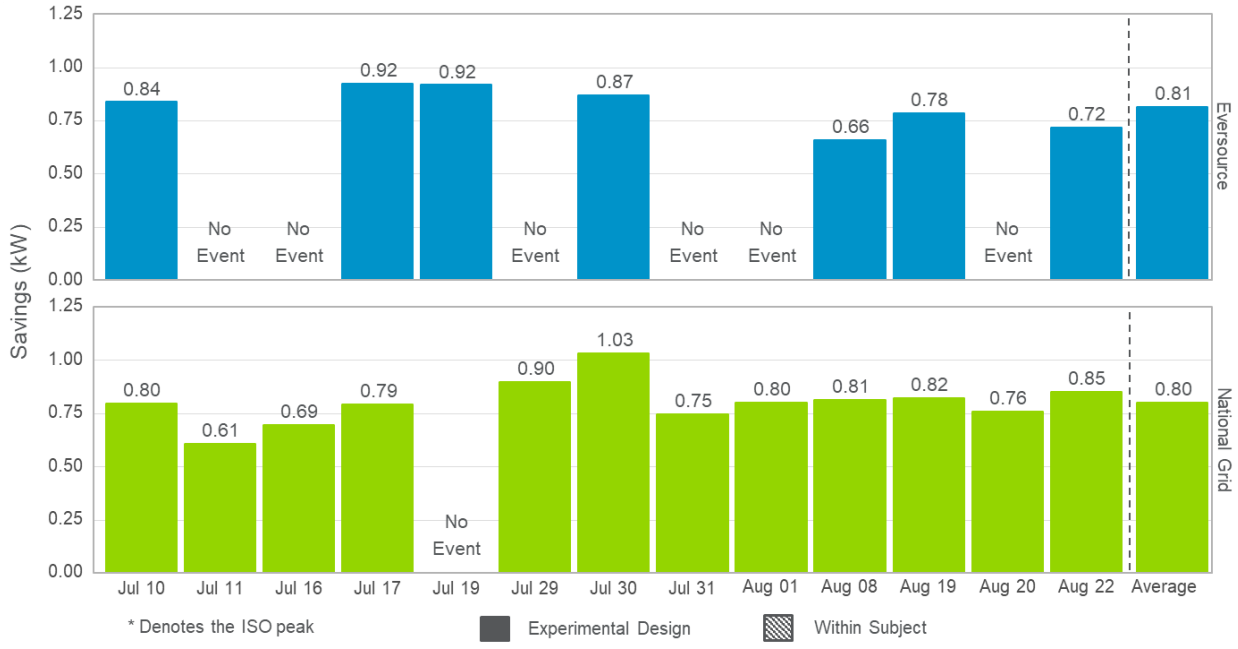
Figure F-3. Dispatched Devices by PA and Event



Source: Navigant analysis of EnergyHub data

Figure F-4 presents the TOT impacts by event, representing the impacts of full participants only (i.e., excluding thermostats that opt-out, where the AC system is in off or heat mode, and thermostats with connectivity or failure issues). The largest impacts are estimated on hotter event days when more cooling is occurring.

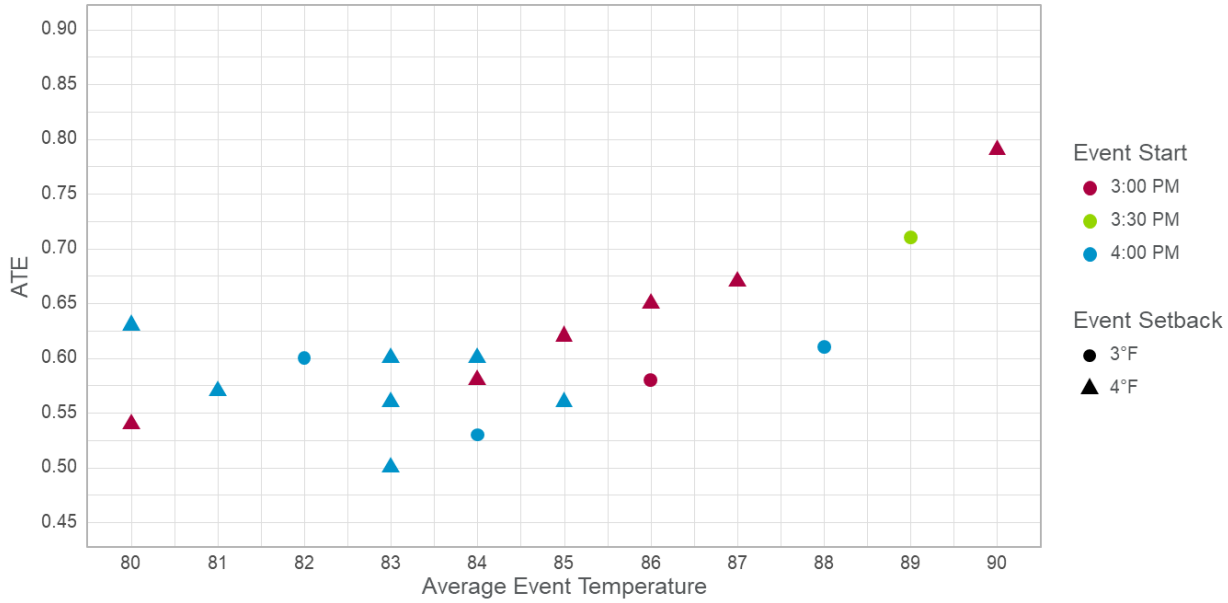
Figure F-4. TOT per Thermostat by PA and Event



Source: Navigant analysis of EnergyHub data

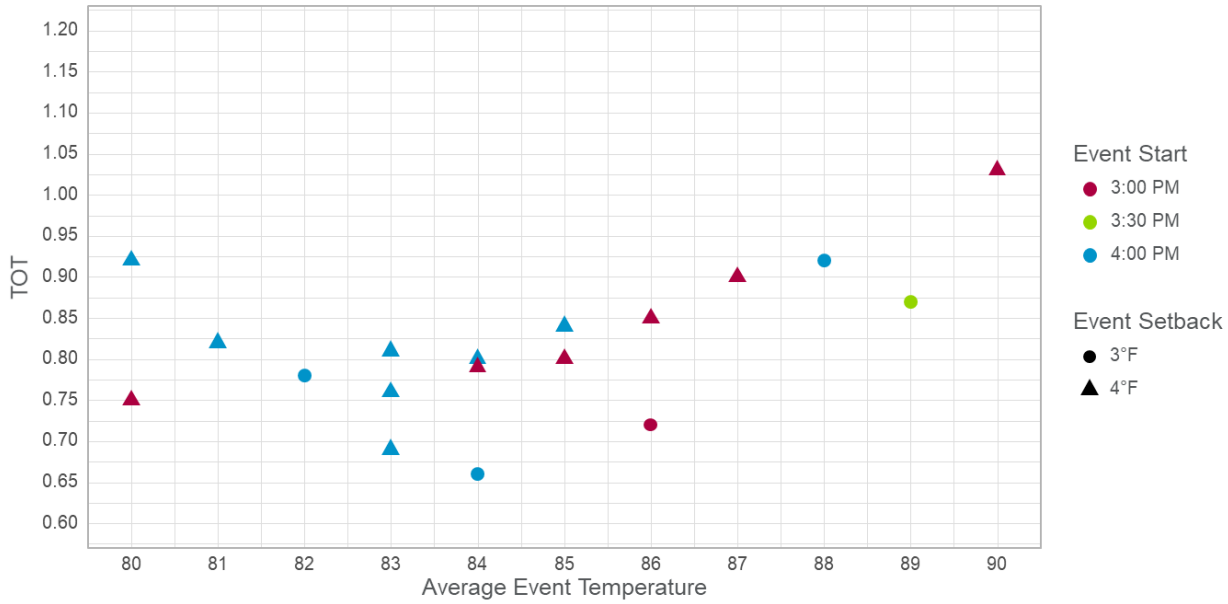
Figure F-5 and Figure F-6 show the relationship between average impacts and temperature for all devices (ATE) and fully participating devices (TOT). The figures also indicate the event start time and setback. A positive correlation is observed between temperature and impacts. Few events exist with the same average temperature but different setbacks, so evidence is limited that a larger setback produces higher impacts.

Figure F-5. ATE per Thermostat by Average Temperature



Source: Navigant analysis of 2019 EnergyHub data

Figure F-6. TOT per Thermostat by Average Temperature



Source: Navigant analysis of 2019 EnergyHub data

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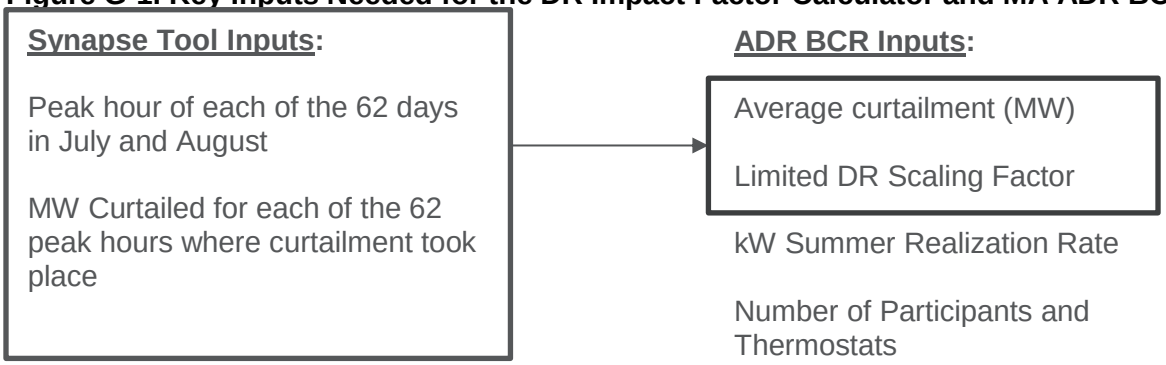
APPENDIX G. MASSACHUSETTS ADR BCR

To claim savings from their Wi-Fi thermostat DLC offerings, Eversource MA, National Grid MA and Unitil MA must compile and enter necessary inputs into the MA Active Demand Reduction (ADR) Benefit Cost Ratio (BCR) model. As an intermediate step, the MA PAs must populate the DR Impact Factor Calculator tool developed by Synapse Energy Economics, Inc (Synapse). Key parameters needed for the Synapse tool and the ADR BCR model are outlined in Figure G-1 below.

Figure G-1. Key Inputs Needed for the DR Impact Factor Calculator and MA ADR BCR



Source: Navigant

Through this evaluation, in support of the above-mentioned process that the Massachusetts PAs must undertake to claim savings related to the Wi-Fi thermostat DLC offering measure, Navigant provides the following:

- Count of participants and thermostats enrolled as of August 31, 2019
- Savings adjustment factors

Participant and thermostat counts for the 2019 offering year include those that had applied and were accepted into the offering as of August 31, 2019.[52] These counts are shown in the table below.

[52] See Section 2.1.2 for more detail.

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Table G-1. Massachusetts Offering Participation as of August 31, 2019

Participation Metric	Eversource MA	National Grid MA	Unitil MA
Participants	5,158	7,814	45
Thermostats	8,020	11,503	70

Source: Navigant analysis of enrollment data

Savings adjustment factors are provided in Section 4.4.1 in the form of static adjustment factors for pre-cool and recovery hours and, for event hours, an equation where the adjustment factor is a function of hourly temperature.

The process for using the required tools, including how savings adjustment factors will be applied, for the purposes of claiming savings in Massachusetts is outlined below:

- Identify the peak hour of each of the 62 days in July and August. Input into the DR Impact Factor Calculator.
- Identify which of the peak hours are within a pre-cooling, event or recovery period on event days. Input into the DR Impact Factor Calculator.
- Obtain average load reduction (MW) from EnergyHub portal load intervals file ("Load Difference" column) for peak hours that are within a pre-cooling, event or recovery period on event days.
- Apply the appropriate savings adjustment factor to the average load reduction for peak hours that are within a pre-cooling, event or recovery period on event days. Enter the resulting "ex-post" load reduction (or increase) values into the DR Impact Factor Calculator ("MW Curtailed" column).
- Enter the resulting DR Impact Factor Calculator outputs - "Average curtailment (MW)" and "Resulting coefficient" - into the MA ADR BCR tool, along with participant counts.[53] kW Summer Realization Rate can be set to 1.

Due to the fact that the DR Impact Factor Calculator considers only the peak hour of each of the 62 days in July and August, the resulting average curtailment value will not align with the average demand reduction per event values provided in Table 4-10 of Section 4.3, which take into account all event hours during the DR season.

[53] EnergyHub has reported that current 2019 participant counts are inaccurate due to Nest erroneously including some devices that were in the same structure as legitimately enrolled devices. The PAs should ensure this error has been resolved before relying on participant counts from the EnergyHub portal.

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