

Division 25-15

Request:

Refer to response to DIV 1-40 (d) (DIV 5-40(d)).

- a. Has the Company or its consultants estimated the C&I demand response potential in Rhode Island?
- b. Please explain how there was an average of 10.6 MW curtailed per demand response event, when only 6.7 MW of capacity was enrolled in the C&I demand response program in 2017?
- c. Please provide the incentives paid in 2017 for C&I demand response. If known, please also provide an estimate of the portion of those incentives retained by customers.
- d. Please reconcile the costs provided in response to DIV 1-40(e) (DIV 5-40 (e)) with the costs provided in response to DIV 3-14 (d) (DIV 10-14 (e)).

Response:

- a. National Grid has contracted Navigant Consulting to complete a demand response potential study for Massachusetts as part of the three-year plan process for the energy efficiency programs in Massachusetts. Once complete, in March 2018, National Grid plans to scale these results for the Rhode Island market.
- b. Several large customers provided demand reductions that were greater than their enrolled capacity in 2017. One of the program rules in 2017 was that customers had to be new to demand response. This resulted in several customers signing up for a capacity commitment that differed from their actual curtailable potential. This rule was changed in 2018 so that the Company could attract customers who are experienced with demand response and would be better able to estimate their curtailment amount.
- c. Incentive payments totaled \$248,457.48 in 2017. The Company does not know the exact portions of these incentives that were held by the vendors, and those that went on to the customers. However, the Company has been informed by the vendors that an incentive split between 60/40 to 80/20 is typical – with the majority of the incentives going to the customers. The Company estimates that approximately 70 percent of the total incentives, or \$173,920.24, went to customers.
- d. These responses refer to prior responses in Docket No. 4770. The Company's original response to Division 5-40(e) contained incorrect cost numbers. The Company submitted

a corrected response to Division 5-40 on February 7, 2018. The costs in that corrected response align with those included in the Company's response to Division 10-14 (d).

(This response is identical to the Company's response to Division 8-15 in Docket No. 4780.)

Division 25-16

Request:

Please provide all evaluation reports for the Company's C&I and residential demand response programs.

Response:

Please see Attachment DIV 25-16, which is the 2016 Residential Wi-Fi Thermostat DR Evaluation Final Report that Navigant Consulting, Inc. prepared for National Grid regarding the residential demand response programs in Rhode Island and Massachusetts. There is no separate evaluation report for the Company's C&I programs at this time.

(This response is identical to the Company's response to Division 8-16 in Docket No. 4780.)



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

Prepared for National Grid

Submitted by:
Navigant Consulting, Inc.
77 South Bedford Street
Suite 400
Burlington, MA 01803

781.270.8300
navigant.com

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2016 Residential Wi-Fi Thermostat DR Evaluation Final
Report

TABLE OF CONTENTS

Disclaimer	iii
Executive Summary	iv
Program Summary	iv
Overview of Program Performance	iv
Key Findings and Recommendations	viii
1. Introduction	1
1.1 Program Overview.....	1
2. Key Research Objectives and Methods	5
3. Program Processes.....	8
3.1 ConnectedSolutions Enrollment Process.....	8
3.2 Rush Hour Rewards Enrollment Process.....	9
3.3 Motivation to Participate	10
4. Program Event Participation	12
4.1 Event Notification and Awareness	12
4.2 Event Participation	13
5. Program Impacts	18
5.1 2016 Program Savings.....	18
5.2 Average Impacts	21
5.2.1 Average Hourly Impacts	22
5.3 Event-Specific Impacts.....	24
5.4 Weather Analysis	26
5.5 Customer-Level Impacts	28
6. Program Satisfaction	30
7. Conclusions.....	31
Appendix A. Program Enrollment.....	A-1
Appendix B. Impacts Per Event	B-1
B.1 ecobee	B-1
B.2 Honeywell	B-3
B.3 Nest.....	B-5
Appendix C. Event Participation	C-1
C.1 ecobee	C-1
C.2 Honeywell	C-2
C.3 Nest.....	C-3
Appendix D. Hourly Impacts: Hot vs. Cool Days	D-1
D.1 ecobee	D-1



2016 Residential Wi-Fi Thermostat DR Evaluation Final
Report

D.2 Honeywell	D-1
D.3 Nest.....	D-2
Appendix E. ConnectedSolutions Enrollment Survey and Results	E-3
Appendix F. Rush Hour Rewards Enrollment Survey and Results	F-1
Appendix G. ConnectedSolutions Post-Event Survey and Results.....	G-1
Appendix H. Rush Hour Rewards Post-Event Survey and Results	H-1
Appendix I. ConnectedSolutions Post-Season Survey and Results	I-1
Appendix J. Rush Hour Rewards Post-Season Survey and Results	J-1



2016 Residential Wi-Fi Thermostat DR Evaluation Final
Report

DISCLAIMER

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2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

EXECUTIVE SUMMARY

National Grid offers a diverse, yet complementary set of demonstration projects targeted to reduce peak demand and inform the design of future demand reduction (DR) programs in Massachusetts and in Rhode Island. The Residential Wi-Fi Thermostat DR program was first offered in Massachusetts and Rhode Island in 2016 and reached over 1,400 customers and enrolled over 2,000 thermostats. The demonstration project was designed to test controllable thermostats as a DR technology (testing various thermostat models from multiple thermostat vendors), as well as customer acceptance of the DR program offerings (testing two program platforms that offer different incentive structures, event frequencies, and event durations in Massachusetts).

Navigant Consulting, Inc.'s (Navigant's) evaluation of the 2016 DR season found the program was successful both in testing the effectiveness of thermostats as a residential DR technology and in customer acceptance of the program offering. National Grid is now positioned to leverage the experience of the 2016 program year to further test the technology and program offering in 2017 informing future program design.

Program Summary

The Residential Wi-Fi Thermostat DR program includes two program offerings: ConnectedSolutions (CS) and Rush Hour Rewards (RHR). Each offering varies in thermostat model, DR event attributes (frequency, duration), incentive mechanism (pay for performance), set back strategy (2°F vs. 3°F), and more. Both programs are aimed at testing the effectiveness of thermostats as a DR technology and customer acceptance of each program offering. In 2016, the criteria for calling a DR event was based on the day-ahead locational marginal price resulting in some DR events being called on days with mild temperatures.¹

Overview of Program Performance

2016 Program Savings

Figure 1 presents the total DR for the Residential Wi-Fi Thermostat DR program by event for the combined Massachusetts and Rhode Island program. The maximum kilowatt (kW) reduction occurred on August 26, 2016, with a total DR of 869 kW. The 2016 Independent System Operator-New England (ISO-NE) system peak was on August 12, 2016.² Navigant estimates a DR savings of 755 kW could have been achieved had the RHR program called an event that day.³

¹ National Grid has an ongoing effort to evaluate various dispatch methodologies.

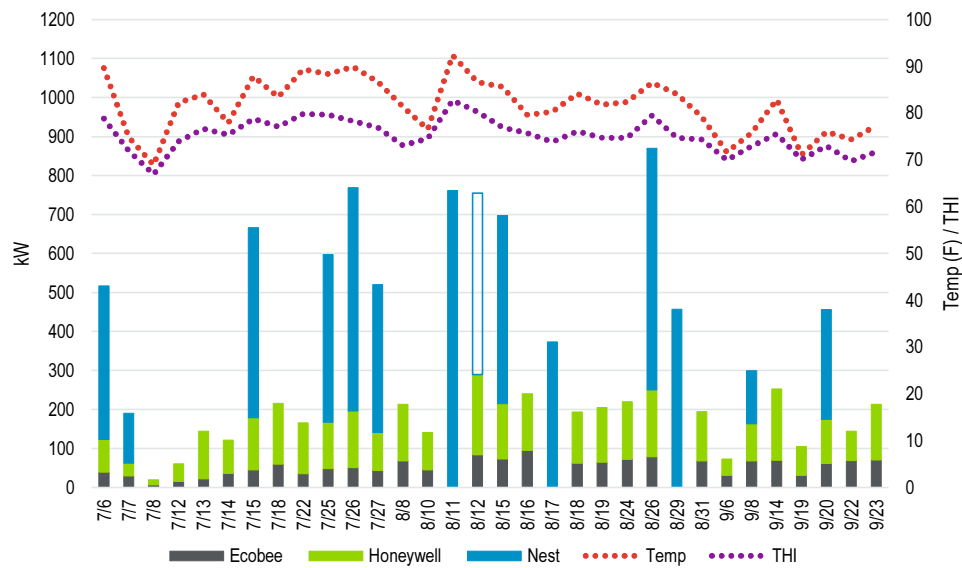
² The 2016 ISO-NE system peak was 25,521 MW, 1,183 MW lower than the 2016 50/50 Reference Peak Forecast of 26,704 MW.

³ The RHR program did not call a DR event on August 12 due to the event being designated a "non-event". Refer to the impact analysis methodology description for additional information. As a result, Navigant estimated DR savings that could have been achieved had a DR event been called. The estimate is calculated as the average demand savings per event for the Nest thermostat (0.39 kW) x the number of active devices based on the prior event (1,193), plus the evaluated savings from the CS devices. This is likely a conservative estimate as average demand savings per event represents average savings across all events, including events on relatively mild days.



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

Figure 1. Total Savings by Event and Thermostat Type, Massachusetts and Rhode Island



Source: Navigant analysis

Note: Navigant estimated DR savings that could have been achieved had a RHR event been called. The estimate is calculated as the average demand savings per event for the Nest thermostat (0.39 kW) x the number of active devices based on the prior event (1,193), plus the evaluated savings from the CS devices. This is likely a conservative estimate as average demand savings per event represents average savings across all events, including events on relatively mild days.

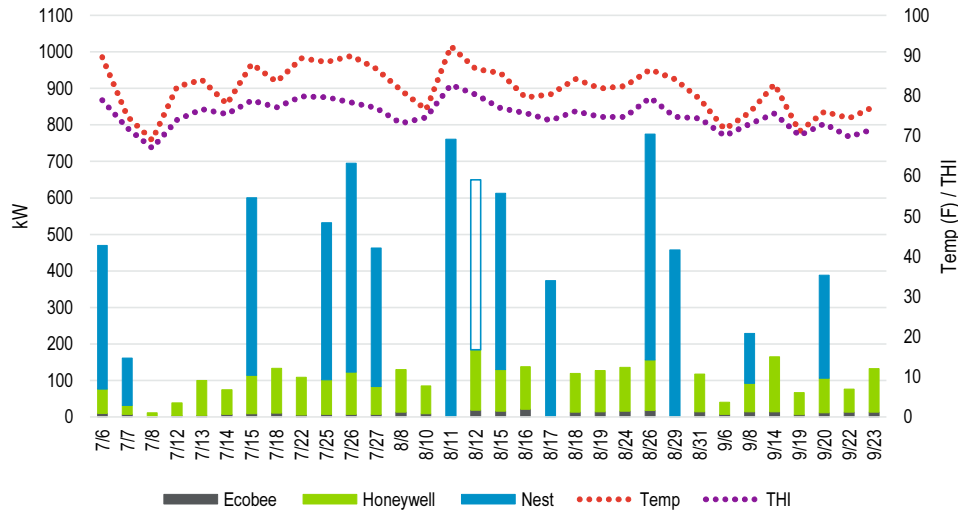
Figure 2 presents the total DR for the Residential Wi-Fi Thermostat DR program by event in Massachusetts. The maximum DR occurred on August 26, 2016, with a total DR of 775 kW. Navigant



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

estimates there could have been a DR of 650 kW on August 12, 2016 (the 2016 ISO-NE system peak) had an RHR program event been called that day.

Figure 2. Total Savings by Event and Thermostat Type, Massachusetts



Source: Navigant analysis

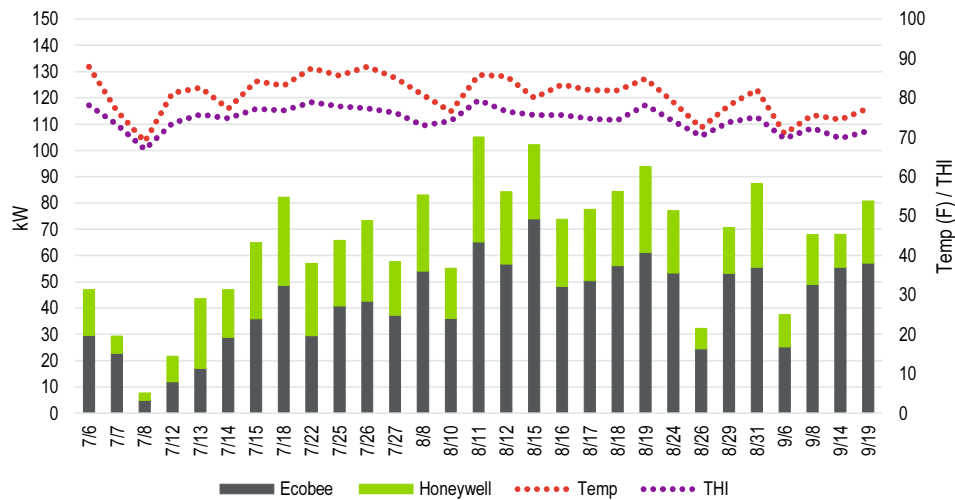
Note: Navigant estimated DR savings that could have been achieved had a RHR event been called. The estimate is calculated as the average demand savings per event for the Nest thermostat (0.39 kW) x the number of active devices based on the prior event (1,193), plus the evaluated savings from the CS devices. This is likely a conservative estimate as average demand savings per event represents average savings across all events, including events on relatively mild days.

Figure 3 presents the total DR for the Residential Wi-Fi Thermostat DR program by event in Rhode Island. The maximum DR occurred on August 12, 2016 (the 2016 ISO-NE system peak), with a total DR of 105 kW.



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

Figure 3. Total Savings by Event and Thermostat Type, Rhode Island

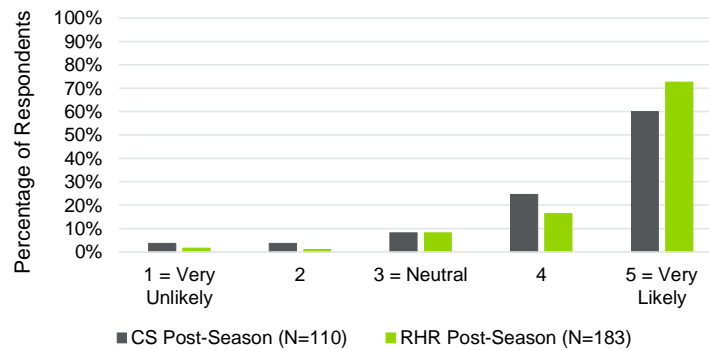


Source: Navigant analysis

Overall Customer Satisfaction

The majority of survey respondents were satisfied with the 2016 program offerings. More than 85% of participants in both programs reported they are “likely” or “very likely” to participate in the program in future summers. Only four thermostats—out of more than 2,000 thermostats—were unenrolled from the program.

Figure 4. Based on your experience to date, in future summers, will you continue to participate in the program?



Source: Post-season surveys administered and analyzed by Navigant



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

Key Findings and Recommendations

This Residential Wi-Fi Thermostat DR program was successful in testing the effectiveness of DR technology and customer acceptance of the program offerings. Navigant's evaluation resulted in several key findings and recommendations (described in Table 1) that should inform future program planning, including the 2017 program year and the 2019-2021 Three-Year Energy Efficiency Plan.

Table 1. Findings and Recommendations

Category	Finding	Recommendation
Marketing and Enrollment	<ul style="list-style-type: none"> Marketing by thermostat vendors was successful in gaining participation; National Grid Marketing also played a large role. About 40% of customers attempting to enroll in RHR were screened out of the process after the "Select A Home" step. About 10% of CS program participants experienced challenges enrolling, which caused them to contact customer support. 	<ul style="list-style-type: none"> Reduce the percentage of ineligible customers with a more targeted marketing effort or ensure the program is not over-screening participants. Automate screening process where possible (i.e., confirm thermostat connection to central air conditioning (CAC), thermostat connectivity issues, etc.). Facilitate more detailed enrollment analytics (count number of completes by field and state for the entire season).
Event Notification	<ul style="list-style-type: none"> Most participants were satisfied with the notification. The most common reason for dissatisfaction was that the event notification was provided too close to the event start time. 	<ul style="list-style-type: none"> Continue to send advance notification. Provide customers options to tailor the frequency of event notifications.
Opt Out	<ul style="list-style-type: none"> The ecobee and Honeywell thermostats experienced opt-out rates of 10%-15%, compared with 25% for the Nest thermostats. The higher opt-out rate of Nest thermostats could be due to a larger temperature setback (3°F vs. 2°F), program incentive structure (no participation incentive), higher event temperatures (on average), or device usability. The majority of opt outs were associated with a relatively small number of thermostats that frequently opt out (serial opt outers). 	<ul style="list-style-type: none"> Monitor participation throughout the DR season to identify customers that opt out frequently and conduct customer outreach. Consider modifications to program design to reduce extent of opt outs (e.g., participation incentives).



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

Category	Finding	Recommendation
Connectivity	<ul style="list-style-type: none"> 10%-30% of Honeywell thermostats experienced a connectivity issue during each event, compared with <10% for ecobee and <2% for Nest. Approximately 2% of ecobee and Honeywell thermostats were not connected the entire DR season, compared with 0% for Nest. 	<ul style="list-style-type: none"> Determine which Honeywell models have a larger share of connectivity issues. If the issue is model-specific, consider restricting models eligible for program participation. Monitor connectivity throughout the DR season to identify devices with persistent issues and conduct customer outreach. Remove thermostats with persistent connectivity issues.
Event Impacts	<ul style="list-style-type: none"> Savings varied by thermostat model, attributed to differences in pre-cooling, performance incentives, setback strategy, connectivity issues, opt-out rates, and event attributes (temperature). 	<ul style="list-style-type: none"> Continue to test combinations of setback strategies and performance incentive mechanisms in 2017.
Pre-cooling	<ul style="list-style-type: none"> Pre-cooling led to a slower degradation of impacts and a smaller maximum peak during the recovery period. 	<ul style="list-style-type: none"> Weigh pre-cooling against adding load during likely high load hours compared to higher sustained savings during the DR event.
Outdoor Temperature	<ul style="list-style-type: none"> Savings were statistically larger for events with an average temperature above 80°F. Most events below 80°F were in early July or September. 	<ul style="list-style-type: none"> Add a temperature threshold to the event criteria.⁴
Multiple Thermostats	<ul style="list-style-type: none"> Customer-level impacts were higher for customers with multiple thermostats, though impacts increased at a decreasing rate. 	<ul style="list-style-type: none"> Continue to monitor the effect of multiple thermostats on savings to determine whether the program should continue to limit the number of thermostats per participating customer.

⁴ National Grid has an ongoing effort to evaluate various dispatch methodologies.



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

1. INTRODUCTION

National Grid offers a diverse, yet complementary set of demonstration projects targeted to reduce peak demand and inform the design of future demand reduction (DR) programs in Massachusetts and in Rhode Island. The Residential Wi-Fi Thermostat DR program was first offered in Massachusetts and Rhode Island in 2016 and reached over 1,400 customers and enrolled over 2,000 thermostats. The demonstration project tests thermostats as a DR technology (testing various thermostat models from at least three thermostat vendors), as well as customer acceptance of the DR program offerings (testing two program platforms that offer different incentive structures, event frequencies, and event durations in Massachusetts).

In this evaluation report, Navigant Consulting, Inc. (Navigant) presents findings from a process and impact evaluation of the 2016 program year, providing recommendations for the 2017 program year.

1.1 Program Overview

National Grid's Residential Wi-Fi Thermostat DR program includes two program offerings: ConnectedSolutions (CS) and Rush Hour Rewards (RHR). Each offering varies in thermostat model (ecobee, Honeywell, and Nest), DR event attributes (frequency, duration), incentive mechanism (pay for performance), set back strategy (2°F vs. 3°F), pre-cooling, and event dispatch criteria⁵ (day-ahead locational marginal price (LMP)) (Table 1-1). In 2016, the program largely relied upon a Bring Your Own Thermostat (BYOT) approach. In 2017, the program plans to increasingly target customers who installed a Wi-Fi thermostat as part of the Home Energy Services (HES) program. National Grid is expecting to more than double the size of the program in 2017.

Table 1-1. Program Design

Category	ConnectedSolutions	Rush Hour Rewards
State	Massachusetts and Rhode Island	Massachusetts
Types of Thermostats	ecobee, Honeywell	Nest
Total Program Duration	108 hours	52 hours
Event Duration	2-4 hours	4 hours
Advance Notification	Day of, >2 hour (customer notified)	Day of, >2 hour (customer notified)
DR Event Opt-Out Option (Before Event, During Event)	No, Yes (ecobee) Yes, Yes (Honeywell)	Yes, Yes
Intended DR Set Point Range	+/- 2°F	+/- 3°F

⁵ The 2016 DR season began June 1, 2016 and ended September 30, 2016. DR events can be called on non-holiday weekdays for both CS and RHR. CS could have five events per week; RHR could have at most three events per week. CS events could range from 2-4 hours and RHR events were 4 hours. CS allowed up to 160 event hours; RHR allowed up to 60 event hours. CS events were called when the day-ahead weighted average LMP exceeded \$49 per MWh for two or more hours. RHR events were called when the day-ahead weighted average LMP exceeded \$62 per MWh for four hours. If the LMP criteria was met for more than four hours, the event was centered around the highest LMP hour.



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

Category	ConnectedSolutions	Rush Hour Rewards
Pre-cooling	Yes (Honeywell), No (ecobee)	Yes
Incentives per thermostat, for up to three thermostats per National Grid account ⁶	<p><u>BYOT</u> \$25 for sign up \$25/year if complete >75% of events</p> <p><u>HES</u>: Free thermostat and installation \$25/year if complete >75% of events</p>	<p><u>BYOT</u>: \$40 for sign up; no event requirement</p>
Participant Delivery Channels	BYOT and HES	Nest
Price Criteria (Weighted Average of Day-Ahead LMP)	\$49 per MWh	\$62 per MWh
Number of Days Meeting Dispatch Criteria	38 days	18 days

Source: National Grid

Figure 1-1 shows the timing and duration of each of the 29 CS events. Though start times for CS events ranged from 1:00 p.m. to 4:00 p.m. with event durations ranging from 2 to 4 hours, most events began at 2:00 p.m. and lasted 4 hours. Average temperatures during the CS events varied throughout the DR season, ranging from 69°F on July 8, 2016 to 89°F on July 22, 2016. The temperature humidity index (THI)⁷ ranged from 67°F to 81°F.

⁶ CS: A \$25 sign-up incentive is provided for each thermostat enrolled in the program, up to three thermostats per National Grid account. The enrollment incentive is provided once per thermostat. A \$25 participation incentive is provided annually for up to three thermostats, assuming each thermostat participates in more than 75% of DR events each year.

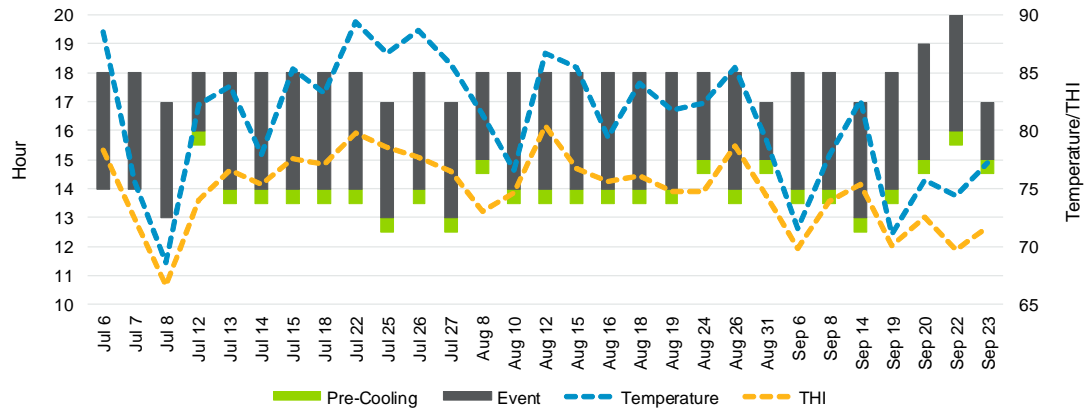
RHR: A \$40 sign-up incentive is provided for each thermostat enrolled in the program, up to three thermostats per National Grid account. The enrollment incentive is provided once per thermostat. After the first season, the annual incentive is \$25 for each thermostat.

⁷ The temperature humidity index (THI) is a weather variable that measures the combined effects of temperature (dry bulb) and relative humidity. The THI calculation used in Figure 1-1 comes from PJM: *PJM Manual 19: Load Forecasting and Analysis*, Effective Date: June 2016, http://www.pjm.com/planning/resource-adequacy-planning/~/_media/documents/manuals/m19.ashx



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

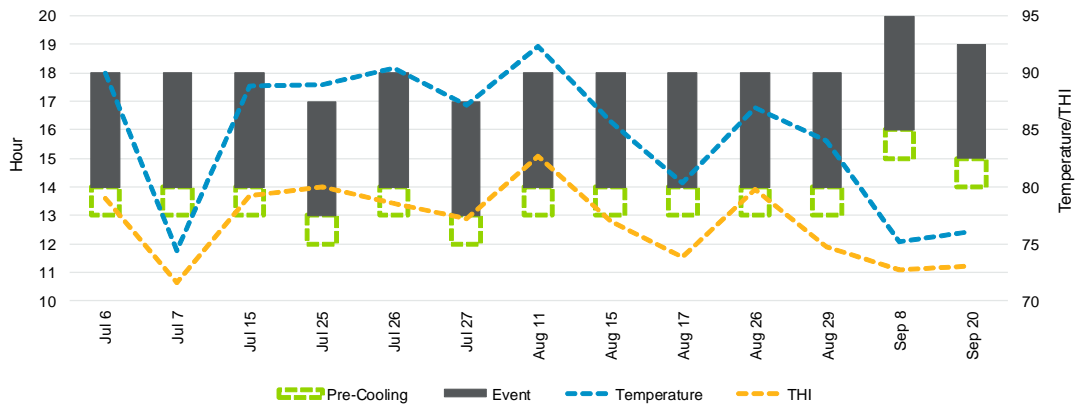
Figure 1-1. Timing of CS Events with Average Temperature and THI



Source: Navigant analysis

Figure 1-2 shows the timing and duration of each of the 13 RHR events. Most events began at 2:00 p.m., although start times ranged from 1:00 p.m. to 4:00 p.m. All events lasted 4 hours. Average temperatures during events were typically higher for RHR than for CS. Average temperatures during RHR events ranged from 74°F on July 7, 2016 to 92°F on August 11, 2016. Average THI ranged from 72°F to 83°F.

Figure 1-2. Timing of RHR Events with Average Temperature and THI



Source: Navigant analysis

As of September 30, 2016, there were 1,492 customers and 2,065 thermostats enrolled in the residential DR program in Massachusetts and Rhode Island.⁸ Figure 1-3 shows the number of enrolled thermostats on event days during the DR season in both Massachusetts and Rhode Island. The number of

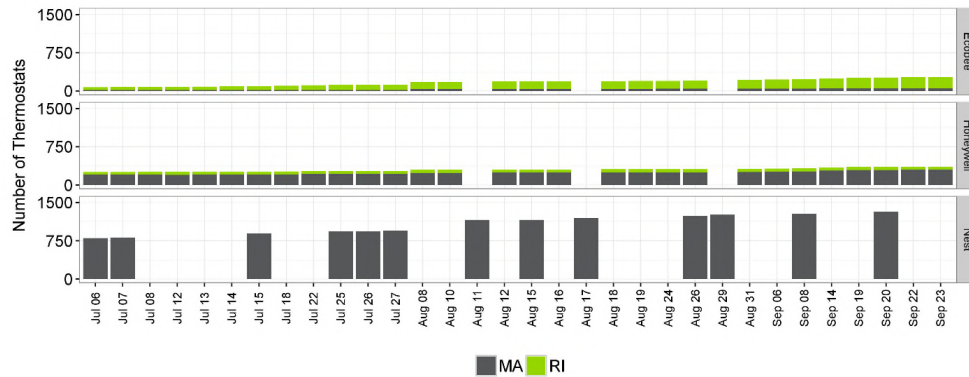
⁸ Customer and thermostat counts are from thermostat telemetry data provided by the thermostat vendors.



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

participants and thermostats enrolled from the start of the program in May 2016 through the end of the DR season is included in Appendix A.

Figure 1-3. Number of Enrolled Thermostats on Event Days during the DR Season, Massachusetts and Rhode Island



Source: Navigant analysis of thermostat telemetry data

Table 1-2 shows the number of enrolled thermostats through September 30, 2016 in total and broken out by state.

Table 1-2. Number of Enrolled Thermostats at End of DR season

Thermostat	Total	MA	RI
ecobee	301	57	244
Honeywell	362	302	60
Nest*	1,402	1,402	N/A
Total	2,065	1,761	302

Source: Navigant analysis of thermostat telemetry data

*Note: Nest device totals do not include commercial accounts

Table 1-3 shows the number of enrolled customers through September 30, 2016 in total and by state.

Table 1-3. Number of Enrolled Customers at End of DR season

Thermostat	Total	MA	RI
ecobee	205	34	171
Honeywell	250	207	43
Nest*	1,037	1,037	N/A
Total	1,492	1,278	214

Source: Navigant analysis of thermostat telemetry data

*Note: Nest customer totals do not include commercial accounts



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

2. KEY RESEARCH OBJECTIVES AND METHODS

The 2016 evaluation had several objectives (identified in Table 2-1) aimed at assessing the effectiveness of the DR offering.

Table 2-1. Evaluation Objectives

Evaluation Objectives
Identify enrollment stage dropout points
Obtain feedback on enrollment process, including information about participant motivations for signing up
Assess customer awareness of and satisfaction with specific DR events
Assess customer satisfaction and experience with the DR program over the summer
Analyze rate of event opt out or thermostat overrides
Assess connectivity of Wi-Fi thermostats during DR event periods
Estimate the average hourly and maximum hourly impacts during the pre-cool, event, and recovery periods, as well as the energy impacts
Assess impact of weather conditions, participant fatigue, and multiple thermostats on savings
Report total 2016 program savings for MA and RI

Navigant's evaluation approach relied on a variety of methods, each of which is briefly described below:

1. Analysis of marketing data, enrollment website usage data, and program enrollment data
2. Surveys, including a post-enrollment survey, post-event surveys, and a post-season survey
3. Thermostat usage assessment, in which thermostat telemetry data was combined with event program data
4. Regression analysis to estimate demand and energy impacts

Unless noted otherwise, analysis and results are presented for Massachusetts and Rhode Island, combined.

Marketing and enrollment website analysis. Navigant's marketing and enrollment website analysis included analyzing the CS and RHR enrollment websites to assess ease-of-use and identify potential enrollment barriers, enrollment website usage statistics, and survey responses to enrollment-related questions. This analysis was limited to Massachusetts as marketing and enrollment data were not available for the program in Rhode Island.

Surveys. Navigant conducted a total of five web-based surveys: one post-enrollment survey, three post-event surveys, and one post-season survey. Of the three post-event surveys, one was a placebo (i.e., survey was conducted following a day in which a DR event was *not* called but that met the event criteria). It was intended to provide context for participant survey responses related to awareness and comfort. Table 2-2 provides a summary of the survey characteristics. Appendix E through Appendix J include the survey instruments and responses to the multi-choice questions.



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

Table 2-2. Survey Characteristics

Survey	CS				RHR			
	Date(s) Initiated	Avg. Max THI	Avg. Max Temp	Number of Completes*	Date(s) Initiated	Avg. Max THI	Avg. Max Temp	Number of Completes*
Post-Enrollment	8/4/2017; 8/19/2017	N/A	N/A	51	8/18/2017	N/A	N/A	79
Post-Event #1	8/26/2017	80	87	159	8/26/2017	81	89	390
Post-Event #2 (Placebo)	9/9/2017	80	89	21	9/9/2017	81	91	90
Post-Event #3	9/14/2017	77	85	19	9/20/2017	75	79	84
Post-Season	11/7/2017	N/A	N/A	111	11/7/2017	N/A	N/A	185

Source: Navigant surveys

*Number of people who completed the entire survey.

Thermostat usage assessment. To analyze the thermostat telemetry data, Navigant first categorized all enrolled devices by event into one of four participation status categories:

- *Full participant:* Thermostat used the DR set point or a more efficient set point for the full event
- *Opt out:* Thermostat actively opted out of an event, either before or during the event
- *Non-participant:* Thermostat did not participate during the event because the system was turned off prior to event notification or was in heating mode
- *No connectivity:* Thermostat did not participate during the event due to a connectivity issue

Navigant then analyzed the participation status, identifying key trends.

Impact analysis. To estimate demand and energy reductions, Navigant used a regression-based within-subject baseline in which participants' non-event days were used to predict baseline usage (or the counterfactual).⁹¹⁰

⁹ The original proposed methodology relied upon designated "non-event" days to predict baseline usage; these days met the same day-ahead LMP pricing criteria as event days, but were randomly designated as a "non-event" day (i.e., a DR event was not initiated). This approach is intended to ensure the non-event days used to predict the baseline are identical to event days, except by random chance a DR event was not called. However, due event criteria being based on day-ahead LMP, the temperature on event days varied considerably (from ~70°F to ~90°F). As a result, the temperature distribution across event and designated "non-event" days was unbalanced, with designated "non-event" days being hotter, on average. To mitigate this imbalance, Navigant included all other non-event days between June 1 and September 30, 2016.

¹⁰ In 2017, National Grid plans to implement the Residential Wi-Fi Thermostat DR program as an experimental design in which participants are randomly assigned into two groups (A and B). On each event, the DR signal will be sent to either group A or group B, with the other serving as the control group. Control group usage serves as the baseline (or counterfactual).



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

Because advanced metering infrastructure (AMI) data was unavailable, Navigant relied exclusively on thermostat telemetry data to estimate impacts after converting thermostat runtime to power.¹¹ Navigant estimated both the average treatment effect (ATE), in which impacts are estimated for all enrolled devices—full participant, opt out, and nonparticipants, including devices with connectivity issues—and the treatment effect of the treated (TOT), in which impacts are estimated for all full participant-enrolled devices only.

¹¹ Navigant converted thermostat runtime to power based on an analysis of metering data from Phase 1 of the 2017 Massachusetts Baseline Study and assumptions regarding average size (2.6 tons) and efficiency (11 Energy Efficiency Ratio) of air conditioners based on the Central AC Digital Check-Up/Tune-Up measure in the 2015 Massachusetts Technical Reference Manual. For example, for a 15-minute interval with 100% runtime at 80°F, the estimated power is 2.6 kW. In 2017, Navigant plans to meter a small sample of DR participants to get a better estimate of the relationship between thermostat runtime and power, as well as the impact of the DR event on whole home usage.



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

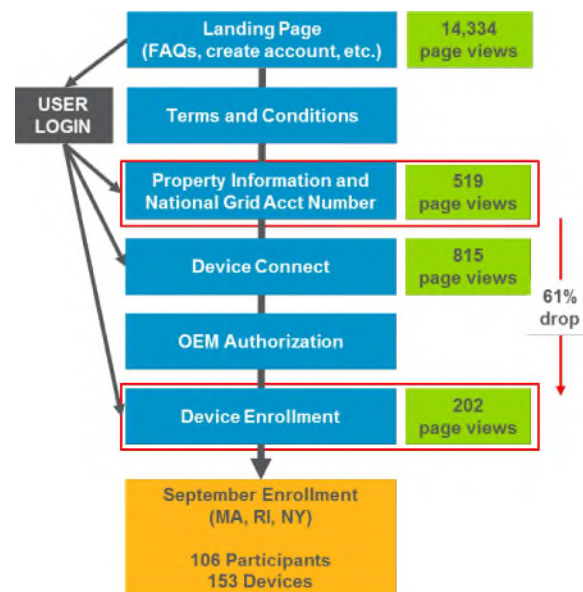
3. PROGRAM PROCESSES

In this section of the report, Navigant reports on the program enrollment process and customer motivations for participation.

3.1 ConnectedSolutions Enrollment Process

Figure 3-1 provides a representation of the CS enrollment website logic (in blue). Green boxes contain the number of page views for a given step in the enrollment process for the month of September, as associated with program enrollment for customers in Massachusetts, Rhode Island, and New York.¹² Although page views alone provide an incomplete picture of enrollment website usage, a 61% drop in page views between the "National Grid Account Number" step and the "Device Enrollment" step indicates a portion of those attempting enrollment either had to visit the Account Number step multiple times or dropped out of the enrollment process altogether at the Account Number step.

Figure 3-1. CS Enrollment Flow and September Page Views in Massachusetts, Rhode Island, and New York



Source: Enrollment website information and enrollment data provided by National Grid

When asked about their satisfaction with the program enrollment process, 90% of CS respondents indicated they were neutral or satisfied with the process. Only 10% of post-season survey respondents

¹² National Grid also implemented a CS program in New York, though this program was not included in this evaluation. Enrollment flow and page views were only provided in the aggregate (i.e., CS could not provide statistics excluding the New York program).



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

reported contacting customer support due to issues enrolling. Reasons cited for contacting support included wanting to confirm enrollment was completed successfully and trouble enrolling a thermostat.

The post-enrollment survey for CS customers included questions about the usability of the CS enrollment website. Approximately 40% of enrollment survey respondents indicated they were confused by the enrollment website's domain not being nationalgrid.com or ngrid.com. Additionally, 40% of respondents were confused by National Grid's color scheme and logo not being more prominent on the website.

The CS enrollment process did not include an automatic assessment of eligibility (e.g., thermostat connectivity). Approximately 2% of ecobee and Honeywell thermostats were not connected the entire DR season, which potentially could have been addressed by an automated assessment during the enrollment process.

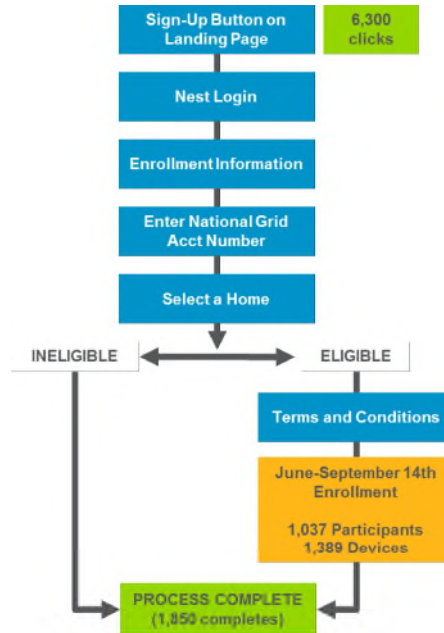
3.2 Rush Hour Rewards Enrollment Process

Figure 3-2 provides a representation of the RHR enrollment website flow (in blue). Notably, the "Select a Home" step filters out thermostats not currently eligible to participate (i.e., if the thermostat is not connected to a cooling system, does not have the most recent version of the software, or has not been connected to the Internet recently). The RHR enrollment process is a continuous flow, which does not allow for page view diagnostics. However, as indicated by the green box at the bottom of the figure, 1,850 National Grid customers completed the RHR enrollment process from June 1, 2016 through September 14, 2016. This includes both customers who successfully enrolled in the program (1,037 customers from June through September 14, 2016) and those who were determined to be ineligible at the "Select a Home" step. This indicates 43% of customers attempting to enroll were determined to be ineligible.



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

Figure 3-2. RHR Enrollment Flow and Usage Data: June through September 14, 2016



Source: Enrollment website information provided by Nest; program enrollment data provided by National Grid

When asked about their satisfaction with the program enrollment process, 96% of RHR respondents indicated they were neutral or satisfied with the process. Only 4% of post-season survey respondents reported contacting customer support due to issues enrolling. The primary reason cited for contacting support during enrollment related to encountering an error when attempting to access the enrollment website.

3.3 Motivation to Participate

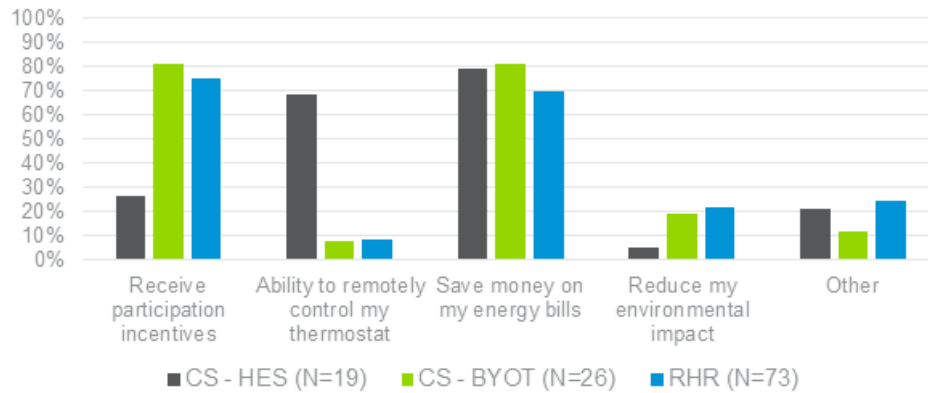
In the post-enrollment survey, participants were asked to rank their motivations for enrolling in the program. As illustrated in Figure 3-3, most participants (70%-80%) believed the program would help them achieve bill savings. This was the first choice selected by a majority of those who enrolled in CS through the HES program and the second choice for a majority of CS and RHR participants who enrolled through the BYOT program.

The majority of CS BYOT and RHR participants cited program incentives as their greatest motivation to enroll in the program. Unsurprisingly, HES participants—the only participants to receive a free Wi-Fi thermostat for program enrollment—were more motivated by the thermostat than by financial incentives.



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

Figure 3-3. What are your main reasons for enrolling in the program? (Rank first and second reasons)



Source: Post-enrollment surveys administered and analyzed by Navigant



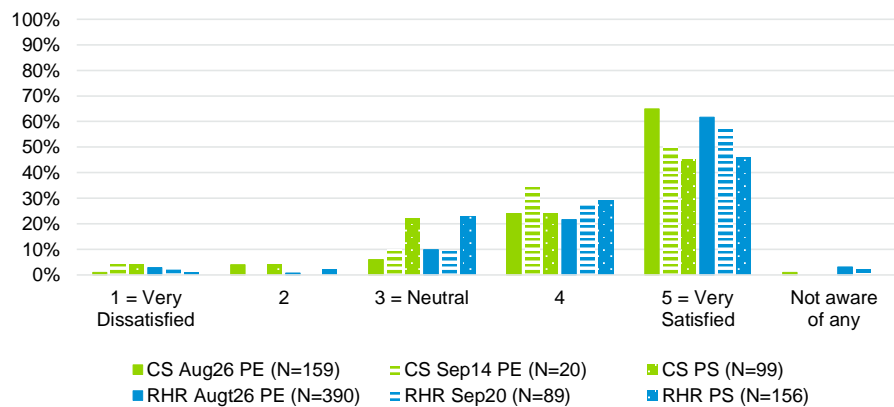
2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

4. PROGRAM EVENT PARTICIPATION

4.1 Event Notification and Awareness

As indicated in Figure 4-1, participants were generally satisfied with the event notifications, but satisfaction decreased somewhat over time—i.e., between the post-event surveys and post-season surveys. The most commonly cited complaint was that there was not enough time between a notification and the start of an event. Additionally, some participants mentioned notifications were not obvious enough or that notifications did not contain enough information about the upcoming event. Finally, some participants mentioned they would like options related to the method and frequency of event notifications.

Figure 4-1. What is your level of satisfaction with the notification you receive about an event that is set to occur?



Source: Post-event surveys and post-season surveys administered and analyzed by Navigant

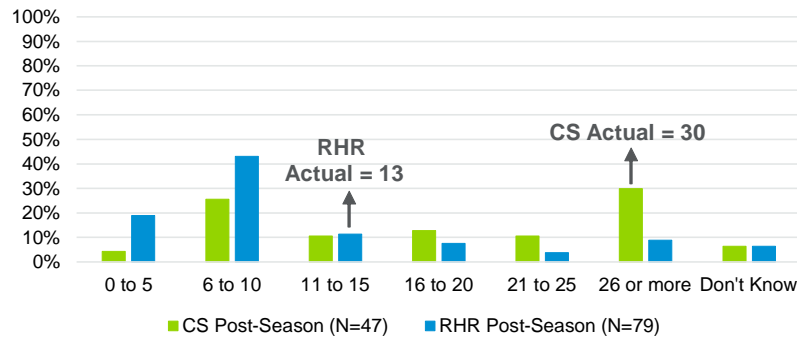
Although more than 85% of participants indicated they were “likely” or “very likely” to participate in the program in future summers (refer to Section 6), survey results revealed that participants’ willingness to participate in the future would drop if no advance notice were provided prior to events. If no advance notice were given, the percentage of participants who were “likely” or “very likely” to participate in the future decreased to 45% and 55% for CS and RHR, respectively.

In post-season surveys, participants were asked to recall the number of events that had occurred during the 2016 summer season. As indicated in Figure 4-2, of the respondents enrolled from the start of the summer season, approximately 60% of respondents in both CS and RHR recalled fewer than the actual number of events that had occurred. Roughly 40% of CS respondents recalled only half of the number of events that occurred.



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

Figure 4-2. About how many events do you remember occurring between June 15 and September 30? (open-ended)



Source: Post-season surveys administered and analyzed by Navigant

4.2 Event Participation

In addition to the post-event surveys administered following two different events during the summer of 2016, the same survey was administered following a non-event—a day that met the program event criteria but during which no event was called. Comparing the post-event and non-event survey responses to comfort-related questions revealed that reported comfort may be more dependent on outdoor climate conditions than on whether or not an event occurred.

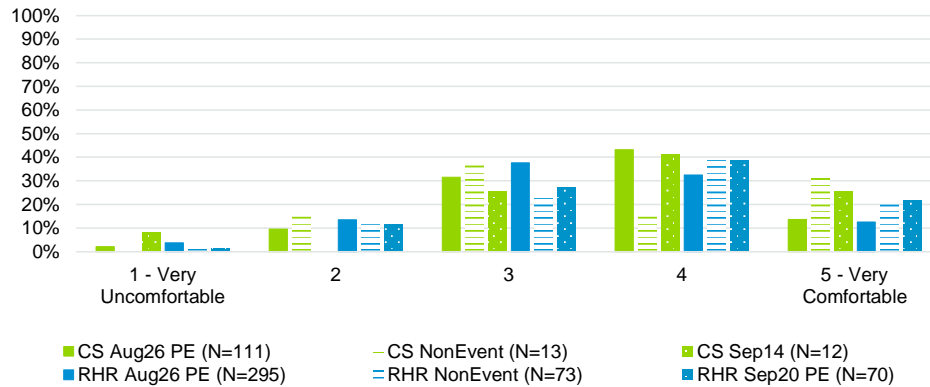
For both programs, the first post-event survey and the non-event survey were administered following similarly hot and humid event days, while the second post-event survey was administered following a day with a lower THI (detailed in Table 2-2). As shown in Figure 4-3, a similar percentage of CS and RHR participants who responded to the first post-event survey and the non-event survey reported being “uncomfortable” or “very uncomfortable.” For both programs, the percentage of those who reported being uncomfortable was discernibly lower during the second post-event survey, which was administered following events with lower max THI.

Regardless of participants’ reasons for their reported comfort level depending on outdoor weather conditions, only 8% to 12% of CS participants and 13% to 17% of RHR participants reported being “uncomfortable” or “very uncomfortable” during (actual) events.



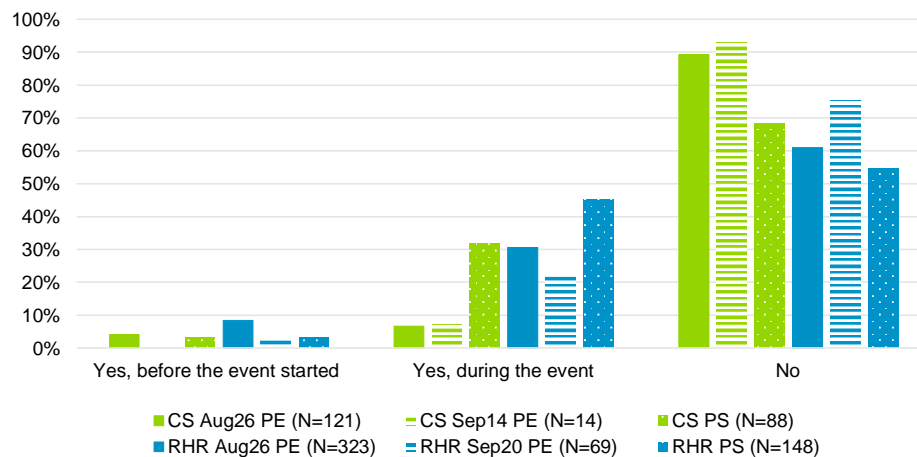
2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

Figure 4-3. Describe the comfort level of your home during [event hours] on [event date] as compared to a typical day with similar outdoor temperatures?



As indicated in Figure 4-4, some participants in both the CS and RHR programs reported choosing to override event temperature setpoints either before or during events. During the post-season survey, 30% of CS participants and 40% of RHR participants indicated they overrode at least one event during the 2016 summer season. Additionally, these results show most overrides occurred during events rather than prior, suggesting participants found pre-cooling to be agreeable or they did not base participation decisions on previous event experiences.

Figure 4-4. Did you ever override your Wi-Fi thermostat setting to stop the program from adjusting your Wi-Fi thermostat remotely during an/the event? Select all that apply.





2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

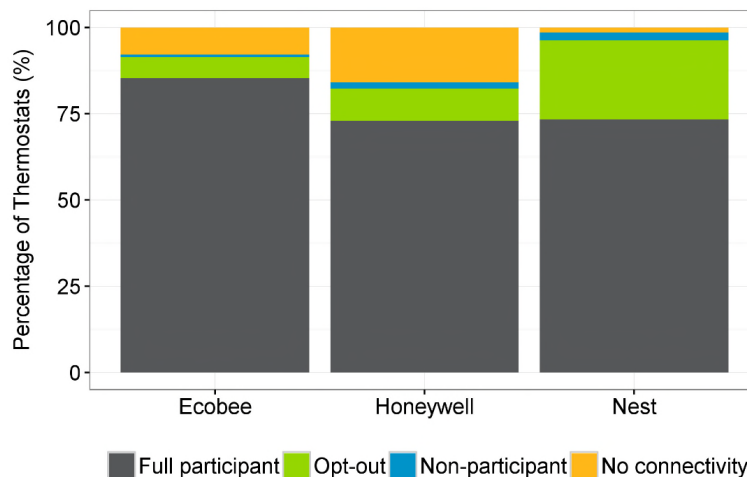
To further study customer acceptance of DR events, Navigant analyzed thermostat telemetry data on event days to characterize the device-level participation status. Figure 4-5 shows the percentage of thermostats that participated in each of the four classifications, averaged across all events.¹³

Considerable differences in participation are seen for each thermostat type. ecobee thermostats had few opt outs or connectivity issues. Together, opt outs and connectivity issues accounted for less than 15% of total participation for ecobee users. Honeywell thermostats had few opt outs but more connectivity issues (about 20%) than ecobee or Nest. Nest had few connectivity issues but, on average, more than 20% of Nest users opted out of events.

The increased opt outs by Nest participants compared with ecobee and Honeywell may have occurred for a variety of reasons, including the following:

1. Nest thermostats had a setback during DR events of 3°F, while ecobee and Honeywell thermostats had a smaller setback of 2°F.
2. CS program participants were required to participate in at least 75% of DR events to qualify for the full incentive, while RHR participants received the full incentive with no participation requirements.
3. RHR events were hotter, on average, than CS events.
4. There may be differences in device usability, the types of users, or the method used to opt out.

Figure 4-5. Average Participation across All CS and RHR Events



Source: Navigant analysis

Navigant analyzed participation status by event for each of the three thermostat types to identify possible trends. Throughout the DR season opt-out rates fluctuated for all thermostat models, suggesting participant fatigue throughout the DR season was not an issue. Connectivity issues also fluctuated

¹³ Refer to Appendix C for participation status by event for each of the three thermostat types.



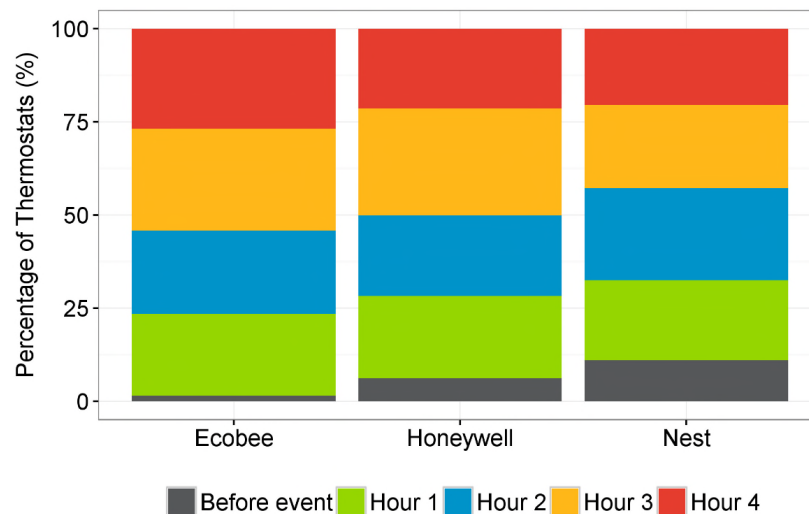
2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

throughout the summer, indicating no systematic or growing connectivity issues. The largest connectivity issues appeared to be isolated to specific days (e.g., July 15 for ecobee and July 12 for the Honeywell).

Next, Navigant analyzed whether there was any correlation between participation status and specific event attributes, including event duration, event frequency, day of week, and temperature. No correlation was identified between opt-out rates and event frequency or day of week for any of the three thermostat models. Navigant did identify a positive correlation between opt-out rates and temperature for the Honeywell thermostat, and a positive correlation between opt-out rates and event duration for the ecobee and Honeywell thermostats.

To further study whether higher opt-out rates for longer events were due to participant fatigue, Navigant investigated the timing of opt outs to determine if a greater percentage occurred toward the end of an event (i.e., indicative of participation fatigue). Figure 4-6 shows the average percentage of thermostats that opted out during DR events lasting 4 hours. This chart shows participants opted out throughout the events, so there is no evidence of participation fatigue.

Figure 4-6. Timing of Opt Outs for 4-Hour Events by Thermostat Type



Source: Navigant analysis

Nest and Honeywell participants have more opt outs before events because participants could override the system prior to the event start during the precooling period. Although ecobee thermostats did not have a precooling period, participants were still able to opt out after they received the event notification and before the event began.

The percentage of opt outs that occurred during each hour of the events was relatively consistent for all thermostat types. In addition, Navigant found relatively stable opt-out rates during events (as seen in Table 4-1), although rates varied between thermostat types.



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

Table 4-1. Opt-Out Rates during DR Events

Thermostat Type	Opt-Out Rate
ecobee	2.0% per hour
Honeywell	2.7% per hour
Nest	6.3% per hour

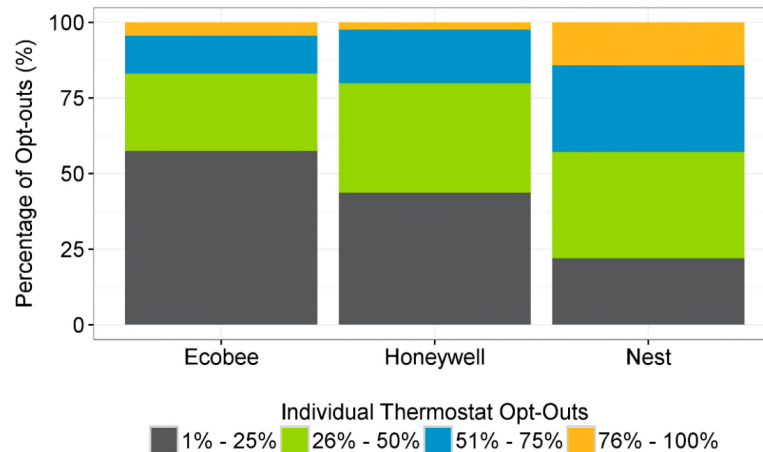
Source: Navigant analysis

Finally, Navigant investigated whether opt-out rates were due to a small set of participants who frequently opted out of events. The evaluation team classified individual thermostat opt outs into four categories based on the number of times each thermostat opted out compared to the total number of events the thermostat was enrolled in. The total number of opt outs for each category was summed and then divided by the total number of opt outs for each thermostat type during the entire DR season.

Figure 4-7 shows the result of this analysis and indicates there were some participants in each program that frequently opted out (serial opt outs) and represented the majority of opt outs. About 50% of all ecobee and Honeywell opt outs were from thermostats that opted out of more than 25% of events, and over 75% of Nest opt outs were from thermostats that opted out of more than 25% of events.

In addition, Figure 4-7 shows that compared to the RHR program, the CS program had a greater share of participants who infrequently opted out (between 1% and 25% of the time) and also had a smaller percentage of participants who opted out frequently (between 76% and 100%).

Figure 4-7. Percentage of Total Opt Outs by Individual Thermostat Opt Outs and Thermostat Type



Source: Navigant analysis



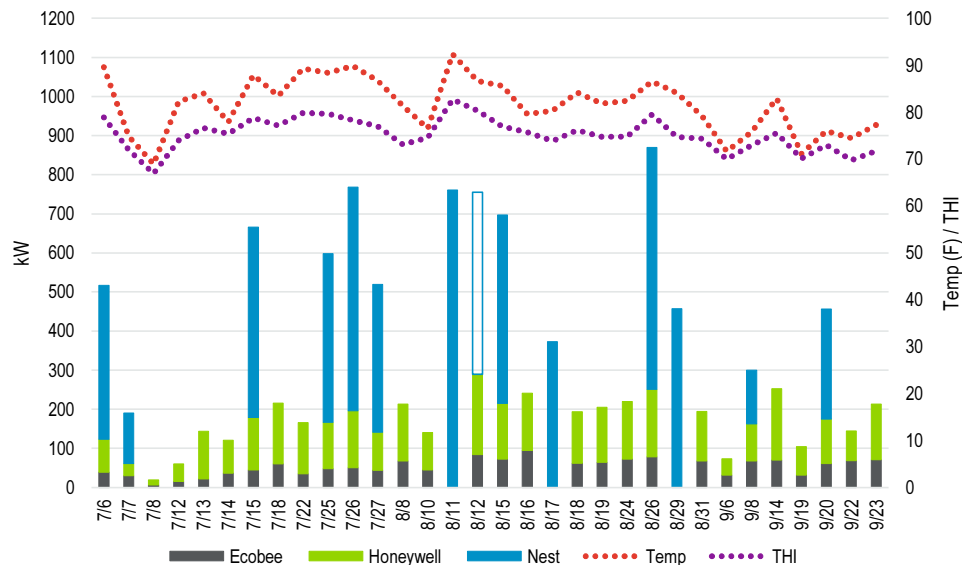
2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

5. PROGRAM IMPACTS

5.1 2016 Program Savings

Figure 5-1 presents the total DR for the Residential Wi-Fi Thermostat DR program by event. The maximum kilowatt reduction occurred on August 26, 2016, with a total DR of 869 kW. The Independent System Operator-New England (ISO-NE) 2016 system peak was on August 12, 2016. Navigant estimates a DR of 755 kW could have been achieved had the RHR program been called an event that day.¹⁴

Figure 5-1. Total Savings by Event and Thermostat Type, Massachusetts and Rhode Island



Source: Navigant analysis

Note: Navigant estimated DR savings that could have been achieved had a RHR event been called. The estimate is calculated as the average demand savings per event for the Nest thermostat (0.39 kW) x the number of active devices based on the prior event (1,193), plus the evaluated savings from the CS devices. This is likely a conservative estimate as average demand savings per event represents average savings across all events, including events on relatively mild days.

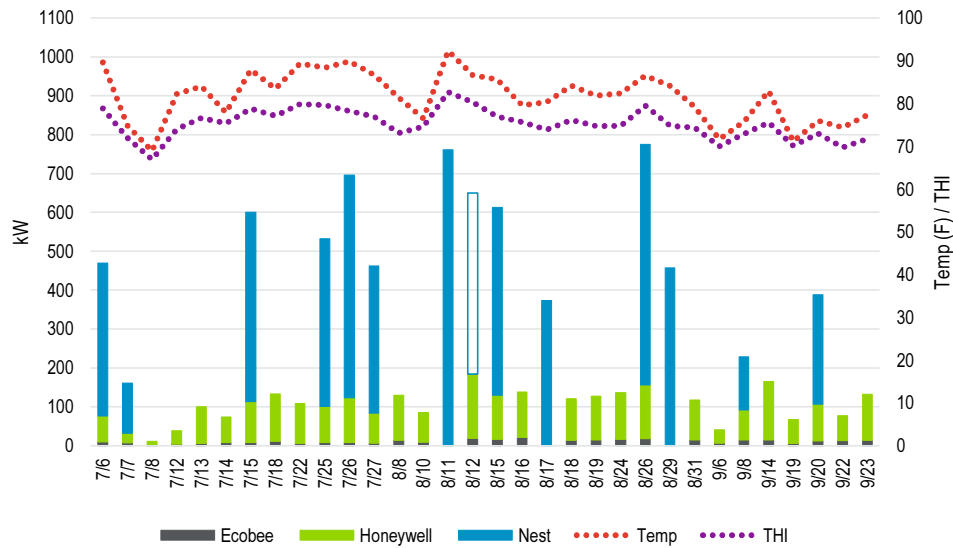
¹⁴ The RHR program did not call a DR event on August 12 due to the event being designated a "non-event". Refer to the impact analysis methodology description for additional information. As a result, Navigant estimated DR savings that could have been achieved had a DR event been called. The estimate is calculated as the average demand savings per event for the Nest thermostat (0.39 kW) x the number of active devices based on the prior event (1,193), plus the evaluated savings from the CS devices. This is likely a conservative estimate as average demand savings per event represents average savings across all events, including events on relatively mild days.



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

Figure 5-2 presents the total DR for the Residential Wi-Fi Thermostat DR program by event in Massachusetts. The maximum DR occurred on August 26, 2016, with a total DR of 775 kW. Navigant estimates there could have been a DR of 650 kW on August 12, 2016 (the ISO-NE system peak) had an RHR program event been called that day.

Figure 5-2. Total Savings by Event and Thermostat Type, Massachusetts



Source: Navigant analysis

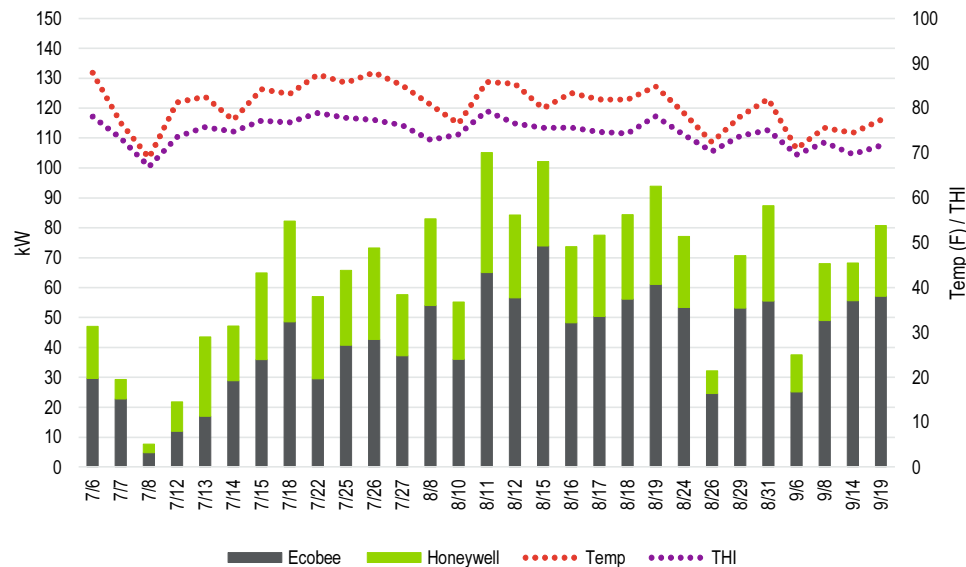
Note: Navigant estimated DR savings that could have been achieved had a RHR event been called. The estimate is calculated as the average demand savings per event for the Nest thermostat (0.39 kW) x the number of active devices based on the prior event (1,193), plus the evaluated savings from the CS devices. This is likely a conservative estimate as average demand savings per event represents average savings across all events, including events on relatively mild days.

Figure 5-3 presents the total DR for the Residential Wi-Fi Thermostat DR program by event in Rhode Island. The maximum DR occurred on August 12, 2016 (the ISO-NE system peak), with a total DR of 105 kW.



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

Figure 5-3. Total Savings by Event and Thermostat Type, Rhode Island



Source: Navigant analysis

Table 5-1 shows the summary of program impacts for the 2016 DR season. The table contains average and maximum impact for the entire season, as well as the average and maximum demand reduction for events with an 80°F+ average temperature based on the actual number of participants for each event (Figure 1-3).

Table 5-1. Summary of 2016 Program Impacts

	Total (kW)	MA (kW)	RI (kW)
Average Demand Reduction per Event (All Events)	325	266	65
Maximum Demand Reduction per Event (All Events)	869	775	105
Demand Reduction on ISO-NE Coincident Peak*	755	650	105
Average Demand Reduction per Event (80°F+ Events)	418	354	75
Maximum Demand Reduction per Event (80°F+ Events)	869	775	105

Source: Navigant analysis

Note: Navigant estimated DR savings that could have been achieved had a RHR event been called. The estimate is calculated as the average demand savings per event for the Nest thermostat (0.39 kW) x the number of active devices based on the prior event (1,193), plus the evaluated savings from the CS devices. This is likely a conservative estimate as average demand savings per event represents average savings across all events, including events on relatively mild days.

Table 5-2 shows the summary of program impacts for the 2016 DR season had all 2,065 thermostats been enrolled at the beginning of the DR season (Table 1-2). While individual event device-level impacts



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

may have differed with end of season enrollment, the table gives a reasonable estimate of the total DR impacts that could be achieved.

Table 5-2. Summary of 2016 Program Impacts Assuming End of Season Enrollment

	Total (kW)	MA (kW)	RI (kW)
Average Demand Reduction per Event (All Events)	439	345	104
Maximum Demand Reduction per Event (All Events)	1152	1020	179
Demand Reduction on ISO-NE Coincident Peak*	923	774	149
Average Demand Reduction per Event (80°F+ Events)	573	467	125
Maximum Demand Reduction per Event (80°F+ Events)	1152	1020	179

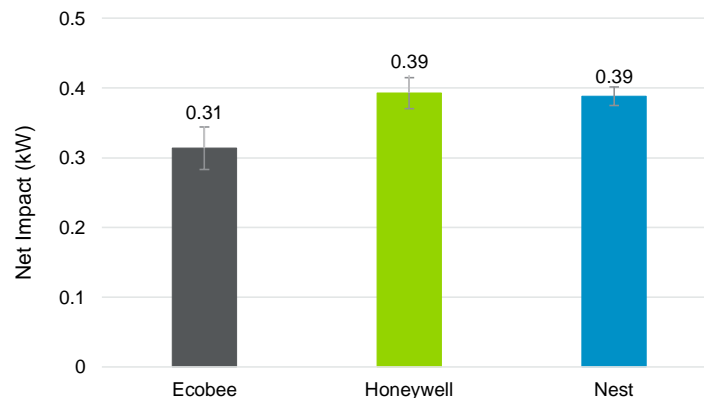
Source: Navigant analysis

Note: Navigant estimated DR savings that could have been achieved had a RHR event been called. The estimate is calculated as the average demand savings per event for the Nest thermostat (0.39 kW) x the number of active devices at end of the season (1,402), plus the estimated savings from the CS devices. This is likely a conservative estimate as average demand savings per event represents average savings across all events, including events on relatively mild days.

5.2 Average Impacts

Navigant estimated the ATE per device, which included all enrolled devices regardless of participation status. This estimate reflects actual impacts, acknowledging a portion of devices will opt out or experience connectivity issues. Average demand impacts varied by thermostat model, with the Honeywell and Nest thermostats achieving average DRs of 0.39 kW per event and the ecobee thermostat achieving 0.31 kW per event (Figure 5-4).

Figure 5-4. Average ATE per Device for All Events



Source: Navigant analysis

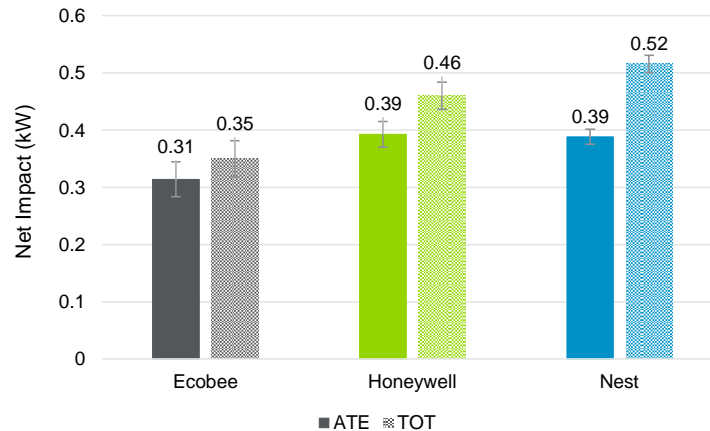
The Honeywell thermostat experienced relatively high rates of connectivity issues, while the Nest experienced relatively high opt-out rates. As a result, Navigant also estimated the TOT per device, which only included full participants (i.e., excluding participants with connectivity issues or who opted out). Figure 5-5 displays both the ATE and TOT by thermostat type, revealing higher TOT average impacts. The Honeywell and ecobee thermostats are both part of the CS program; as a result, the remaining



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

differences in TOT average impacts were likely due to differences in precooling or customer attributes. Differences between the Nest and the ecobee and Honeywell thermostats may be due to differences in program design (set back strategies, event temperature, event duration, etc.).

Figure 5-5. Average ATE vs. TOT per Device for All Events



Source: Navigant analysis

5.2.1 Average Hourly Impacts

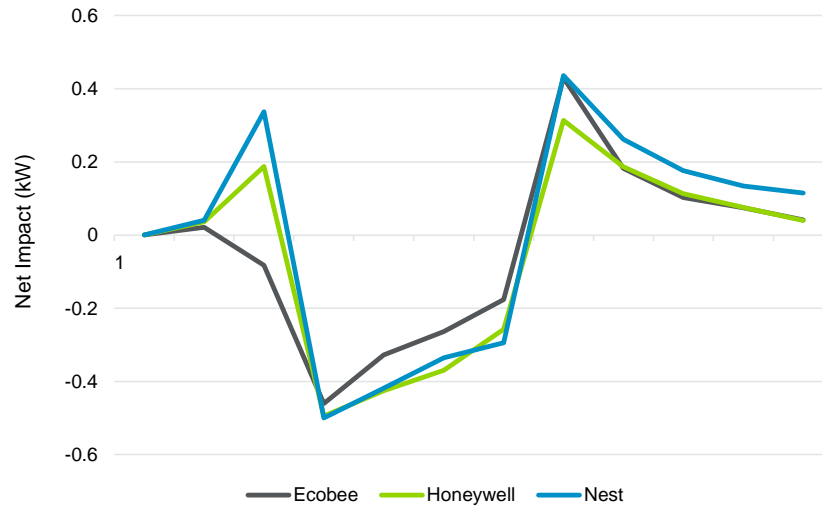
The previous section presented average hourly impacts—i.e., the average of hourly impacts over the duration of the event. In this section, Navigant presents the hourly impacts for both the event period and for the precooling and recovery periods. The precooling period included the 3 hours preceding an event, while the recovery period covered the 3 hours immediately following an event. Average hourly impacts are displayed in Figure 5-6. Of note, the largest impacts are observed during the final precooling interval (for the Honeywell and Nest, which have precooling) and the first intervals during the event and recovery periods.¹⁵ Impacts during the event are largest during the first hour and steadily degrade. This is a common feature of thermostat DR programs where indoor air temperatures increase throughout the duration of the event, resulting in increased cooling loads.

¹⁵ For certain ecobee devices on certain events, the start time of the event began 15 minutes prior to the scheduled start time (e.g., the DR algorithm initiated at 1:45 p.m. rather than 2:00 p.m.). This led to the decrease in demand observed immediately prior to the event start and likely contributed to the lower average impacts for the ecobee thermostat.



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

Figure 5-6. Average Hourly Impacts for All Events (ATE)



Source: Navigant analysis

Table 5-3 summarizes the average impact (ATE) during the precooling, event, and recovery periods by thermostat type, as well as the maximum hourly impact. One thing to note is the increase in demand during the precooling period for the Honeywell and Nest thermostats, with the Nest having a higher maximum hourly peak (the ecobee does not pre-cool). Average impacts match those presented in Figure 5-4, though the maximum hourly impact is comparable across all thermostat models. Finally, an increase in demand during the recovery period is observed for all thermostat models, with slightly lower maximum hourly impacts for the Honeywell and Nest thermostats—likely due to precooling. Navigant also reports energy impacts, which show a reduction in energy usage during the precooling, event, and recovery periods across all thermostat models. This energy reduction is smaller for the Honeywell and Nest, both of which precool.

Table 5-3. Summary of Seasonal Impacts (ATE) by Period

Thermostat	Average Impact	Pre-cooling (kW)	Event (kW)	Recovery (kW)	Energy Impact (kWh)
ecobee	Event Average	-0.02	-0.31	0.17	-0.82
	Maximum Hourly	0.03	-0.50	0.46	N/A
Honeywell	Event Average	0.08	-0.39	0.15	-0.90
	Maximum Hourly	0.19	-0.50	0.32	N/A
Nest	Event Average	0.13	-0.39	0.23	-0.48
	Maximum Hourly	0.34	-0.51	0.44	N/A

Source: Navigant analysis

summarizes the average impact for full participants (TOT) during the precooling, event, and recovery periods by thermostat type, as well as the maximum hourly impact. These results present the savings that could be achieved if all connectivity issues were addressed and there were no opt outs.



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

Table 5-4. Summary of Seasonal Impacts (TOT) by Period

Thermostat	Average Impact	Pre-cooling (kW)	Event (kW)	Recovery (kW)	Energy Impact (kWh)
ecobee	Event Average	-0.02	-0.35	0.16	-0.96
	Maximum Hourly	0.03	-0.51	0.46	N/A
Honeywell	Event Average	0.08	-0.46	0.15	-1.15
	Maximum Hourly	0.18	-0.55	0.32	N/A
Nest	Event Average	0.14	-0.52	0.28	-0.81
	Maximum Hourly	0.38	-0.55	0.51	N/A

Source: Navigant analysis

5.3 Event-Specific Impacts

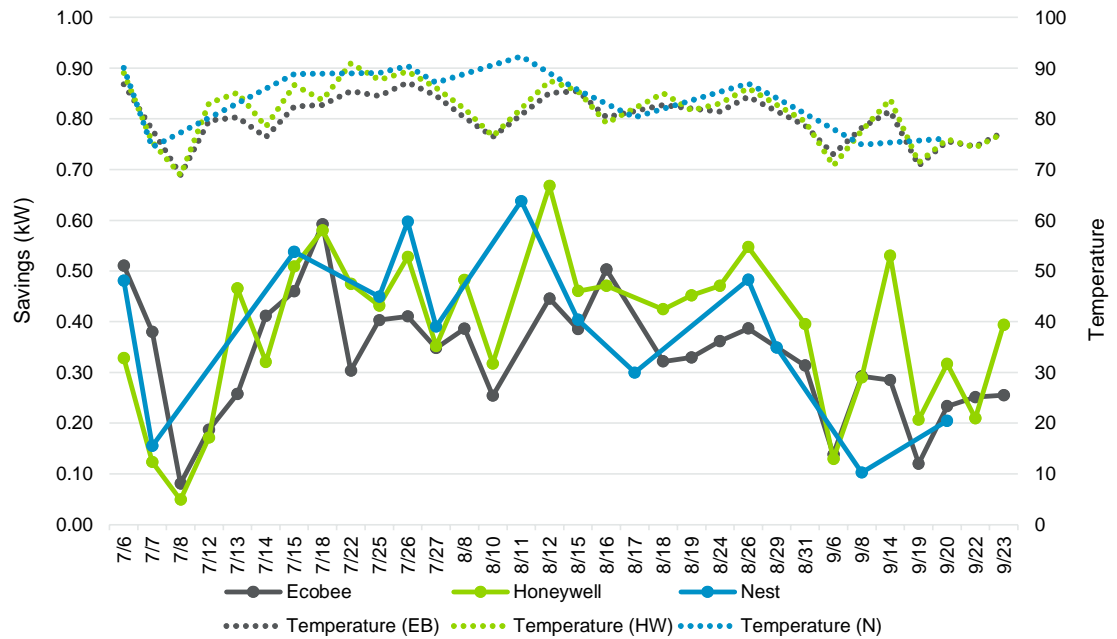
Figure 5-7 displays the average impacts (ATE) by event for each thermostat type, along with the average temperature.¹⁶ Note that the average temperature varies by thermostat type—a result of the different geographic distributions of enrolled thermostats. As is evident in the figure, average impacts were correlated with temperature, with impacts ranging from 0.05 kW to 0.2 kW on the coolest event days to 0.6 kW to 0.7 kW on the hottest event days.

¹⁶ Refer to Appendix D for figures presenting average demand savings by event for each thermostat type.



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

Figure 5-7. Event Average Demand Savings (ATE) by Event



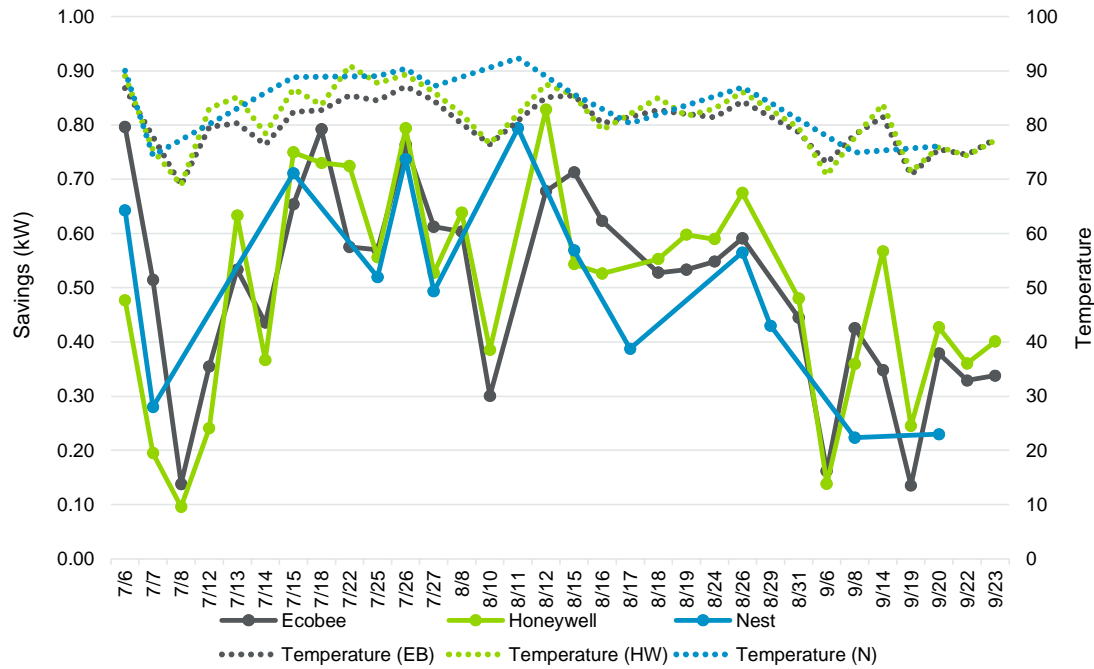
Source: Navigant analysis

Figure 5-8 presents the maximum hourly impacts by event. On the hottest days, maximum impacts reach 0.8 kW.



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

Figure 5-8. Maximum Hourly Demand Savings (ATE) by Event



Source: Navigant analysis

5.4 Weather Analysis

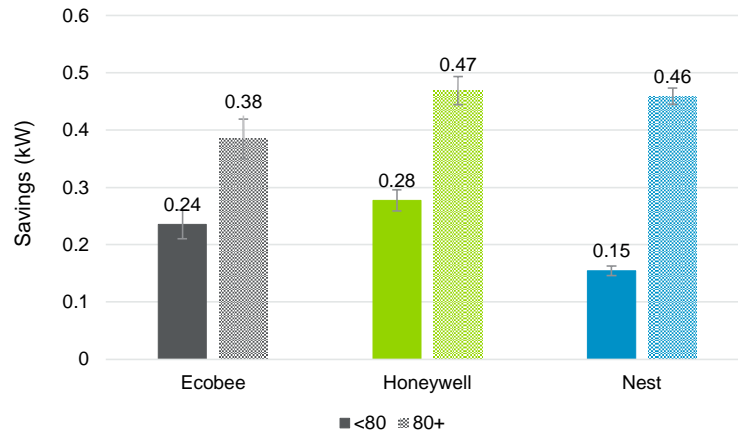
Given some events were called when outdoor air temperature was relatively mild (average DR event temperature was lower than 80°F for 12 of 29 CS events and 3 of 13 RHR events), Navigant estimated the average impacts per event (ATE) for events with an average temperature above and below the temperature threshold of 80°F. As shown in Figure 5-9, events above 80°F had significantly higher DRs as compared to events on sub-80°F days.¹⁷

¹⁷ Appendix B presents average hourly impacts for the hottest and coolest event days by thermostat type.



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

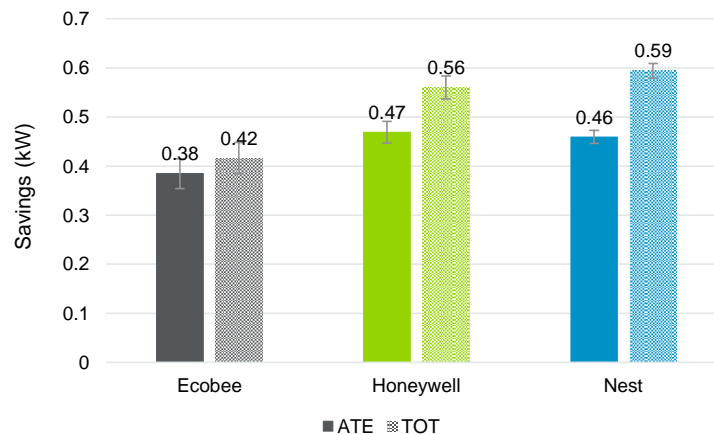
Figure 5-9. Event Average Demand Savings (ATE) by Temperature Threshold



Source: Navigant analysis

Figure 5-10 presents average impacts (ATE and TOT) for events above 80°F. Compared with Figure 5-9, average impacts are notably higher, ranging from 0.42 kW to 0.59 kW.

Figure 5-10. Event Average Demand Savings ATE vs. TOT per Device for Events above 80°F



Source: Navigant analysis

Table 5-5 provides a summary of average impacts and maximum hourly impacts, similar to Table 5-3 above but limited to events above the 80°F threshold. DRs (event average and maximum hourly) and energy savings are larger for events above the 80°F threshold.



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

Table 5-5. Summary of Seasonal Impacts (ATE) for Events Over 80°F

Thermostat	Average Impact	Pre-Cooling (kW)	Event (kW)	Recovery (kW)	Energy (kWh)
ecobee	Event Average	-0.02	-0.38	0.19	-1.06
	Maximum Hourly	0.03	-0.62	0.54	N/A
Honeywell	Event Average	0.07	-0.47	0.13	-1.27
	Maximum Hourly	0.19	-0.63	0.34	N/A
Nest	Event Average	0.13	-0.46	0.21	-0.83
	Maximum Hourly	0.35	-0.58	0.40	N/A

Source: Navigant analysis

Table 5-6 provides a summary of average impacts and maximum hourly impacts for full participants, similar to Table 5-4 above but limited to events above the 80°F threshold. The event average and maximum hourly impacts and energy savings are larger for events above the 80°F threshold. Similar to Table 5-4, these results present the savings that could be achieved on event days with temperature above 80°F if all connectivity issues were addressed and there were no opt outs.

Table 5-6. Summary of Seasonal Impacts (TOT) for Events Over 80°F

Thermostat	Average Impact	Pre-Cooling (kW)	Event (kW)	Recovery (kW)	Energy (kWh)
ecobee	Event Average	-0.02	-0.42	0.19	-1.17
	Maximum Hourly	0.04	-0.62	0.54	N/A
Honeywell	Event Average	0.07	-0.56	0.13	-1.62
	Maximum Hourly	0.19	-0.68	0.35	N/A
Nest	Event Average	0.14	-0.59	0.26	-1.17
	Maximum Hourly	0.40	-0.63	0.47	N/A

Source: Navigant analysis

5.5 Customer-Level Impacts

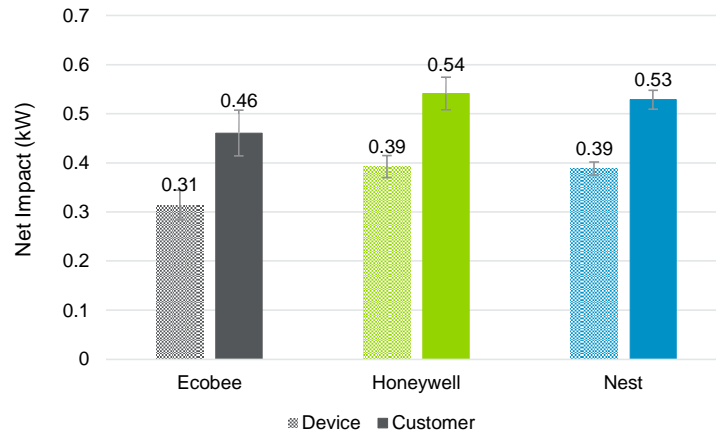
The results presented thus far represent device-level impacts. However, program participants have, on average, 1.4 thermostats. To better assess the DR associated with a participating customer, Navigant re-analyzed the thermostat telemetry data, aggregating it to the customer level. Figure 5-11 presents a comparison of the average device-level and customer-level impacts (ATE) per event. Customer-level average impacts (0.46 kW to 0.54 kW) are larger than device-level average impacts (0.31 kW to 0.39 kW).¹⁸

¹⁸ Navigant analyzed device-level impacts for customers with one, two, and three thermostats to determine whether average impacts vary with the number of thermostats. Results suggested each additional thermostat yields lower impacts, though this difference was not statistically significant.



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

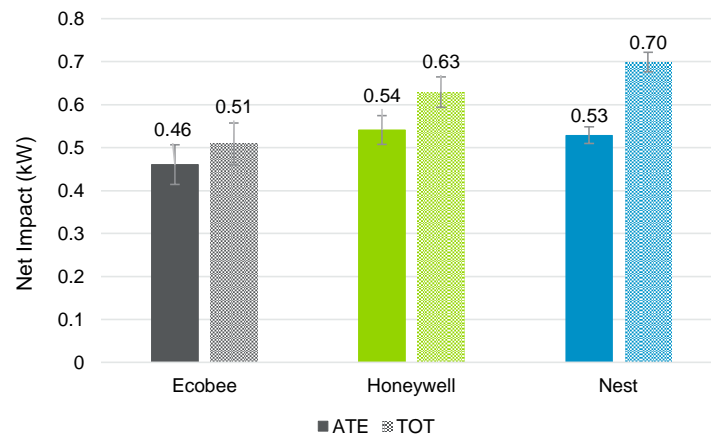
Figure 5-11. ATE Comparison: Device vs. Customer



Source: Navigant analysis

Figure 5-12 presents a comparison of customer-level impacts when including all enrolled customers (ATE) and only full participants (TOT). Customer-level impacts for full participants ranged from 0.51 kW to 0.70 kW.

Figure 5-12. Average ATE vs. TOT per Customer



Source: Navigant analysis

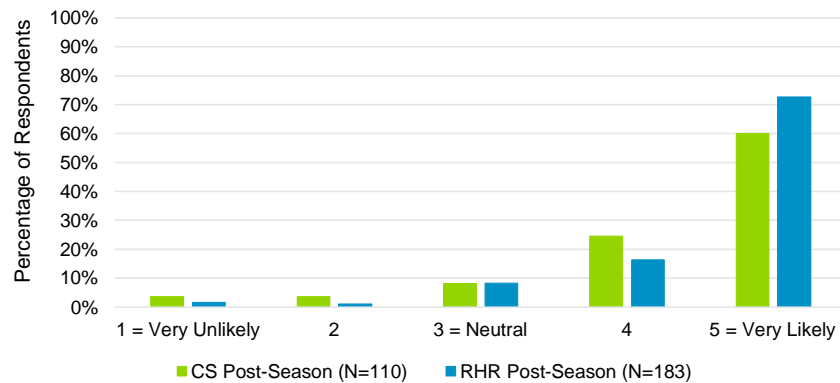


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

6. PROGRAM SATISFACTION

The majority of survey respondents were satisfied with the 2016 program offering. More than 85% of participants in both programs reported they were “likely” or “very likely” to participate in the program in future summers (Figure 6-1). Only four participants—out of more than 2,000—unenrolled from the program.

Figure 6-1. Based on your experience to date, in future summer, will you continue to participate in the program?



Source: Post-season surveys administered and analyzed by Navigant

Survey respondents provided relatively minor suggestions for program improvements, including providing more advanced notification options for receiving information and more information related to event performance (and progress toward receiving performance incentives in the case of CS participants).



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

7. CONCLUSIONS

Navigant's evaluation of the Residential Wi-Fi Thermostat DR program evaluation found it was successful in testing the effectiveness of thermostats as a residential DR technology and customer acceptance of the program offering. The evaluation shows promise for thermostats as a residential DR technology, though important differences exist across different thermostat models and customer acceptance has not been adequately tested due to the relatively mild temperatures on event days. In addition, the evaluation revealed important findings regarding how various program design features affect customer acceptance of the DR program offerings and program savings. National Grid is now positioned to leverage the experience of the 2016 program year to further test the technology and the Residential Wi-Fi Thermostat DR program offering in 2017.

The evaluation resulted in several key findings and recommendations (described in Table 7-1) that should inform future program planning.

Table 7-1. Findings and Recommendations

Category	Finding	Recommendation
Marketing and Enrollment	<ul style="list-style-type: none"> Marketing by thermostat vendors was successful in gaining participation; National Grid Marketing also played a large role. About 40% of customers attempting to enroll in RHR were screened out of the process after the "Select A Home" step. About 10% of CS program participants experienced challenges enrolling, which caused them to contact customer support. 	<ul style="list-style-type: none"> Reduce the percentage of ineligible customers with a more targeted marketing effort or ensure the program is not over-screening participants. Automate screening process where possible (i.e., confirm thermostat connection to central air conditioning (CAC), thermostat connectivity issues, etc.). Facilitate more detailed enrollment analytics (count number of completes by field and state for the entire season).
Event Notification	<ul style="list-style-type: none"> Most participants were satisfied with the notification. The most common reason for dissatisfaction was that the event notification was provided too close to the event start time. 	<ul style="list-style-type: none"> Continue to send advance notification. Provide customers options to tailor the frequency of event notifications.



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

Category	Finding	Recommendation
Opt Out	<ul style="list-style-type: none"> The ecobee and Honeywell thermostats experienced opt-out rates of 10%-15%, compared with 25% for the Nest thermostats. The higher opt-out rate of Nest thermostats could be due to a larger temperature setback (3°F vs. 2°F), program incentive structure (no participation incentive), higher event temperatures (on average), or device usability. The majority of opt outs were associated with a relatively small number of thermostats that frequently opt out (serial opt outers). 	<ul style="list-style-type: none"> Monitor participation throughout the DR season to identify customers that opt out frequently and conduct customer outreach. Consider modifications to program design to reduce extent of opt outs (e.g., participation incentives).
Connectivity	<ul style="list-style-type: none"> 10%-30% of Honeywell thermostats experienced a connectivity issue during each event, compared with <10% for ecobee and <2% for Nest. Approximately 2% of ecobee and Honeywell thermostats were not connected the entire DR season, compared with 0% for Nest. 	<ul style="list-style-type: none"> Determine which Honeywell models have a larger share of connectivity issues. If the issue is model-specific, consider restricting models eligible for program participation. Monitor connectivity throughout the DR season to identify devices with persistent issues and conduct customer outreach. Remove thermostats with persistent connectivity issues.
Event Impacts	<ul style="list-style-type: none"> Savings varied by thermostat model, attributed to differences in pre-cooling, performance incentives, setback strategy, connectivity issues, opt-out rates, and event attributes (temperature). 	<ul style="list-style-type: none"> Continue to test combinations of setback strategies and performance incentive mechanisms in 2017.
Pre-cooling	<ul style="list-style-type: none"> Pre-cooling led to a slower degradation of impacts and a smaller maximum peak during the recovery period. 	<ul style="list-style-type: none"> Weigh pre-cooling against adding load during likely high load hours compared to higher sustained savings during the DR event.
Outdoor Temperature	<ul style="list-style-type: none"> Savings were statistically larger for events with an average temperature above 80°F. Most events below 80°F were in early July or September. 	<ul style="list-style-type: none"> Add a temperature threshold to the event criteria.¹⁹
Multiple Thermostats	<ul style="list-style-type: none"> Customer-level impacts were higher for customers with multiple thermostats, though impacts increased at a decreasing rate. 	<ul style="list-style-type: none"> Continue to monitor the effect of multiple thermostats on savings to determine whether the program should continue to limit the number of thermostats per participating customer.

¹⁹ National Grid has an ongoing effort to evaluate various dispatch methodologies.

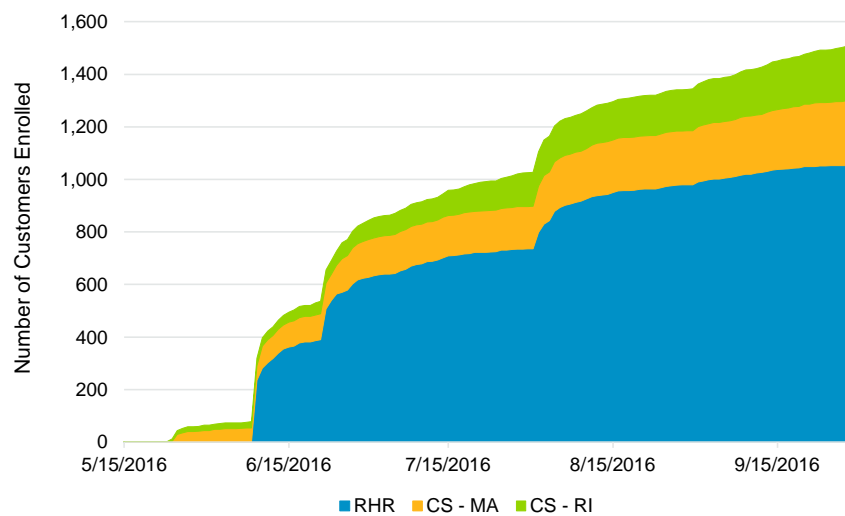


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

APPENDIX A. PROGRAM ENROLLMENT

National Grid customers began enrolling in the program in May 2016 and enrollments continued throughout the DR season. Figure A-1 provides the number customers enrolled in CS and RHR by state, and Figure A-2 provides the number of thermostats enrolled in CS and RHR by state.

Figure A-1. 2016 DR Program Customer Enrollment

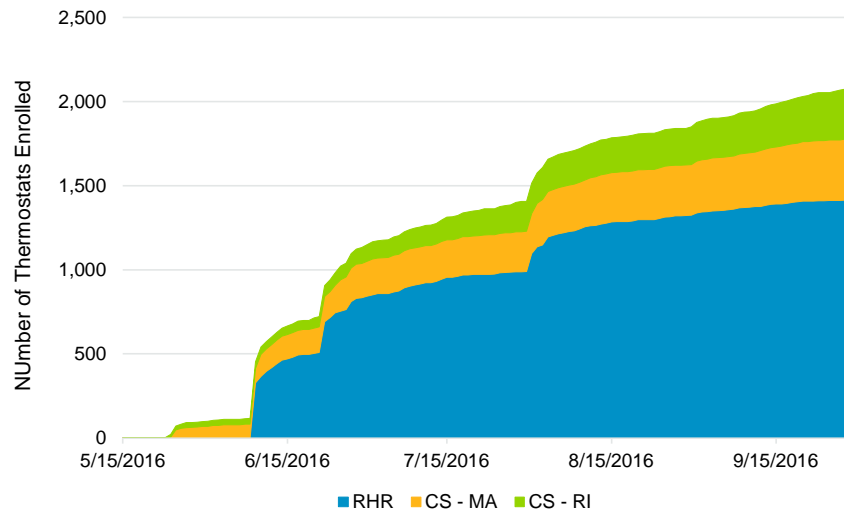


Source: Navigant analysis of National Grid enrollment data



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

Figure A-2. 2016 DR Program Thermostat Enrollment



Source: Navigant analysis of National Grid enrollment data



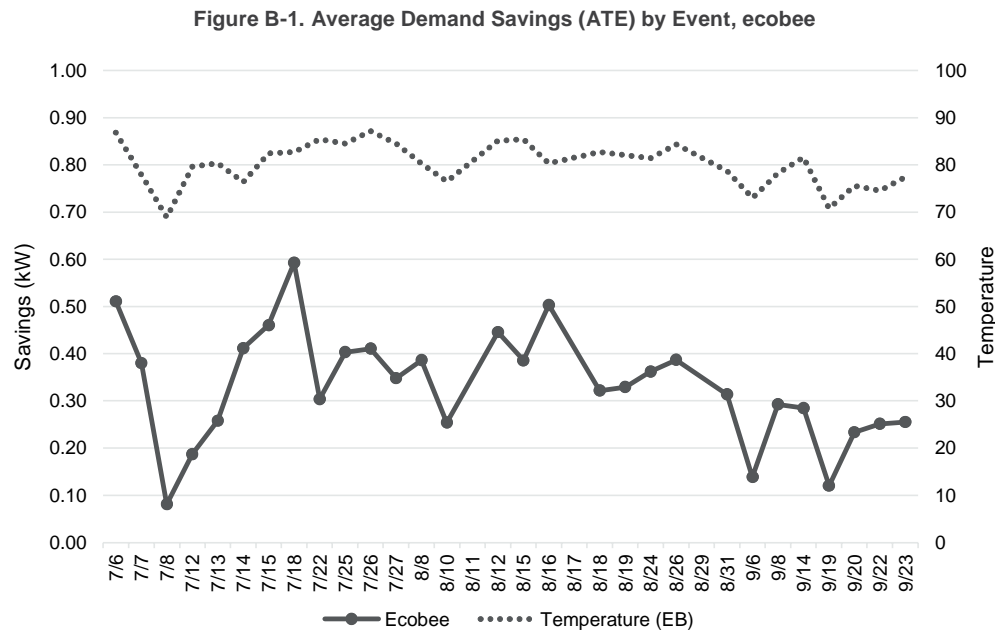
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APPENDIX B. IMPACTS PER EVENT

This appendix presents average demand savings and maximum hourly impact (ATE) per event for ecobee, Honeywell, and Nest thermostats separately.

B.1 ecobee

Figure B-1 displays the average demand savings (ATE) by event and Figure B-2 displays the maximum hourly demand savings (ATE) for ecobee thermostats, along with the average temperature

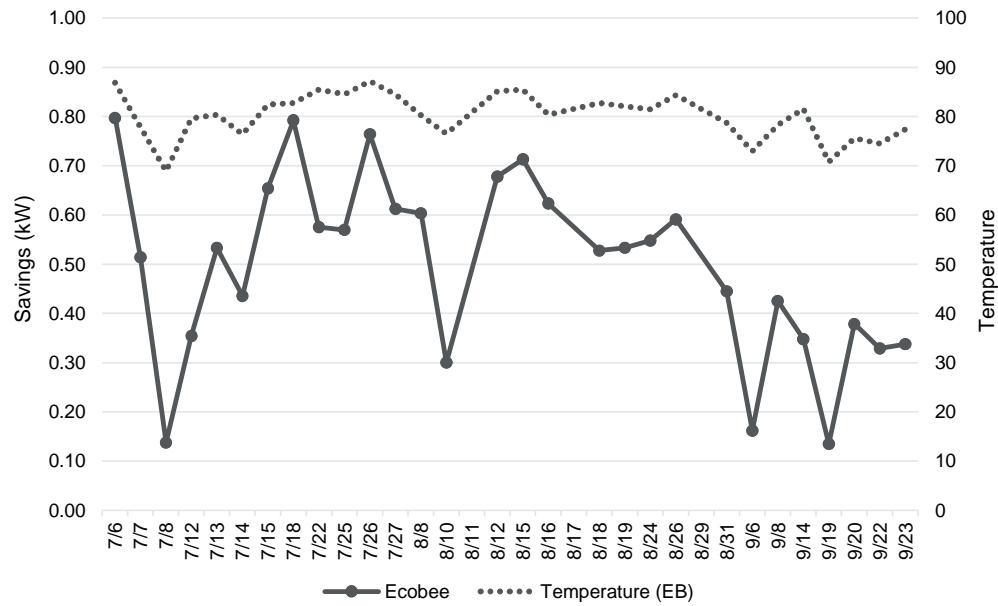


Source: Navigant analysis



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

Figure B-2. Maximum Hourly Demand Savings (ATE) by Event, ecobee



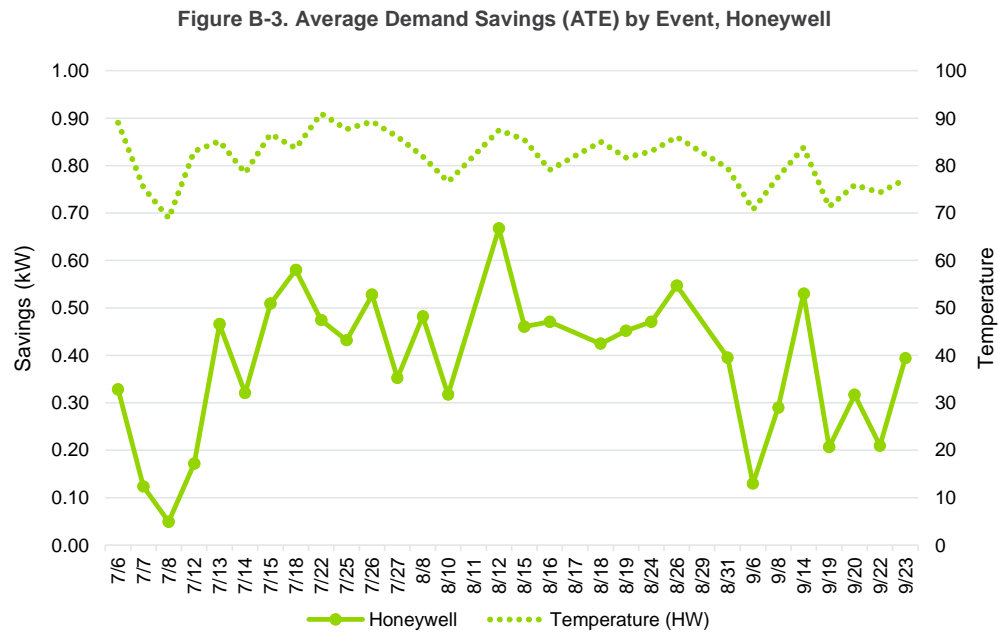
Source: Navigant analysis



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

B.2 Honeywell

Figure B-3 displays the average demand savings (ATE) by event and Figure B-4 displays the maximum hourly savings (ATE) for Honeywell thermostats, along with the average temperature.

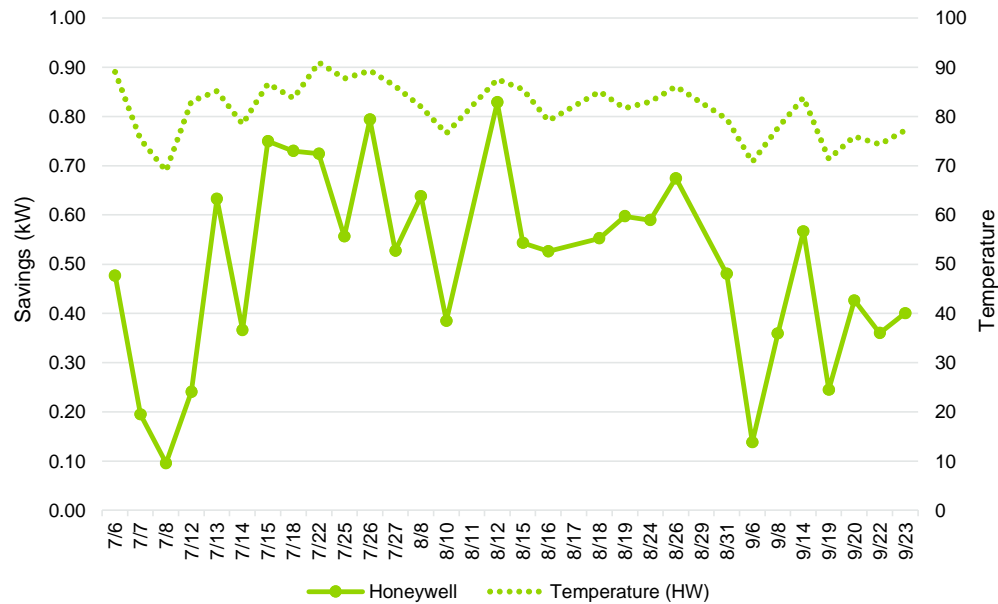


Source: Navigant analysis



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Figure B-4. Maximum Hourly Demand Savings (ATE) by Event, Honeywell



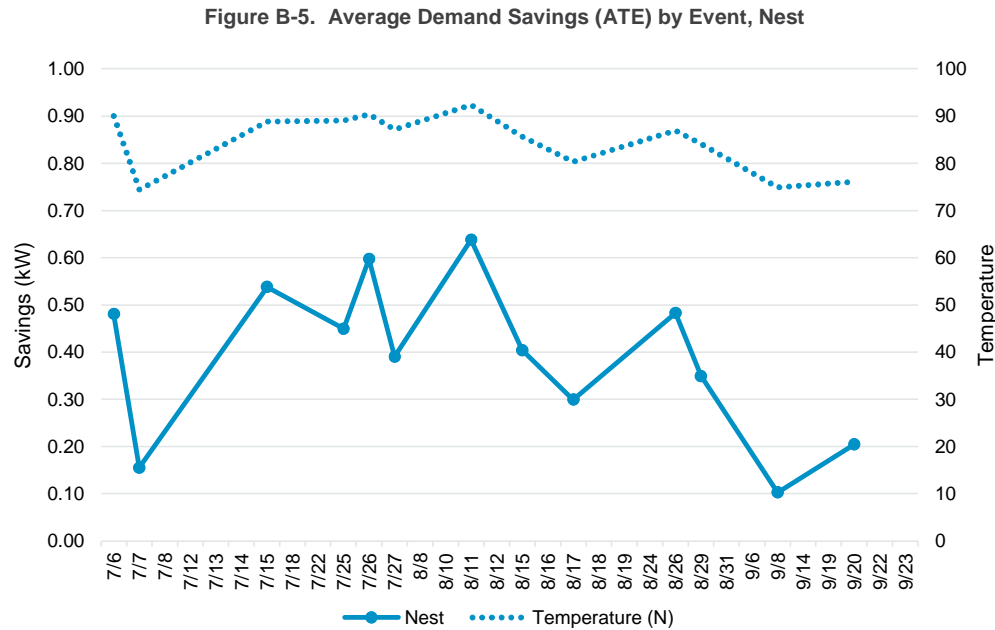
Source: Navigant analysis



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

B.3 Nest

Figure B-5 displays the average impacts (ATE) by event and Figure B-6 displays the maximum hourly impacts (ATE) by event for Nest thermostats, along with the average temperature.

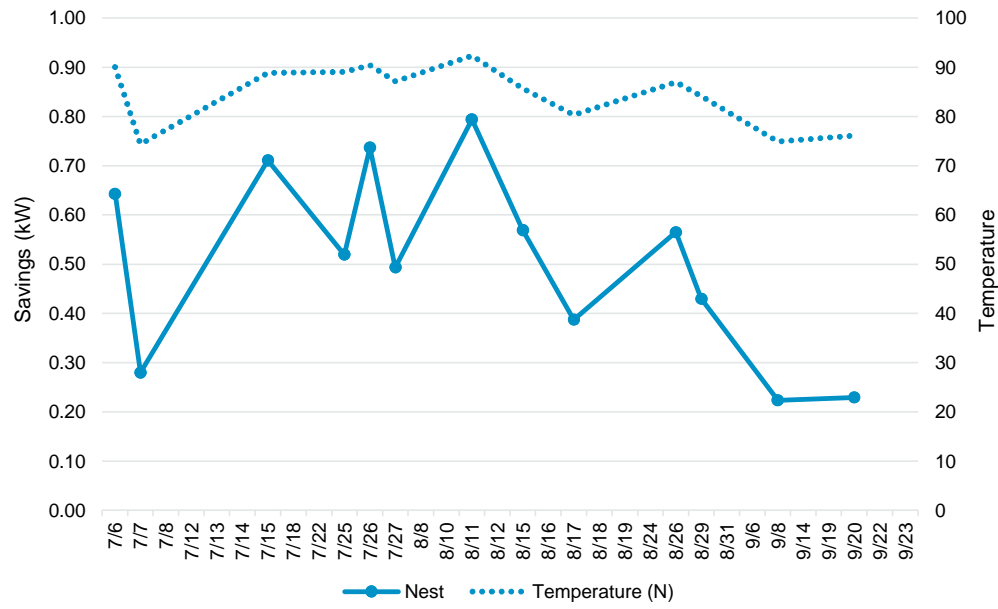


Source: Navigant analysis



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

Figure B-6. Maximum Hourly Demand Savings (ATE) by Event, Nest



Source: Navigant analysis



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

APPENDIX C. EVENT PARTICIPATION

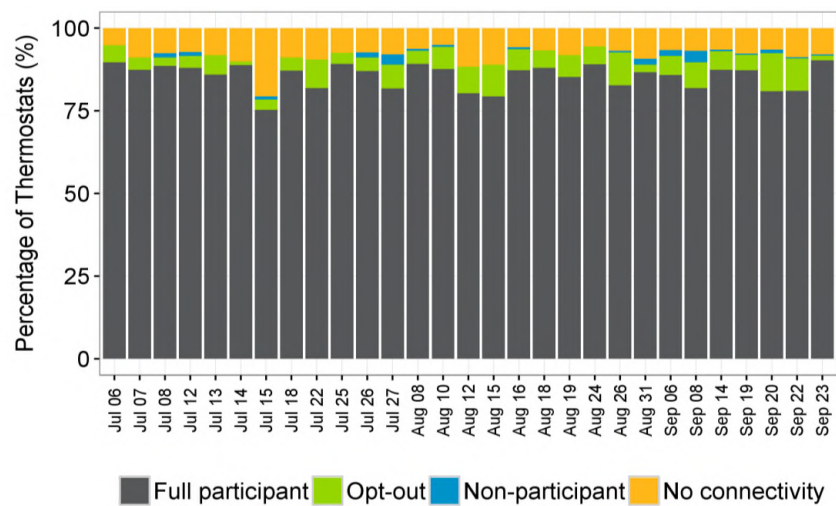
Navigant analyzed participation status by event for each of the three thermostat types to identify possible trends.

C.1 ecobee

ecobee thermostat participation for each CS event is shown in Figure C-1. ecobee thermostats generally had few devices that opted out of any event (less than 10% per event) and had less than 10% of devices experience connectivity issues for most events.

Opt outs fluctuated throughout the summer, indicating there was no clear evidence of fatigue during the DR season. Connectivity issues also fluctuated throughout the summer, though there were increased connectivity issues on July 15, 2016. Additionally, there were 19 ecobee thermostats (about 7% of all participating thermostats) without connectivity for all event days.

Figure C-1. Participation of ecobee Thermostats by Event



Source: Navigant analysis



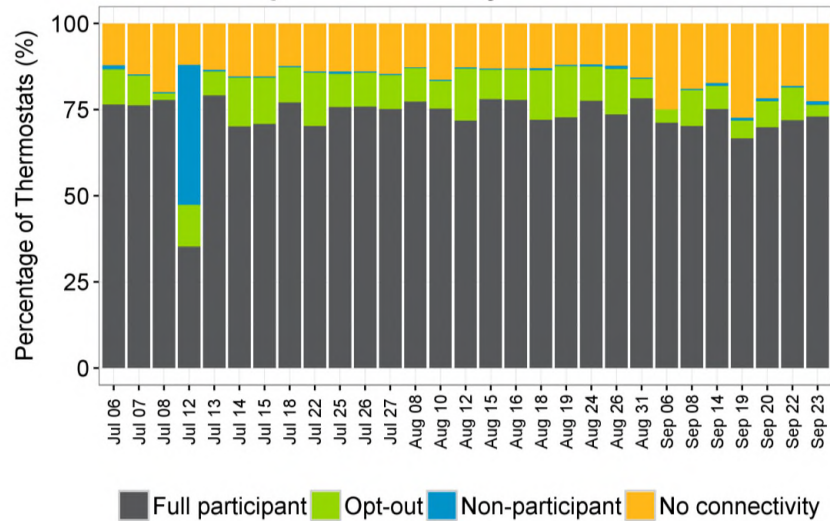
2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

C.2 Honeywell

Figure C-2 shows the participation of Honeywell thermostats for each CS event. Honeywell thermostats generally had few opt outs (less than 15% per event), but a larger percentage of devices experienced connectivity issues (10%-30% per event).

Opt outs fluctuated throughout the summer, indicating there was no clear evidence of fatigue during the DR season. However, opt-out rates decreased during all events in September, while the percentage of thermostats experiencing connectivity issues increased. There were also notable connectivity issues on July 12, 2016 due to Honeywell server issues at the start of the event. The DR event signal was not sent successfully until 1 hour after the planned event start, and even after the successful signal transmission, a large number of participants had connectivity issues. In addition, there were 41 Honeywell thermostats (about 11% of all participating thermostats) without connectivity for all event days.

Figure C-2. Participation of Honeywell Thermostats by Event



Source: Navigant analysis



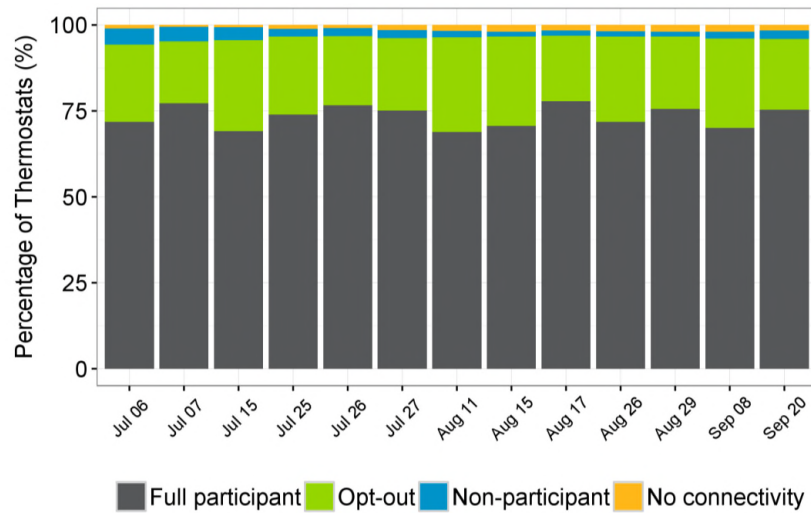
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C.3 Nest

Figure C-3 shows the participation of Nest thermostats for each RHR event. Nest thermostats generally had good connectivity (less than 2% had connectivity issues per event), but a larger percentage of devices opted out during events (about 25% per event).

Opt outs fluctuated throughout the summer, indicating there was no clear evidence of fatigue during the DR season. On average, less than 2% of Nest thermostats had connectivity issues during each event, and there were no thermostats without connectivity for all events. However, it appears the percentage of thermostats with connectivity issues increased slightly throughout the season.

Figure C-3. Participation of Nest Thermostats by Event



Source: Navigant analysis



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

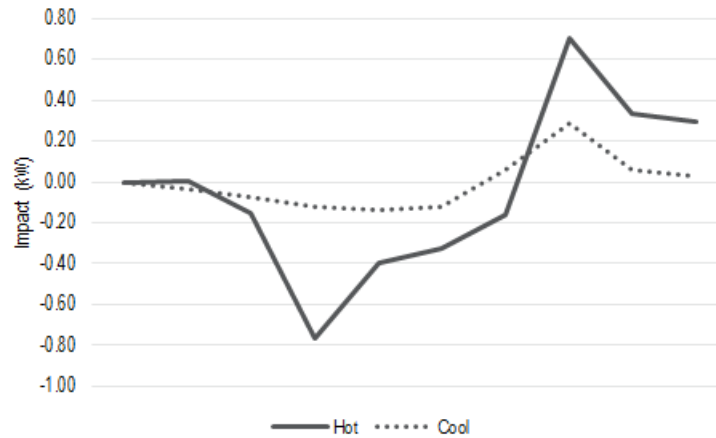
APPENDIX D. HOURLY IMPACTS: HOT VS. COOL DAYS

This appendix presents average hourly impacts by device for the coolest and hottest event days during the summer of 2016.

D.1 ecobee

The lack of pre-cooling for ecobee yielded a rapid decline of impacts as compared to Honeywell and Nest on the hot day. The increase in usage during the recovery period on cool days was due to the indoor temperature reaching the scheduled set point following the event.

Figure D-1. Average Hourly Impacts (ATE) for ecobee on a Hot and Cool Event Day



Source: Navigant analysis

Note: The hot day was July 26 (87°F) and the cool day was July 8 (69°F).

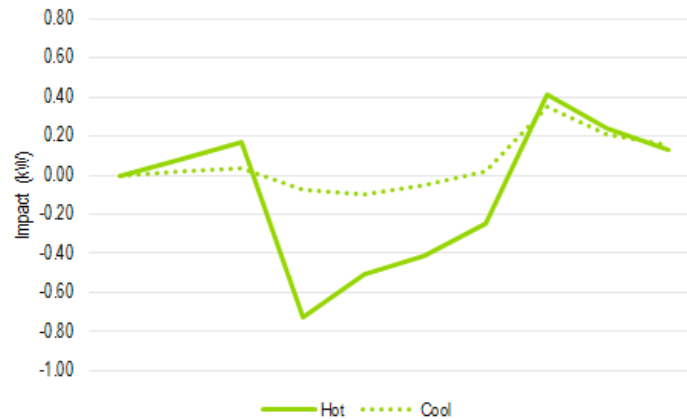
D.2 Honeywell

Pre-cooling led to a less aggressive decline in impacts during the event. Similar to ecobee, Honeywell saw an increase in usage during the recovery period on the cool event day.



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

Figure D-2. Average Hourly Impacts (ATE) for Honeywell on a Hot and Cool Event Day



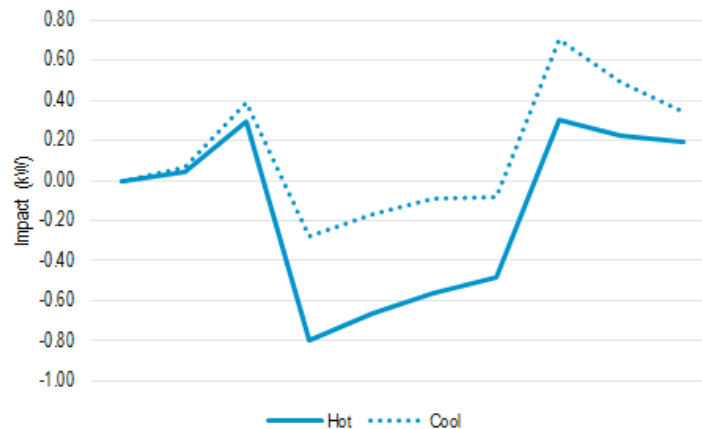
Source: Navigant analysis

Note: The hot day was July 22 (91°F) and the cool day was July 8 (69°F).

D.3 Nest

Similar to the Honeywell, pre-cooling led to a less aggressive decline in impacts during the event. Similar to ecobee and Honeywell, the Nest also saw an increase in usage during the recovery period on the cool event day.

Figure D-3. Average Hourly Impacts (ATE) for Nest on a Hot and Cool Event Day



Source: Navigant analysis

Note: The hot day was August 11 (92°F) and the cool day was July 6 (74°F).



2016 Residential Wi-Fi Thermostat DR Evaluation Final
Report

APPENDIX E. CONNECTEDSOLUTIONS ENROLLMENT SURVEY AND RESULTS

This section includes the survey instrument and responses to the multi-choice questions.

- 1) How did you hear about National Grid's ConnectedSolutions program? (select all that apply)
 - a) National Grid (via website, email, or direct mail)
 - b) Your thermostat manufacturer (via website, in-store advertising, email, or direct mail).
Specify _____
 - c) WeatherBug Home (via website, app, or email)
 - d) MassSave website
 - e) Print advertising/news
 - f) Online advertising/news
 - g) Radio
 - h) TV
 - i) Home energy auditor
 - j) My thermostat installer
 - k) Friend/family/neighbor
 - l) Other _____
 - m) Not sure
- 2) Did an installer complete the online ConnectedSolutions enrollment process on your behalf?
 - a) Yes, my thermostat installer completed the online enrollment.
 - b) No, I completed the online enrollment process.
- 3) {If Q2 = b, CONTINUE. Otherwise SKIP to Q5} After first learning of the program, when did you first visit the ConnectedSolutions enrollment website?
 - a) Within 24 hours
 - b) Within 1 week
 - c) Within 1 month
 - d) More than 1 month
- 4) How would you describe your actions upon first visiting the Connected Solutions enrollment website?
 - a) Read through some or all of the information provided on the website and then signed up
 - b) Signed up without reading any of the information provided on the website
 - c) Signed up at a later date



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

- 5) To the best of your understanding, which of the following will you be receiving as a part of your participation in National Grid's ConnectedSolutions program?

	<i>For each offering, choose Yes, No, or Uncertain</i>
Access and Control The ability to see and control your smart thermostat and other smart devices anytime and anywhere via the WeatherBug mobile app	[Coded to accept only Yes, No, Uncertain]
Sign-up Incentives	[Coded to accept only Yes, No, Uncertain]
Annual Participation Incentives	[Coded to accept only Yes, No, Uncertain]
Peak Optimization (i.e., during select hottest days, ConnectedSolutions will automatically adjust your smart thermostat in order to reduce overall peak demand, while still keeping you comfortable)	[Coded to accept only Yes, No, Uncertain]
Weather Optimization (i.e., on all days, ConnectedSolutions automatically adjusts your smart thermostat in order to save you money, while ensuring that you stay comfortable)	[Coded to accept only Yes, No, Uncertain]

- 6) Do you consider ConnectedSolutions to be a
- a) WeatherBug Home program
 - b) National Grid program
 - c) MassSave program
 - d) National Grid and WeatherBug Home program
 - e) Do not know
- 7) (If Q2 = b, CONTINUE. Otherwise SKIP to Q14) National Grid has partnered with WeatherBug Home to bring you the ConnectedSolutions program. As you completed the enrollment process for ConnectedSolutions were you confused or concerned because the website domain was not nationalgrid.com or ngrid.com?
- o Yes (I would have preferred to enroll at www.ngrid.com/connectedsolutions rather than connectedsolutions.weatherbughome.com)
 - o No
 - o Other _____
- 8) National Grid has partnered with WeatherBug Home to bring you the ConnectedSolutions program. As you completed the enrollment process for ConnectedSolutions were you confused or concerned that National Grid's color scheme and logo were not more prominently featured?
- a) Yes
 - b) No
- 9) Did you experience any technical issues (e.g., received an unexpected error message) with the ConnectedSolutions website before completing your enrollment?
- a) Yes
 - b) No



2016 Residential Wi-Fi Thermostat DR Evaluation Final
Report

- 10) {If Q9 = Yes, CONTINUE. Otherwise SKIP to Q12} What actions did you take in order to resolve the technical issue(s)? (select all that apply)
- a) I had to visit the Connected Solutions website multiple times to complete enrollment
 - b) I contacted WeatherBug Home/ConnectedSolutions support services
 - c) I contacted National Grid support services
 - d) I solved the issue without contacting any technical support
 - e) Other _____
- 11) {If Q9 = b or c, CONTINUE. Otherwise SKIP to Q12} Using a scale of 1 to 5 where 1 indicates "Very Unsatisfied" and 5 indicates "Very Satisfied," how satisfied were you with the level of support you received?
- a) 1 = Very unsatisfied
 - b) 2
 - c) 3
 - d) 4
 - e) 5 = Very satisfied
 - f) Not sure
- 12) Using a scale of 1 to 5 where 1 indicates "Very Difficult or Confusing" and 5 indicates "Very Easy," how easy did you find National Grid's ConnectedSolutions online enrollment process?
- a) 1 = Very difficult/confusing
 - b) 2
 - c) 3
 - d) 4
 - e) 5 = Very easy
 - f) Not sure
- 13) {If Q12 = a-c, CONTINUE. Otherwise SKIP to Q14} What part of the online enrollment process was the most challenging?
- a) Setting up a ConnectedSolution account (e.g., username already taken)
 - b) Registering my Wi-Fi thermostat (e.g., indicating Wi-Fi thermostat manufacturer)
 - c) Linking to my National Grid account (e.g., entering my account number)
 - d) Other _____
 - e) Not sure



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

14) What are your main reasons for enrolling in National Grid's ConnectedSolutions program?

	<i>Rank your first (=1), second (=2), and third (=3) reasons for enrolling</i>
Receive participation incentives	[Coded to accept only 1-3 or blank]
Access to my AC usage information	[Coded to accept only 1-3 or blank]
Ability to remotely control my thermostat	[Coded to accept only 1-3 or blank]
Ability to schedule my thermostat	[Coded to accept only 1-3 or blank]
Save money on my energy bills	[Coded to accept only 1-3 or blank]
Maximize comfort in my home	[Coded to accept only 1-3 or blank]
Reduce my environmental impact	[Coded to accept only 1-3 or blank]
Other _____	[Coded to accept only 1-3 or blank]

15) Which of the following best describes your property type?

- a) Single family home
- b) Multi-family home (2-4 units)
- c) Multi-family home (5+ units)
- d) Mobile home
- e) Not a residence (business, workshop or other)
- f) Other _____

16) {If Q15 = a, b, c or d Continue. Otherwise skip to Q22} Which of the following best describes your ownership status of your property?

- a) Own and live in
- b) Own and don't live in
- c) Rent

17) {If Q15 = a, b, c or d Continue. Otherwise skip to Q22} How many people, including yourself, live in your home during the summer months (June through September)? (enter a number)
____ {programmed to accept numeric input only}

18) {If Q15 = a, b, c or d Continue. Otherwise skip to Q22} During the summer, in a given week, for how many weekdays per week is at least one-person home from 6 a.m. to 9 a.m.? (enter a number from 0 to 5)
____ {programmed to accept numeric input only}

19) {If Q15 = a, b, c or d Continue. Otherwise skip to Q22} During the summer, for how many weekdays per week is at least one-person home from 9 a.m. to 1 p.m.? (enter a number from 0 to 5)
____ {programmed to accept numeric input only}



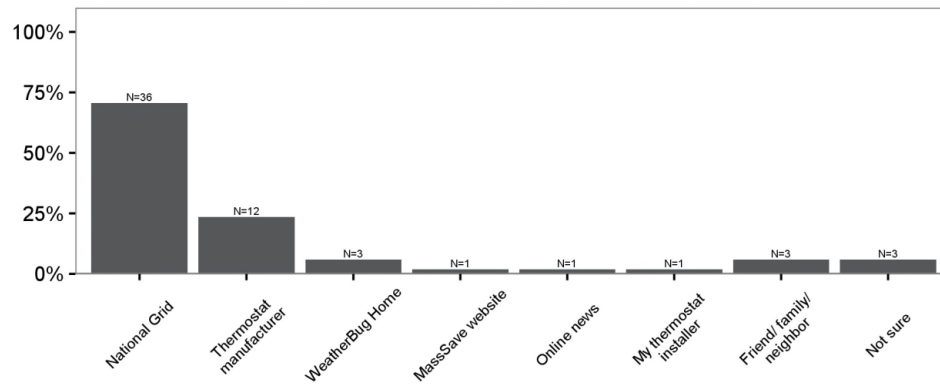
2016 Residential Wi-Fi Thermostat DR Evaluation Final
Report

- 20) {If Q15 = a, b, c or d Continue. Otherwise skip to Q22} During the summer, for how many weekdays per week is at least one-person home from 1 p.m. to 5 p.m.? (enter a number from 0 to 5)
_____ {programmed to accept numeric input only}
- 21) {If Q15 = a, b, c or d Continue. Otherwise skip to Q22} During the summer, for how many weekdays per week is at least one-person home from 5 p.m. to 10 p.m.? (enter a number from 0 to 5)
_____ {programmed to accept numeric input only}
- 22) Do you have any other Wi-Fi thermostats that you did not enroll in ConnectedSolutions?
a) Yes (Enter number) _____ {programmed to accept numeric input only}
b) No
c) I don't know
- 23) Do you have any window AC units in addition to central air conditioning unit?
a) Yes (Enter number) _____ {programmed to accept numeric input only}
b) No
c) I don't know
- 24) Please provide the email address that you used to enroll in the ConnectedSolutions program
_____ {programmed as optional}
- {End of Survey}

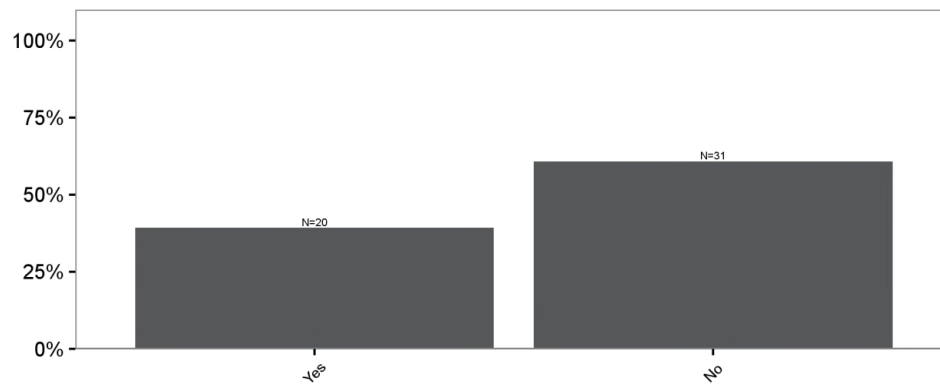


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

1. How did you hear about National Grid's ConnectedSolutions program? Select all that apply.



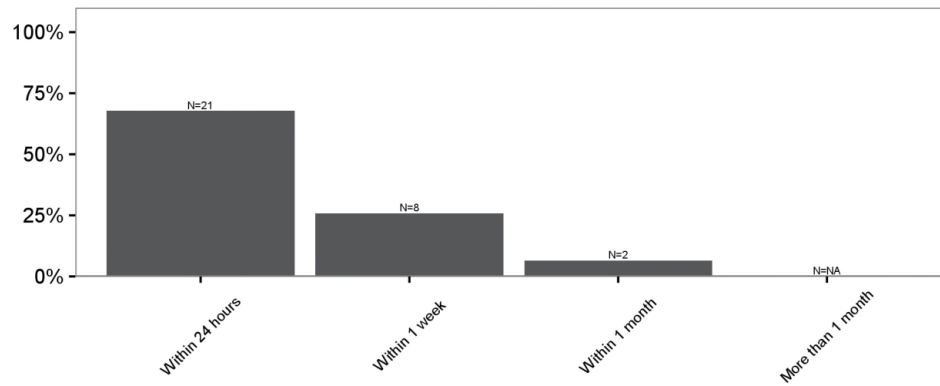
2. Did an installer complete the online ConnectedSolutions enrollment process on your behalf?



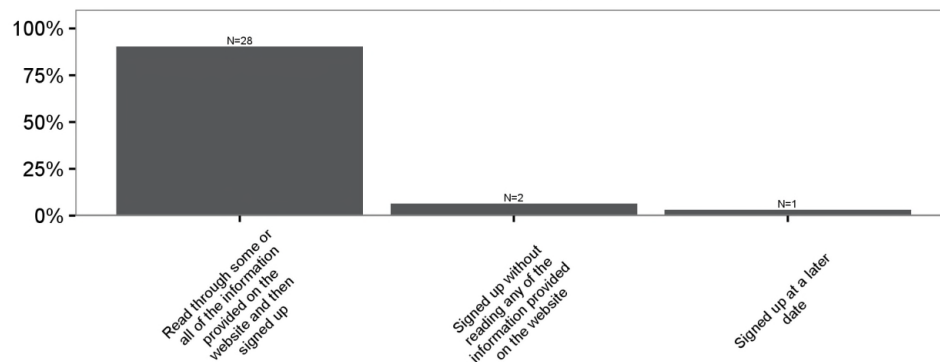


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

3. After first learning of the program, when did you first visit the ConnectedSolutions enrollment website?



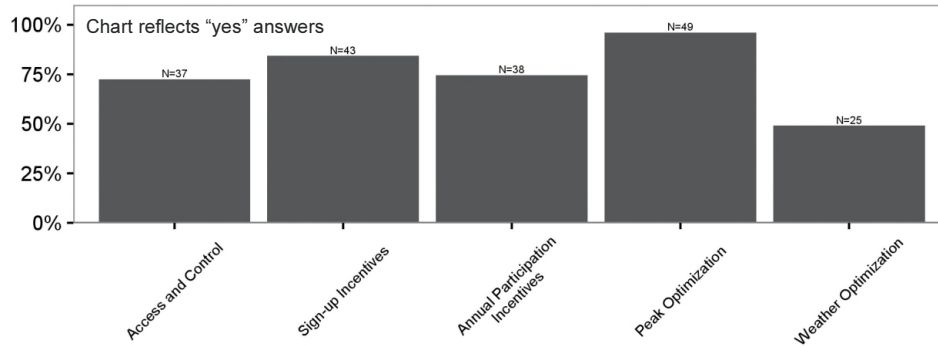
4. How would you describe your actions upon first visiting the ConnectedSolutions enrollment website?



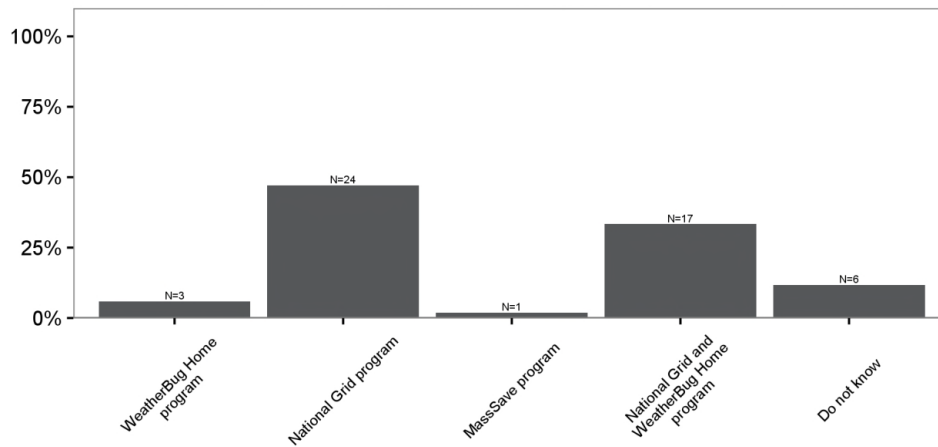


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

5. To the best of your understanding, which of the following will you be receiving as a part of your participation in National Grid's ConnectedSolutions program?



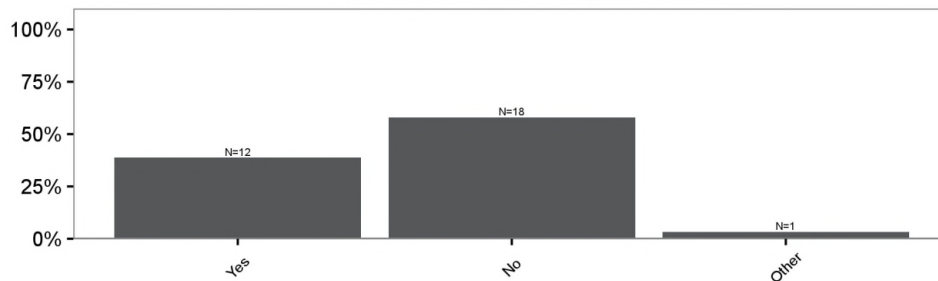
6. Do you consider ConnectedSolutions to be a





2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

7. National Grid has partnered with WeatherBug Home to bring you the ConnectedSolutions program. As you completed the enrollment process for ConnectedSolutions were you confused or concerned because the website domain was not nationalgrid.com or ngrid.com?



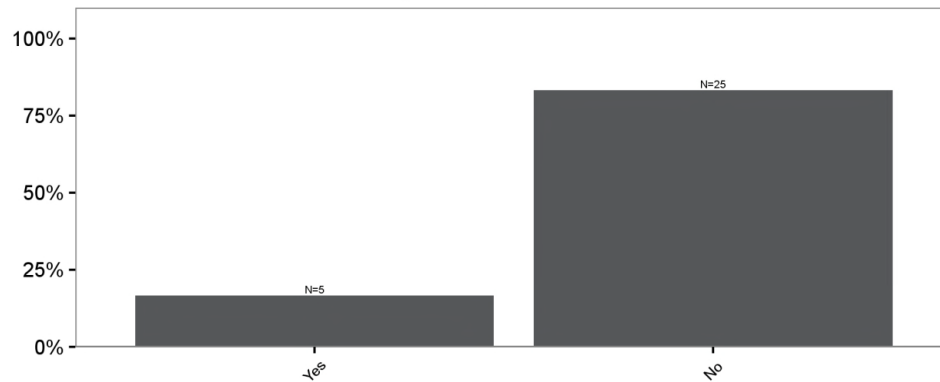
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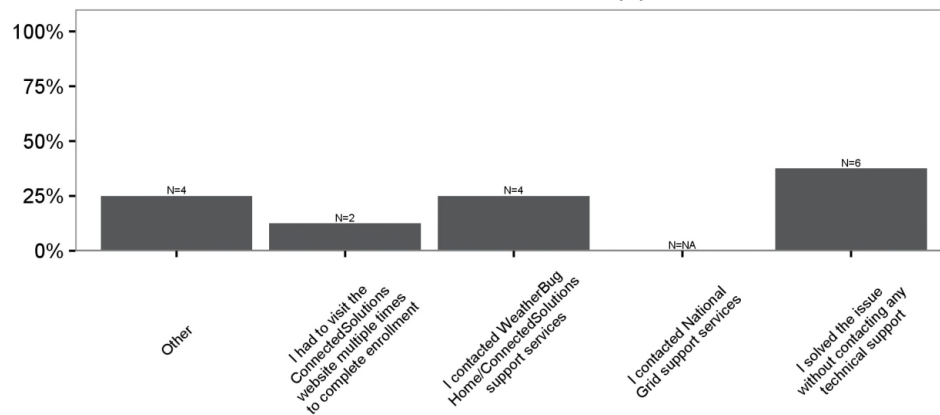


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

9. Did you experience any technical issues with the ConnectedSolutions website before completing your enrollment?



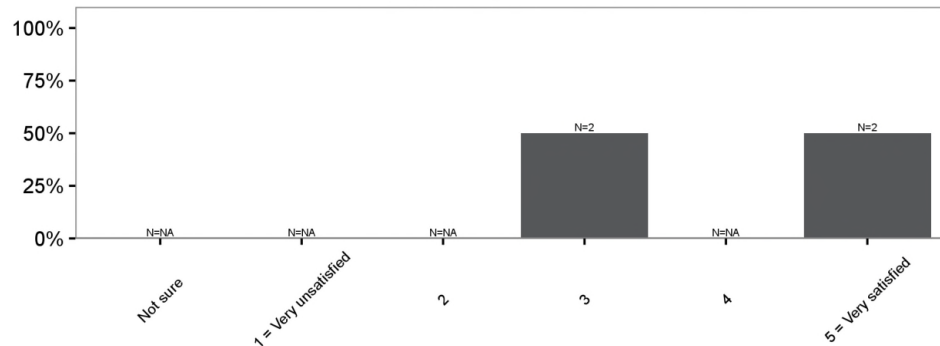
10. What actions did you take in order to resolve the technical issue(s)?



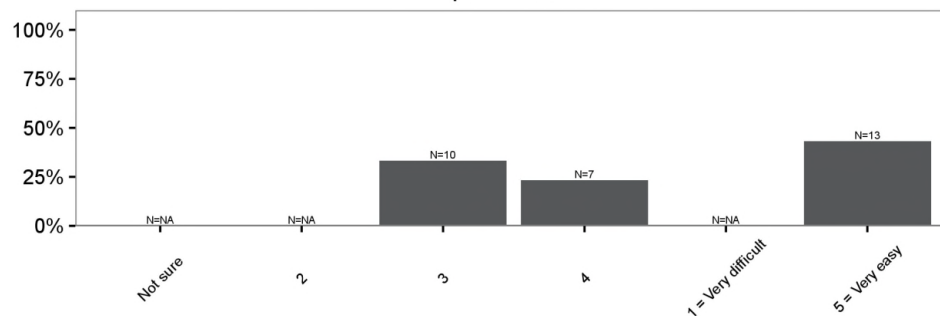


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

11. Using a scale of 1 to 5 where 1 indicates "Very Unsatisfied" and 5 indicates "Very Satisfied," how satisfied were you with the level of support you received?



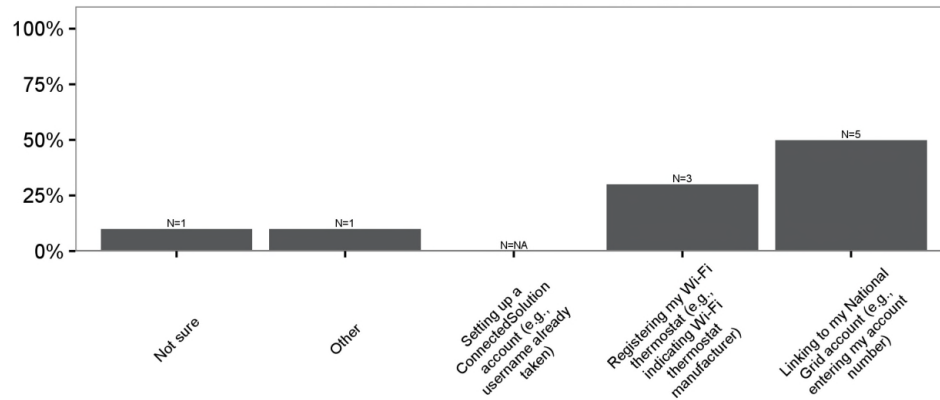
12. Using a scale of 1 to 5 where 1 indicates "Very Difficult or Confusing" and 5 indicates "Very Easy," how easy did you find National Grid's ConnectedSolutions online enrollment process?



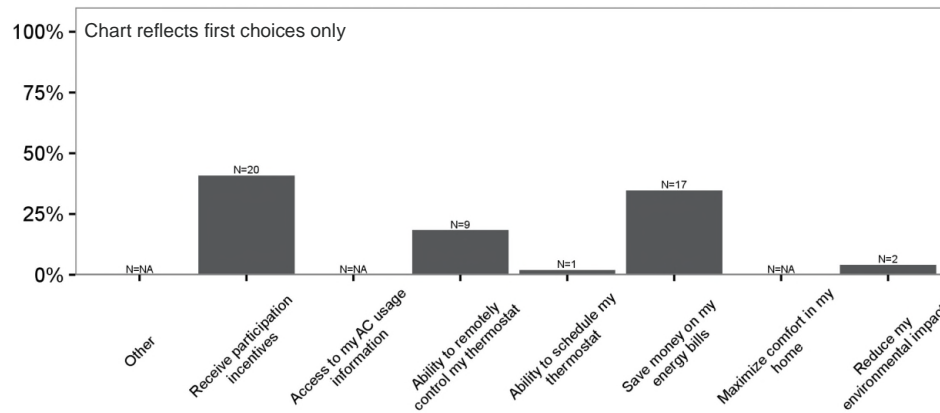


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

13. What part of the online enrollment process was the most challenging?



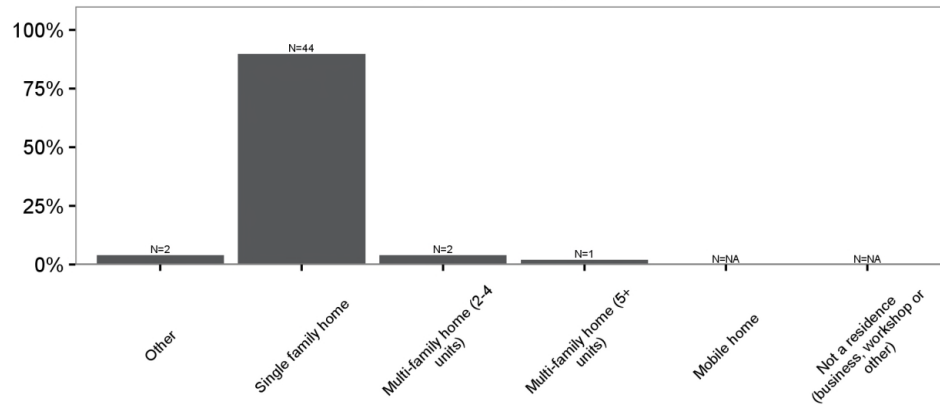
14. What are your main reasons for enrolling in National Grid's ConnectedSolutions program?



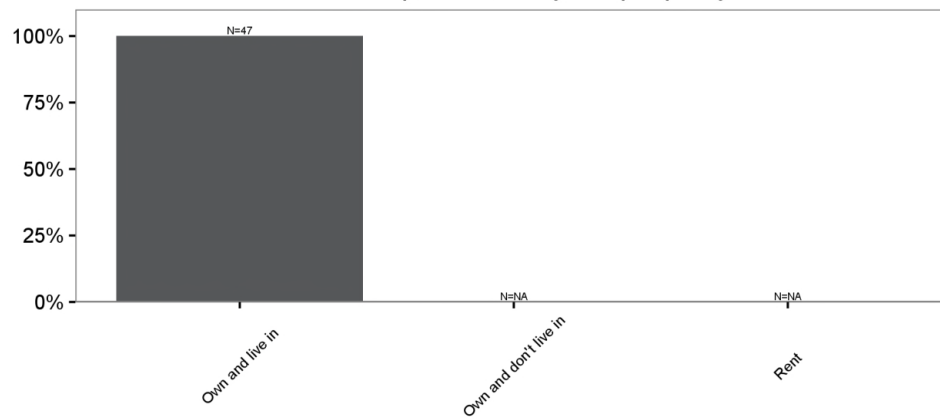


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

15. Which of the following best describes your property type?



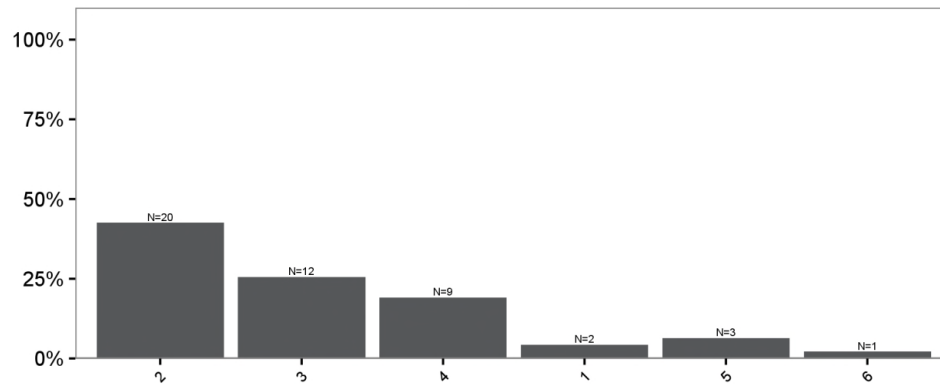
16. Which of the following best describes your ownership status of your property?



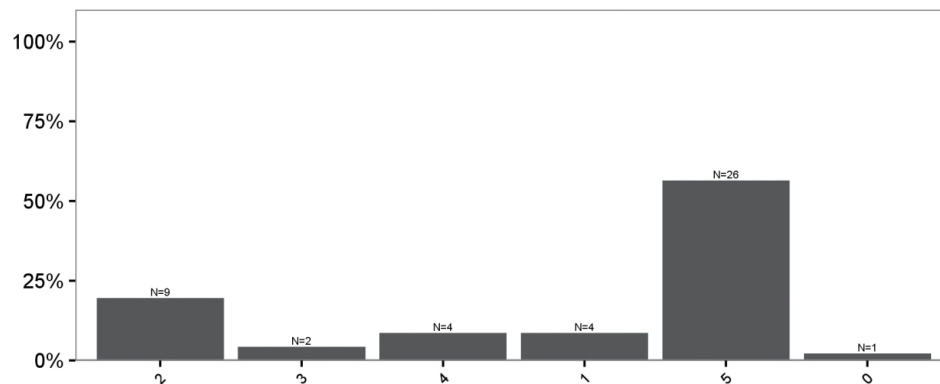


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

17. How many people, including yourself, live in your home during the summer months (June through September)?



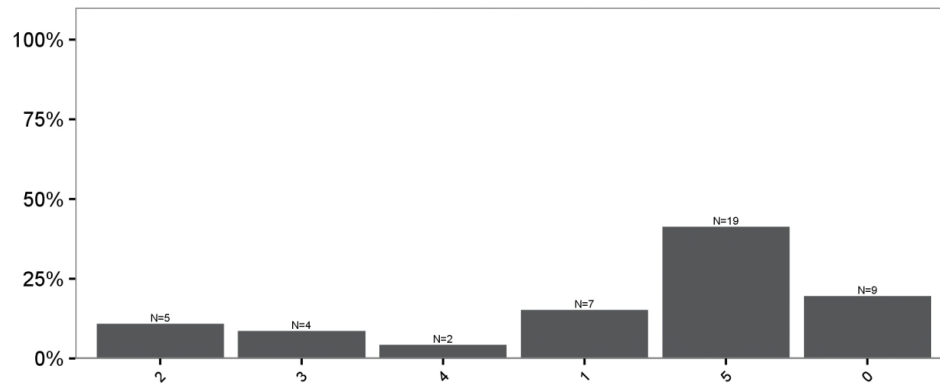
18. During the summer, in a given week, for how many weekdays per week is at least one person home from 6 a.m. to 9 a.m.



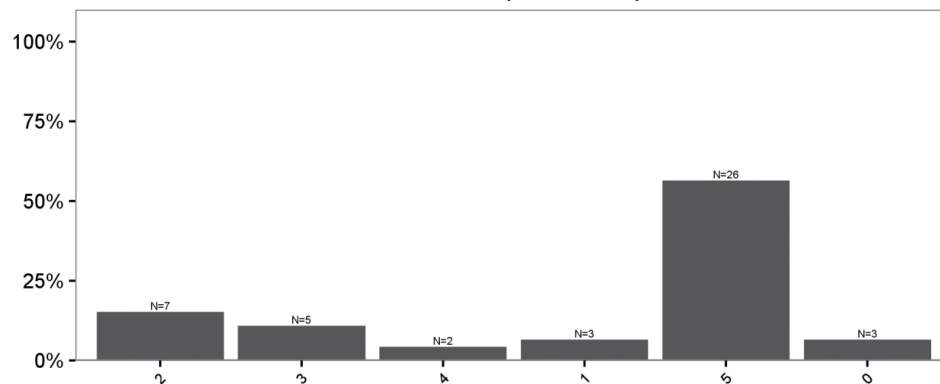


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19. During the summer, in a given week, for how many weekdays per week is at least one person home from 9 a.m. to 1 p.m.



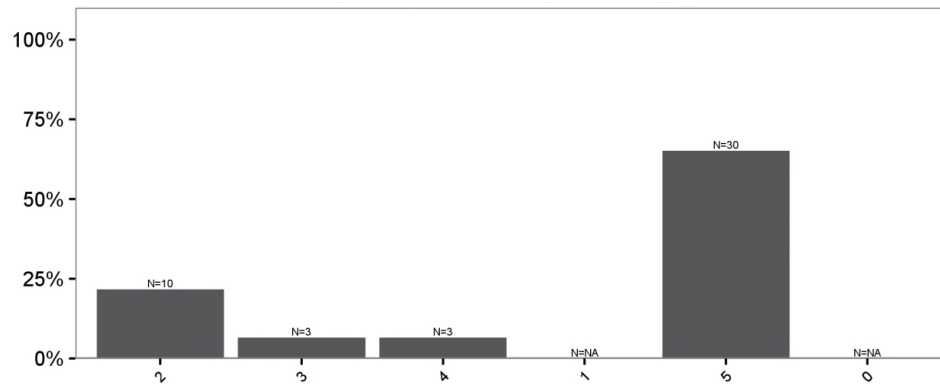
20. During the summer, in a given week, for how many weekdays per week is at least one person home from 1 p.m. to 5 p.m.



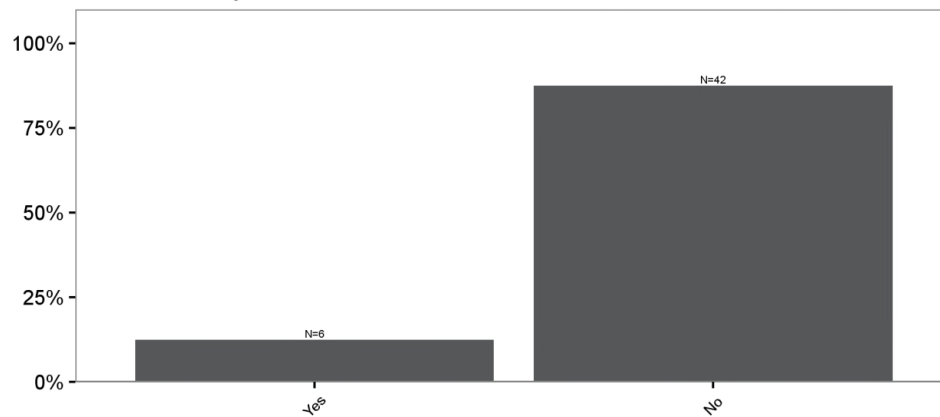


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21. During the summer, in a given week, for how many weekdays per week is at least one person home from 5 p.m. to 10 p.m.



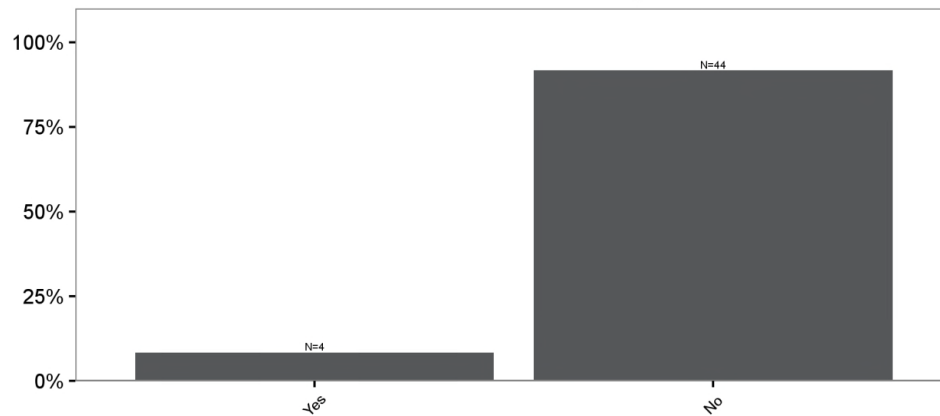
22. Do you have any other Wi-Fi thermostats that you did not enroll in ConnectedSolutions?





2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

23. Do you have any window AC units in addition to central air conditioning unit?





2016 Residential Wi-Fi Thermostat DR Evaluation Final
Report

APPENDIX F. RUSH HOUR REWARDS ENROLLMENT SURVEY AND RESULTS

This section includes the survey instrument and responses to the multi-choice questions.

- 1) How did you hear about Nest's Rush Hour Rewards program? (select all that apply)
 - a) National Grid (via website, email, print/online advertising, or direct mail)
 - b) Nest (via website, app, online advertising, email, or direct mail)
 - c) MassSave website
 - d) Print news
 - e) Online news
 - f) Radio
 - g) TV
 - h) Home energy auditor
 - i) My Nest thermostat installer
 - j) Friend/family/neighbor
 - k) Other _____
 - l) Not sure
- 2) After first learning of the program, when did you first visit the Rush Hour Rewards enrollment website?
 - a) Within 24 hours
 - b) Within 1 week
 - c) Within 1 month
 - d) More than 1 month
- 3) How would you describe your actions upon first visiting Rush Hour Rewards enrollment website?
 - a) Read through some or all of the information provided on the website and then signed up
 - b) Signed up without reading any of the information provided on the website
 - c) Signed up at a later date



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

- 4) To the best of your understanding, which of the following will you be receiving as a part of your participation in Nest's Rush Hour Rewards program?

	<i>For each offering, choose Yes, No, or Uncertain</i>
Access and Control The ability to see and control your smart thermostat and other smart devices anytime and anywhere via the Nest mobile app	[Coded to accept only Yes, No, Uncertain]
Sign-up Incentive	[Coded to accept only Yes, No, Uncertain]
Peak Optimization (i.e., during select hottest days, Rush Hour Rewards will automatically adjust your smart thermostat in order to reduce overall peak demand, while still keeping you comfortable)	[Coded to accept only Yes, No, Uncertain]
Weather Optimization (i.e., on all days, Rush Hour Rewards automatically adjusts your smart thermostat in order to save you money, while ensuring that you stay comfortable)	[Coded to accept only Yes, No, Uncertain]

- 5) Did you experience any technical issues (e.g., received an unexpected error message) with the Rush Hour Rewards website before completing your enrollment?
- Yes
 - No
- 6) {If Q5 = Yes, CONTINUE. Otherwise SKIP to Q7} What actions did you take in order to resolve the technical issue(s)? (select all that apply)
- I had to visit the Rush Hour Rewards website multiple times to complete enrollment
 - I contacted Nest/Rush Hour Rewards support services
 - I contacted National Grid support services
 - I solved the issue without contacting any technical support
 - Other _____
- 7) {If Q6 = b or c, CONTINUE. Otherwise SKIP to Q8} Using a scale of 1 to 5 where 1 indicates "Very Unsatisfied" and 5 indicates "Very Satisfied," how satisfied were you with the level of support you received?
- 1 = Very unsatisfied
 - 2
 - 3
 - 4
 - 5 = Very satisfied
 - Not sure



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

- 8) Using a scale of 1 to 5 where 1 indicates "Very Difficult or Confusing" and 5 indicates "Very Easy," how easy did you find Nest's Rush Hour Rewards online enrollment process?
- a) 1 = Very difficult/confusing
 - b) 2
 - c) 3
 - d) 4
 - e) 5 = Very easy
 - f) Not sure
- 9) {If Q8 = a-c, CONTINUE. Otherwise SKIP to Q10} What part of the online enrollment process was the most challenging?
- a) Setting up a Nest account (e.g., username already taken)
 - b) Linking to my National Grid account (e.g., entering my account number)
 - c) Other _____
 - d) Not sure
- 10) What are your main reasons for enrolling in Nest's Rush Hour Rewards program?

	<i>Rank your first (=1), second (=2), and third (=3) reasons for enrolling</i>
Participation incentives	[Coded to accept only 1-3]
Access to usage information	[Coded to accept only 1-3]
Ability to remotely control thermostat	[Coded to accept only 1-3]
Ability to schedule thermostat	[Coded to accept only 1-3]
Save money on my energy bills	[Coded to accept only 1-3]
Maximize comfort in my home	[Coded to accept only 1-3]
Reduce my environmental impact	[Coded to accept only 1-3]
Other _____	[Coded to accept only 1-3]

- 11) Which of the following best describes your property type?
- a) Single family home
 - b) Multi-family home (2-4 units)
 - c) Multi-family home (5+ units)
 - d) Mobile home
 - e) Not a residence (business, workshop or other)
 - f) Other _____
- 12) {If Q11 = a, b, c or d Continue. Otherwise skip to Q13} Which of the following best describes your ownership status of your property?
- a) Own and live in
 - b) Own and don't live in
 - c) Rent



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Report

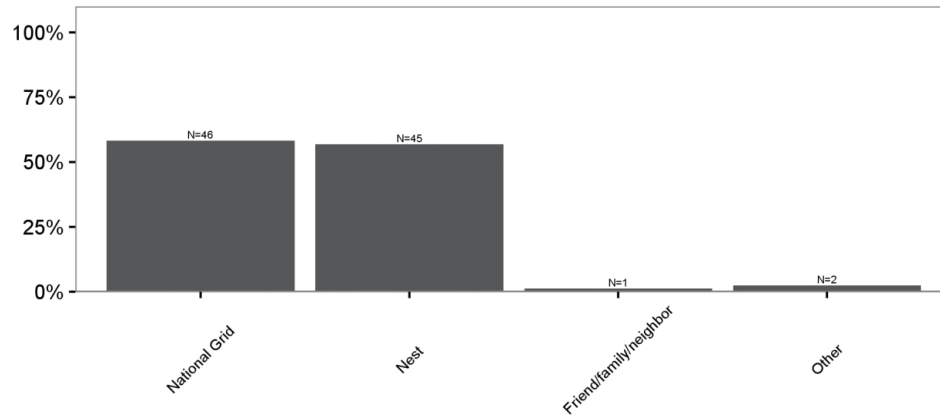
- 13) Do you have any other Wi-Fi thermostats that you did not enroll in Rush Hour Rewards?
a) Yes (Enter number) _____ {programmed to accept numeric input only}
b) No
c) I don't know
- 14) Do you have any window AC units in addition to central air conditioning unit?
a) Yes (Enter number) _____ {programmed to accept numeric input only}
b) No
c) I don't know
- 15) Please provide the email address that you used to enroll in the Rush Hour Rewards program
_____ {programmed as optional}

{End of Survey}

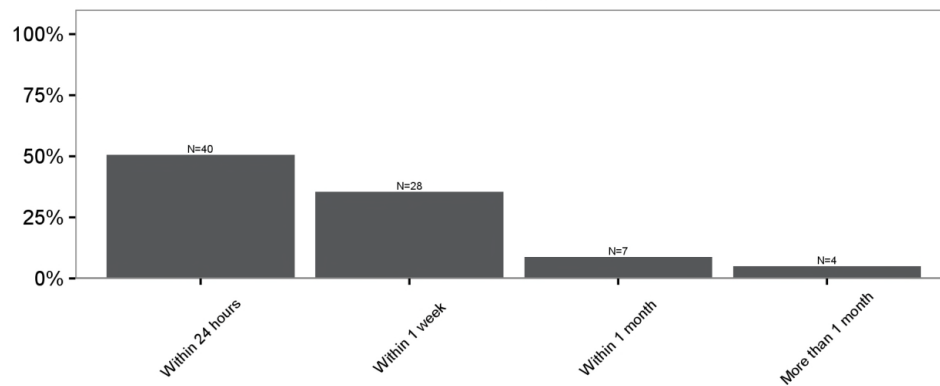


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

1. How did you hear about Nest's Rush Hour Rewards program? Select all that apply.



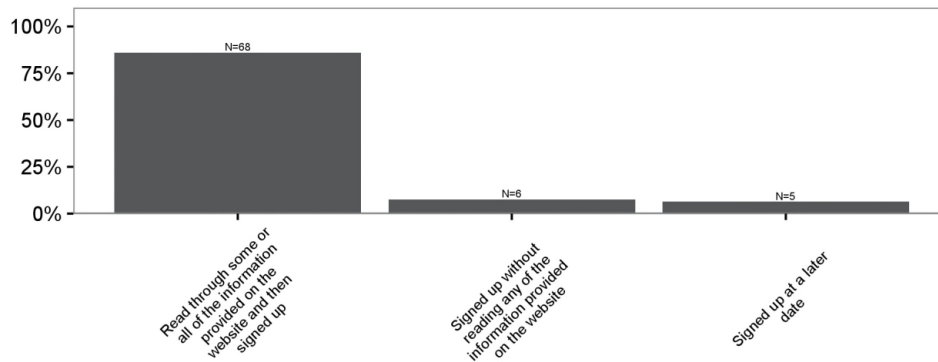
2. After first learning of the program, when did you first visit the Rush Hour Rewards enrollment website?



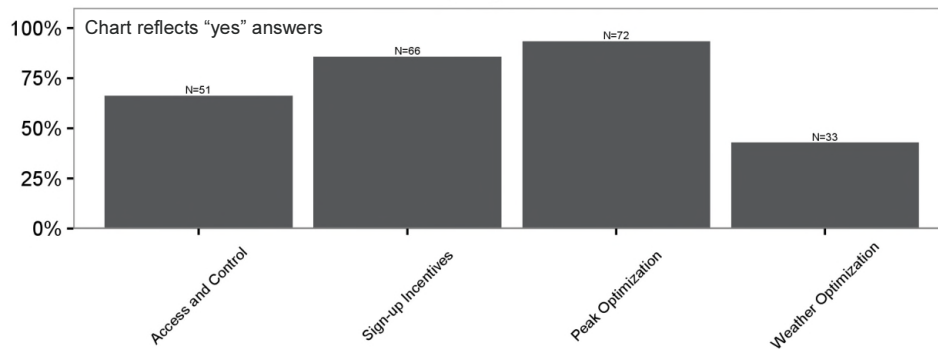


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

3. How would you describe your actions upon first visiting the Rush Hour Rewards enrollment website?



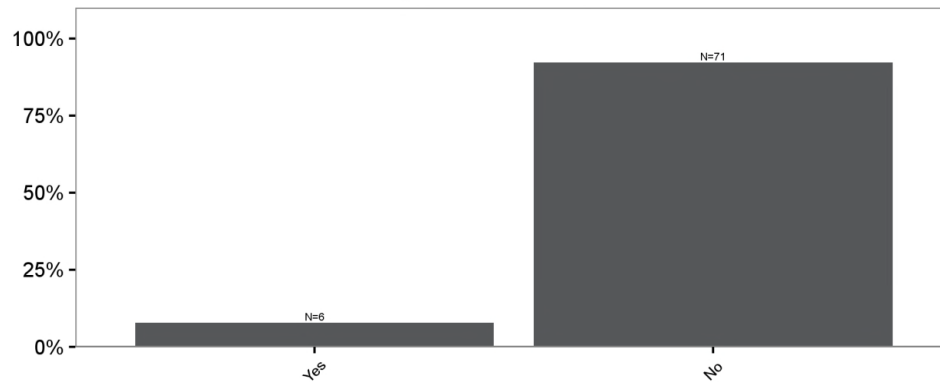
4. To the best of your understanding, which of the following will you be receiving as a part of your participation in Nest's Rush Hour Rewards program?



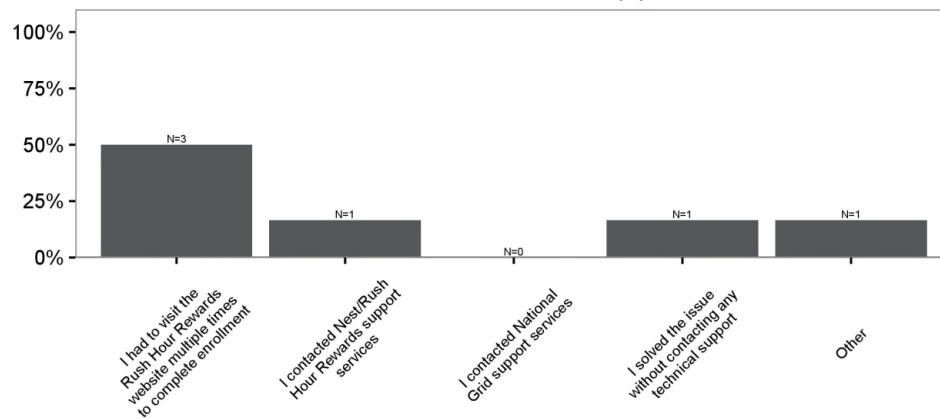


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

5. Did you experience any technical issues with the Rush Hour Rewards website before completing your enrollment?



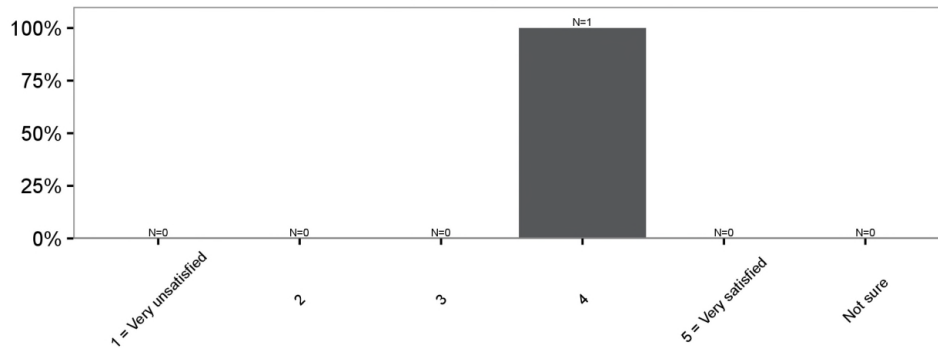
6. What actions did you take in order to resolve the technical issue(s)?



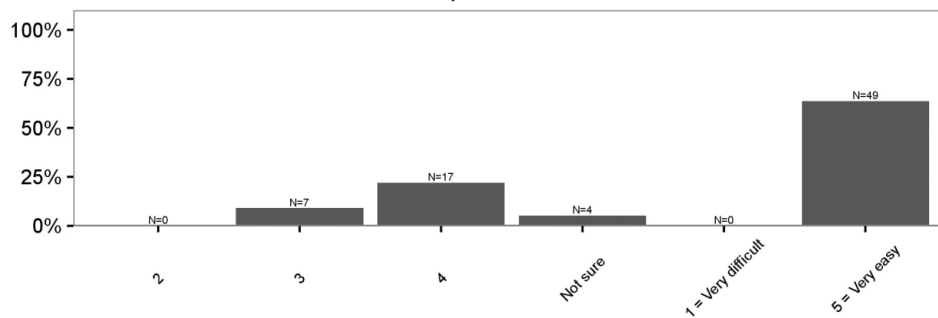


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

7. Using a scale of 1 to 5 where 1 indicates "Very Unsatisfied" and 5 indicates "Very Satisfied," how satisfied were you with the level of support you received?



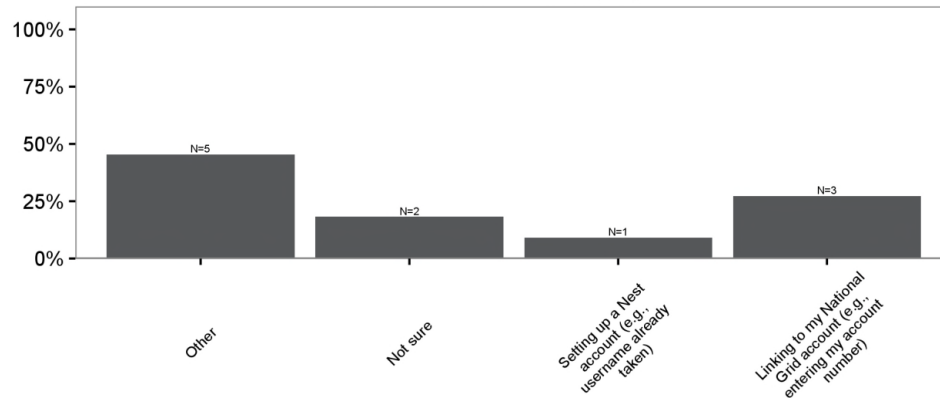
8. Using a scale of 1 to 5 where 1 indicates "Very Difficult or Confusing" and 5 indicates "Very Easy," how easy did you find National Grid's Rush Hour Rewards online enrollment process?



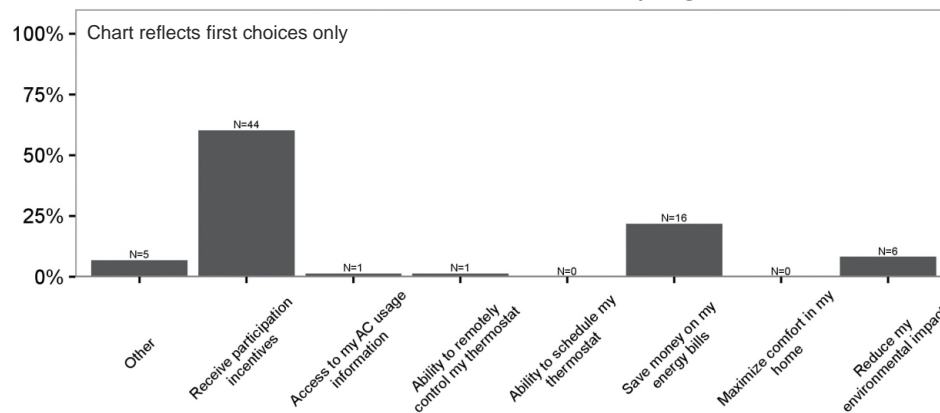


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

9. What part of the online enrollment process was the most challenging?



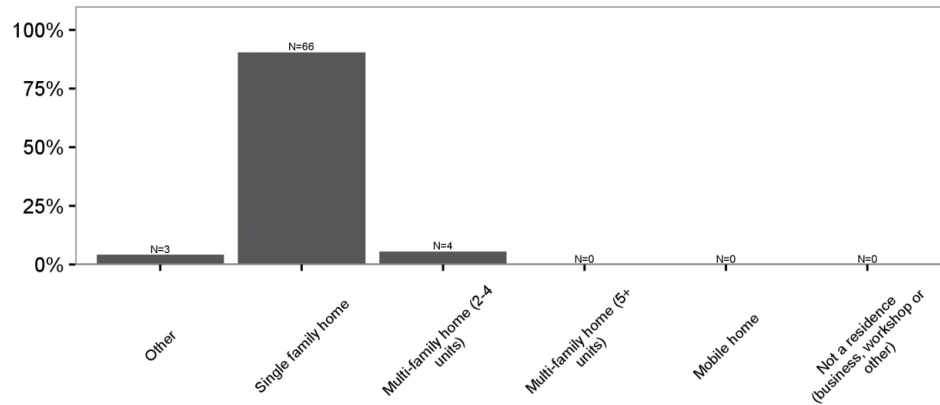
10. What are your main reasons for enrolling in Nest's Rush Hour Rewards program?



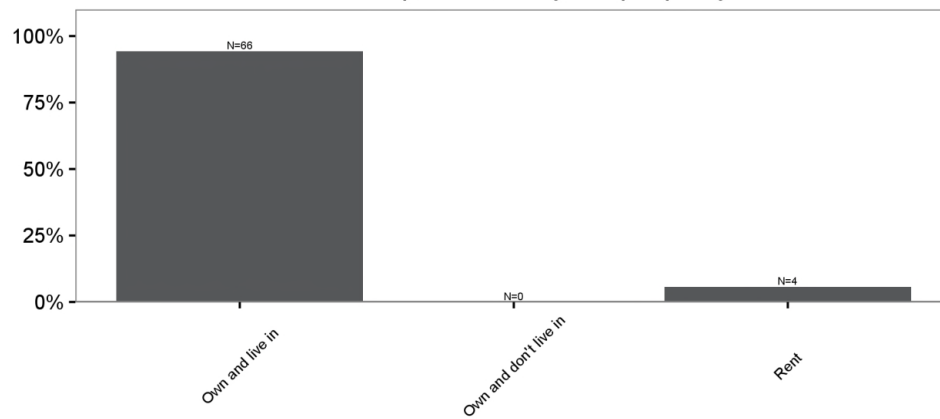


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

11. Which of the following best describes your property type?



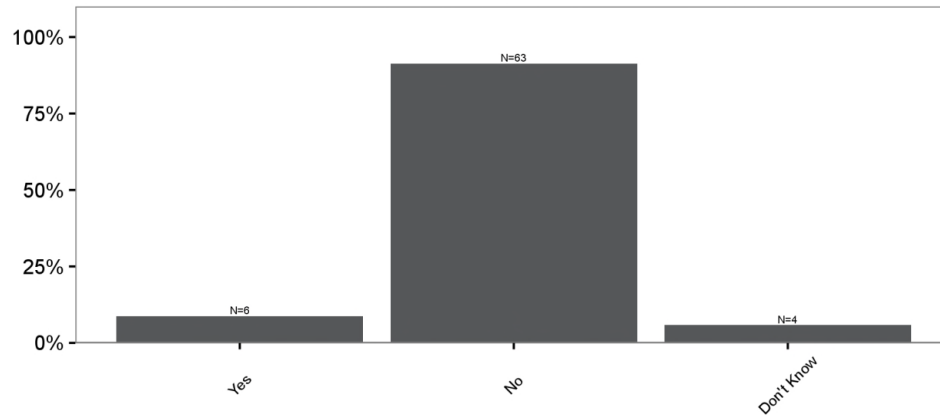
12. Which of the following best describes your ownership status of your property?



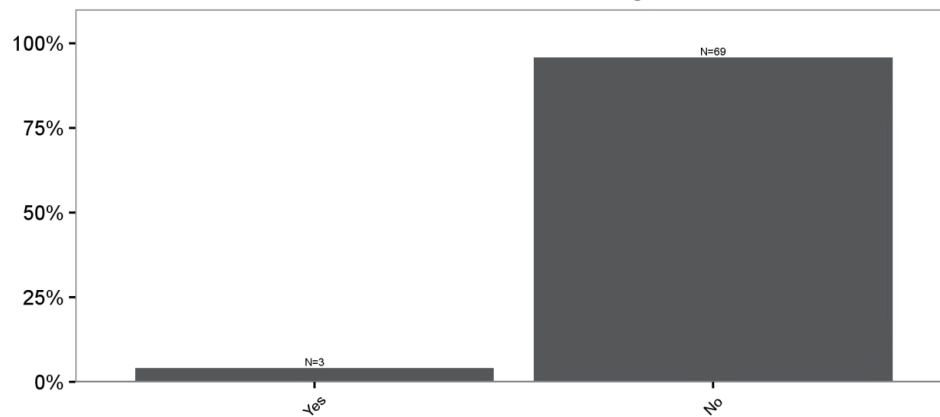


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

13. Do you have any other Wi-Fi thermostats that you did not enroll in Rush Hour Rewards?



14. Do you have any window AC units in addition to central air conditioning unit?





2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

APPENDIX G. CONNECTEDSOLUTIONS POST-EVENT SURVEY AND RESULTS

1. ConnectedSolutions helps you earn incentives from National Grid for saving energy during peak demand periods (aka "Peak Energy Events"), while still keeping you comfortable. During a Peak Energy Event, National Grid has the ability to adjust the cooling of your central air conditioner by sending a signal to your Wi-Fi thermostat and adjusting the setpoint by a maximum of 2 degrees.

Has National Grid called a Peak Energy Event since you enrolled in ConnectedSolutions?

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

2. How do you know when you are in a Peak Energy Event? **[OPEN-END, OPTIONAL]**

3. Using a scale of 1 to 5, where 1 means "Very Dissatisfied" and 5 means "Very Satisfied", what is your level of satisfaction with the notification you receive about an upcoming Peak Energy Event?

a. Very Dissatisfied	b.	c.	d.	e. Very Satisfied	f. I have not been aware of any Peak Energy Event notifications	g. Don't Know
1	2	3	4	5		

[IF Q3 = a-c (1-3), CONTINUE. OTHERWISE SKIP]

4. What caused the Peak Energy Event notification to be less than satisfying? **[OPEN-END, OPTIONAL]**
5. Did you or another member of your household notice a change in the temperature in your home at any point on **[INSERT HIGHTEMP_DATE]**?
- a. Yes
 - b. No
 - c. Don't Know



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

6. Were you aware that National Grid adjusted your Wi-Fi thermostat(s) setpoint for a Peak Energy Event on **[INSERT HIGHTEMP_DATE]**?
- Yes
 - No
 - Don't know

7. National Grid called a Peak Energy Event on **[INSERT HIGHTEMP_DATE]**, starting at **[INSERT EVENT_STARTTIME]** and ending at **[INSERT EVENT_ENDTIME]**.

Which of the following characterizes your presence during this Peak Energy Event? (Select only one)

- I was home during this entire period.
- I was home for only part of this period (specify the hours you were home).
- I was not home during any of this period and was not monitoring my Wi-Fi thermostat or WeatherBug mobile App.
- I was not home during any of this period, but I was monitoring my Wi-Fi thermostat or WeatherBug mobile App.
- Don't Know

[IF Q7 = c OR d, CONTINUE. OTHERWISE SKIP TO Q9]

8. Was another member of your household at home on **[INSERT HIGHTEMP_DATE]**, between **[INSERT EVENT_STARTTIME]** and **[INSERT EVENT_ENDTIME]**? (Select only one)
- At least one other member of my household was at home for this entire period.
 - At least one other member of my household was at home, but for only part of this period (specify the hours during which at least one other household member was home).
 - No other members of my household were home.
 - Don't Know

[IF Q7 = a OR b, OR IF Q8 = A OR b, CONTINUE. ELSE SKIP to Q13]

9. Using a scale of 1 to 5, where 1 means "Very Uncomfortable" and 5 means "Very Comfortable", how would you describe the comfort level of your home from **[PRE-COOL_STARTTIME]** to **[EVENT_STARTTIME]** on **[INSERT HIGHTEMP_DATE]** as compared to a typical day with similar outdoor temperatures?

a. Very Uncomfortable	b.	c.	d.	e. Very Comfortable	I. Don't Know
1	2	3	4	5	



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

[IF Q9 = a-c (1-3), CONTINUE. OTHERWISE SKIP TO Q11]

[IF SAMPLE_TYPE = 1 "EVENT", Q10_INSERT = "ConnectedSolutions Peak Energy Event"]

[IF SAMPLE_TYPE = 2 "NON-EVENT", Q10_INSERT = "ConnectedSolutions"]

10. What caused the decrease in comfort from **[PRE-COOL_STARTTIME]** to **[EVENT_STARTTIME]** on **[INSERT HIGHTEMP_DATE]**? (select all that apply)
- [INSERT Q10_INSERT]**
 - Too cold
 - Too warm
 - Too humid
 - Other (*Please specify*)
 - Don't know

11. Using a scale of 1 to 5, where 1 means "Very Uncomfortable" and 5 means "Very Comfortable", how would you describe the comfort level of your home from **[EVENT_STARTTIME]** to **[EVENT_ENDTIME]** on **[INSERT HIGHTEMP_DATE]** as compared to a typical day with similar outdoor temperatures?

a. Very Uncomfortable	b.	c.	d.	e. Very Comfortable	f. Don't Know
1	2	3	4	5	

[IF Q11 = a-c (1-3), CONTINUE. OTHERWISE SKIP TO Q3]

[IF SAMPLE_TYPE = 1 "EVENT", Q12_INSERT = "ConnectedSolutions Peak Energy Event"]

[IF SAMPLE_TYPE = 2 "NON-EVENT", Q12_INSERT = "ConnectedSolutions"]

12. What caused the decrease in comfort from **[EVENT_STARTTIME]** to **[EVENT_ENDTIME]** on **[INSERT HIGHTEMP_DATE]**? (select all that apply)
- [INSERT Q12_INSERT]**
 - Too cold
 - Too warm
 - Too humid
 - Other (*Please specify*)
 - Don't know

[IF Q7 = a, b, OR d, OR IF Q8 = a OR b, CONTINUE. ELSE SKIP to Q17]

13. At any point before or during the hours of **[INSERT HOURS OF EVENT]** on **[INSERT HIGHTEMP_DATE]**, did you or any other members of your household adjust your thermostat, or **[ONLY IF SAMPLE_TYPE = 1 "EVENT"]** press an 'opt-out' button on your thermostat or on the ConnectedSolutions web portal or WeatherBug mobile app? (select all that apply)
- Yes, adjusted thermostat before the hours of **[INSERT HOURS OF EVENT]**
 - [ONLY IF SAMPLE_TYPE = 1 "EVENT"]** Yes, pressed an "opt-out" button on thermostat before the hours of **[INSERT HOURS OF EVENT]**
 - Yes, adjusted thermostat during the hours of **[INSERT HOURS OF EVENT]**
 - No
 - Don't Know



2016 Residential Wi-Fi Thermostat DR Evaluation Final
Report

[IF Q13 ANSWER INCLUDES a, CONTINUE. OTHERWISE SKIP TO Q15]

14. Why did you or another household member adjust your thermostat before the hours of **[INSERT HOURS OF EVENT]** on **[INSERT HIGHTEMP_DATE]**? (select all that apply)
- a. Home temperature was too low
 - b. Home temperature was too high
 - c. **[ONLY IF SAMPLE_TYPE = 1 "EVENT"]** Did not want house to get too warm/uncomfortable later on
 - d. Someone in the home needed the temperature adjusted for health reasons
 - e. **[ONLY IF SAMPLE_TYPE = 1 "EVENT"]** Was too uncomfortable during previous Peak Energy Events
 - f. Had guests/visitors over on **[INSERT HIGHTEMP_DATE]**
 - g. Other (*Please specify*)
 - h. Don't Know

[IF Q13 ANSWER INCLUDES b, CONTINUE. OTHERWISE SKIP TO Q16]

15. Why did you or another household member press the "opt-out" button on your thermostat or the ConnectedSolutions web portal? (select all that apply)
- a. Did not want house to get too warm/uncomfortable
 - b. Someone in the home needed the temperature cooler for health reasons
 - c. Was too uncomfortable during previous Peak Energy Events
 - d. Had guests/visitors over on **[INSERT HIGHTEMP_DATE]**
 - e. Other (*Please specify*)
 - f. Don't Know

[IF Q13 ANSWER INCLUDES c, CONTINUE. OTHERWISE SKIP TO Q17]

16. Why did you or another household member adjust your thermostat during the hours of **[INSERT HOURS OF EVENT]** on **[INSERT HIGHTEMP_DATE]**? (select all that apply)
- a. Home temperature was too low
 - b. Home temperature was too high
 - c. Did not want house to get too warm/uncomfortable
 - d. Someone in the home needed the temperature adjusted for health reasons
 - e. **[ONLY IF SAMPLE_TYPE = 1 "EVENT"]** Was too uncomfortable during previous Peak Energy Events
 - f. Had guests/visitors over on **[INSERT HIGHTEMP_DATE]**
 - g. Other (*Please specify*)
 - h. Don't Know



2016 Residential Wi-Fi Thermostat DR Evaluation Final
Report

[IF Q7 = a OR b, OR IF Q8 = a OR b, CONTINUE. ELSE SKIP TO Q19]

17. During the Peak Energy Event on **[INSERT HIGHTEMP_DATE]**, what did you or other members of your household do to keep cool? (select all that apply)
- a. Continued normal activities/Didn't do anything different
 - b. Did not notice a difference in temperature
 - c. Turned on fans
 - d. Turned on room/window air conditioners
 - e. Closed blinds/shades
 - f. Moved to a cooler part of the house
 - g. Left the house and went somewhere cool
 - h. Wore less clothing
 - i. Drank more water/cool drinks
 - j. Opened windows
 - k. Other (Please Specify)
 - l. Don't know

18. What actions, if any, did you take to reduce your electricity use on **[INSERT HIGHTEMP_DATE]** when a Peak Energy Event occurred? (choose all that apply)
- a. Discussed energy conservation strategies with my family
 - b. Sought activities outside of the home
 - c. Did not use certain appliances
 - d. Other (Please specify)
 - e. None
 - f. Don't Know

19. In future summers, would you continue to participate in the ConnectedSolutions program?
- a. Yes
 - b. No
 - c. It depends

[IF Q19 = b or c, CONTINUE. OTHERWISE SKIP TO Q21]

20. What change(s) to the ConnectedSolutions program would encourage you to continue participating?
[OPEN-END, OPTIONAL]

[IF Q19 = a, CONTINUE. OTHERWISE SKIP TO Q22]

21. What recommendations would you make to help improve the ConnectedSolutions program going forward? **[OPEN-END, OPTIONAL]**
22. We have reached the end of the survey. Do you have any additional comments regarding National Grid's ConnectedSolutions program? **[OPEN-END, OPTIONAL]**



2016 Residential Wi-Fi Thermostat DR Evaluation Final
Report

23. Thank you for taking the time to complete this survey. Your name will be entered to win a \$100 Amazon gift card. Please provide your contact information so that we may send you the gift card, if your name is selected. [\[OPEN-END, OPTIONAL\]](#)

First Name:

Last Name:

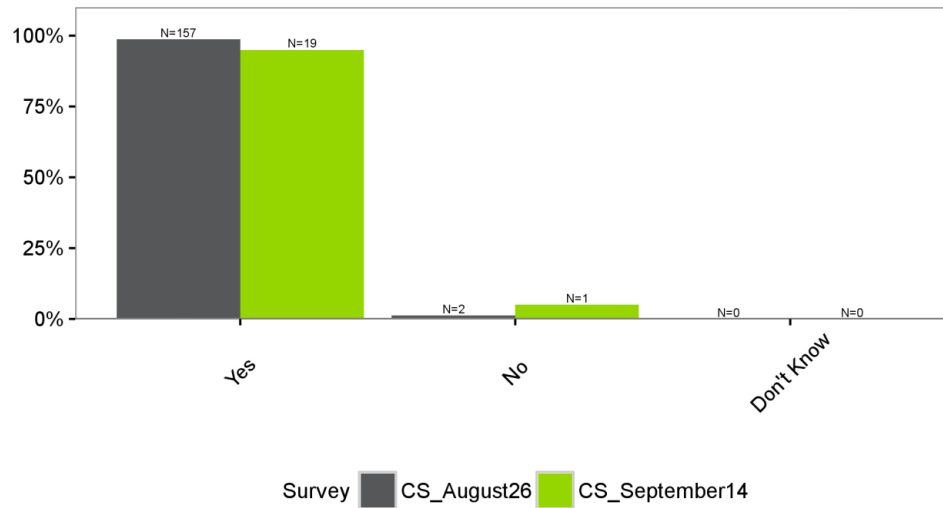
Home Address:

Email:

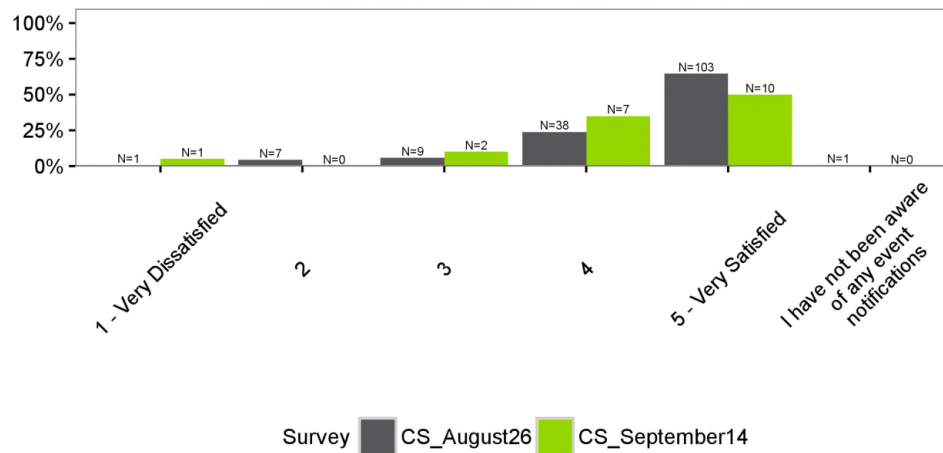


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1. Has National Grid called an event since you enrolled in the program?



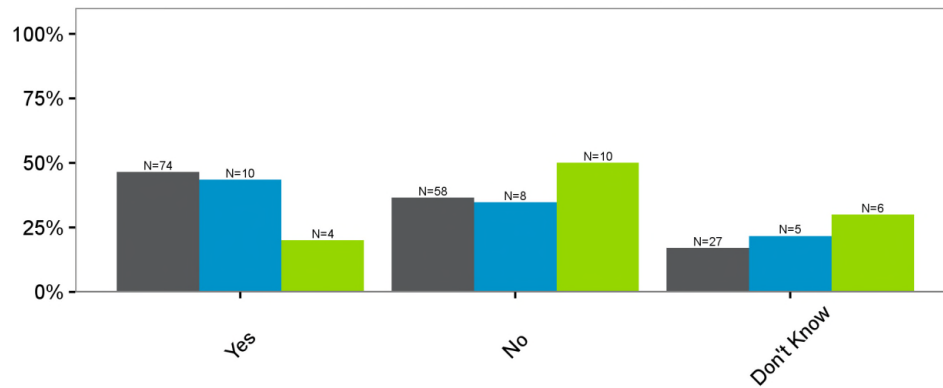
3. Using a scale of 1 to 5, where 1 means "Very Dissatisfied" and 5 means "Very Satisfied", what is your level of satisfaction with the notification you receive about an upcoming event?





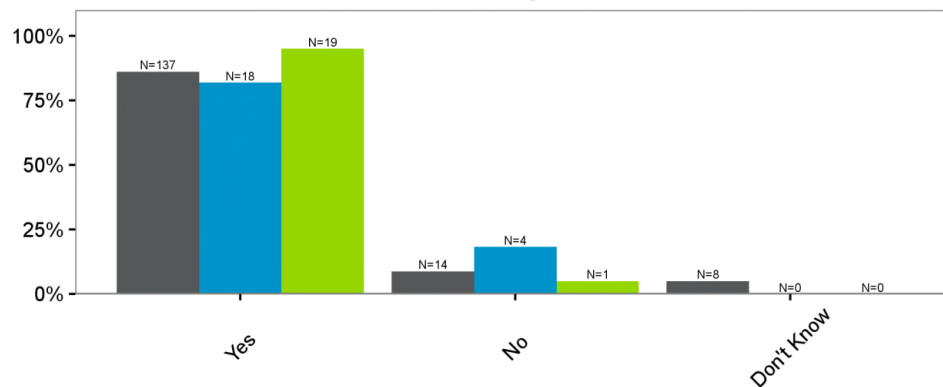
2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

5. Did you or another member of your household notice a change in the temperature in your home at any point on the [event date]?



Survey CS_August26 CS_NonEvent CS_September14

6. Were you aware that National Grid adjusted your Wi-Fi thermostat(s) setpoint on [event date]?

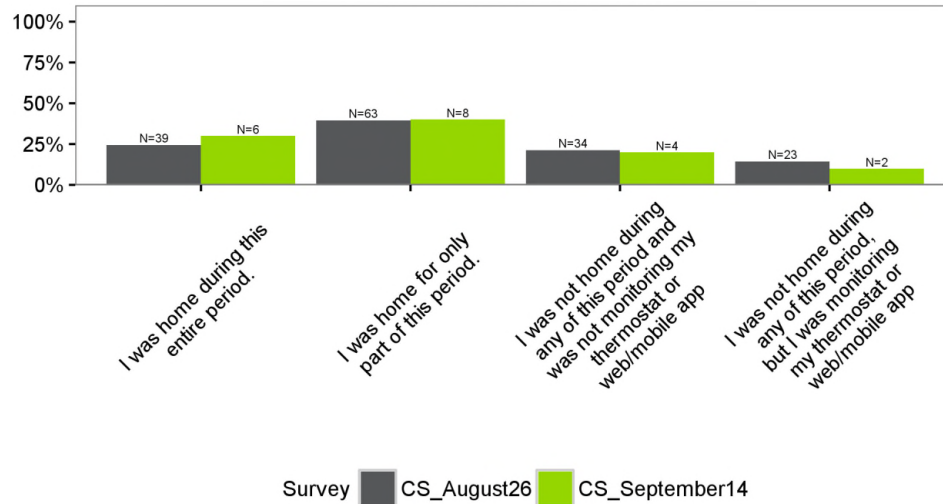


Survey CS_August26 CS_NonEvent CS_September14

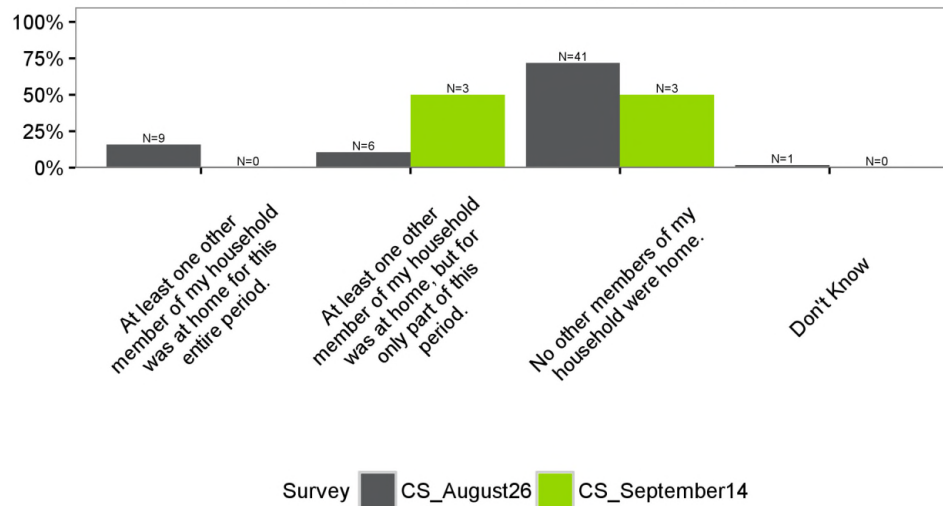


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

7. Which of the following characterizes your presence during this event?



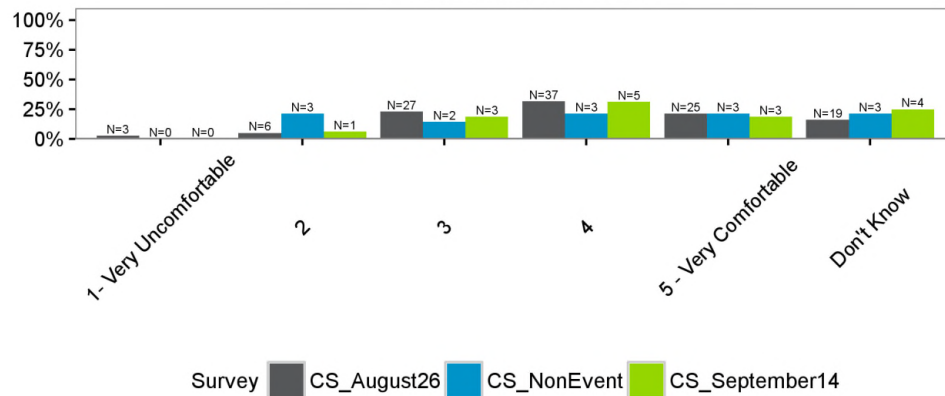
8. Was another member of your household at home during the [event hours] on [event date]?



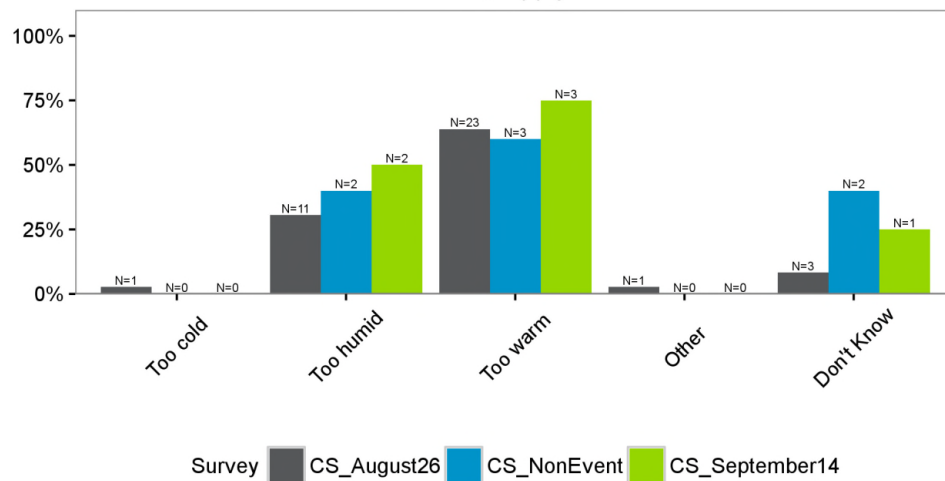


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

9. Using a scale of 1 to 5, where 1 means "Very Uncomfortable" and 5 means "Very Comfortable", how would you describe the comfort level of your home during the [precooling hours] on [event date] as compared to a typical day with similar outdoor temperatures?



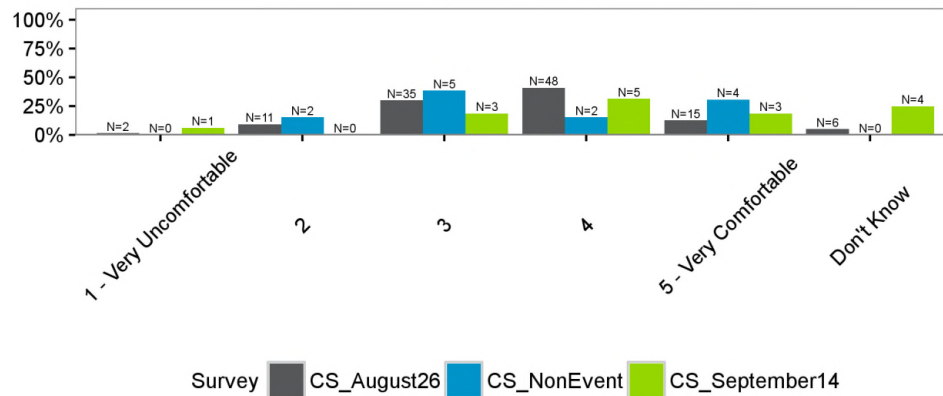
10. What caused the decrease in comfort during [precooling hours] on [event date]? Select all that apply.



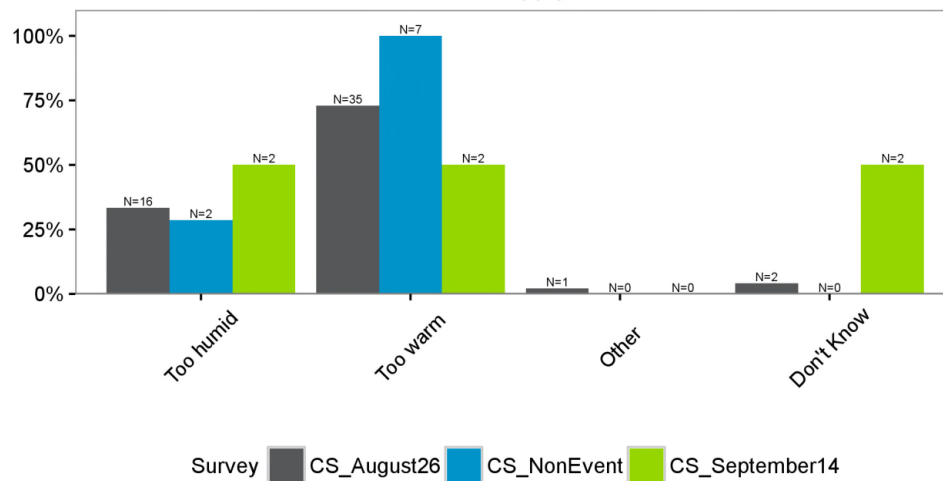


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

11. Using a scale of 1 to 5, where 1 means "Very uncomfortable" and 5 means "Very comfortable," how would you describe the comfort level of your home during [event hours] on [event date] as compared to a typical day with similar outdoor temperatures?



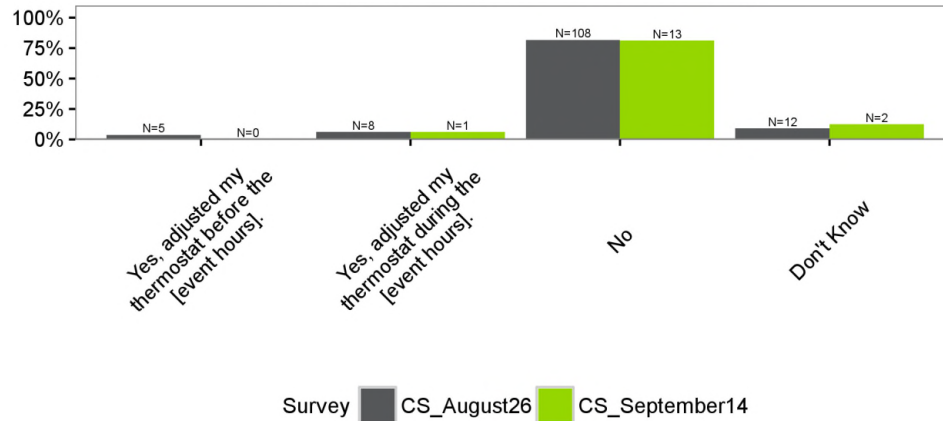
12. What caused the decrease in comfort during the [event hours] on the [event date]? Select all that apply.



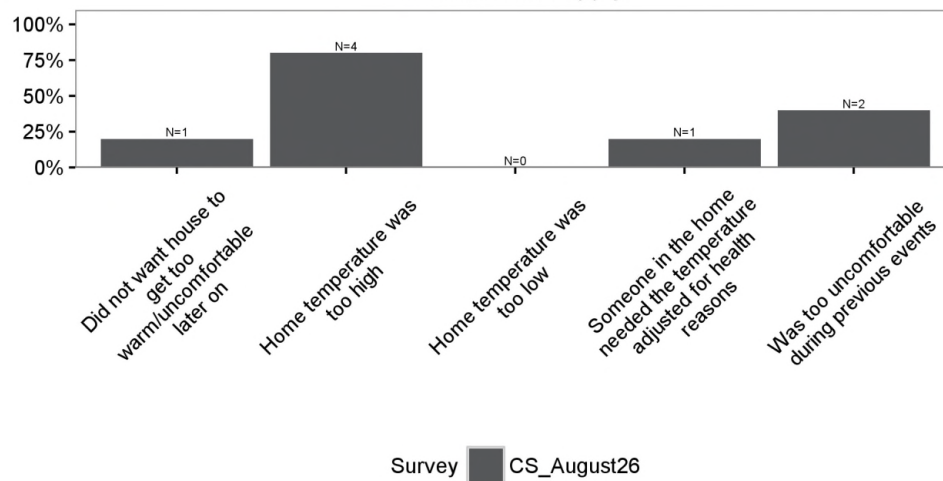


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

13. At any point before or during the [event hours] on [event date], did you or any other members of your household adjust your thermostat, or press an 'opt-out' button on your thermostat or web or mobile app? Select all that apply.



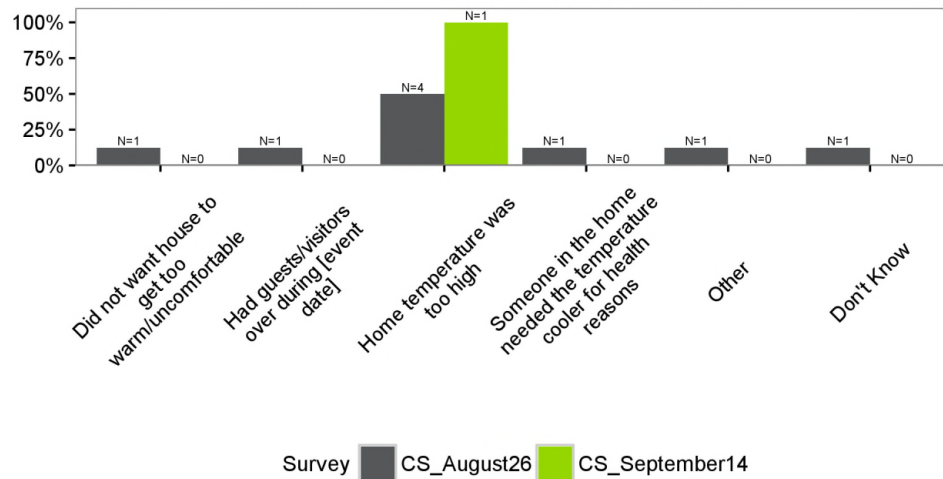
14. Why did you or another household member adjust your thermostat before the event hours? Select all that apply.



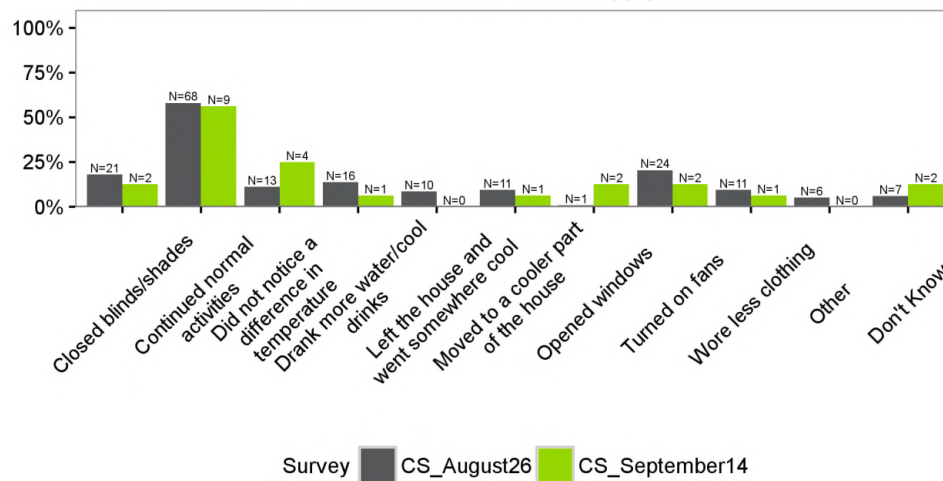


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16. Why did you or another household member adjust your thermostat during the [event hours] on [event date]? Select all that apply.



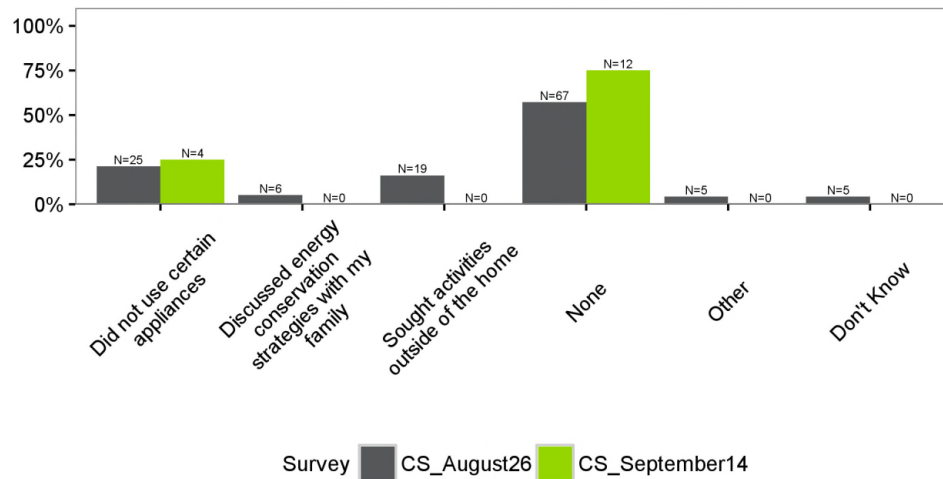
17. During the event on [event date] what did you or other members of your household do to keep cool? Select all that apply.



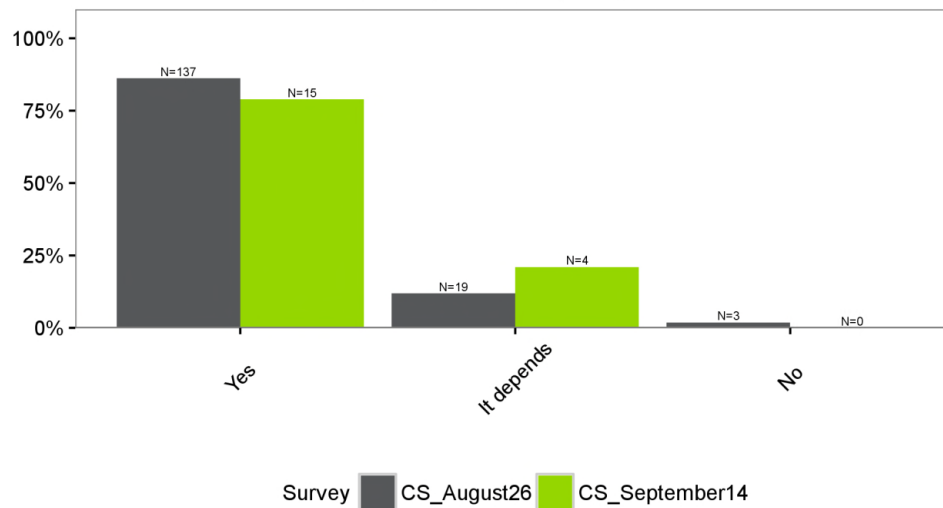


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18. What actions, if any, did you take to reduce your electricity use on [event date] when an event occurred? Select all that apply.



19. In future summers, would you continue to participate in the program?





2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

APPENDIX H. RUSH HOUR REWARDS POST-EVENT SURVEY AND RESULTS

This section includes the survey instrument and responses to the multi-choice questions.

1. Rush Hour Rewards helps you earn rewards from National Grid for saving energy during peak demand periods (aka "Rush Hours"), while still keeping you comfortable.

During a Rush Hour Event, Nest has the ability to adjust the cooling of your central air conditioner by sending a signal to your Nest Thermostat and adjusting the setpoint by a maximum of 3 degrees.

Has a Rush Hour Event occurred since you enrolled in Rush Hour Rewards?

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

2. How do you know when you are in a Rush Hour Event? **[OPEN-END, OPTIONAL]**

3. Using a scale of 1 to 5, where 1 means "Very Dissatisfied" and 5 means "Very Satisfied", what is your level of satisfaction with the notification you receive about a Rush Hour Event that is set to occur?

a. Very Dissatisfied	b.	c.	d.	e. Very Satisfied	f. I have not been aware of any Rush Hour Event notifications	g. Don't Know
1	2	3	4	5		

[IF Q3 = a-c (1-3), CONTINUE. OTHERWISE SKIP]

4. What caused the Rush Hour Event notification to be less than satisfying? **[OPEN-END, OPTIONAL]**

5. Did you or another member of your household notice a change in the temperature in your home at any point on **[INSERT HIGHTEMP_DATE]**?

- d. Yes
- e. No
- f. Don't Know

6. Were you aware that Nest adjusted your Nest Thermostat setpoint for a Rush Hour Event on **[INSERT HIGHTEMP_DATE]**?

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



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

7. National Grid called a Rush Hour Event on [INSERT HIGHTEMP_DATE], starting at [INSERT EVENT_STARTTIME] and ending at [INSERT EVENT_ENDTIME].

Which of the following characterizes your presence during this Rush Hour Event? (Select only one)

- f. I was home during this entire period.
- g. I was home for only part of this period (specify the hours you were home).
- h. I was not home during any of this period and was not monitoring my Nest Thermostat or Nest App.
- i. I was not home during any of this period, but I was monitoring my Nest Thermostat or Nest App.
- j. Don't Know

[IF Q7 = d OR c, CONTINUE. OTHERWISE SKIP TO Q9]

8. Besides yourself, was another member of your household at home on [INSERT HIGHTEMP_DATE], between [INSERT EVENT_STARTTIME] and [INSERT EVENT_ENDTIME]? (Select only one)
- e. At least one other member of my household was at home for this entire period.
 - f. At least one other member of my household was at home, but for only part of this period (specify the hours during which at least one other household member was home).
 - g. No other members of my household were home.
 - h. Don't Know

[IF Q7 = a OR b, OR IF Q8 = A OR b, CONTINUE. ELSE SKIP to Q13]

9. Using a scale of 1 to 5, where 1 means "Very Uncomfortable" and 5 means "Very Comfortable", how would you describe the comfort level of your home from [PRE-COOL_STARTTIME] to [EVENT_STARTTIME] on [INSERT HIGHTEMP_DATE] as compared to a typical day with similar outdoor temperatures?

a. Very Uncomfortable	b.	c.	d.	e. Very Comfortable	f. Don't Know
1	2	3	4	5	

[IF Q9 = a-c (1-3), CONTINUE. OTHERWISE SKIP TO Q11]

[IF SAMPLE_TYPE = 1 "EVENT", Q10_INSERT = "Rush Hour Event"]

[IF SAMPLE_TYPE = 2 "NON-EVENT", Q10_INSERT = "Rush Hour Rewards program"]

10. What caused the decrease in comfort from [PRE-COOL_STARTTIME] to [EVENT_STARTTIME] on [INSERT HIGHTEMP_DATE]? (select all that apply)
- a. [INSERT Q10_INSERT]
 - b. Too cold
 - c. Too warm
 - d. Too humid
 - e. Other (Please specify)
 - f. Don't know



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

11. Using a scale of 1 to 5, where 1 means "Very Uncomfortable" and 5 means "Very Comfortable", how would you describe the comfort level of your home from [EVENT_STARTTIME] to [EVENT_ENDTIME] on [INSERT HIGHTEMP_DATE] as compared to a typical day with similar outdoor temperatures?

a. Very Uncomfortable	b.	c.	d.	e. Very Comfortable	f. Don't Know
1	2	3	4	5	

[IF Q11 = a-c (1-3), CONTINUE. OTHERWISE SKIP TO Q13]
[IF SAMPLE_TYPE = 1 "EVENT", Q12_INSERT = "Rush Hour Event"]
[IF SAMPLE_TYPE = 2 "NON-EVENT", Q12_INSERT = "Rush Hour Rewards program"]

12. What caused the decrease in comfort from [EVENT_STARTTIME] to [EVENT_ENDTIME] on [INSERT HIGHTEMP_DATE]? (select all that apply)
- a. [INSERT Q12_INSERT]
 - b. Too cold
 - c. Too warm
 - d. Too humid
 - e. Other (*Please specify*)
 - f. Don't know

[IF Q7 = a, b, OR d, OR IF Q8 = a OR b, CONTINUE. ELSE SKIP to Q16]

13. At any point before or during the hours of [INSERT HOURS OF EVENT] on [INSERT HIGHTEMP_DATE], did you or any other member of your household adjust your thermostat? (select all that apply)
- a. Yes, adjusted thermostat before the hours of [INSERT HOURS OF EVENT]
 - b. Yes, adjusted thermostat during the hours of [INSERT HOURS OF EVENT]
 - c. No
 - d. Don't Know

[IF Q13 ANSWER INCLUDES a, CONTINUE. OTHERWISE SKIP TO Q15]

14. Why did you or another member of your household adjust your thermostat before the hours of [INSERT HOURS OF EVENT] on [INSERT HIGHTEMP_DATE]? (select all that apply)
- i. Home temperature was too low
 - j. Home temperature was too high
 - k. [ONLY IF SAMPLE_TYPE = 1 "EVENT"] Did not want house to get too warm/uncomfortable later on
 - l. Someone in the home needed the temperature adjusted for health reasons
 - m. [ONLY IF SAMPLE_TYPE = 1 "EVENT"] Was too uncomfortable during previous Rush Hour Events
 - n. Had guests/visitors over on [INSERT HIGHTEMP_DATE]
 - o. Other (*Please specify*)
 - p. Don't Know



2016 Residential Wi-Fi Thermostat DR Evaluation Final
Report

[IF Q13 ANSWER INCLUDES b, CONTINUE. OTHERWISE SKIP TO Q16]

15. Why did you or another member of your household adjust your thermostat during the hours of **[INSERT HOURS OF EVENT]** on **[INSERT HIGHTEMP_DATE]**? (select all that apply)
- a. Home temperature was too low
 - b. Home temperature was too high
 - c. Did not want house to get too warm/uncomfortable
 - d. Someone in the home needed the temperature adjusted for health reasons
 - e. **[ONLY IF SAMPLE_TYPE = 1 "EVENT"]** Was too uncomfortable during previous Rush Hour Events
 - f. Had guests/visitors over on **[INSERT HIGHTEMP_DATE]**
 - g. Other (*Please specify*)
 - h. Don't Know

[IF Q7 = a OR b, OR IF Q8 = a OR b, CONTINUE. ELSE SKIP TO Q18]

16. During the Rush Hour Event on **[INSERT HIGHTEMP_DATE]**, what did you or other members of your household do to keep cool? (select all that apply)
- m. Continued normal activities/Didn't do anything different
 - n. Did not notice a difference in temperature
 - o. Turned on fans
 - p. Turned on room/window air conditioners
 - q. Closed blinds/shades
 - r. Moved to a cooler part of the house
 - s. Left the house and went somewhere cool
 - t. Wore less clothing
 - u. Drank more water/cool drinks
 - v. Opened windows
 - w. Other (*Please specify*)
 - x. Don't know

17. What actions, if any, did you take to reduce your electricity use on **[INSERT HIGHTEMP_DATE]** when a Rush Hour Event occurred? (choose all that apply)
- g. Discussed energy conservation strategies with my family
 - h. Sought activities outside of the home
 - i. Did not use certain appliances
 - j. Other (*Please specify*)
 - k. None
 - l. Unsure

18. In future summers, would you continue to participate in Rush Hour Rewards?
- a. Yes
 - b. No
 - c. It depends

[IF Q18 = b OR c, CONTINUE. OTHERWISE SKIP TO Q20]

19. What change(s) to the Rush Hour Rewards program would encourage you to continue participating?
[OPEN-END, OPTIONAL]



2016 Residential Wi-Fi Thermostat DR Evaluation Final
Report

[IF Q18 = a, CONTINUE. OTHERWISE SKIP TO Q21]

20. What recommendations would you make to help improve the Rush Hour Rewards program going forward? **[OPEN-END, OPTIONAL]**
21. We have reached the end of the survey. Do you have any additional comments regarding Rush Hour Rewards program? **[OPEN-END, OPTIONAL]**
22. Thank you for taking the time to complete this survey. Your name will be entered to win a \$100 Amazon gift card. Please provide your contact information so that we may send you the gift card, if your name is selected. **[OPEN-END, OPTIONAL]**

First Name:

Last Name:

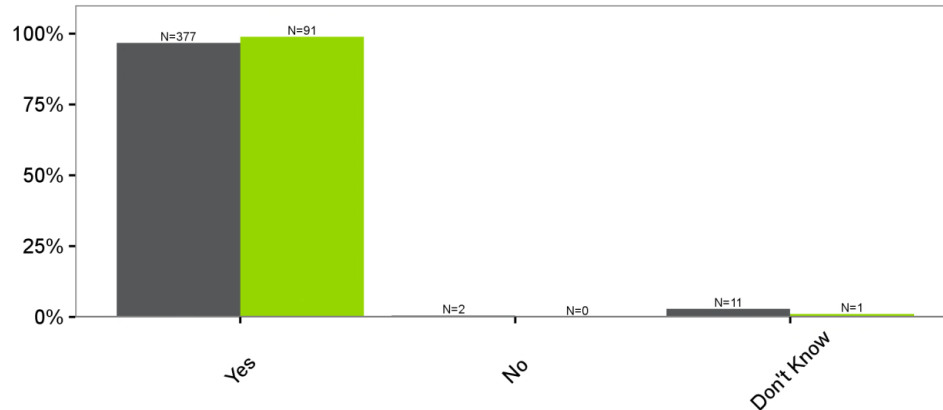
Home Address:

Email:



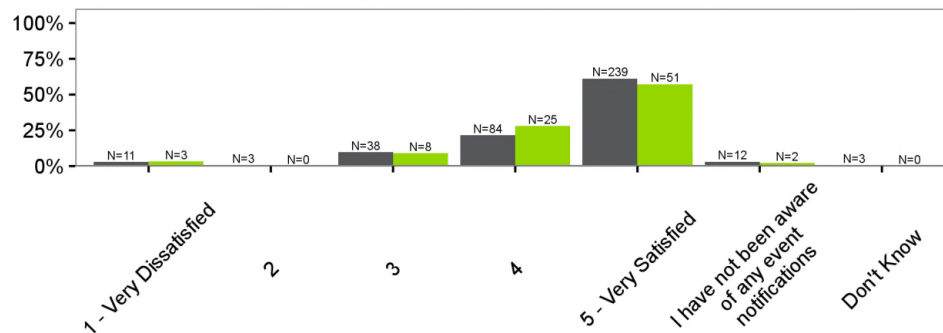
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1. Has National Grid called an event since you enrolled in the program?



Survey RHR_August26 RHR_September20

3. Using a scale of 1 to 5, where 1 means "Very Dissatisfied" and 5 means "Very Satisfied", what is your level of satisfaction with the notification you receive about an upcoming event?

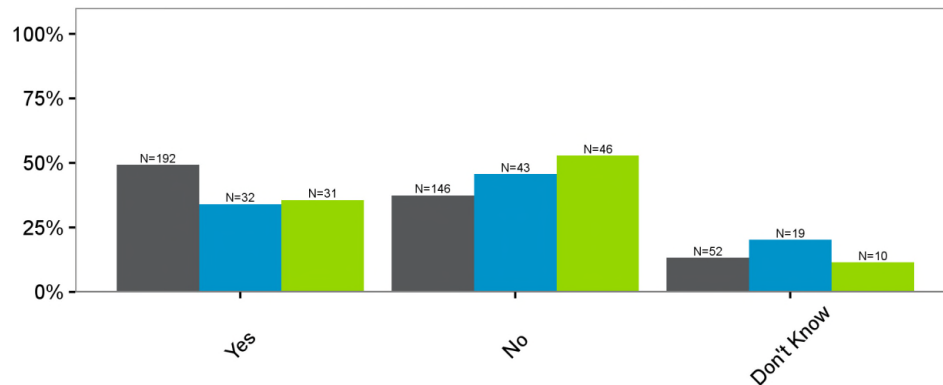


Survey RHR_August26 RHR_September20



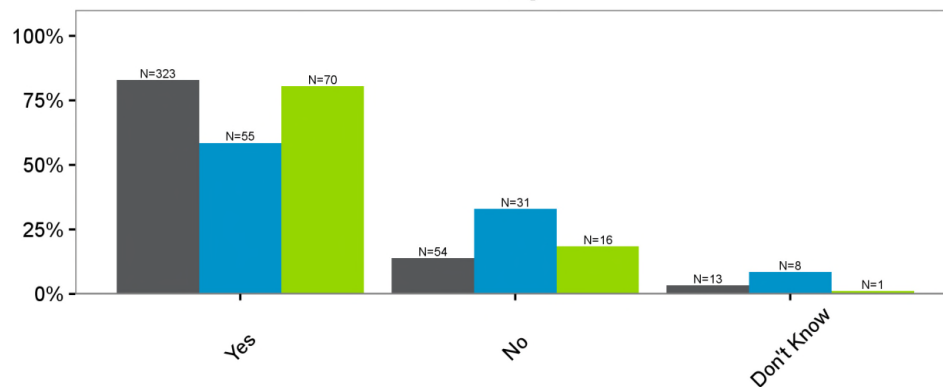
2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

5. Did you or another member of your household notice a change in the temperature in your home at any point on the [event date]?



Survey RHR_August26 RHR_NonEvent RHR_September20

6. Were you aware that National Grid adjusted your Wi-Fi thermostat(s) setpoint on [event date]?

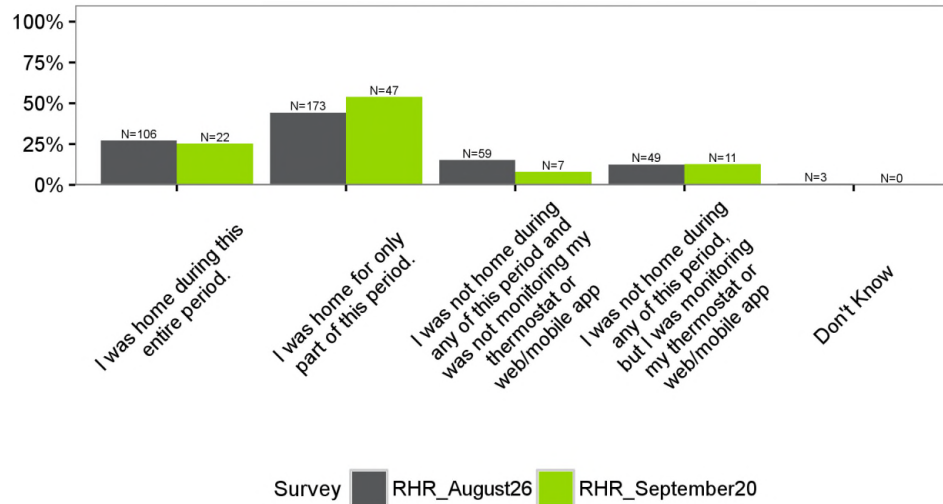


Survey RHR_August26 RHR_NonEvent RHR_September20

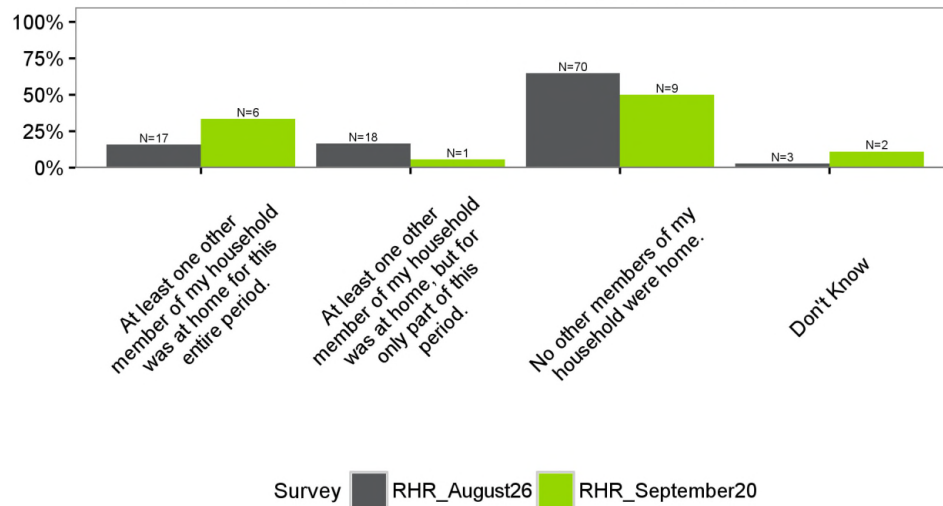


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7. Which of the following characterizes your presence during this event?



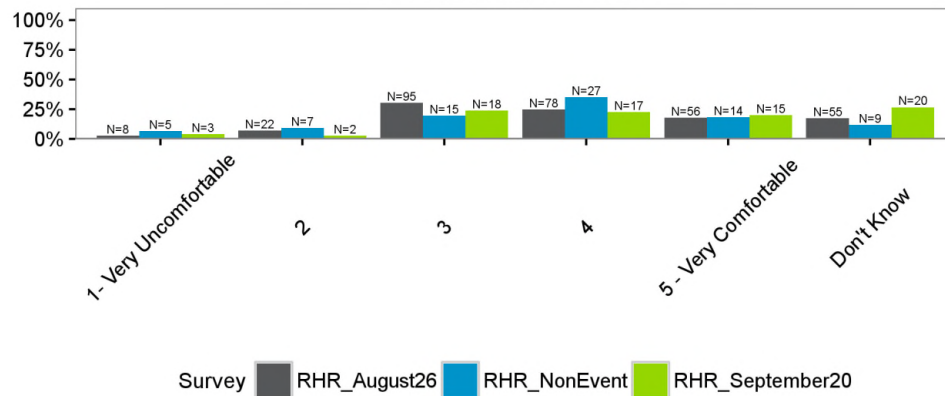
8. Was another member of your household at home during the [event hours] on [event date]?



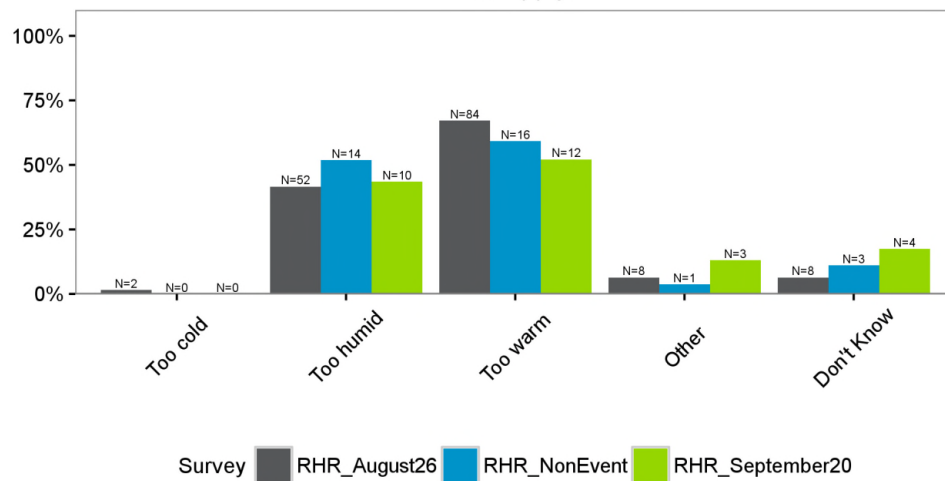


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

9. Using a scale of 1 to 5, where 1 means "Very Uncomfortable" and 5 means "Very Comfortable", how would you describe the comfort level of your home during the [precooling hours] on [event date] as compared to a typical day with similar outdoor temperatures?



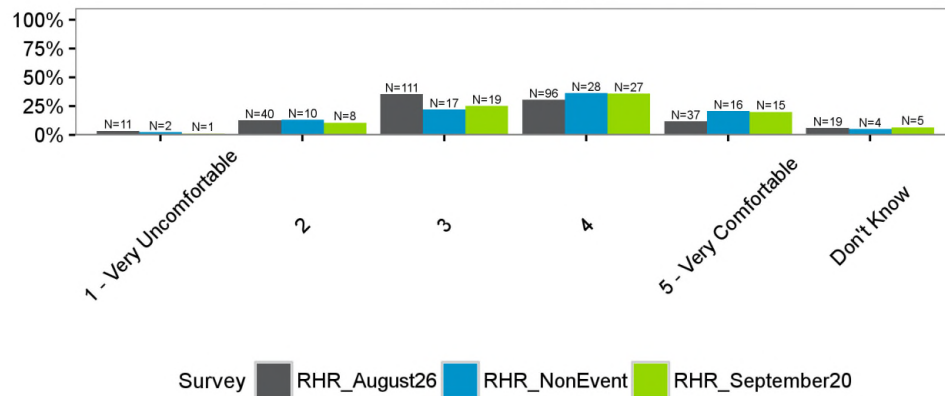
10. What caused the decrease in comfort during [precooling hours] on [event date]? Select all that apply.



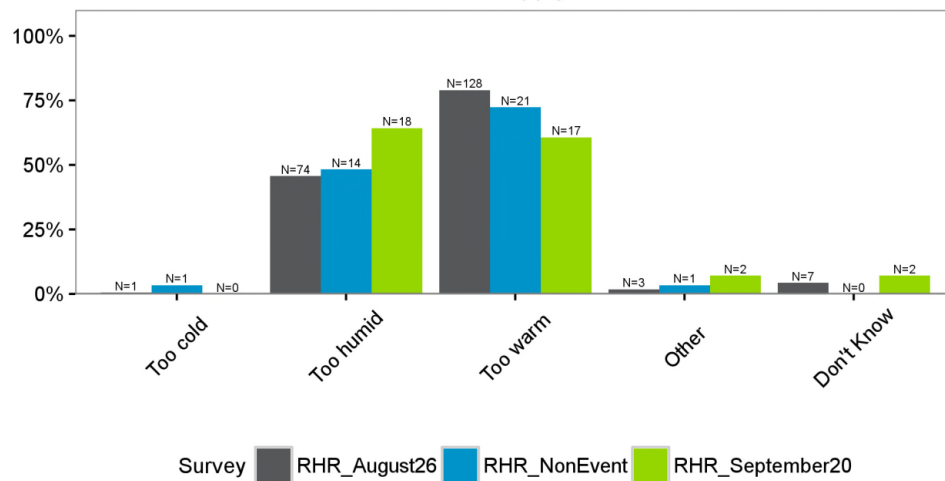


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

11. Using a scale of 1 to 5, where 1 means "Very uncomfortable" and 5 means "Very comfortable," how would you describe the comfort level of your home during [event hours] on [event date] as compared to a typical day with similar outdoor temperatures?



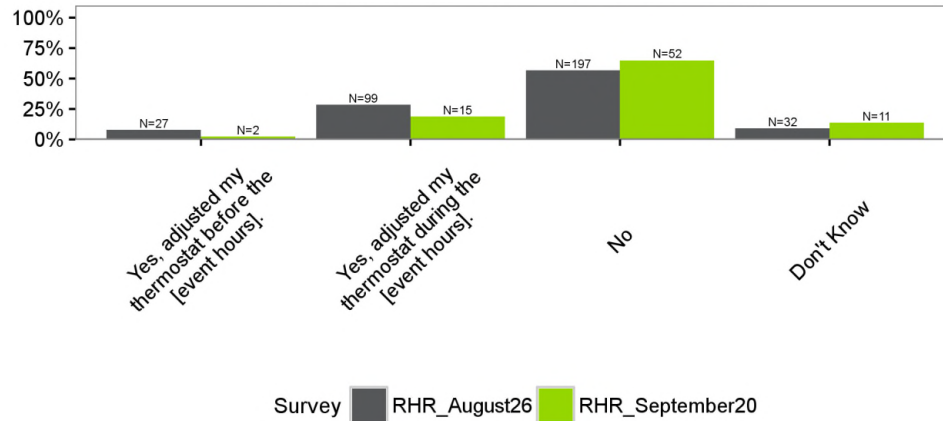
12. What caused the decrease in comfort during the [event hours] on the [event date]? Select all that apply.



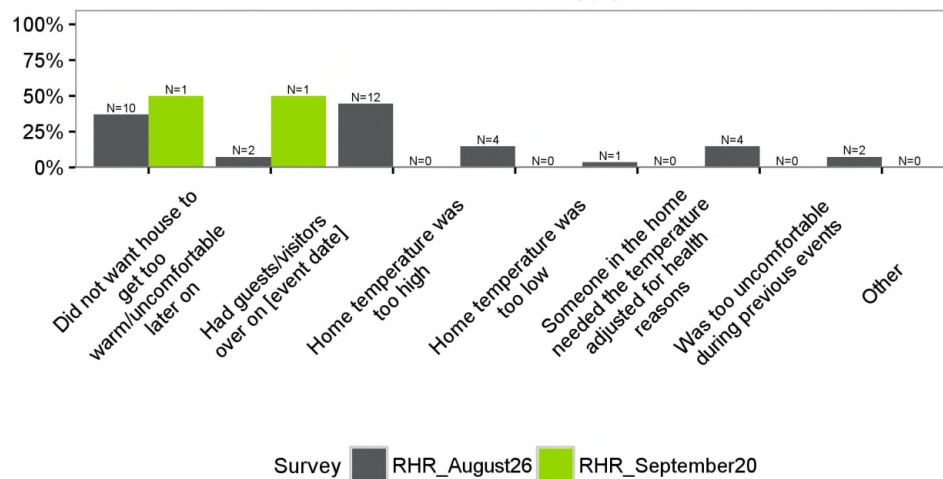


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

13. At any point before or during the [event hours] on [event date], did you or any other members of your household adjust your thermostat, or press an 'opt-out' button on your thermostat or web or mobile app? Select all that apply.



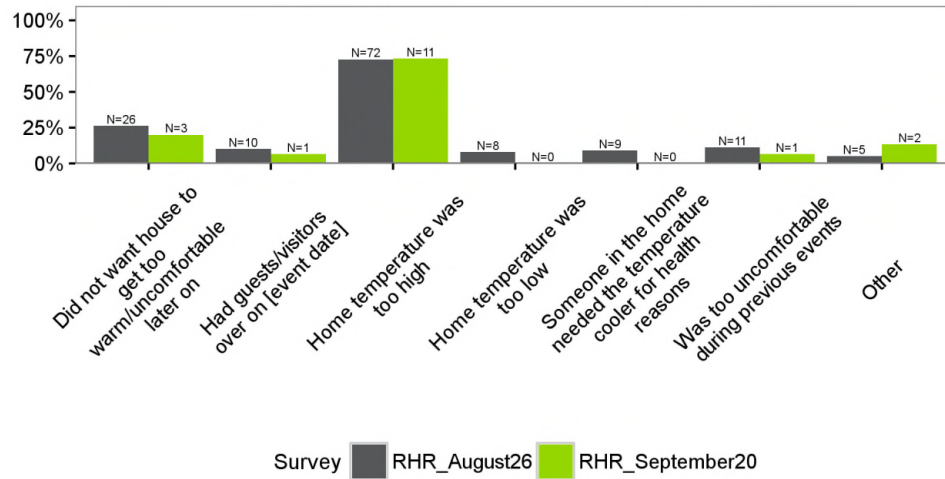
14. Why did you or another household member adjust your thermostat before the event hours? Select all that apply.



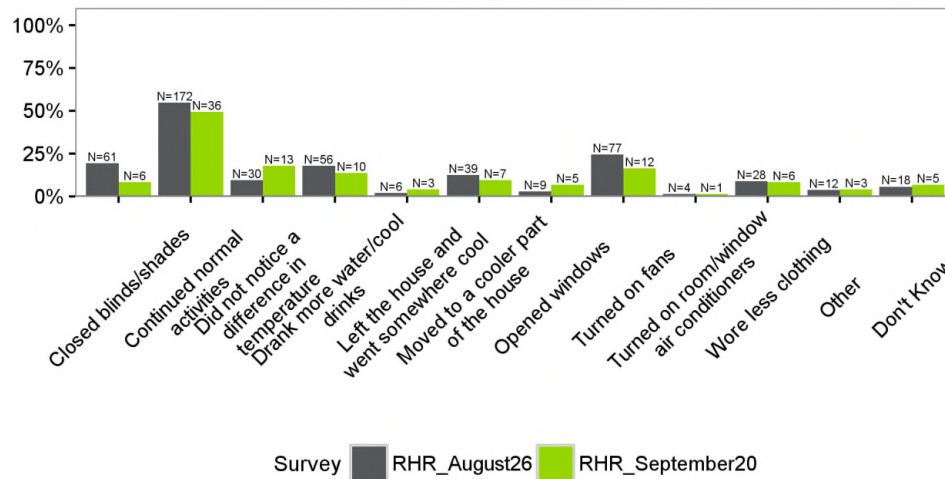


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

15. Why did you or another household member adjust your thermostat during the [event hours] on [event date]? Select all that apply.



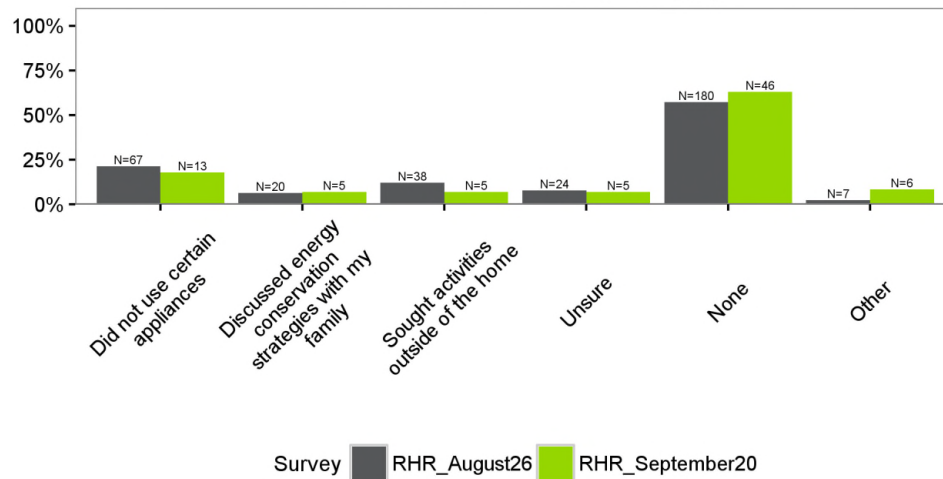
16. During the event on [event date] what did you or other members of your household do to keep cool? Select all that apply.



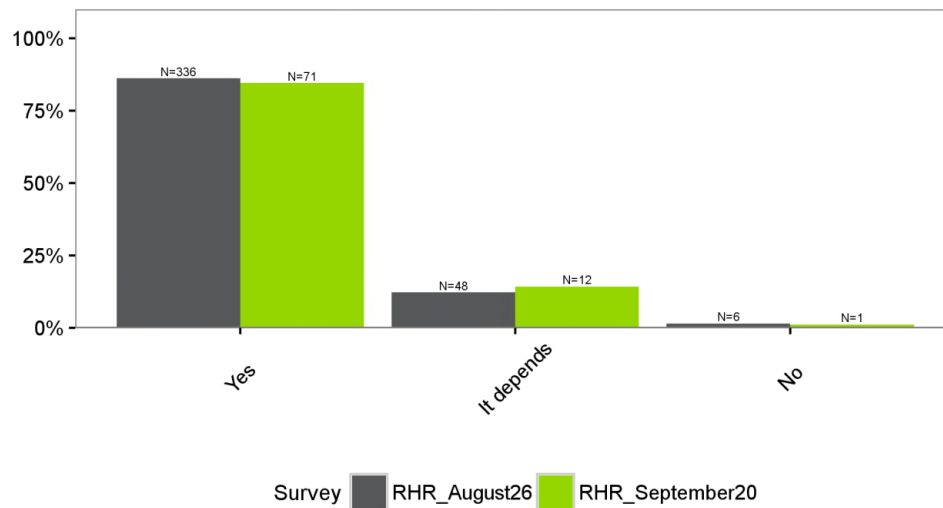


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

17. What actions, if any, did you take to reduce your electricity use on [event date] when an event occurred? Select all that apply.



18. In future summers, would you continue to participate in the program?





2016 Residential Wi-Fi Thermostat DR Evaluation Final
Report

APPENDIX I. CONNECTEDSOLUTIONS POST-SEASON SURVEY AND RESULTS

This section includes the survey instrument and responses to the multi-choice questions.

0. What are your main reasons for enrolling in National Grid's **ConnectedSolutions** program?
 - a. Receive participation incentives
 - b. Ability to remotely control my Wi-Fi thermostat
 - c. Ability to schedule temperatures on my Wi-Fi thermostat
 - d. Save money on my energy bills
 - e. Maximize comfort in my home
 - f. Reduce my environmental impact
 - g. Help to lower electricity demand during peak load periods
 - h. Other [\[OPEN-END\]](#)

1. About how many Peak Energy Events do you remember occurring between June 15 and September 30? (Please make your best estimate).
 - a. {ENTER NUMBER}
 - b. Don't know

2. What time did Peak Energy Events typically start (i.e. when the temperature in your home increased by two degrees)?
 - a. 11 am
 - b. 12 pm
 - c. 1 pm
 - d. 2 pm
 - e. 3 pm
 - f. 4 pm
 - g. 5 pm
 - h. Other_____
 - i. Don't Know

3. What time did Peak Energy Events typically end?
 - a. 2 pm
 - b. 3 pm
 - c. 4 pm
 - d. 5 pm
 - e. 6 pm
 - f. 7 pm
 - g. 8 pm
 - h. Other_____
 - i. Don't Know



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

4. During this past summer, how did you typically become aware that a Peak Energy Event was going to occur? **[OPEN-END, OPTIONAL]**
5. During this past summer, approximately how far in advance were you typically notified that a Peak Energy Event was set to occur?
- Less than 1 hour
 - 1 hour
 - 2 hours
 - 3 hours
 - 4 hours
 - 5 hours
 - 6 hours
 - More than 6 hours
 - I have not been aware of any Peak Energy Event notifications
 - Don't know

[IF Q5 <= i, CONTINUE. ELSE SKIP]

6. Using a scale of 1 to 5, where 1 means "Very Dissatisfied" and 5 means "Very Satisfied", what is your level of satisfaction with the notification you receive about a Peak Energy Event that is set to occur?

a. Very Dissatisfied	b.	c. Neutral	d.	e. Very Satisfied	f. I have not been aware of any Peak Energy Event notifications	g. Don't Know
1	2	3	4	5		

[IF Q6 = a-b (1-2), CONTINUE. OTHERWISE SKIP]

7. What caused the Peak Energy Event notification to be less than satisfying? **[OPEN-END, OPTIONAL]**

[IF Q6 = a-b (1-2), CONTINUE. OTHERWISE SKIP]

8. How could the Peak Energy Event notification be improved? **[OPEN-END, OPTIONAL]**

9. This summer, for the Peak Energy Events you can recall, about how often were you or another family member home during the Peak Energy Event hours?
- Home for all Peak Energy Event hours
 - Home for most Peak Energy Event hours
 - Home for some Peak Energy Event hours
 - Never at home during Peak Energy Event hours
 - Don't know



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

10. 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?

	a. Very Dissatisfied	b.	c. Neutral	d.	e. Very Satisfied	f. Don't know
	1	2	3	4	5	
10a. Program enrollment process						
10b. Number of Peak Energy Events during the 2016 summer season						
10c. Length of Peak Energy Events						
10d. Timing of Peak Energy Events (i.e. what period during the day events occurred)						

[IF Q10a = a-b (1-2), CONTINUE. ELSE SKIP TO Q13]

11. Please let us know why you were not fully satisfied with the program enrollment process.

a. Don't know

[OPEN-END]

[IF Q10a = a-b (1-2), CONTINUE. ELSE SKIP TO Q13]

12. Please let us know how the enrollment process can be improved.

a. Don't know

[OPEN-END]

[IF Q10b = a-b (1-2), CONTINUE. ELSE SKIP TO Q17]

13. Did the number of Peak Energy Events that occurred on consecutive days impact your satisfaction level?

- a. Very Much
- b. Somewhat
- c. Not At All

[IF Q10b = a-b (1-2), CONTINUE. ELSE SKIP TO Q17]

14. On a scale of 1 through 5, where 1 is "Very dissatisfied" and 5 is "Very satisfied", how satisfied would you have been with the number of Peak Energy Events if there had been 5 fewer events over the course of the summer?

a. Very Dissatisfied	b.	c. Neutral	d.	e. Very Satisfied	g. Don't Know
1	2	3	4	5	



2016 Residential Wi-Fi Thermostat DR Evaluation Final
Report

[IF Q10b = a-b (1-2), CONTINUE. ELSE SKIP TO Q17]

15. On a scale of 1 through 5, where 1 is "Very dissatisfied" and 5 is "Very satisfied", how satisfied would you have been with the number of Peak Energy Events if there had been 10 fewer events over the course of the summer?

a. Very Dissatisfied	b.	c. Neutral	d.	e. Very Satisfied	g. Don't Know
1	2	3	4	5	

[IF Q10b = a-b (1-2), CONTINUE. ELSE SKIP TO Q17]

16. On a scale of 1 through 5, where 1 is "Very dissatisfied" and 5 is "Very satisfied", how satisfied would you have been with the number of Peak Energy Events if there had been 15 fewer events over the course of the summer?

a. Very Dissatisfied	b.	c. Neutral	d.	e. Very Satisfied	g. Don't Know
1	2	3	4	5	

[IF Q10c = a-b (1-2), CONTINUE. ELSE SKIP TO Q20]

17. Please let us know why you are not fully satisfied with the length of the Peak Energy Events.

[IF Q10c = a-b (1-2), CONTINUE. ELSE SKIP TO Q20]

18. On a scale of 1 through 5, where 1 is "Very dissatisfied" and 5 is "Very satisfied", how satisfied would you have been with the length of Peak Energy Events if they had been 1 hour shorter?

a. Very Dissatisfied	b.	c. Neutral	d.	e. Very Satisfied	g. Don't Know
1	2	3	4	5	

[IF Q10c = a-b (1-2), CONTINUE. ELSE SKIP TO Q20]

19. On a scale of 1 through 5, where 1 is "Very dissatisfied" and 5 is "Very satisfied", how satisfied would you have been with the length of Peak Energy Events if they had been 2 hours shorter?

a. Very Dissatisfied	b.	c. Neutral	d.	e. Very Satisfied	g. Don't Know
1	2	3	4	5	

[IF Q10d = a-b (1-2), CONTINUE. ELSE SKIP TO Q23]

20. Please let us know why you are not fully satisfied with the timing of some or all of the Peak Energy Events.



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

[IF Q10d = a-b (1-2), CONTINUE. ELSE SKIP TO Q23]

21. Based on your experience with the program this summer, what would the optimal start time be for a Peak Energy Event (i.e. for a temperature increase in your home)?

- a. 10 am
- b. 11 am
- c. 12 pm
- d. 1 pm
- e. 2 pm
- f. 3 pm
- g. 4 pm
- h. 5 pm
- i. Other _____
- j. I don't have a strong opinion
- k. Don't Know

[IF Q10d = a-b (1-2), CONTINUE. ELSE SKIP TO Q23]

22. Based on your experience with the program this summer, what would the optimal end time be for a Peak Energy Event?

- a. 2 pm
- b. 3 pm
- c. 4 pm
- d. 5 pm
- e. 6 pm
- f. 7 pm
- g. 8 pm
- h. Other _____
- i. I don't have a strong opinion
- j. Don't Know

23. Did you contact **ConnectedSolutions** support, National Grid, WeatherBug Home, or your thermostat manufacturer at any point over the course of the summer regarding the program? (select all that apply)

- a. **ConnectedSolutions** support
- b. National Grid
- c. WeatherBug Home
- d. Thermostat manufacturer support
- e. I did not contact any party about the program

[IF Q23 <> d, CONTINUE. OTHERWISE SKIP TO Q26]

24. Please describe your reason(s) for contacting [INSERT Q24 ANSWER]. _____

25. Using a scale of 1 to 5, where 1 means "Very Dissatisfied" and 5 means "Very Satisfied", what is your level of satisfaction with the support you received when you contacted [INSERT Q24 ANSWER]?

a. Very Dissatisfied	b.	c.	d.	e. Very Satisfied	g. Don't Know
1	2	3	4	5	



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

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

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

[IF Q26 = a OR b, CONTINUE. OTHERWISE SKIP TO Q28]

27. What change(s) to the **ConnectedSolutions** program would encourage you to continue participating?
[OPEN-END, OPTIONAL]

[IF Q26 = C-F, CONTINUE. OTHERWISE SKIP TO Q29]

28. What recommendations would you make to help improve the **ConnectedSolutions** program going forward? [OPEN-END, OPTIONAL]

29. In future summers, on a scale of 1-5, where 1 is "Very Unlikely" and 5 is "Very Likely," how likely would you be to participate in the **ConnectedSolutions** program if you are not provided advance notice of Peak Energy Events before they occur?

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

30. We'd like to understand how you typically used your Wi-Fi thermostat throughout the past summer. Which of the following most accurately characterizes how you typically used your Wi-Fi thermostat?

- a. Adjusted my Wi-Fi thermostat setting as needed
- b. Set a temperature schedule
- c. Did not set my Wi-Fi thermostat
- d. Don't know

31. Over the past summer, how did you typically monitor the temperature of your home or adjust the setting of your Wi-Fi thermostat? (select all that apply)

- a. On the Wi-Fi thermostat itself
- b. WeatherBug Home app
- c. **ConnectedSolutions** website
- d. WeatherBug Home website
- e. App provided by Wi-Fi thermostat manufacturer
- f. Other _____
- g. Don't know



2016 Residential Wi-Fi Thermostat DR Evaluation Final
Report

32. Now we'd like to understand the frequency with which you adjusted your Wi-Fi thermostat's setting or schedule during 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 _____
 - h. Don't know

[IF Q32 = f, SKIP]

33. We'd also like to understand whether the frequency with which you adjusted your Wi-Fi thermostat's setting or schedule was different on Peak Energy Event days compared to other days. Would you say you adjusted your home's temperature...
- a. More on Peak Energy Event days than on other days
 - b. Less on Peak Energy Event days than on other days
 - c. About the same amount regardless of whether it was a Peak Energy Event day or not
 - d. Don't know

[If Q9 = d, SKIP]

34. When you or a family member was at home for any part of a Peak Energy Event, what actions, if any, did you take to reduce your electricity use during the Peak Energy Event? (select all that apply)
- a. Discussed energy conservation strategies with my family
 - b. Pre-cooled my home during morning off-peak hours
 - c. Sought activities outside of the home
 - d. Avoided use of certain appliances or electricity intensive devices
 - e. None
 - f. Other (Please specify)
 - g. Don't know
35. In general, over the course of the summer, did the **ConnectedSolutions** program encourage you and/or your family members to be more aware of your household's energy use?
- a. Very Much
 - b. Somewhat
 - c. Not At All
 - d. Don't know



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

36. In general, over the course of the summer, did the **ConnectedSolutions** program encourage you and/or your family members to use less energy than you may have otherwise?
- Very Much
 - Somewhat
 - Not At All
 - Don't know

[IF Q9 = a, b, OR c, CONTINUE. ELSE SKIP TO Q38]

37. During the Peak Energy Events, how would you generally describe your comfort compared to typical afternoons with similar outdoor temperatures? Would you say it was...?
- Much more comfortable
 - Somewhat more comfortable
 - About the same
 - Somewhat less comfortable
 - Much less comfortable
 - Unsure/Don't know
 - I prefer not to answer

38. On Peak Energy Event days, did you ever "opt-out" or override your Wi-Fi thermostat setting to stop the program from adjusting your Wi-Fi thermostat remotely during the Peak Energy Event? (select all that apply)
- Yes, before the Peak Energy Event started
 - Yes, during the Peak Energy Event
 - No
 - Unsure/Don't know

[IF Q38 = a OR b, CONTINUE. ELSE SKIP Q40]

39. Why did you opt-out or override the Wi-Fi thermostat setting? (select all that apply)
- Did not want the home to get too warm/uncomfortable
 - Someone in the home needed the temperature cooler for health reasons
 - Someone in the home wanted the temperature cooler
 - Wanted the home cooler for a pet
 - Felt too uncomfortable during previous Peak Energy Events
 - Had guests/visitors over
 - Other (Please specify)
 - Don't know

40. On a scale of 1-5, where 1 is "Not influenced at all" and 5 is "Strongly influenced", how much would you say the program's \$25 participation incentive influenced you not to opt-out or override the Wi-Fi thermostat setting during Peak Energy Events?

a. Not influenced at all	b.	c.	d.	e. Strongly influenced	g. Don't Know
1	2	3	4	5	



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

41. Using a scale of 1 to 5, where 1 means "Not Well" and 5 means "Very Well", how well did your Wi-Fi thermostat work as needed during the Peak Energy Events (i.e. Wi-Fi connectivity, clearness of interface in indicating there is an event scheduled or in-progress, ability to successfully override events, etc.)?

a. Not Well	b.	c. Neutral	d.	e. Very Well	g. Don't Know
1	2	3	4	5	

[IF Q41 = a-b (1-2), CONTINUE ELSE SKIP TO Q43]

42. What issues did your Wi-Fi thermostat have during Peak Energy Events?

43. Do you have any additional comments on the performance of your Wi-Fi thermostat in general over the course of the summer? _____

You're almost done. We have a few final questions about yourself and your household.

44. Are you or is anyone in your household a National Grid employee?

- a. Yes
- b. No

45. What is your gender?

- a. Yes
- b. No

46. Which one of these options best describes this residence?

- a. Single-family detached house
- b. Townhouse, duplex, or row house (shares common wall with neighboring unit from basement to roof)
- c. Apartment with 2-4 units (either rent or own)
- d. Apartment with 5 or more units (either rent or own)
- e. Mobile home or trailer
- f. Other (Please Specify)
- g. Don't know
- h. I prefer not to answer



2016 Residential Wi-Fi Thermostat DR Evaluation Final
Report

47. How many square feet of living space are there in this residence, including bathrooms, foyers, and hallways? Please exclude unheated rooms and garages. If you live in an apartment building, please answer for the living space considered "your home."

- a. Less than 1,000
- b. 1,001 – 1,500
- c. 1,501 – 2,000
- d. 2,001 – 2,500
- e. 2,501 – 2,999
- f. 3,000 – 3,500
- g. 3,501 – 4,000
- h. Greater than 4,000
- i. Don't know
- j. I prefer not to answer

48. How many rooms are in this residence? Please exclude bathrooms, halls, pantries, unheated rooms, and garages

 [ENTER # OF ROOMS]

- a. Don't know
- b. I prefer not to answer

49. Approximately what year was this residence built?

- a. Before 1930
- b. 1930-1939
- c. 1940-1949
- d. 1950-1959
- e. 1960-1969
- f. 1970-1979
- g. 1980-1989
- h. 1990-1999
- i. 2000-2004
- j. 2005-2009
- k. 2010-present
- l. Unsure/Don't know
- m. I prefer not to answer

50. Please select the range that best describes this household's gross income for 2015 (before adjustments for taxes and credits). Please include all sources of income such as salaries, wages, rent, interest, dividends, pensions, and social security.

- a. Less than \$30,000
- b. \$30,000 to \$49,999
- c. \$50,000 to \$69,999
- d. \$70,000 to \$99,999
- e. \$100,000 to \$149,999
- f. \$150,000 to \$199,999
- g. \$200,000 to \$249,999
- h. \$250,000 to \$499,999
- i. \$500,000 or higher
- j. Don't know
- k. I prefer not to answer



2016 Residential Wi-Fi Thermostat DR Evaluation Final
Report

51. What is the highest level of education completed by the head of household in this residence?

- a. Elementary (Grades 1-8)
- b. Some high school (Grades 9-12)
- c. High School Graduate
- d. Some College/Trade/Vocational School
- e. College Graduate
- f. Postgraduate College
- g. Don't know
- h. I prefer not to answer

[IF Q40 = b, ASK. ELSE SKIP]

52. Thank you for taking the time to complete this survey. For completing the survey, you will receive a \$5 Amazon gift card. Please provide your current contact information so that we can mail you the gift card.

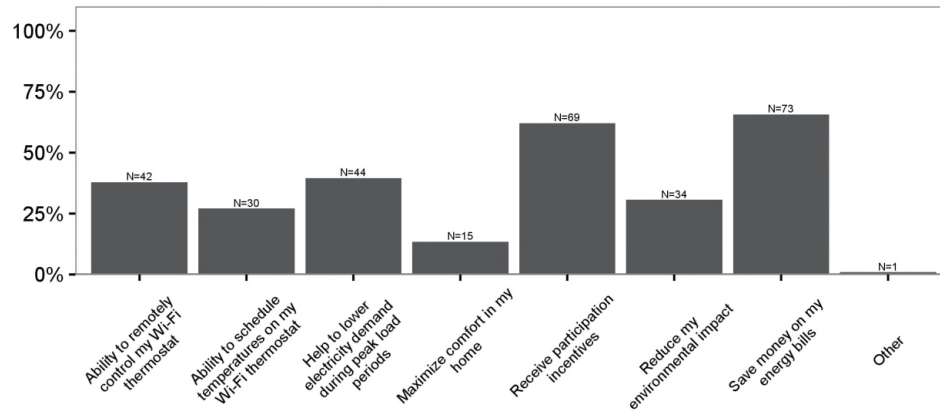
- a. Name (Please specify)
- b. Email address (Please specify)

[CLOSE]

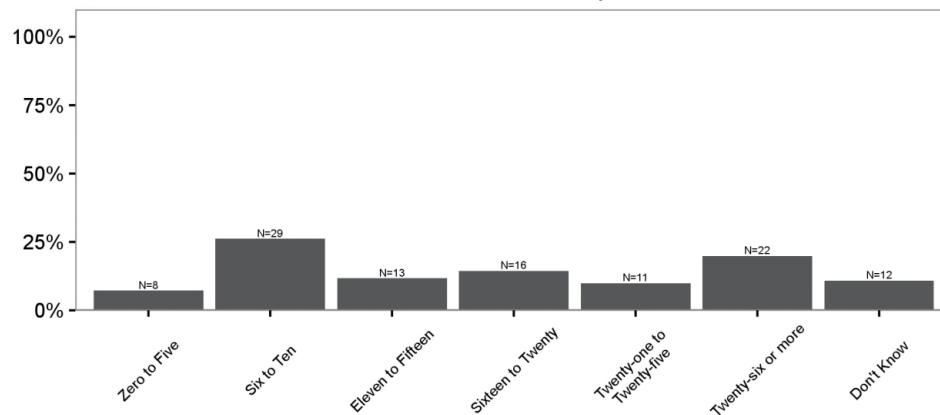


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

0. What are your main reasons for enrolling in the program? Select all that apply.



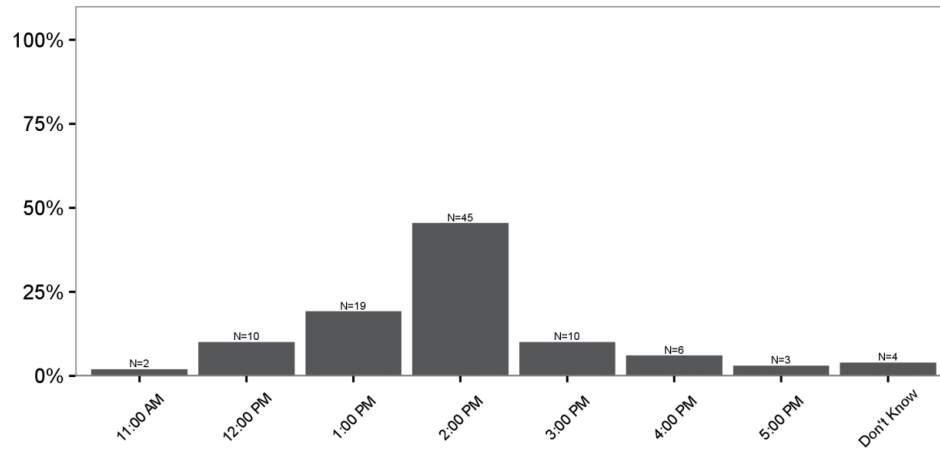
1. About how many events do you remember occurring between June 15 and September 30?



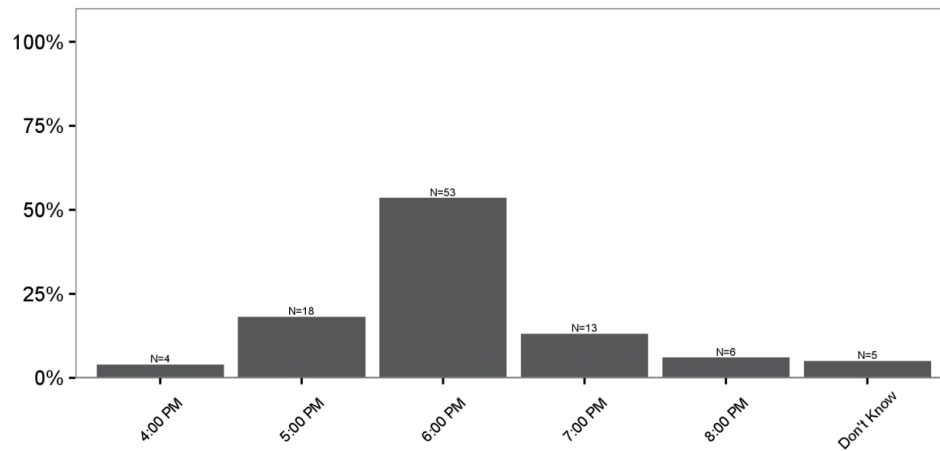


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

2. What time did events typically start?



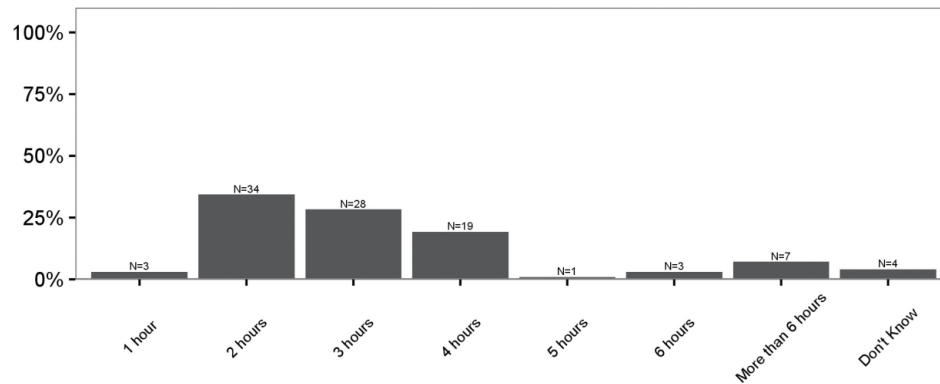
3. What time did events typically end?



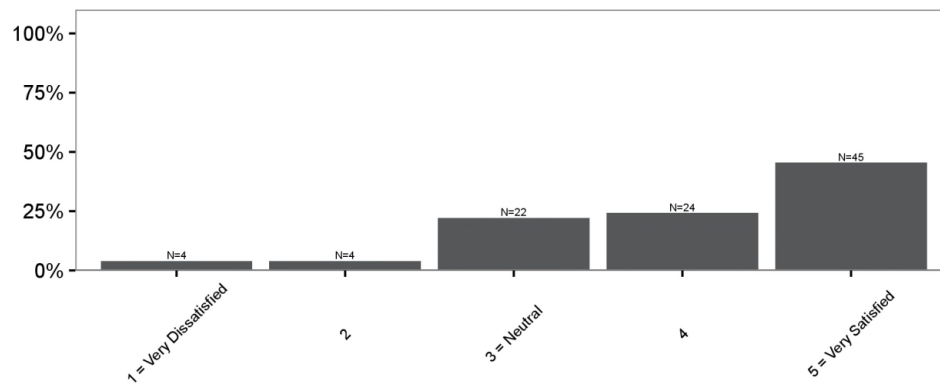


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

5. During this past summer, approximately how far in advance were you typically notified that an event was set to occur?



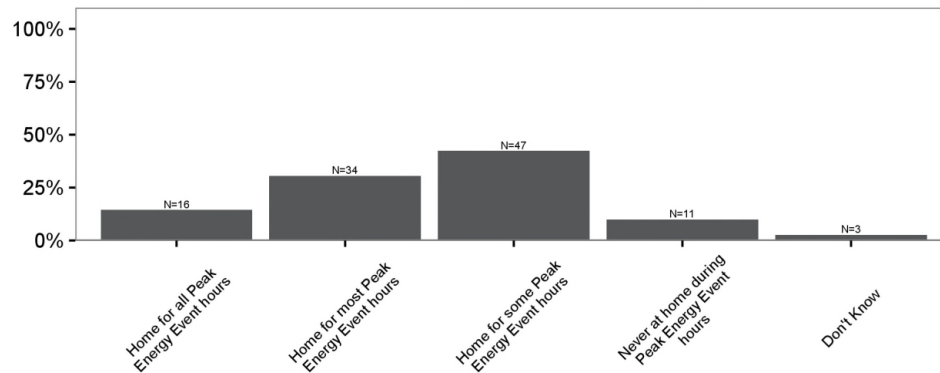
6. What is your level of satisfaction with the notification you receive about a Peak Energy Event that is set to occur?



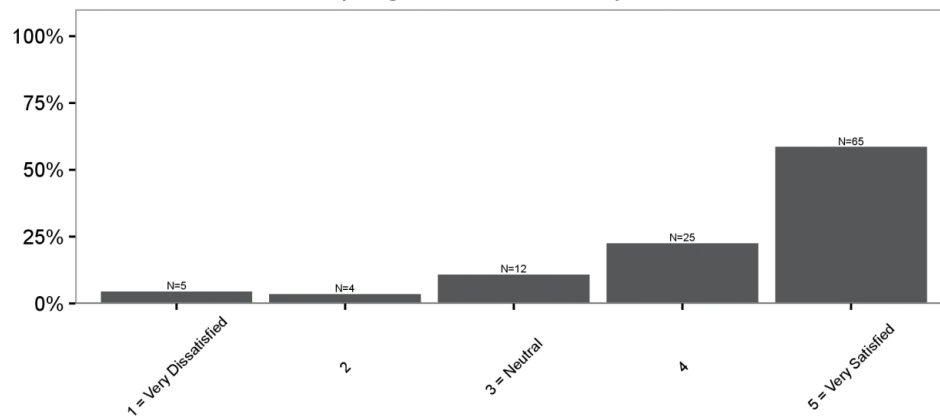


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

9. This summer, for the events you can recall, about how often were you or another family member home during the event hours?



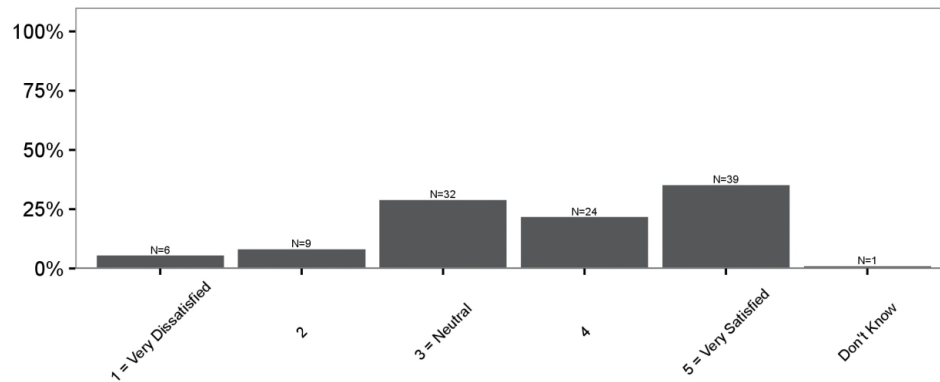
10.1. How would you rate your satisfaction with the program enrollment process?



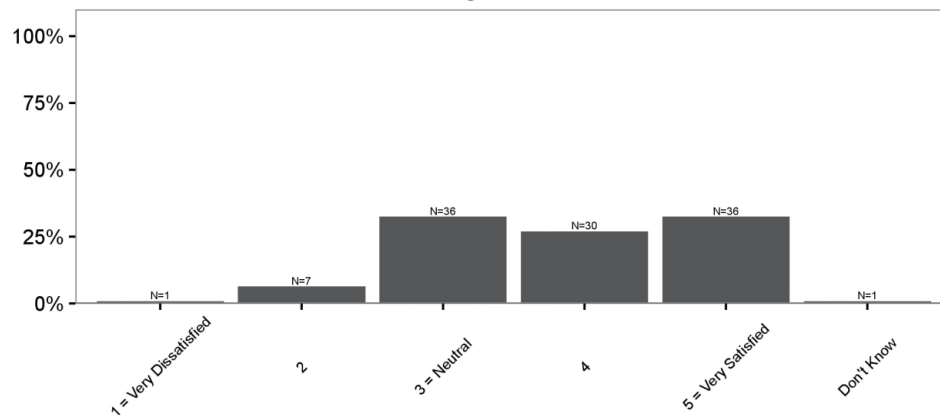


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

10.2. How would you rate your satisfaction with the number of events during the 2016 summer season?



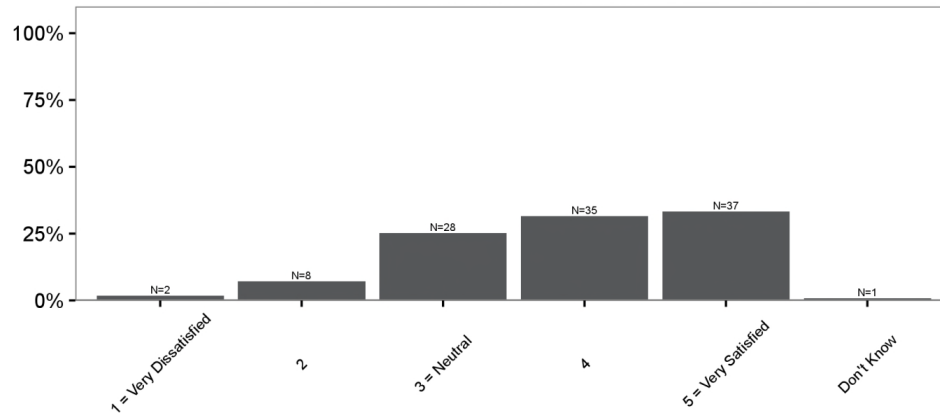
10.3. How would you rate your satisfaction with the length of events?



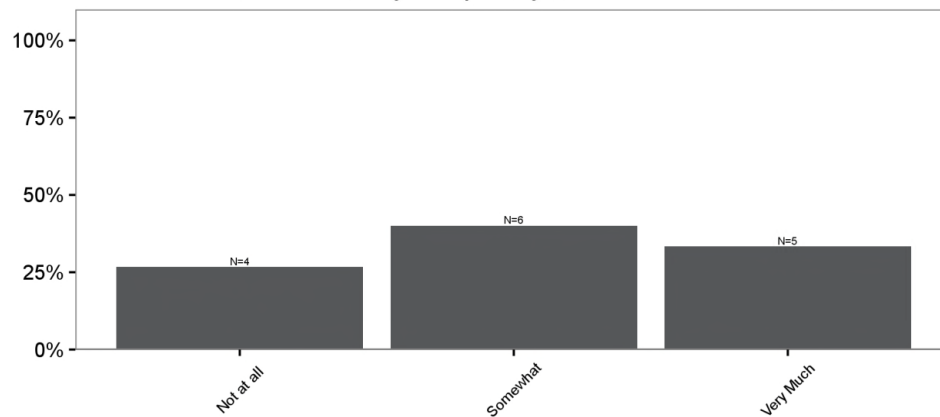


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

10.4. How would you rate your satisfaction with the timing of events?



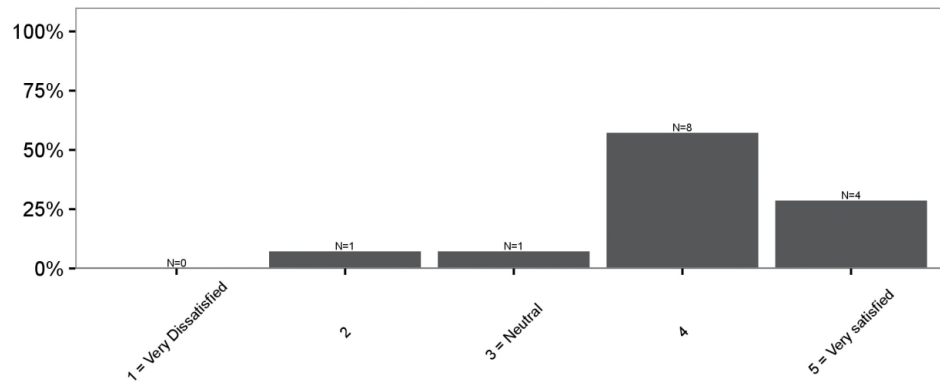
13. Did the number of events that occurred on consecutive days impact your satisfaction level?



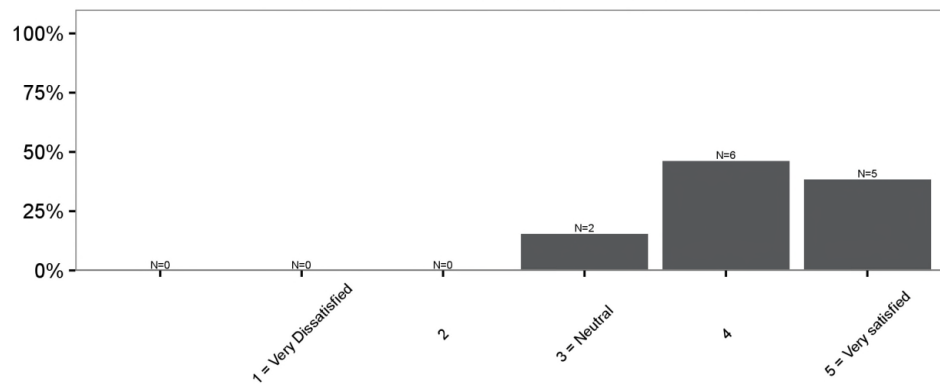


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

14. How satisfied would you have been with the number of events if there had been 5 fewer events over the course of the summer?



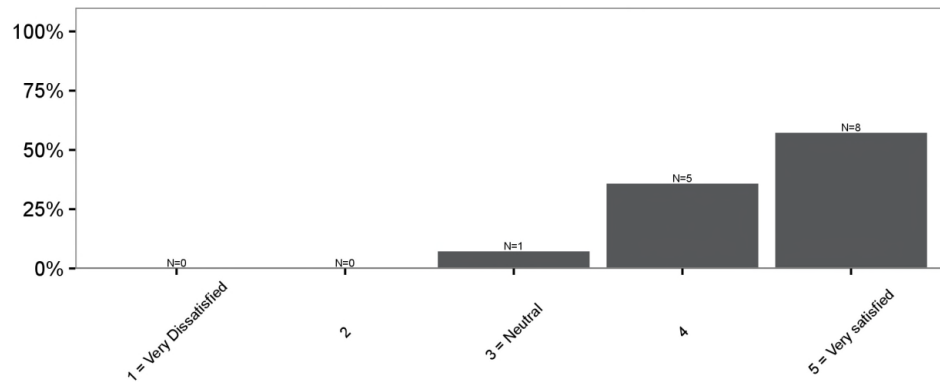
15. How satisfied would you have been with the number of events if there had been 10 fewer events over the course of the summer?



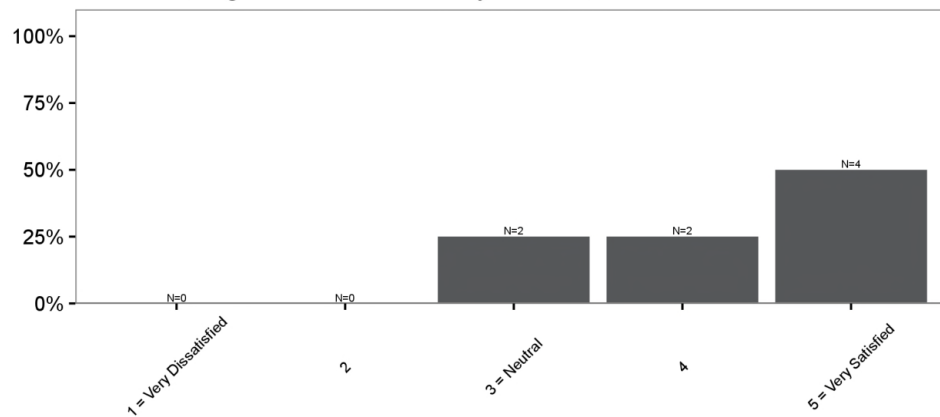


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

16. How satisfied would you have been with the number of events if there had been 15 fewer events over the course of the summer?



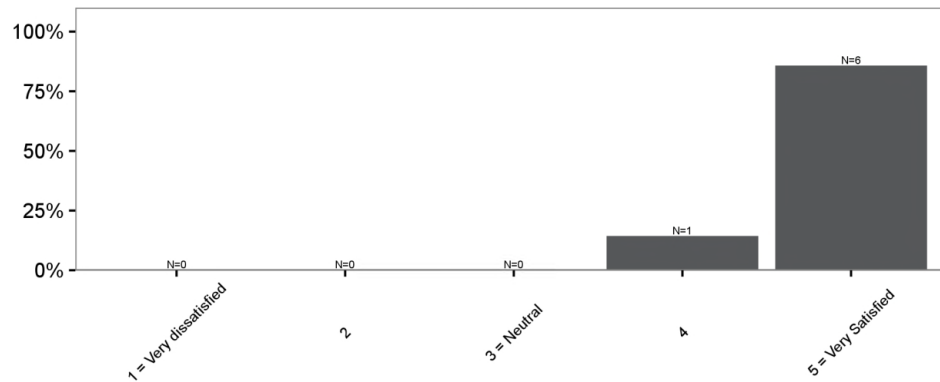
18. How satisfied would you have been with the length of events if they had been 1 hour shorter?



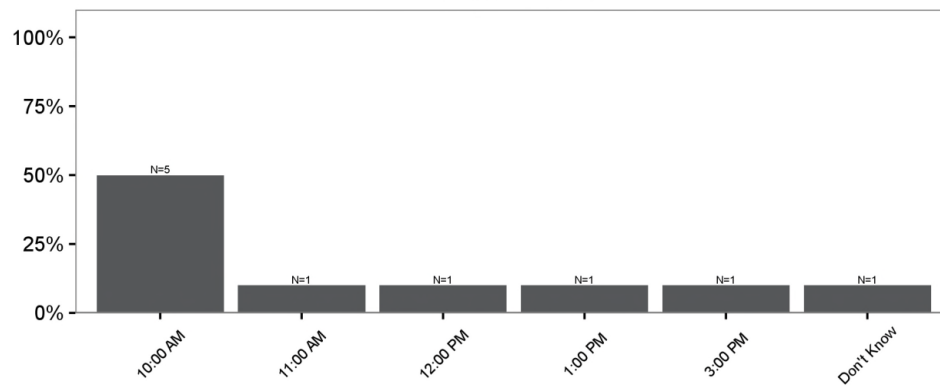


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

19. How satisfied would you have been with the length of events if they had been 2 hours shorter?



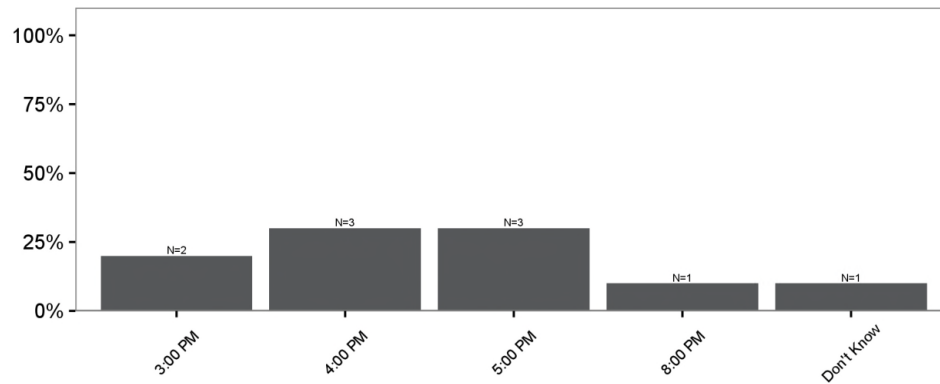
21. Based on your experience with the program this summer, what would the optimal start time be for an event?



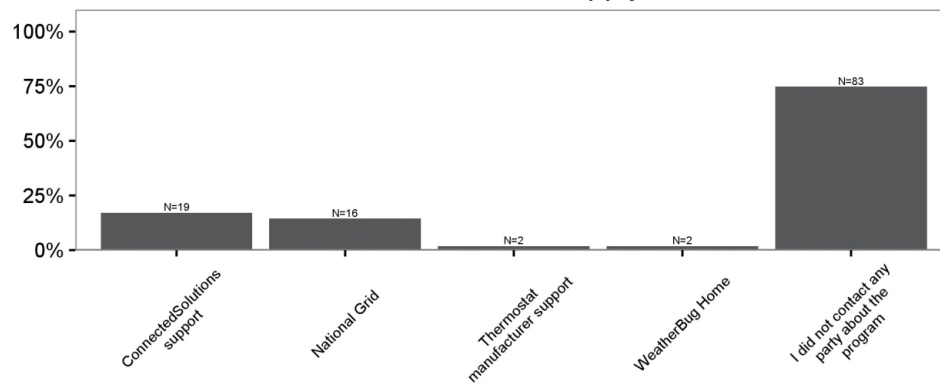


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

22. Based on your experience with the program this summer, what would the optimal end time be for an event?



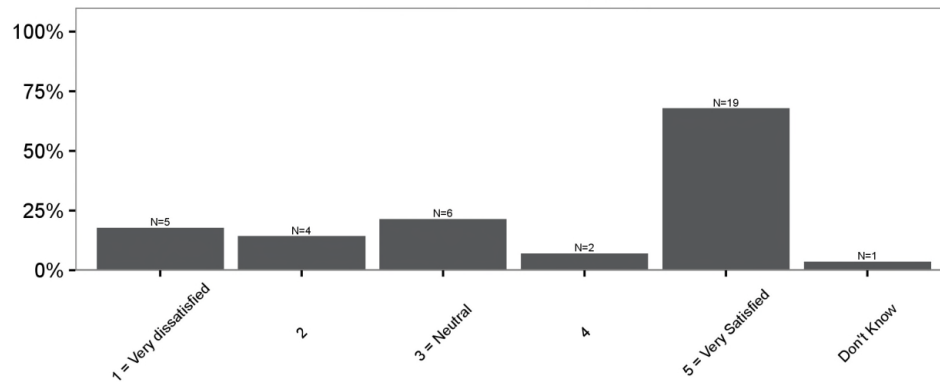
23. Did you contact support at any point over the course of the summer regarding the program? Select all that apply.



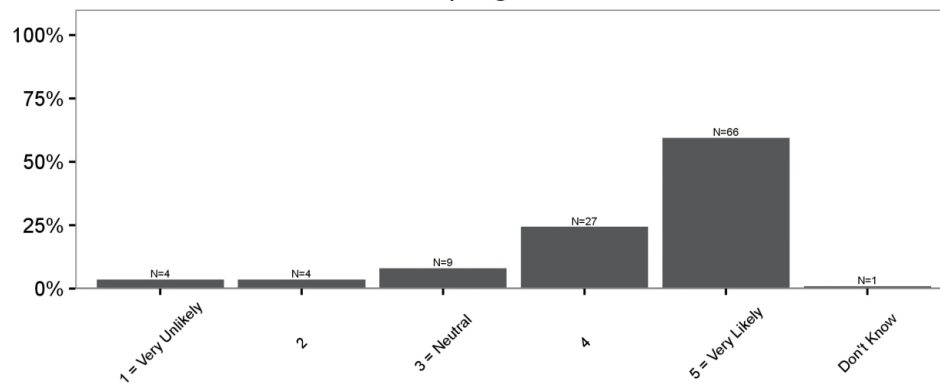


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

25. What is your level of satisfaction with the support you received when you contacted support?
Select all that apply.



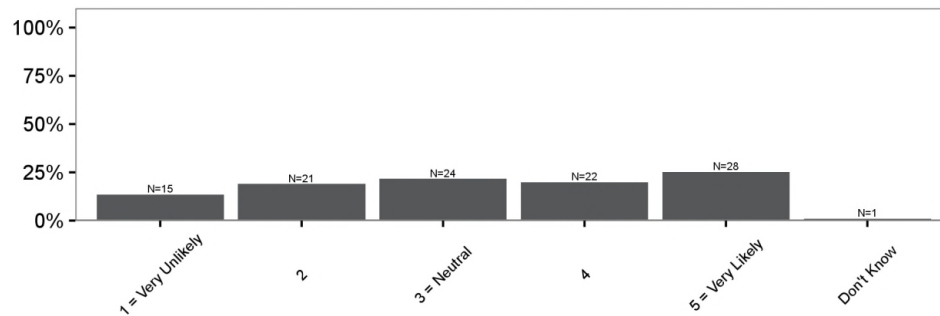
26. Based on your experience to date, in future summers, will you continue to participate in the program?



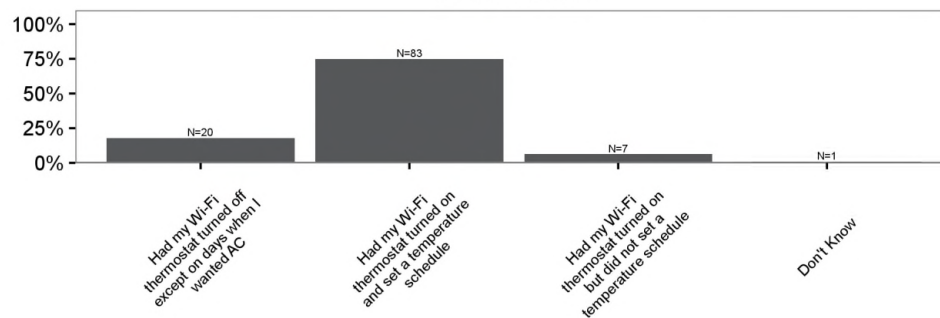


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

29. In future summers, on a scale of 1-5, where 1 is "Very Unlikely" and 5 is "Very Likely," how likely would you be to participate in the program if you are not provided advance notice of events before they occur?



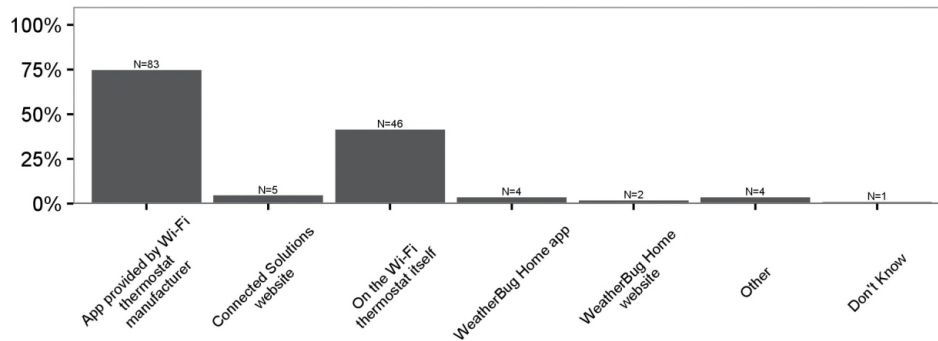
30. We'd like to understand how you typically used your Wi-Fi thermostat throughout the past summer. Which of the following most accurately characterizes how you typically used your Wi-Fi thermostat?



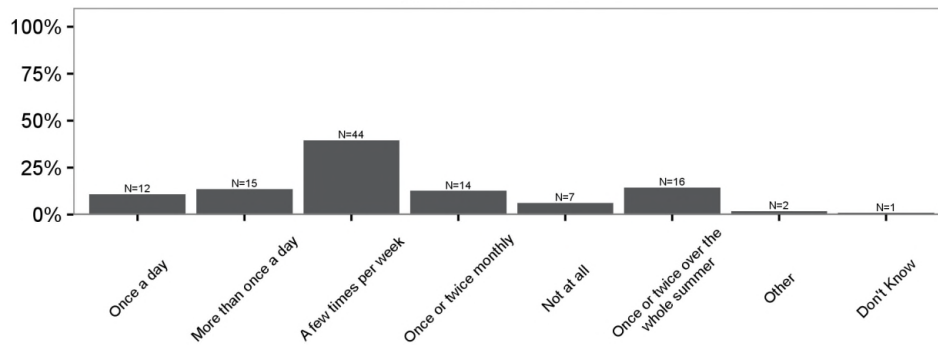


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

31. Over the past summer, how did you typically monitor the temperature of your home or adjust the setting of your Wi-Fi thermostat? Select all that apply.



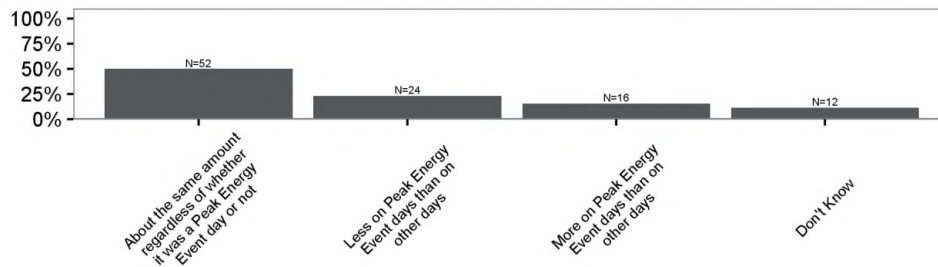
32. Now we'd like to understand the frequency with which you adjusted your Wi-Fi thermostat's setting or schedule during this summer. Would you say it was...



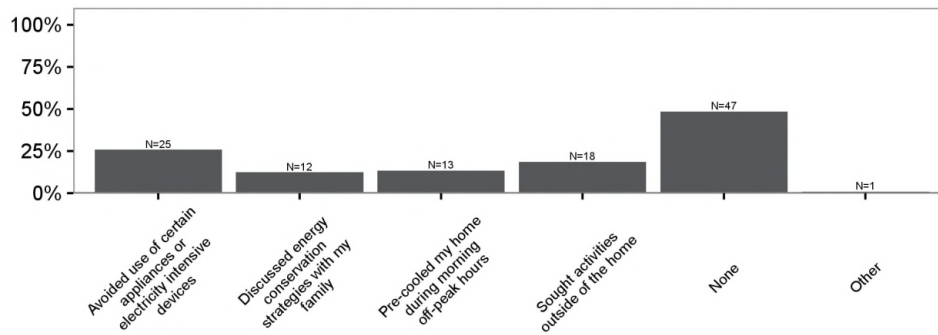


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

33. We'd also like to understand whether the frequency with which you adjusted your Wi-Fi thermostat's setting or schedule was different on Peak Energy Event days compared to other days. Would you say you adjusted your home's temperature...



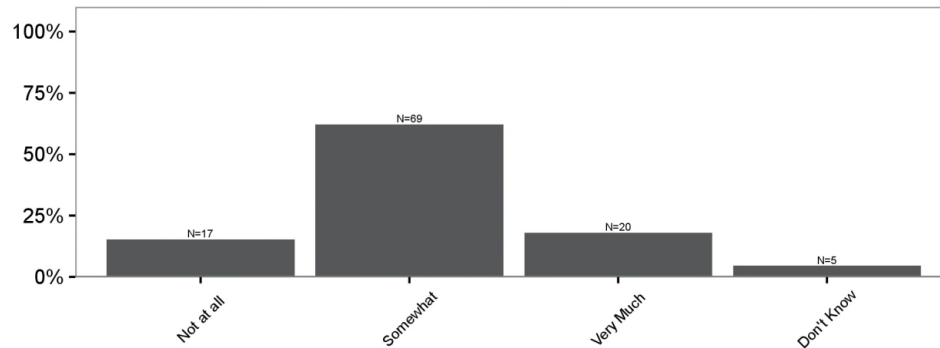
34. When you or your family member was at home for any part of an event, what actions, if any, did you take to reduce your electricity use during the event? Select all that apply.



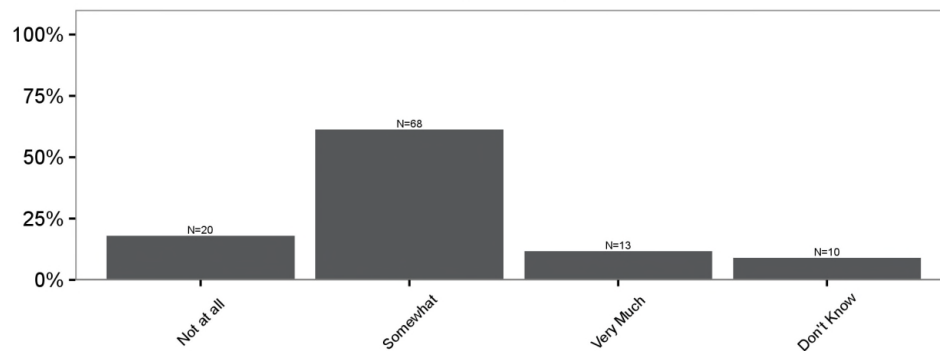


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

35. In general, over the course of the summer, did the program encourage you and/or your family members to be more aware of your household's energy use?



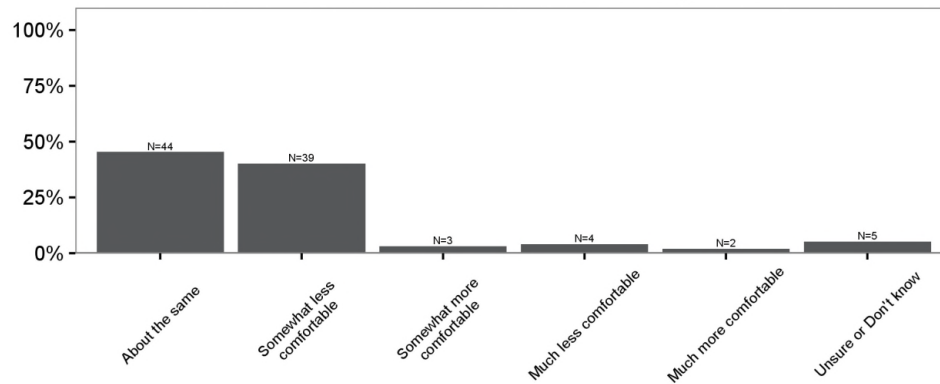
36. In general, over the course of the summer, did the program encourage you and/or your family members to use less energy than you may have otherwise?



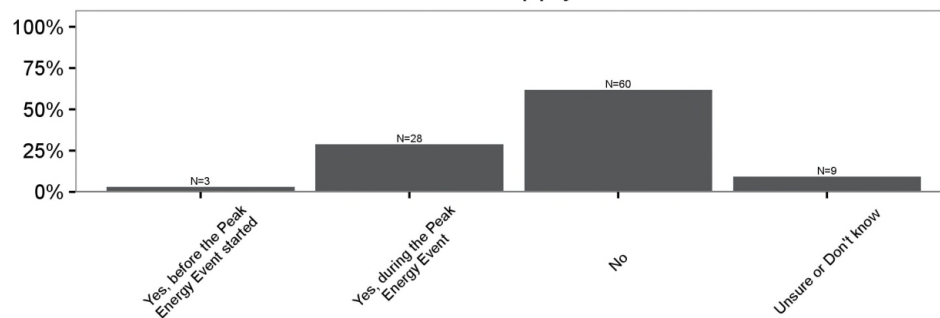


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

37. During the events, how would you generally describe your comfort compared to typical afternoons with similar outdoor temperatures?



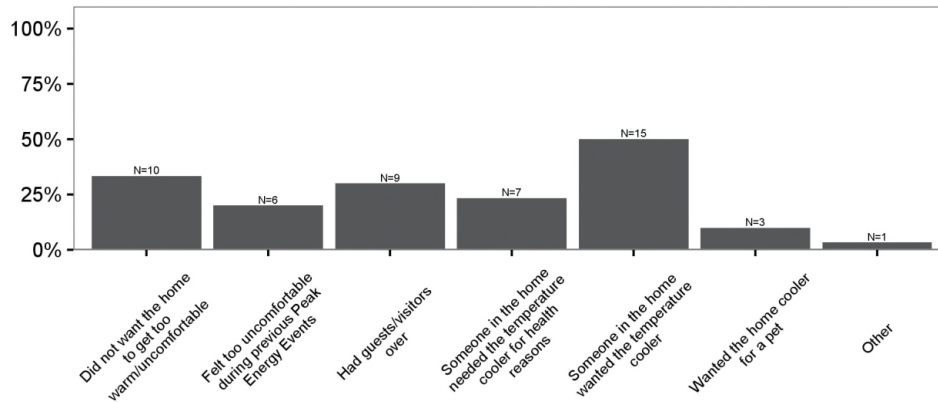
38. On event days, did you ever "opt-out" or override your Wi-Fi thermostat setting to stop the program from adjusting your Wi-Fi thermostat remotely during the Peak Energy Event? Select all that apply.



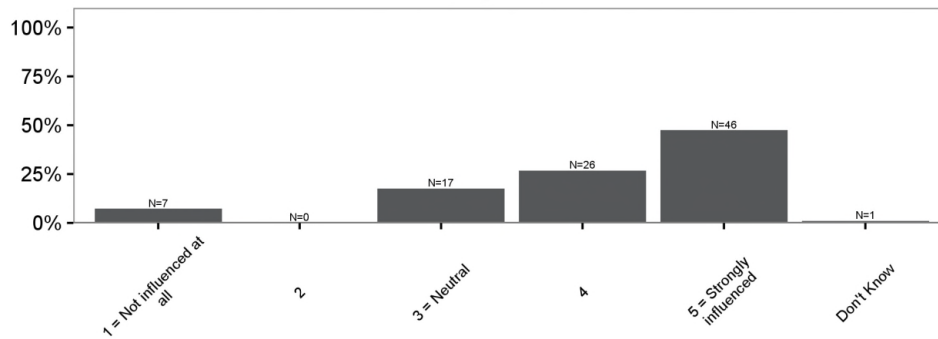


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

39. Why did you opt-out or override the Wi-Fi thermostat setting? Select all that apply.



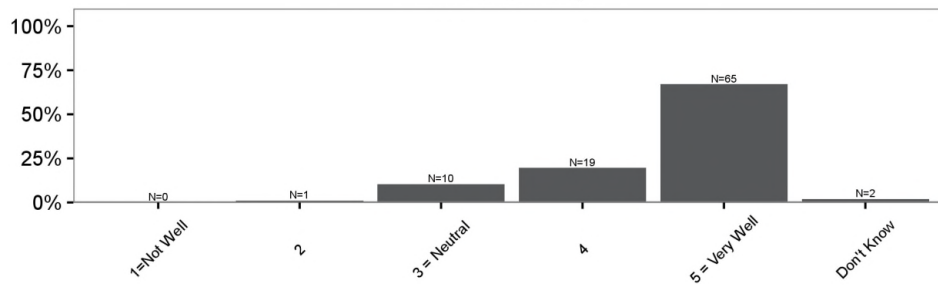
40. How much would you say the program's \$25 participation incentive influenced you not to opt-out or override the Wi-Fi thermostat setting during events?



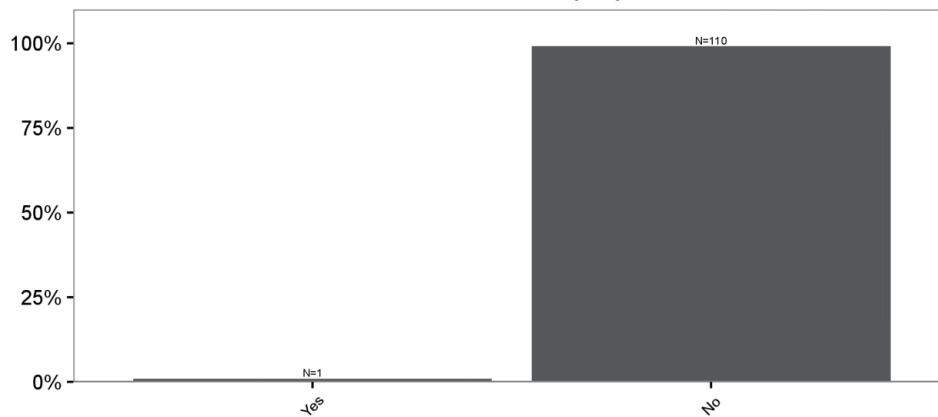


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

41. How well did your Wi-Fi thermostat work as needed during the Peak Energy Events (i.e. Wi-Fi connectivity, clearness of interface in indicating there is an event scheduled or in-progress, ability to successfully override events, etc.)?



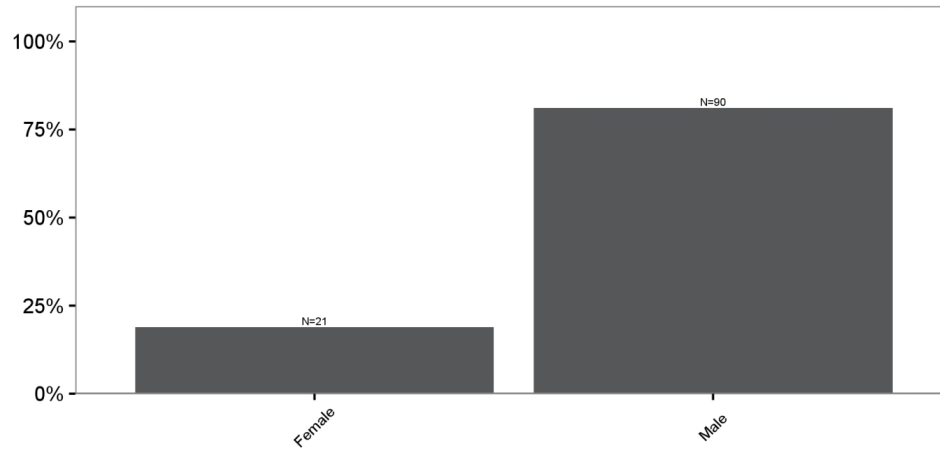
44. Are you or is anyone in your household a National Grid employee?



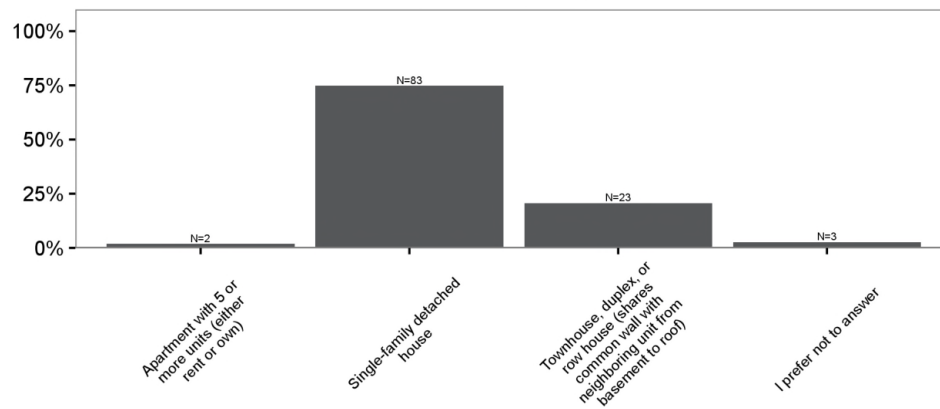


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

45. What is your gender?



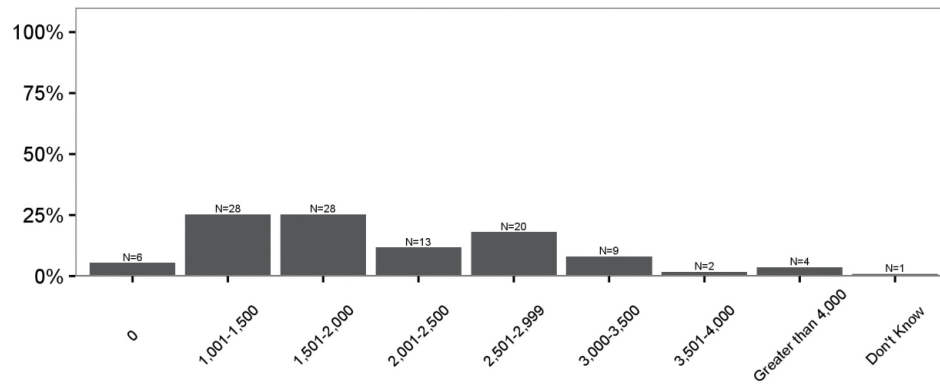
46. Which one of these options best describes this residence?



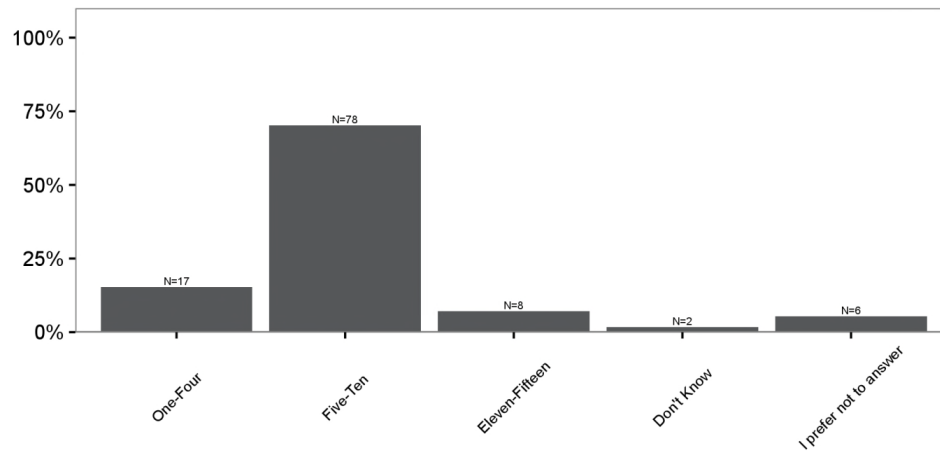


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

47. How many square feet of living space are there in this residence, including bathrooms, foyers, and hallways?



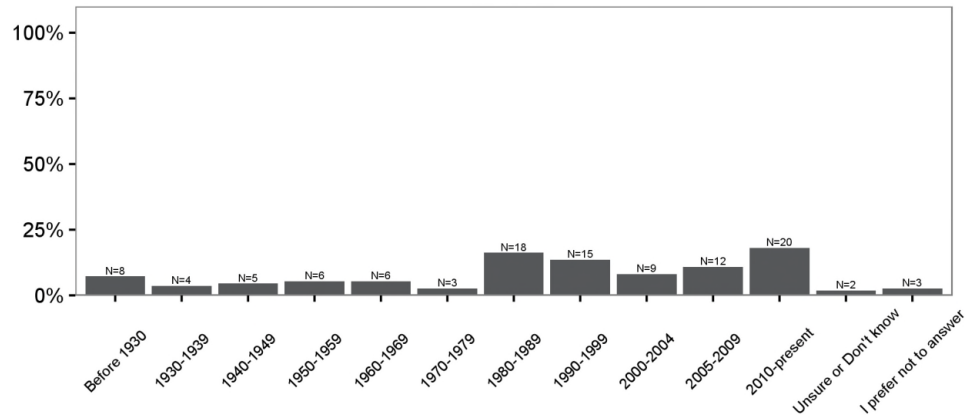
48. How many rooms are in this residence



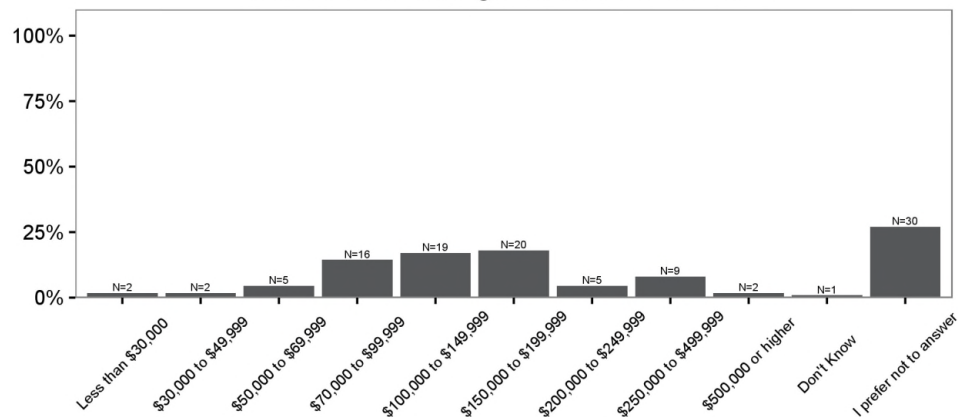


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

49. Approximately what year was this residence built?



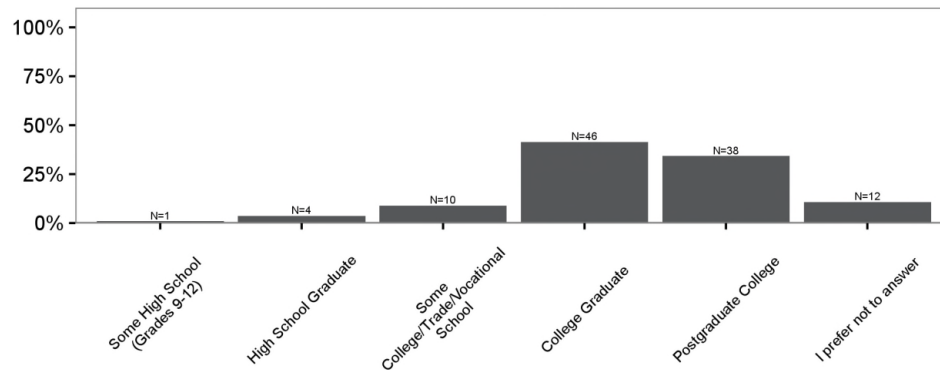
50. Please select the range that best describes this household's gross income for 2015





2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

51. What is the highest level of education completed by the head of household in this residence?





2016 Residential Wi-Fi Thermostat DR Evaluation Final
Report

APPENDIX J. RUSH HOUR REWARDS POST-SEASON SURVEY AND RESULTS

This section includes the survey instrument and responses to the multi-choice questions. The numbering of the results follows the question numbers from the ConnectedSolutions Post-Season Survey.

0. What are your main reasons for enrolling in Nest's Rush Hour Rewards program? (*select all that apply*)
- a. Receive participation incentives
 - b. Ability to remotely control my Nest thermostat
 - c. Ability to schedule temperatures on my Nest thermostat
 - d. Save money on my energy bills
 - e. Maximize comfort in my home
 - f. Reduce my environmental impact
 - g. Help to lower electricity demand during peak load periods
 - h. Other [\[OPEN-END\]](#)
1. About how many Rush Hour events do you remember occurring between June 15 and September 30? (Please make your best estimate).
- a. {ENTER NUMBER}
 - b. Don't know
2. What time did Rush Hour events typically start (i.e. when the temperature in your home increased)?
- a. 11 am
 - b. 12 pm
 - c. 1 pm
 - d. 2 pm
 - e. 3 pm
 - f. 4 pm
 - g. 5 pm
 - h. Other _____
 - i. Don't know
3. What time did Rush Hour events typically end?
- a. 2 pm
 - b. 3 pm
 - c. 4 pm
 - d. 5 pm
 - e. 6 pm
 - f. 7 pm
 - g. 8 pm
 - h. Other _____
 - i. Don't know



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

4. During this past summer, how did you typically become aware that a Rush Hour event was going to occur? **[OPEN-END, OPTIONAL]**
5. During this past summer, approximately how far in advance were you typically notified that a Rush Hour event was going to occur?
- Less than 1 hour
 - 1 hour
 - 2 hours
 - 3 hours
 - 4 hours
 - 5 hours
 - 6 hours
 - More than 6 hours
 - I have not been aware of any Rush Hour event notifications
 - Don't know

[IF Q5 <= i, CONTINUE. ELSE SKIP]

6. Using a scale of 1 to 5, where 1 means "Very Dissatisfied" and 5 means "Very Satisfied", what is your level of satisfaction with the notification you receive about a Rush Hour event that is set to occur?

a. Very Dissatisfied	b.	c. Neutral	d.	e. Very Satisfied	f. I have not been aware of any Rush Hour event notifications	g. Don't know
1	2	3	4	5		

[IF Q6 = a-b (1-2), CONTINUE. OTHERWISE SKIP]

7. What caused the Rush Hour event notification to be less than satisfying? **[OPEN-END, OPTIONAL]**

[IF Q6 = a-b (1-2), CONTINUE. OTHERWISE SKIP]

8. How could the Rush Hour event notification be improved (i.e. in terms of frequency, timing, method etc.)? **[OPEN-END, OPTIONAL]**
9. This summer, for the Rush Hour events you can recall, about how often were you or another family member home during Rush Hour event hours?
- Home for all Rush Hour event hours
 - Home for most Rush Hour event hours
 - Home for some Rush Hour event hours
 - Never at home during Rush Hour event hours
 - Don't know



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

10. 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 Rush Hour Rewards program?

	a. Very Dissatisfied	b.	c. Neutral	d.	e. Very Satisfied	f. Don't know
	1	2	3	4	5	
10a. Program enrollment process						
10b. Number of Rush Hour events during the 2016 summer season						
10c. Length of Rush Hour events						
10d. Timing of Rush Hour events (i.e. what period during the day events occurred)						

[IF Q10a = a-b (1-2), CONTINUE. ELSE SKIP TO Q13]

11. Please let us know why you were not fully satisfied with the program enrollment process.

[OPEN-END]

a. Don't know

[IF Q10a = a-b (1-2), CONTINUE. ELSE SKIP TO Q13]

12. Please let us know how the enrollment process can be improved.

[OPEN-END,

OPTIONAL]

a. Don't know

[IF Q10b = a-b (1-2), CONTINUE. ELSE SKIP TO Q16]

13. Did the number of Rush Hour events that occurred on consecutive days impact your satisfaction level?

- a. Very Much
- b. Somewhat
- c. Not At All

[IF Q10b = a-b (1-2), CONTINUE. ELSE SKIP TO Q16]

14. On a scale of 1 through 5, where 1 is "Very dissatisfied" and 5 is "Very satisfied", how satisfied would you have been with the number of Rush Hour events if there had been 5 fewer events over the course of the summer?

a. Very Dissatisfied	b.	c. Neutral	d.	e. Very Satisfied	g. Don't know
1	2	3	4	5	



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

[IF Q10b = a-b (1-2), CONTINUE. ELSE SKIP TO Q16]

15. On a scale of 1 through 5, where 1 is "Very dissatisfied" and 5 is "Very satisfied", how satisfied would you have been with the number of Rush Hour events if there had been 10 fewer events over the course of the summer?

a. Very Dissatisfied	b.	c. Neutral	d.	e. Very Satisfied	g. Don't know
1	2	3	4	5	

[IF Q10c = a-b (1-2), CONTINUE. ELSE SKIP TO Q19]

16. Please let us know why you are not fully satisfied with the length of the Rush Hour events.

[IF Q10c = a-b (1-2), CONTINUE. ELSE SKIP TO Q19]

17. On a scale of 1 through 5, where 1 is "Very dissatisfied" and 5 is "Very satisfied", how satisfied would you have been with the length of Rush Hour events if they had been 1 hour shorter?

a. Very Dissatisfied	b.	c. Neutral	d.	e. Very Satisfied	g. Don't know
1	2	3	4	5	

[IF Q10c = a-b (1-2), CONTINUE. ELSE SKIP TO Q19]

18. On a scale of 1 through 5, where 1 is "Very dissatisfied" and 5 is "Very satisfied", how satisfied would you have been with the length of Rush Hour events if they had been 2 hours shorter?

a. Very Dissatisfied	b.	c. Neutral	d.	e. Very Satisfied	g. Don't know
1	2	3	4	5	

[IF Q10d = a-b (1-2), CONTINUE. ELSE SKIP TO Q22]

19. Please let us know why you are not fully satisfied with the timing of some or all of the Rush Hour events (i.e. what period during the day events occurred).



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

[IF Q10d = a-b (1-2), CONTINUE. ELSE SKIP TO Q22]

20. Based on your experience with the program this summer, what would the optimal start time be for a Rush Hour event (i.e. for a temperature increase in your home)?

- a. 10 am
- b. 11 am
- c. 12 pm
- d. 1 pm
- e. 2 pm
- f. 3 pm
- g. 4 pm
- h. 5 pm
- i. Other _____
- j. I don't have a strong opinion
- k. Don't know

[IF Q10d = a-b (1-2), CONTINUE. ELSE SKIP TO Q22]

21. Based on your experience with the program this summer, what would the optimal end time be for a Rush Hour event?

- a. 2 pm
- b. 3 pm
- c. 4 pm
- d. 5 pm
- e. 6 pm
- f. 7 pm
- g. 8 pm
- h. Other _____
- i. I don't have a strong opinion
- j. Don't know

22. Did you contact Nest or National Grid support at any point over the course of the summer regarding the program? (select all that apply)

- a. Nest
- b. National Grid
- c. I did not contact any party about the program

[IF Q22 <> d, CONTINUE. OTHERWISE SKIP TO Q25]

23. Please describe your reason(s) for contacting **[INSERT Q22 ANSWER]**. _____

24. Using a scale of 1 to 5, where 1 means "Very Dissatisfied" and 5 means "Very Satisfied", what is your level of satisfaction with the support you received when you contacted **[INSERT Q22 ANSWER]**?

a. Very Dissatisfied	b.	c. Neutral	d.	e. Very Satisfied	f. Don't know
1	2	3	4	5	



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

25. Based on your experience to date, in future summers, on a scale of 1-5, where 1 is "Very Unlikely" and 5 is "Very Likely," how likely would you be to participate in the Rush Hour Rewards program?

a. Very Unlikely	b.	c. Neutral	d.	e. Very Likely	f. Don't know
1	2	3	4	5	

[IF Q25 = a OR b, CONTINUE. OTHERWISE SKIP TO Q27]

26. What change(s) to the Rush Hour Rewards program would encourage you to continue participating?
[OPEN-END, OPTIONAL]

[IF Q25 = C-F, CONTINUE. OTHERWISE SKIP TO Q28]

27. What recommendations would you make to help improve the Rush Hour Rewards program going forward? [OPEN-END, OPTIONAL]

28. In future summers, on a scale of 1-5, where 1 is "Very Unlikely" and 5 is "Very Likely," how likely would you be to participate in the Rush Hour Rewards program if you are not provided advance notice of Rush Hour events before they occur?

a. Very Unlikely	b.	c. Neutral	d.	e. Very Likely	g. Don't know
1	2	3	4	5	

29. We'd like to understand how you typically used your Nest thermostat throughout the past summer. Which of the following most accurately characterizes how you typically used your Nest thermostat?

- Adjusted my Nest thermostat setting as needed
- Set a temperature schedule
- Did not set my Nest thermostat
- Don't know

30. Over the past summer, how did you typically monitor the temperature of your home or adjust the setting of your Nest thermostat? (select all that apply)

- On the Nest thermostat itself
- Nest app
- Nest website
- Other_____
- Don't know



2016 Residential Wi-Fi Thermostat DR Evaluation Final
Report

31. Now we'd like to understand the frequency with which you adjusted your Nest thermostat's setting or schedule during 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 _____
 - h. Don't know

[IF Q31 = f, SKIP]

32. We'd also like to understand whether the frequency with which you adjusted your Nest thermostat's setting or schedule was different on Rush Hour event days compared to other days. Would you say you adjusted your home's temperature...
- a. More on Rush Hour event days than on other days
 - b. Less on Rush Hour event days than on other days
 - c. About the same amount regardless of whether it was a Rush Hour event day or not
 - d. Don't know

[If Q9 = d, SKIP]

33. When you or a family member was at home for any part of a Rush Hour event, what actions, if any, did you take to reduce your electricity use during the Rush Hour event? (select all that apply)
- a. Discussed energy conservation strategies with my family
 - b. Pre-cooled my home during morning off-peak hours
 - c. Sought activities outside of the home
 - d. Avoided use of certain appliances or electricity intensive devices
 - e. None
 - f. Other (Please specify)
 - g. Don't know
34. In general, over the course of the summer, did the Rush Hour Rewards program encourage you and/or your family members to be more aware of your household's energy use?
- a. Very Much
 - b. Somewhat
 - c. Not At All
 - d. Don't know
35. In general, over the course of the summer, did the Rush Hour Rewards program encourage you and/or your family members to use less energy than you may have otherwise?
- a. Very Much
 - b. Somewhat
 - c. Not At All
 - d. Don't know



2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

[IF Q9 = a, b, OR c, CONTINUE. ELSE SKIP TO Q34]

36. During the Rush Hour events, how would you generally describe your comfort compared to typical afternoons with similar outdoor temperatures? Would you say it was...?

- a. Much more comfortable
- b. Somewhat more comfortable
- c. About the same
- d. Somewhat less comfortable
- e. Much less comfortable
- f. Unsure/Don't know

37. On Rush Hour event days, did you ever override your Nest thermostat setting to stop the program from adjusting your Nest thermostat remotely during the Rush Hour event? (select all that apply)

- a. Yes, before the Rush Hour event started
- b. Yes, during the Rush Hour event
- c. No
- d. Unsure/Don't know

[IF Q37 = a OR b, CONTINUE. ELSE SKIP Q39]

38. Why did you override the Nest thermostat setting? (select all that apply)

- a. Did not want the home to get too warm/uncomfortable
- b. Someone in the home needed the temperature cooler for health reasons
- c. Someone in the home wanted the temperature cooler
- d. Wanted the home cooler for a pet
- e. Felt too uncomfortable during previous Rush Hour events
- f. Had guests/visitors over
- g. Other (Please specify)
- h. Don't know

39. Using a scale of 1 to 5, where 1 means "Not Well" and 5 means "Very Well", how well did your Nest thermostat work as needed during the Rush Hour events (i.e. Wi-Fi connectivity, clearness of interface in indicating there is an event scheduled or in-progress, ability to successfully override events, etc.)?

a. Not Well	b.	c. Neutral	d.	e. Very Well	g. Don't know
1	2	3	4	5	

[IF Q39 = a-b (1-2), CONTINUE ELSE SKIP TO Q41]

40. What issues did your Nest thermostat have during the Rush Hour events?

41. Do you have any additional comments on the performance of your Nest thermostat in general over the course of the summer?



2016 Residential Wi-Fi Thermostat DR Evaluation Final
Report

You're almost done. We have a few final questions about yourself and your household.

42. Are you or is anyone in your household a National Grid employee?
- a. Yes
 - b. No
 - c. Don't know
 - d. I prefer not to answer
43. What is your gender?
- a. Yes
 - b. No
44. Which one of these options best describes this residence?
- a. Single-family detached house
 - b. Townhouse, duplex, or row house (shares common wall with neighboring unit from basement to roof)
 - c. Apartment with 2-4 units (either rent or own)
 - d. Apartment with 5 or more units (either rent or own)
 - e. Mobile home or trailer
 - f. Other (Please Specify)
 - g. Don't know
 - h. I prefer not to answer
45. How many square feet of living space are there in this residence, including bathrooms, foyers, and hallways? Please exclude unheated rooms and garages. If you live in an apartment building, please answer for the living space considered "your home."
- a. Less than 1,000
 - b. 1,001 – 1,500
 - c. 1,501 – 2,000
 - d. 2,001 – 2,500
 - e. 2,501 – 2,999
 - f. 3,000 – 3,500
 - g. 3,501 – 4,000
 - h. Greater than 4,000
 - i. Don't know
 - j. I prefer not to answer
46. How many rooms are in this residence? Please exclude bathrooms, halls, pantries, unheated rooms, and garages
- _____ **[ENTER # OF ROOMS]**
- a. Don't know
 - b. I prefer not to answer



2016 Residential Wi-Fi Thermostat DR Evaluation Final
Report

47. Approximately what year was this residence built?

- a. Before 1930
- b. 1930-1939
- c. 1940-1949
- d. 1950-1959
- e. 1960-1969
- f. 1970-1979
- g. 1980-1989
- h. 1990-1999
- i. 2000-2004
- j. 2005-2009
- k. 2010-present
- l. Unsure/Don't know
- m. I prefer not to answer

48. Please select the range that best describes this household's gross income for 2015 (before adjustments for taxes and credits). Please include all sources of income such as salaries, wages, rent, interest, dividends, pensions, and social security.

- a. Less than \$30,000
- b. \$30,000 to \$49,999
- c. \$50,000 to \$69,999
- d. \$70,000 to \$99,999
- e. \$100,000 to \$149,999
- f. \$150,000 to \$199,999
- g. \$200,000 to \$249,999
- h. \$250,000 to \$499,999
- i. \$500,000 or higher
- j. Don't know
- k. I prefer not to answer

49. What is the highest level of education completed by the head of household in this residence?

- a. Elementary (Grades 1-8)
- b. Some High School (Grades 9-12)
- c. High School Graduate
- d. Some College/Trade/Vocational School
- e. College Graduate
- f. Postgraduate College
- g. Don't know
- h. I prefer not to answer

[IF Q42 = b, ASK. ELSE SKIP]

50. Thank you for taking the time to complete this survey. For completing the survey, you will receive a \$5 Amazon gift card. Please provide your current contact information so that we can mail you the gift card.

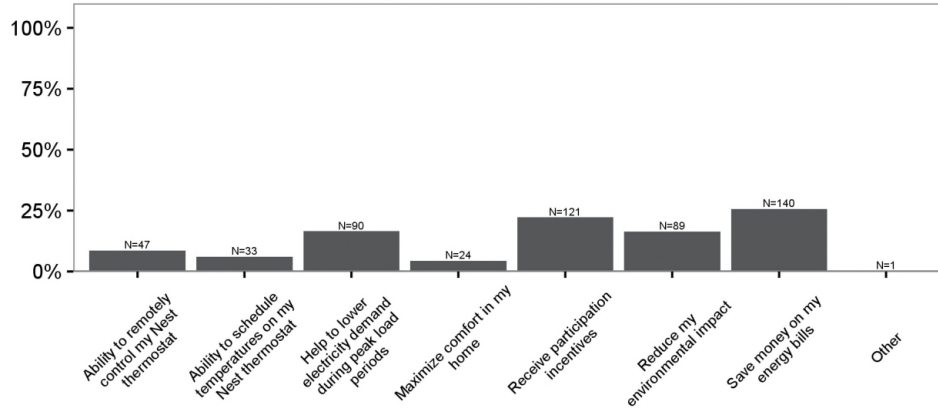
- a. Name (Please specify)
- b. Email address (Please specify)

[CLOSE]

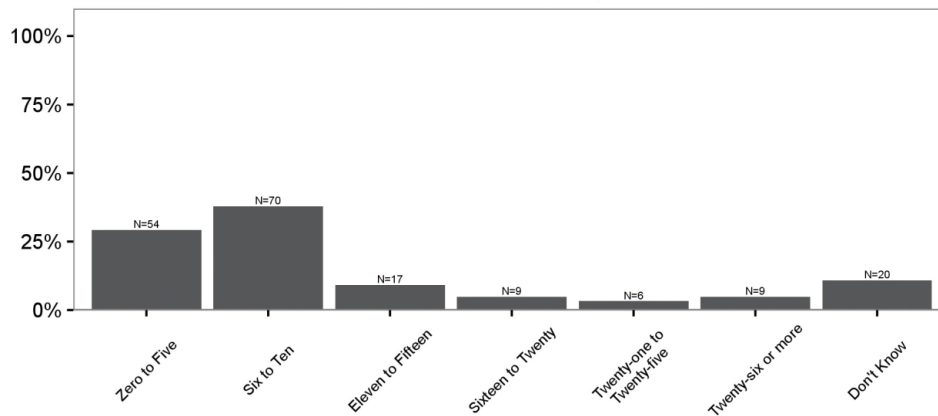


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0. What are your main reasons for enrolling in the program? Select all that apply.



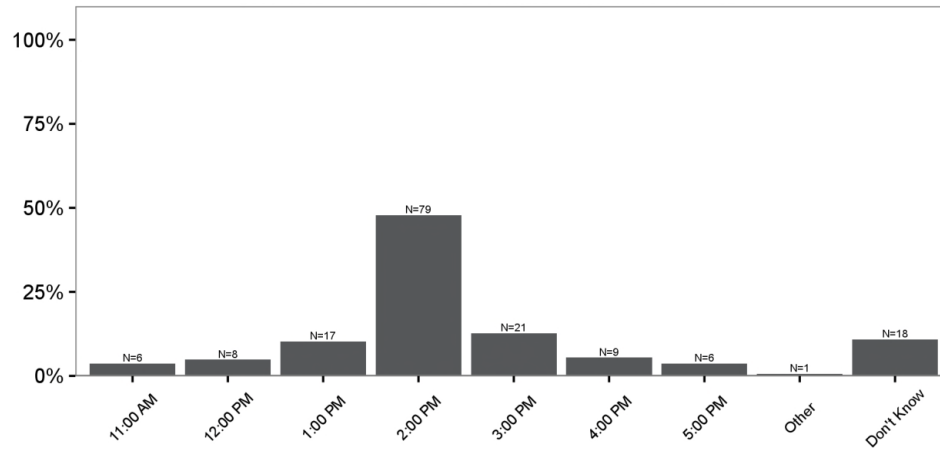
1. About how many events do you remember occurring between June 15 and September 30?



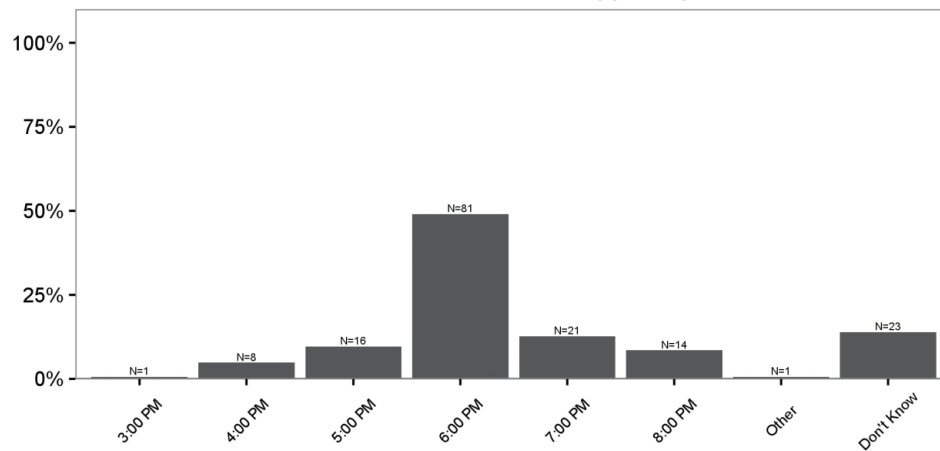


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2. What time did events typically start?



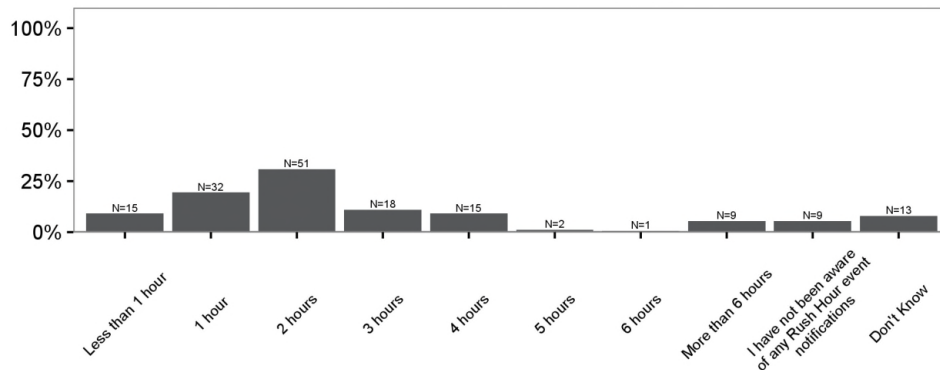
3. What time did events typically end?



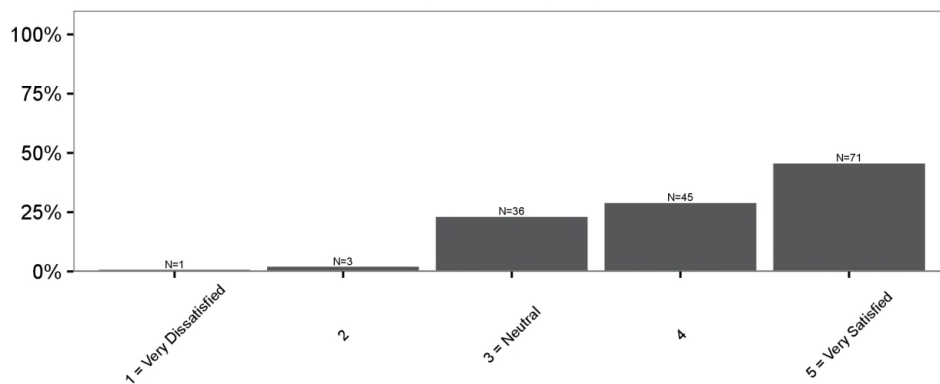


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5. During this past summer, approximately how far in advance were you typically notified that an event was set to occur?



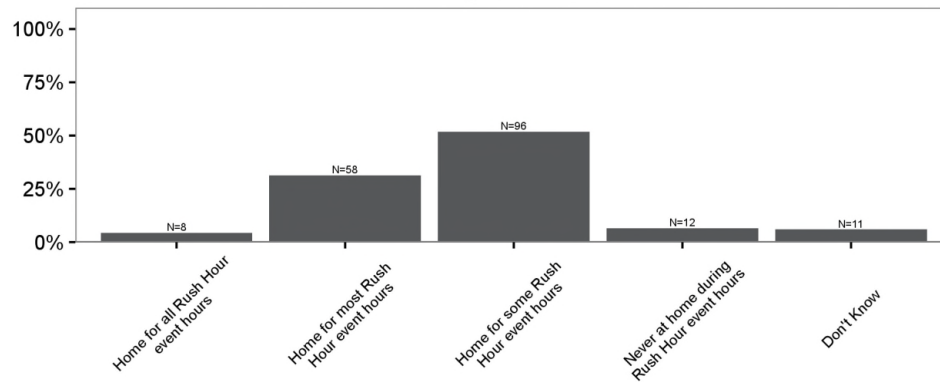
6. What is your level of satisfaction with the notification you receive about an event that is set to occur?



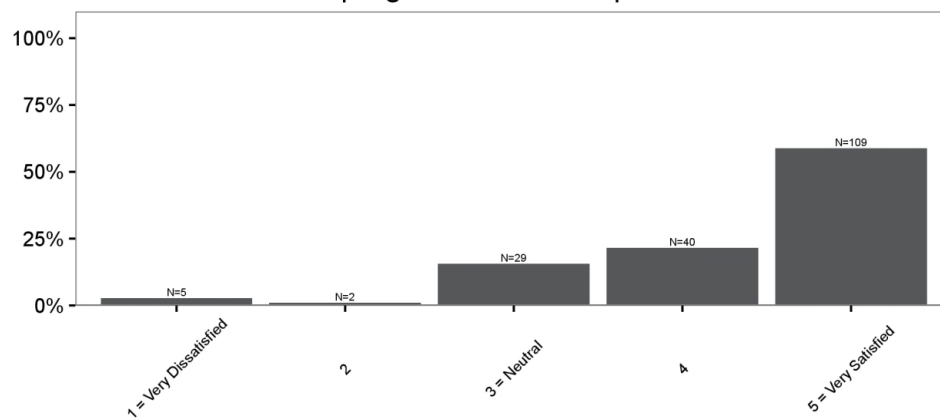


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

9. This summer, for the events you can recall, about how often were you or another family member home during the event hours?



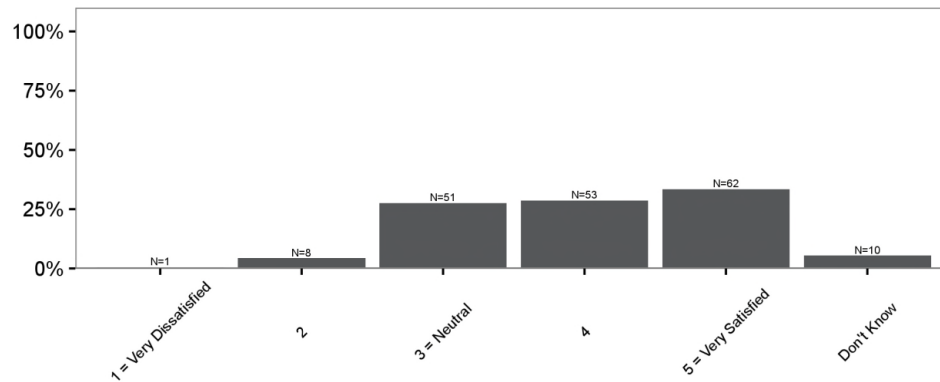
10.1. How would you rate your satisfaction with the program enrollment process?



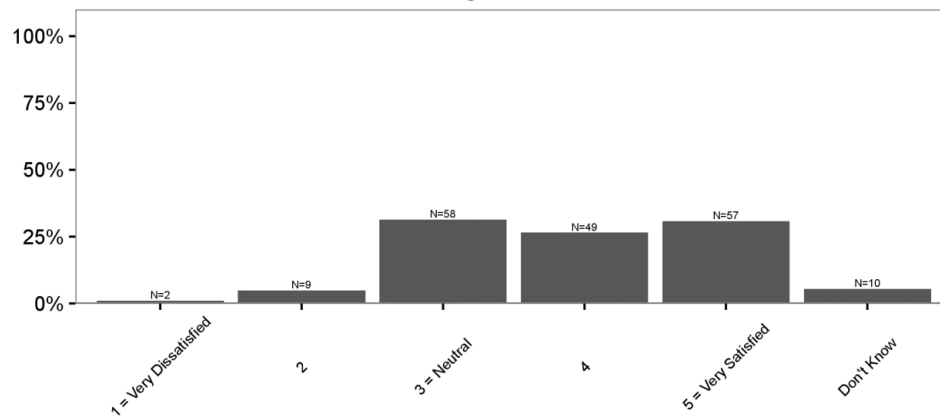


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10.2. How would you rate your satisfaction with the number of events during the 2016 summer season?



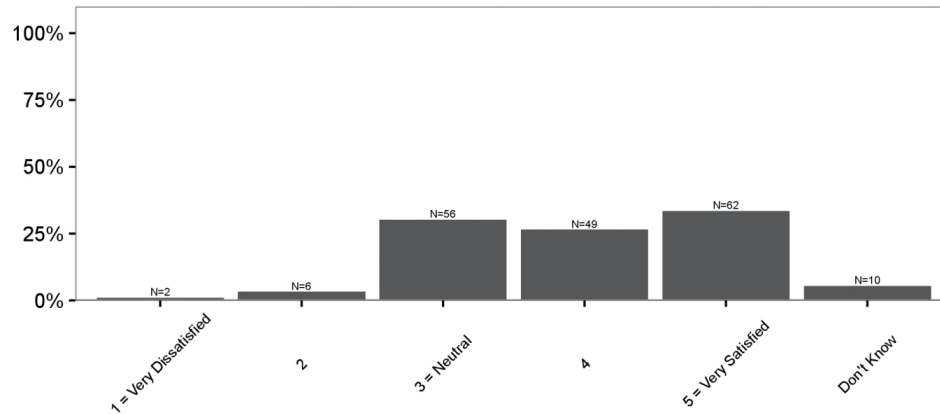
10.3. How would you rate your satisfaction with the length of events?



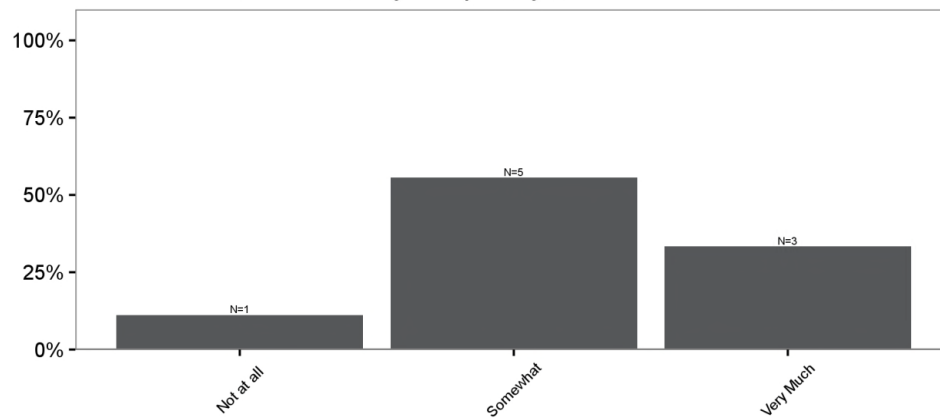


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

10.4. How would you rate your satisfaction with the timing of events?



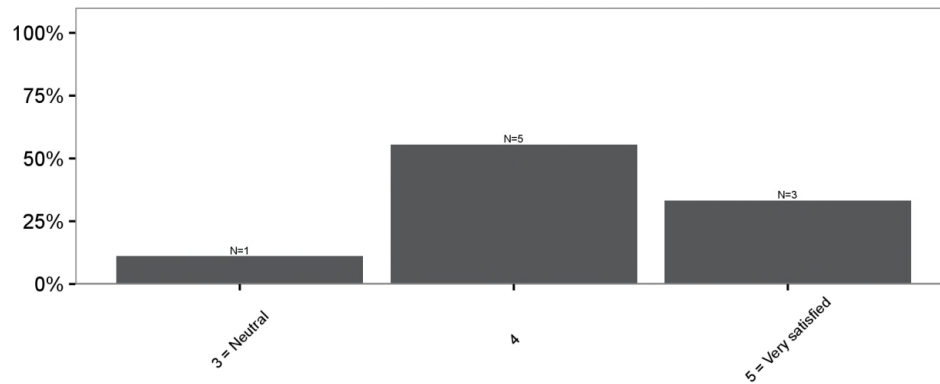
13. Did the number of events that occurred on consecutive days impact your satisfaction level?



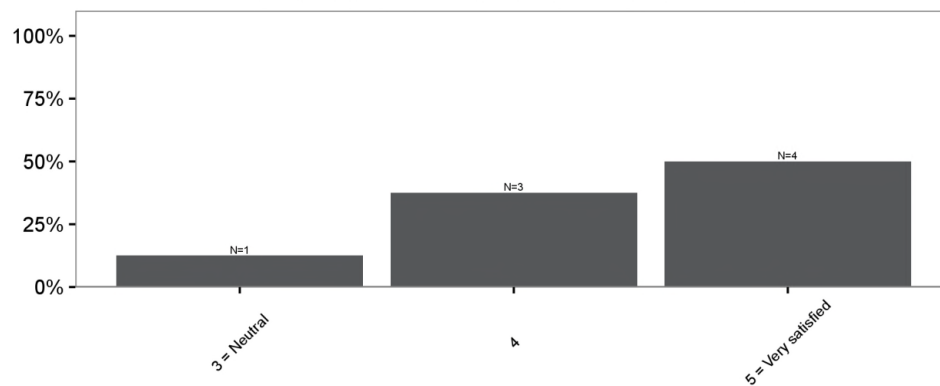


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

14. How satisfied would you have been with the number of events if there had been 5 fewer events over the course of the summer?



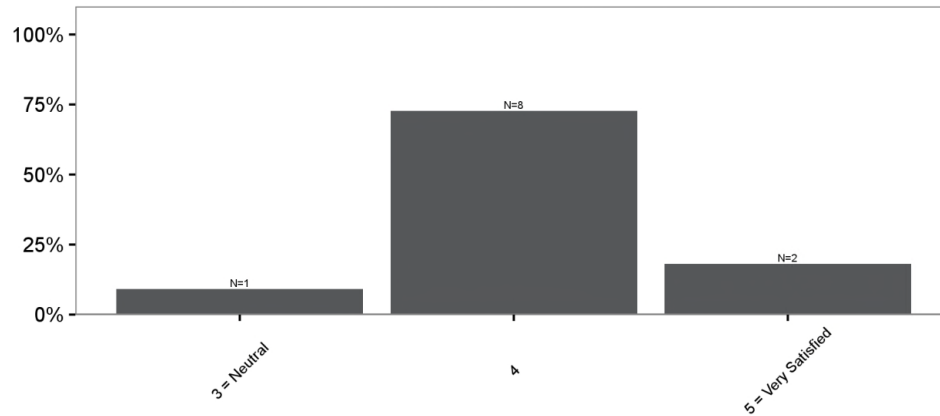
15. How satisfied would you have been with the number of events if there had been 10 fewer events over the course of the summer?



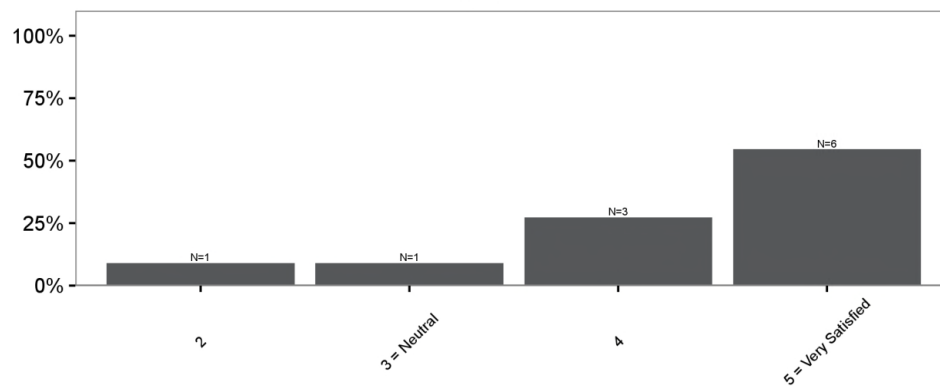


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

18. How satisfied would you have been with the length of events if they had been 1 hour shorter?



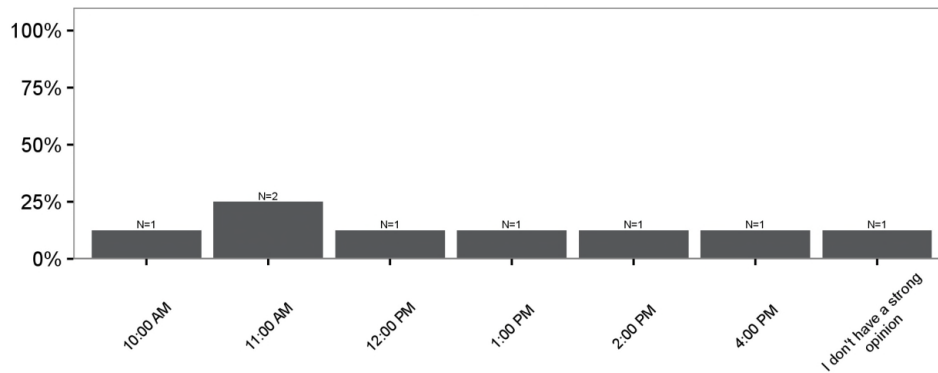
19. How satisfied would you have been with the length of events if they had been 2 hours shorter?



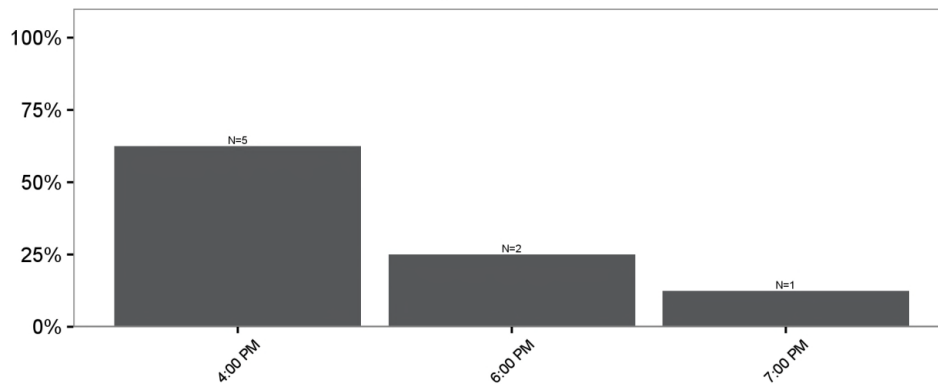


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

21. Based on your experience with the program this summer, what would the optimal start time be for an event?



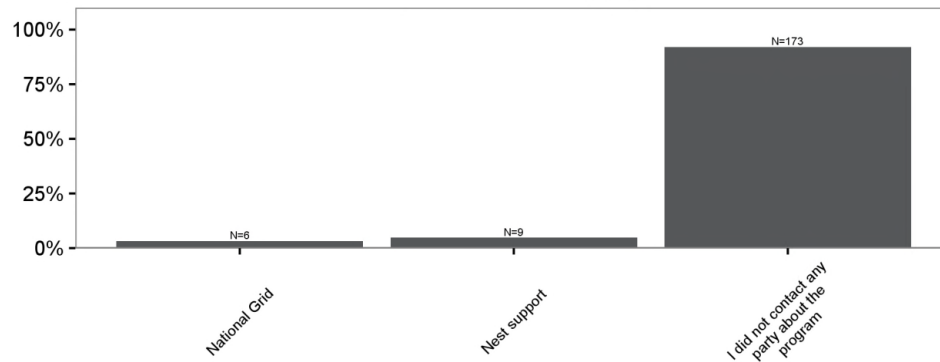
22. Based on your experience with the program this summer, what would the optimal end time be for an event?



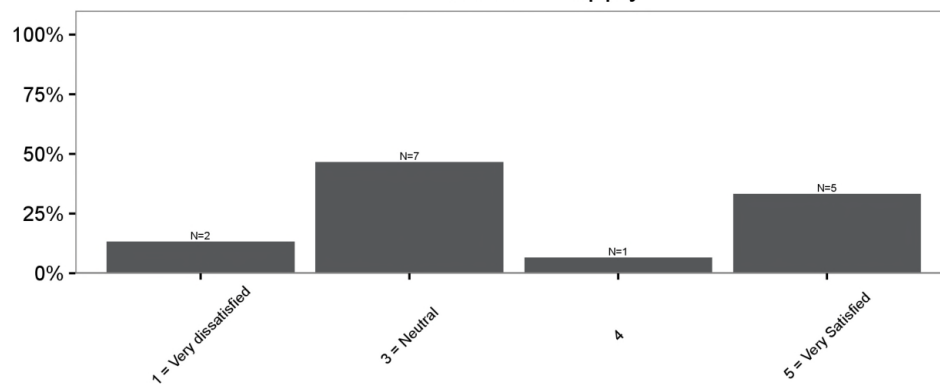


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

23. Did you contact support at any point over the course of the summer regarding the program?
Select all that apply.



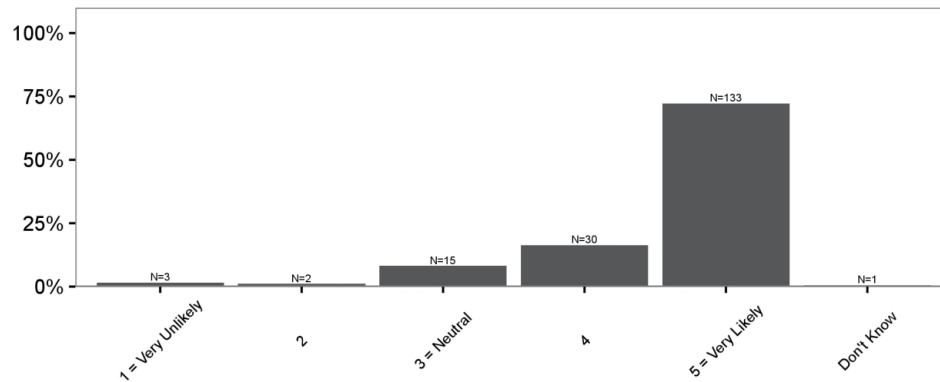
25. What is your level of satisfaction with the support you received when you contacted support?
Select all that apply.



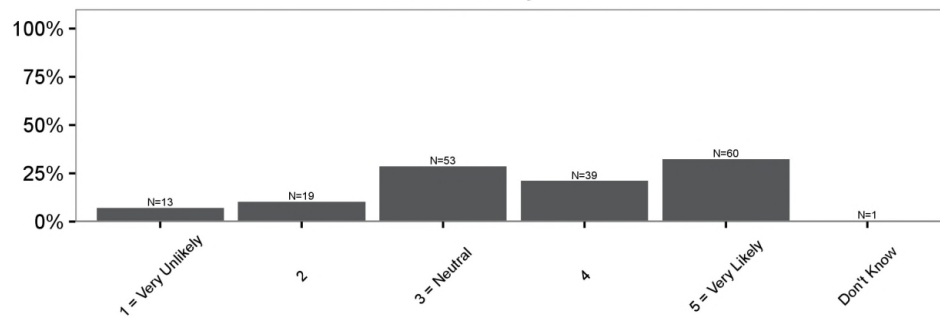


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

26. Based on your experience to date, in future summers, will you continue to participate in the program?



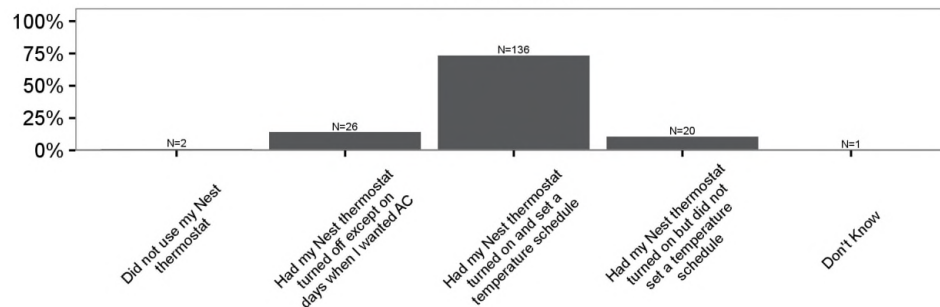
29. In future summers, on a scale of 1-5, where 1 is "Very Unlikely" and 5 is "Very Likely," how likely would you be to participate in the program if you are not provided advance notice of events before they occur?



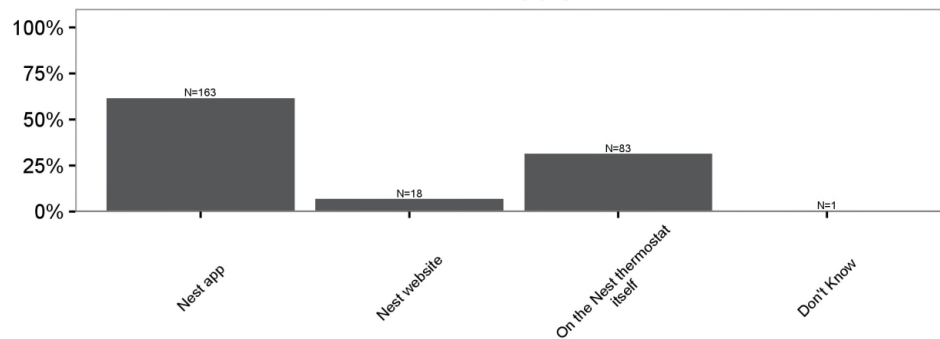


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

30. We'd like to understand how you typically used your Wi-Fi thermostat throughout the past summer. Which of the following most accurately characterizes how you typically used your Wi-Fi thermostat?



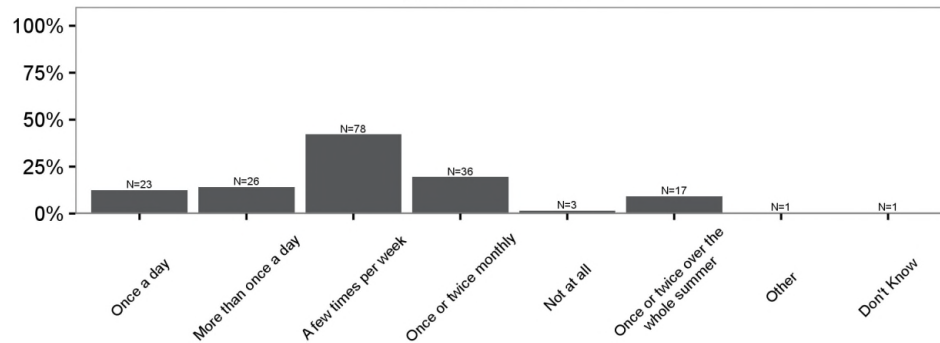
31. Over the past summer, how did you typically monitor the temperature of your home or adjust the setting of your Wi-Fi thermostat? Select all that apply.



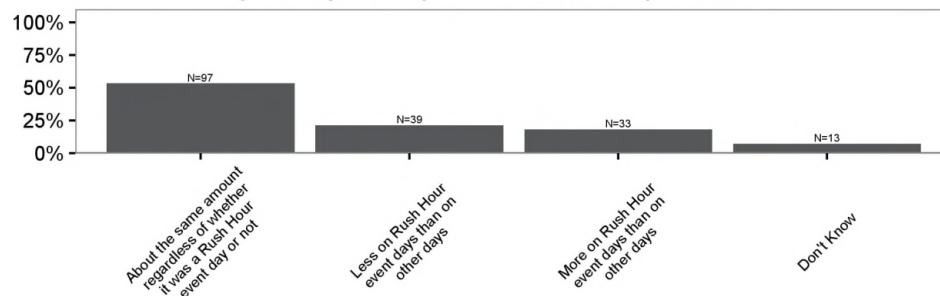


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32. Now we'd like to understand the frequency with which you adjusted your Wi-Fi thermostat's setting or schedule during this summer. Would you say it was...



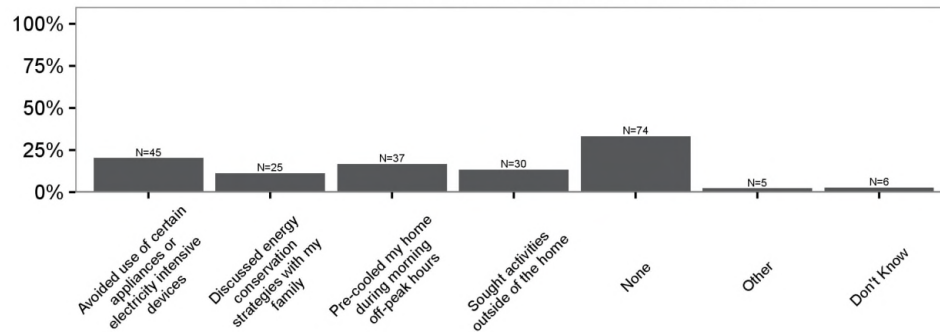
33. We'd also like to understand whether the frequency with which you adjusted your Wi-Fi thermostat's setting or schedule was different on event days compared to other days. Would you say you adjusted your home's temperature...



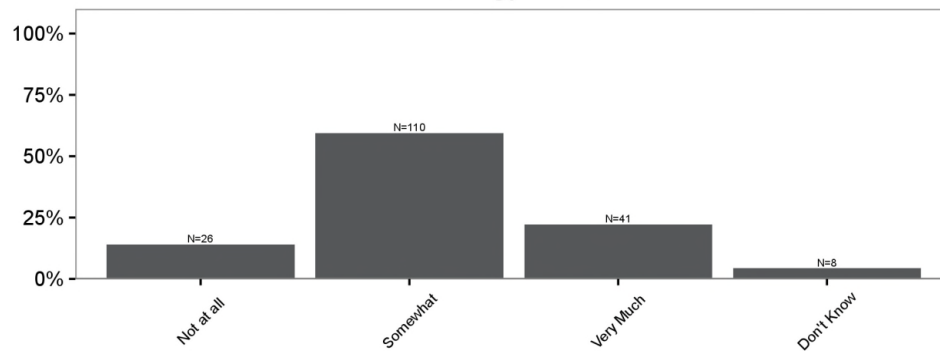


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

34. When you or your family member was at home for any part of an event, what actions, if any, did you take to reduce your electricity use during the event? Select all that apply.



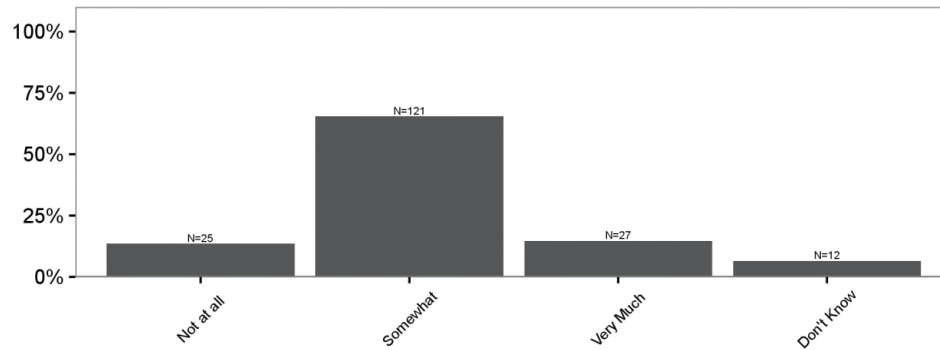
35. In general, over the course of the summer, did the program encourage you and/or your family members to be more aware of your household's energy use?



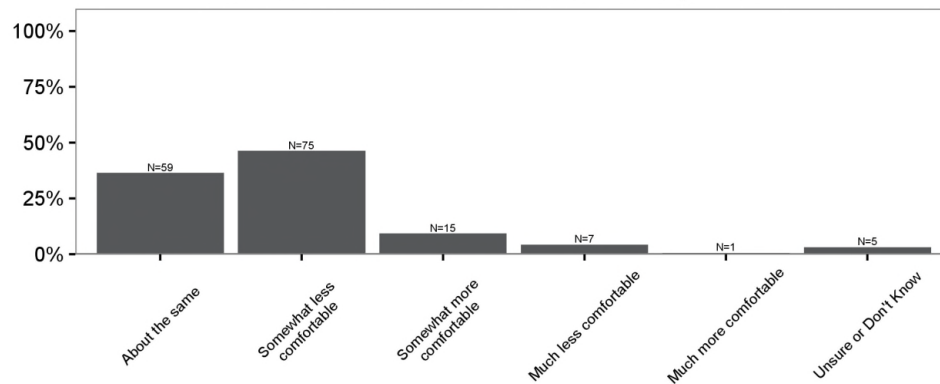


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

36. In general, over the course of the summer, did the program encourage you and/or your family members to use less energy than you may have otherwise?



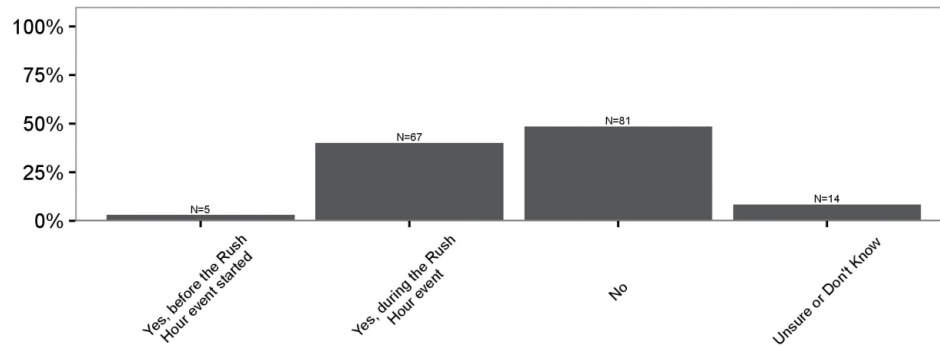
37. During the events, how would you generally describe your comfort compared to typical afternoons with similar outdoor temperatures?



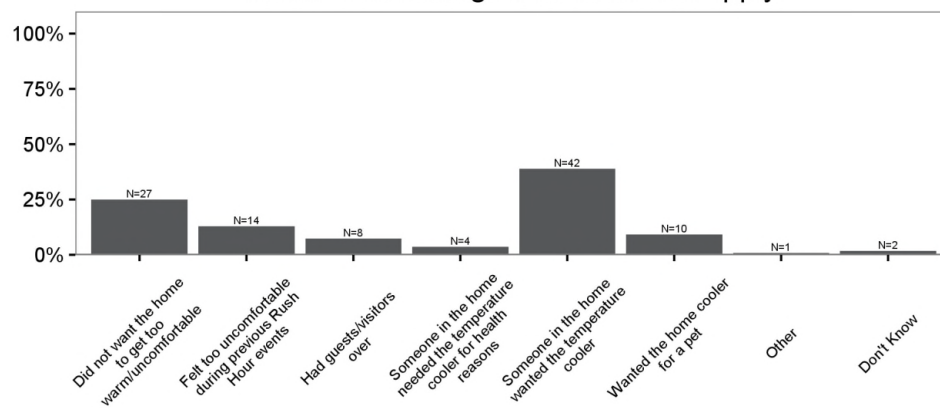


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

38. On event days, did you ever "opt-out" or override your Wi-Fi thermostat setting to stop the program from adjusting your Wi-Fi thermostat remotely during the event? Select all that apply.



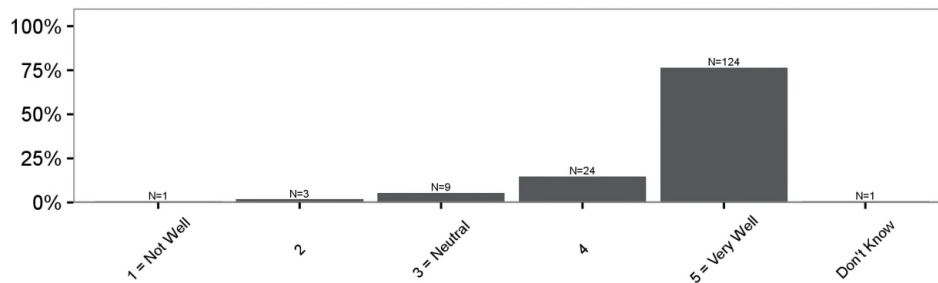
39. Why did you opt-out or override the Wi-Fi thermostat setting? Select all that apply.



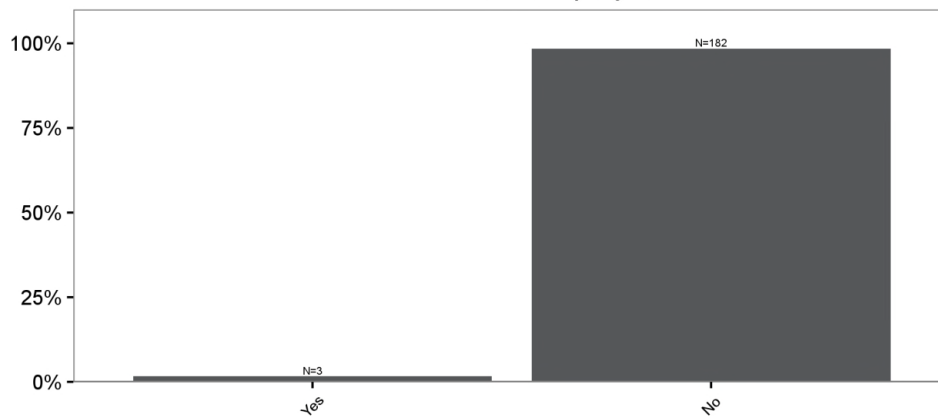


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

41. How well did your Wi-Fi thermostat work as needed during the events (i.e. Wi-Fi connectivity, clearness of interface in indicating there is an event scheduled or in-progress, ability to successfully override events, etc.)?



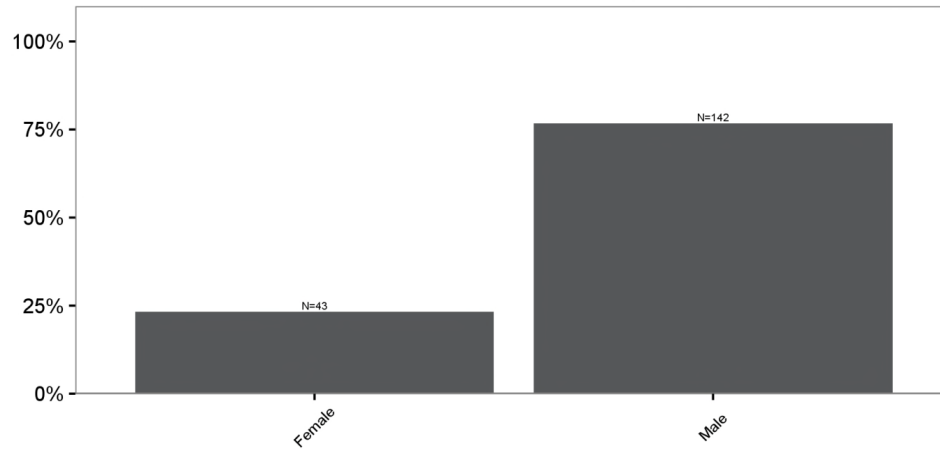
44. Are you or is anyone in your household a National Grid employee?



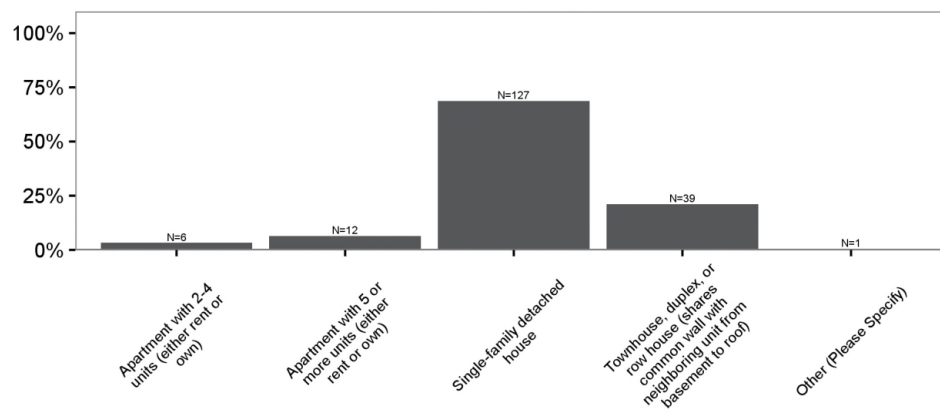


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

45. What is your gender?



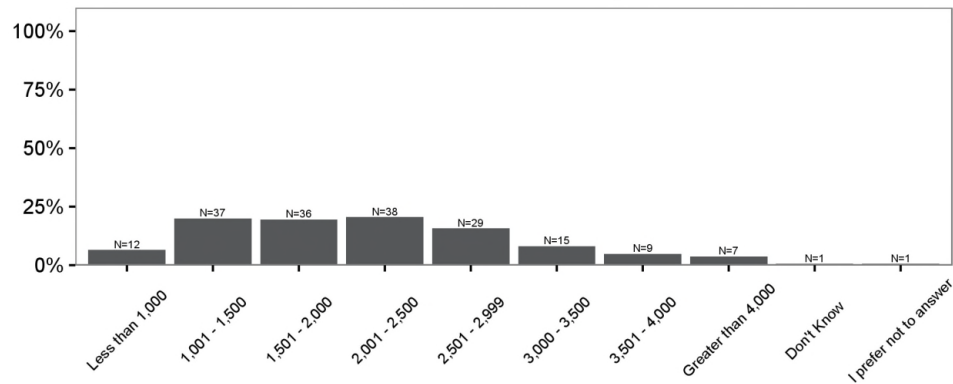
46. Which one of these options best describes this residence?



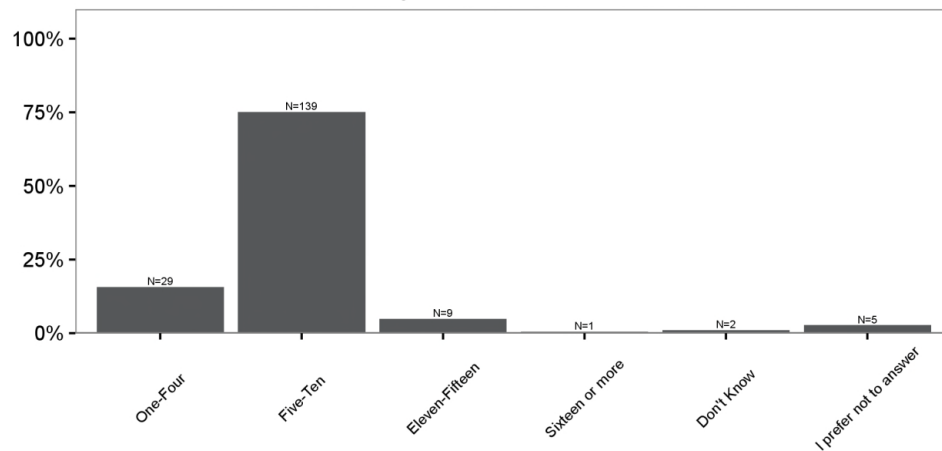


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

47. How many square feet of living space are there in this residence, including bathrooms, foyers, and hallways?



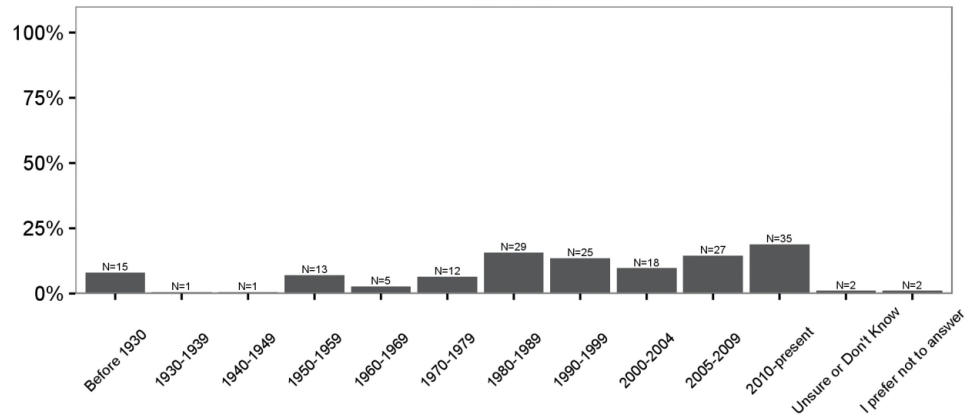
48. How many rooms are in this residence?



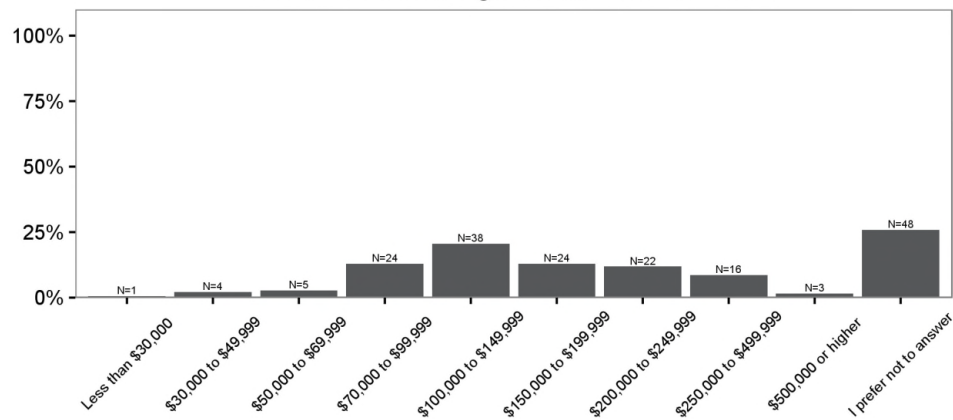


2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

49. Approximately what year was this residence built?



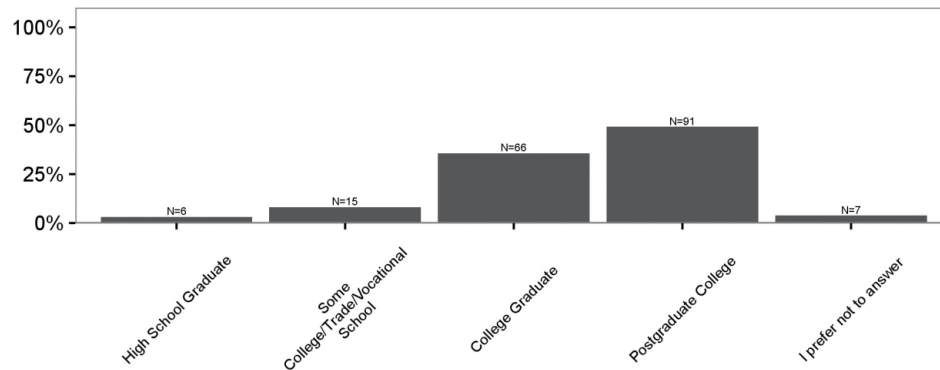
50. Please select the range that best describes this household's gross income for 2015





2016 Residential Wi-Fi Thermostat DR Evaluation Final Report

51. What is the highest level of education completed by the head of household in this residence?



Division 25-17

Request:

Refer to response DIV 3-12 (a) regarding the Company's 3V0 Program, proposed as part of the ISR plan.

- a. How many substations is the Company planning to install 3V0 at in FY2019 through the ISR program?
- b. How many transformers is the Company planning to install 3V0 on in FY2019 through the ISR program?
- c. What are the expected costs associated with installing 3V0 through the ISR plan for FY2019? Please provide a detailed accounting of expected costs.
- d. Please explain whether the cost to install 3V0 varies by transformer and substation, and, if so, to what extent?
- e. Please provide a detailed description of the issues and problems on the distribution system that the Company is currently experiencing that 3V0 would help to mitigate. Please provide data to support your response.

Response:

- a. In Fiscal Year 2019, the Company will complete 3V0 installation at Kilvert Street and Old Baptist Road substations and start 3V0 work at Tiverton and Hopkins Hill substations.
- b. In Fiscal Year 2019, the Company will complete 3V0 installation at two transformers, T1 of Kilvert Street and T1 of Old Baptist Road and start 3V0 work at four transformers, T1 & T2 of Tiverton and T1 & T2 of Hopkins Hill.
- c. Please see the following table for the proposed Transmission (T-Sub) and Distribution (D-Sub) capital costs for installing 3V0 on the above mentioned substations in Fiscal Year 2019:

Number	Substation	Station Voltage (kV)	Spend Type	FY19 Cost Estimate
1	Tiverton	115/12.47	T-Sub	\$525,000
			D-Sub	\$60,000
2	Kilvert Street	115/12.47	T-Sub	\$82,500
			D-Sub	\$17,500
3	Old Baptist Road	115/12.47	T-Sub	\$82,500
			D-Sub	\$17,500
4	Hopkins Hill	34.5/12.47	D-Sub	\$122,500
T-Sub Total				\$690,000
D-Sub Total				\$217,500

- d. The cost to install 3V0 varies based on the existing physical configuration of the substation and associated protection schemes. Costs can vary up to 50 percent depending on the existing protection schemes and station layout. Specifically, the costs are affected by the ability to place coupling capacitor voltage transformers (CCVT) on the three phases of the high side transformer. Attached is a picture of a typical CCVT:



- e. Significant amount of solar and wind power capacity are being installed at the distribution level in Rhode Island, and installed capacity of these resources will have to continue to grow to meet the State's renewable energy targets. As the aggregation of distributed generation saturates distribution circuits to a level of concern, depending on the protection schemes in place at the given substation, 3V0 protection equipment is required. Distributed energy sources (DER) on Delta-Wye (or Ungrounded Wye-Wye) connected transformers cannot contribute zero sequence ground fault current during single line to ground faults on a transmission line, resulting in the voltages on the unfaulted phases rising significantly and rapidly. These overvoltages have the potential to exceed insulation levels of the substation and transmission line equipment, and

maximum continuous operating voltage of surge arresters. National Grid employs 3V0 protection on the primary side of the transformer to detect these overvoltage conditions. This 3V0 protection will open all feeder protective devices to disconnect all possible DER sources from the substation bus, thereby stopping the DER source from contributing to the transmission-side fault condition.

(This response is identical to the Company's response to Division 8-17 in Docket No. 4780.)

Division 25-18

Request:

Refer to Workpaper 9.2 – Electric Heat Initiative Targets.

- a. Please provide the full working electronic version of this workpaper, with all formulae intact.
- b. Please provide justification and documentation for the GSHP program providing 55.23 tons avoided CO₂ per year. If this assumption is derived from the BCA Workbook, tabs 8 through 12, please provide the specific cell location of the value and describe how it was calculated.
- c. Please provide justification and documentation for the equipment incentives providing 149, 168, and 195 incremental tons annually for years 1, 2, 3. If this assumption is derived from the BCA Workbook, tabs 8 through 12, please provide the specific cell location of the value and describe how it was calculated.
- d. Please reconcile the CO₂ tons reductions in Workpaper 9.2 with the fuel oil CO₂ Emissions Reduction from the Electric Heat Initiative in the BCA workbook, tab “11.EH – Benefits”, row 67.
- e. Please explain how achievement of the target will be measured, and provide all assumptions that will be used to measure CO₂ reductions.

Response:

- a. Please refer to Attachment DIV 25-18, which includes the original Workpaper 9-2 with all formulae intact. In responding to this data request, minor errors were discovered in the calculation of the CO₂ targets, as well as in the valuation of those CO₂ reductions. These errors resulted in a minor underestimation of both the amount and the value of avoided CO₂ emissions expected from the program. Specifically, two errors were discovered and corrected while responding to this data request:
 - **Underestimating the volume of CO₂ avoided by mixing short tons and metric tons.** In the original calculation of the net CO₂ benefits attributable to the Electric Heat Initiative, the benefit-cost analysis (BCA) file incorrectly mixed English and metric units of measure. CO₂ emissions from electricity were calculated in short tons, while CO₂ emissions from other fuels were calculated in metric tons. Since 1 metric ton is equal to 1.102 short tons, the CO₂ emissions from electricity appeared larger than the emissions from avoided fuel reduction. As a result, the CO₂ targets were distorted downward by approximately 15 percent.

- **Using Inappropriate CO₂ Value to Calculate Benefits of Avoided Fuels.** The societal value of avoided CO₂ emissions from natural gas, fuel oil, and propane were inappropriately calculated on the basis of the AESC forecast of non-embedded CO₂ cost, a forecast that is specific to electric power generation emissions. The more appropriate basis is the social cost of CO₂: \$100 per short ton (\$110.23 per metric ton). As a result, the benefits from avoided end-use fuel combustion were distorted downward by approximately 20 percent.

These and other minor corrections will be reflected in an updated BCA that will be filed with the annual Power Sector Transformation Plan on December 1, 2018.

- b. The BCA Workbook was used to calculate the CO₂ savings targets for both the Ground-Source Heat Pump and Equipment Incentives programs, and these calculations were transferred to Workpaper 9.2. The specific estimate of 55.23 tons for the Ground-Source Heat Pump program can be found by:

- First navigating to BCA Workbook Tab 10 "EH – Inputs" Cells I17:K20 and setting to zero (0) the installation schedule for all Type A, Type B, and Type D heat pumps. This leaves only one (1) Type C installation, the large Ground-Source Heat Pump system.
- Second, navigating to BCA Workbook Tab 11 "EH – Benefits" Cells L75, and dividing that value (the annual dollar value "Benefit from Reduced Greenhouse Gas Externality Costs") by Cell L58 (the corresponding annual value for "Non-embedded CO₂ Cost").

The specifications for the Ground-Source Heat Pump system and the system it is assumed to be replacing are found in "EH – Inputs" Cells D240:F266. The Ground-Source Heat Pump system is assumed to be sized at 82 tons of capacity, and replacing a heating system that uses 1,255 MMBTU of fuel oil per heating season.

- c. The specific estimates of 149, 168, and 195 tons for the Equipment Incentives program can be found by:

- First navigating to BCA Workbook Tab 10 "EH – Inputs" Cells I17:K20 and setting to zero (0) the installation schedule for all Type C installations. This leaves only Type A and Type B systems, those contemplated to be installed in the BCA as filed.
- Second, navigating to BCA Workbook Tab 11 "EH – Benefits" Cells K75:M75, and dividing these three values (the annual dollar value "Benefit from Reduced

Greenhouse Gas Externality Costs”) by Cells K58:M58 (the corresponding annual values for “Non-embedded CO₂ Cost”).

The specifications for the Type A and Type B ASHP systems, and the systems they are assumed to be replacing, are found in “EH – Inputs” Cells D182:F208 (Type A – ASHP 3 ton) and Cells D211:F237 (Type B – GSHP 4 ton).

- d. The referenced cells from Tab 11 “EH – Benefits” row 67 represent only the sum of avoided CO₂ emissions from avoided combustion of end-use fuels, prior to netting out increased emissions from electricity use. For this reason, the values in row 67 are higher than the targets described in Workpaper 9.2, which net out increased electric sector emissions.
- e. The Company proposes to measure achievement of the target by add up the avoided CO₂ emissions attributable to all conversions supported by the Initiative in each year, and to subtract the avoided CO₂ emissions from increased electric use from those same conversions.

Because of the costs and complexities of directly metering customer heating system use, the Company does not propose to directly measure CO₂ reductions of the Electric Heat Initiative, but rather to assign deemed CO₂ savings values to each type of conversion. Total deemed CO₂ savings realized through each year of the program will be a function of how many conversions of each system type are delivered each year. The initiative will support 12 types of conversions:

- Equipment Incentives program will support nine types of conversions: three heat pump configurations (Type A, Type B, and Type D) replacing three types of fuels (fuel oil, propane, and electric resistance).
- The Ground-Source Heat Pump program will support up to three types of conversions: one heat pump configuration (Type C) replacing three types of fuels (fuel oil, propane, and electric resistance).

(This response is identical to the Company's response to Division 8-18 in Docket No. 4780.)

PREVIOUS TARGETS (INCORRECT)**ANNUALIZED CO2 Reductions**

Program Design Element	Program Metrics	Target Levels	Targets (annual metric tons CO2)		
			2018	2019	2020
1. GSHP Program	Carbon reduction (metric tons CO2 avoided per year)	Min	0	44	0
		Mid	0	55	0
		Max	0	66	0
2. Equipment Incentives	Carbon reduction (metric tons CO2 avoided per year)	Min	119	134	156
		Mid	149	168	195
		Max	179	202	234

Final Targets (combined metric tons CO2 avoided per year)

	2018	2019	2020
Min	119	178	156
Mid	149	223	195
Max	179	268	234

GSHP: 55.23 tons avoided CO2 expected per year of the system

Equipment Incentives: 149, 168, and 195 incremental tons annually for years 1, 2, 3

REVISED TARGETS (CORRECTED)

Program Design Element	Program Metrics	Target Levels	Targets (annual metric tons CO2)		
			2018	2019	2020
1. GSHP Program	Carbon reduction (metric tons CO2 avoided per year)	Min	0	47	0
		Mid	0	59	0
		Max	0	71	0
2. Equipment Incentives	Carbon reduction (metric tons CO2 avoided per year)	Min	137	155	179
		Mid	171	194	224
		Max	206	232	269

Final Targets (combined metric tons CO2 avoided per year)

	2018	2019	2020
Min	137	202	179
Mid	171	253	224
Max	206	303	269

GSHP: 59 tons avoided CO2 expected per year of the system

Equipment Incentives: 171, 194, and 224 incremental tons annually for years 1, 2, 3

Change in Targets (absolute)

	2018	2019	2020
Min	18	24	23
Mid	22	30	29
Max	27	36	35

Change in Targets (percentage)

	2018	2019	2020
Min	15%	13%	15%
Mid	15%	13%	15%
Max	15%	13%	15%

Assumptions				
Carbon Emissions Factors - non-electric fuels				
Fuel	Lbs / MMBTU	Short Ton / MMBTU	Metric Ton / MMBTU	Source
Natural Gas	117	0.0585	0.05307037	https://www.eia.gov/tools/faqs/faq.cfm?id=73&t=11
Fuel Oil	161.3	0.08065	0.073164536	https://www.eia.gov/tools/faqs/faq.cfm?id=73&t=11
Propane	139	0.0695	0.063049414	https://www.eia.gov/tools/faqs/faq.cfm?id=73&t=11

	Metric tons CO2	% reduction
Average annual emissions of an oil-heated home	~8	n/a
Average annual avoided CO2 from oil-to-ccASHP conversion	~3	38%
Average annual avoided CO2 from oil-to-GSHP conversion	~5	63%

Division 25-19

Request:

Regarding the electric heat benefit-cost analysis:

- a. Please identify all non-energy benefits included in the BCA for electric heat, including low-income non-energy benefits.
- b. To what extent do non-energy benefits for electric heat align with the non-energy benefits included in the 2018 Energy Efficiency Plan for this type of measure?

Response:

- a. Please refer to the Company's response to Division 5-2, included here as Attachment DIV 25-19 for ease of reference. Consistent with the Benefit-Cost Framework of the Docket 4600 Stakeholder Working Group Process,¹ all of the Power Sector Transformation (PST) Initiatives included two categories of non-energy benefits in the benefit-cost analysis (BCA): Greenhouse Gas (GHG) Externality Costs, and Criteria Air Pollutant Costs and Other Environmental Costs.

In particular, the Company's response to Division 5-2 clarifies that the Docket 4600 Benefit-Cost Framework was the primary reference for the Electric Heat Initiative BCA:

"The benefits and costs included in the [Power Sector Transformation Societal Cost Test] SCT were those benefits and costs listed in Appendix B: Benefit-Cost Framework of the Docket 4600 Stakeholder Working Group Process, Report to the Public Utilities Commission (Stakeholder Report), which the Public Utilities Commission (PUC) incorporated into its Guidance on Goals, Principles and Values for Matters Involving The Narragansett Electric Company d/b/a National Grid (Docket 4600 Guidance Document), and which represent net societal impacts resulting from utility investment that the Company was able to quantify and monetize based on available data and methods."

- b. Please refer to the Company's response to Division 5-2 regarding a thorough comparison of the Company's BCA methods in the PST Plan and the 2018 Energy Efficiency Plan.

(This response is identical to the Company's response to Division 8-19 in Docket No. 4780.)

¹ See Docket 4600 Stakeholder Working Group Process, Report to the Public Utilities Commission (Stakeholder Report), RIPUC Docket No. 4600, April 5, 2017, Appendix B: Benefit-Cost Framework; *see also* Report and Order No. 22851, RIPUC Docket No. 4600, at 23, 29 (July 31, 2017) (accepting the Stakeholder Report and adopting the Benefit-Cost Framework).

Division 5-2

Request:

For each benefit-cost analysis included in the rate case filing, please describe each methodology or assumption that is different from the methodologies and assumptions used by the Company when modeling the cost-effectiveness of its energy efficiency programs.

Response:

Wherever applicable and appropriate, the benefit-cost analysis (BCA) methodologies and assumptions relied upon for each of the investments proposed in the Company's Power Sector Transformation (PST) Plan are aligned with those used by the Company when modeling the cost-effectiveness of its energy efficiency programs. The methodologies and assumptions used for the PST BCAs that differ from those used by the Company when modeling the cost-effectiveness of energy efficiency programs in its 2018 Energy Efficiency Program Plan (EEP)¹ are as follows:

- **Cost test:** the cost-effectiveness of each PST investment was evaluated based primarily on a Societal Cost Test (SCT). For each PST investment, the Company also has included the results of a Rate Impact Measure (RIM) to present the monetary benefits to all customers relative to associated costs.² The benefits and costs included in the SCT and RIM are shown in Appendix 2.1 - Program BCA of the Company's Power Sector Transformation Plan.³ The benefits and costs included in the SCT were those benefits and costs listed in Appendix B: Benefit-Cost Framework of the Docket 4600 Stakeholder Working Group Process, Report to the Public Utilities Commission (Stakeholder Report), which the Public Utilities Commission (PUC) incorporated into its Guidance on Goals, Principles and Values for Matters Involving The Narragansett Electric Company d/b/a

¹ The Narragansett Electric Company d/b/a National Grid, 2018 Energy Efficiency Program Plan (EEP) 8, Settlement of the Parties, RIPUC Docket No. 4755, November 1, 2017, Attachment 4— 2018 Rhode Island Test Description.

² See The Narragansett Electric Company d/b/a National Grid, Investigation as to the Propriety of the Proposed Tariff Changes, Rhode Island Public Utilities Commission, RIPUC Docket No. 4770, November 27, 2017, Schedule PST-1, Chapter 2 – 4600 Goals/Framework, at 5-6 (Bates Pages 36-37 of PST Book 1).

³ See *Id.*, Appendix 2.1 – Program BCA, at 4 (Bates Page 196 of PST Book 1).

The Narragansett Electric Company
d/b/a National Grid
RIPUC Docket No. 4770
Responses to Division's Fifth Set of Data Requests
Issued January 3, 2018

National Grid (Docket 4600 Guidance Document),⁴ and which represent net societal impacts resulting from utility investment that the Company was able to quantify and monetize based on available data and methods. The benefits and costs included in the RIM test were those benefits and costs listed in Appendix B of the Docket 4600 Guidance Document, which represent net monetary ratepayer impacts resulting from utility investment that the Company was able to quantify and monetize based on available data and methods.

The cost-effectiveness of the Company's energy efficiency programs are evaluated based on the Rhode Island Benefit Cost Test (RI Test), pursuant to the Least Cost Procurement Standards (Standards) for the procurement of energy efficiency resources.⁵ The benefits and costs included in the RI Test for energy efficiency programs are listed in Attachment 4 – 2018 Rhode Island Test Description to the Company's 2018 EEP.⁶ With the exception of economic development benefits, each benefit and cost listed in the RI Test Description for the Company's 2018 EEP aligns with a benefit or cost considered under the SCT that the Company to evaluate the proposed PST investments.⁷ As described in Chapter 2 of the PST Plan⁸, economic development benefits are not included in the SCT that the Company used to evaluate the proposed PST investments, but are included as qualitative benefits in Chapters 4 through 8 of the PST Plan as part of the overall business case for each proposed investment.

- **Discount rate:** The discount rate used to estimate the net present value of the costs and benefits associated with each PST investment is the Company's after-tax weighted average cost of capital (WACC). The discount rate used by the Company to evaluate

⁴ See Docket 4600 Stakeholder Working Group Process, Report to the Public Utilities Commission (Stakeholder Report), RIPUC Docket No. 4600, April 5, 2017, Appendix B: Benefit-Cost Framework; *see also* Report and Order No. 22851, RIPUC Docket No. 4600, at 23, 29 (July 31, 2017) (accepting the Stakeholder Report and adopting the Benefit-Cost Framework).

⁵ See Rhode Island Energy Efficiency and Resource Management Council (EERMC) – Proposed Energy Efficiency Savings Targets for The Narragansett Electric Company d/b/a National Grid's Energy Efficiency and System Reliability Procurement for the Period 2018-2020, RIPUC Docket No. 4684, Least Cost Procurement Standards, , July 27, 2017, Section 1.2(B).

⁶ See 2018 EEP, Settlement of the Parties, Attachment 4– 2018 Rhode Island Test Description, at 4-9.

⁷ Under the SCT, which the Company used to evaluate the proposed PST investments, any water and sewer benefits resulting from the proposed investments would be a sub-category of Net Non-Energy Benefits; Natural gas benefits would be considered under Non-Electric Avoided Fuel Costs.

⁸ See Investigation as to the Propriety of the Proposed Tariff Changes, Schedule PST-1, Chapter 2 – 4600 Goals/Framework, at 6 (Bates Page 37 of PST Book 1).

The Narragansett Electric Company
d/b/a National Grid
RIPUC Docket No. 4770
Responses to Division's Fifth Set of Data Requests
Issued January 3, 2018

energy efficiency programs for the Annual Energy Efficiency Plan for 2018 is the twelve-month average of the historic yields from a ten-year United States Treasury note, using the 2016 calendar year to determine the twelve-month average.⁹ Please refer to the Company's response to Division 5-4 for more information on this difference.

- **Electric Transmission Capacity and Distribution Capacity Benefits/Avoided Transmission and Distribution Capacity Infrastructure:** Under the RI Test that the Company used to evaluate statewide energy efficiency programs, a statewide marginal cost of transmission and distribution capacity is calculated based on Company-specific historical and forecast incremental capital investments caused by load growth and is applied to summer demand reductions resulting from the energy efficiency measure.¹⁰

The methodology used to evaluate the proposed PST investments calculates avoided transmission and distribution capacity infrastructure benefits based on location-specific peak demand reductions valued at the marginal cost of distribution system infrastructure avoided or deferred by the project.¹¹ This methodology is included in the list of candidate methodologies for the distribution capacity costs benefit/cost category in Appendix B: Benefit-Cost Framework, which is incorporated into the Docket 4600 Guidance Document.¹²

- **Delivered Fuel Benefits/Non-Electric Avoided Fuel Cost:** The proposed Electric Heat Initiative BCA relies on the 2017 EIA Annual Energy Outlook forecasts¹³ for oil and propane fuel price assumptions, while the Annual Energy Efficiency Plan for 2018 relies on oil and propane fuel price forecasts from the Avoided Energy Supply Costs in New England: 2015 Report.¹⁴ The 2017 EIA forecast was chosen for evaluating the proposed Electric Heat Initiative investment to reflect the most recently modeled projections available at the time.

⁹ See 2018 EEP, Settlement of the Parties, Attachment 4– 2018 Rhode Island Test Description, at 18.

¹⁰ 2018 EEP, Settlement of the Parties, Attachment 4– 2018 Rhode Island Test Description, at 7-8.

¹¹ The five proposed PST investments are not expected to result in load reduction impacts that avoid the need for incremental transmission or distribution infrastructure; therefore, these benefits are not included in the BCA results presented in Chapters 4 through 8 of the PST Plan.

¹² See Stakeholder Report, Appendix B: Benefit-Cost Framework.

¹³ See U.S. Energy Information Administration, Annual Energy Outlook 2017, Table: Energy Prices by Sector and Source, New England Residential Energy Price Forecast, Reference Case.

¹⁴ See Hornby, Rick et al., Avoided Energy Supply Costs in New England: 2015 Report, March 27, 2015, Revised April 3, 2015, Appendix D, Avoided Costs of Other Fuels.

The Narragansett Electric Company
d/b/a National Grid
RIPUC Docket No. 4770
Attachment DIV 25-19
Page 4 of 4

The Narragansett Electric Company
d/b/a National Grid
RIPUC Docket No. 4770
Responses to Division's Fifth Set of Data Requests
Issued January 3, 2018

(This response is identical to the Company's response to Division 1-2 in Docket No. 4780).

Division 25-20

Request:

The Electric Heat initiative is the most cost-effective effort of the investment categories, yet the budget is substantially smaller than other investment categories. How were the cost-effectiveness outputs used to set budgets for the four investment categories (i.e., electric vehicles, electric heat, solar, and energy storage)?

Response:

The Company has presented these four Power Sector Transformation (PST) investment categories as a holistic suite of investments that advance various policy and system objectives described in Docket 4600 and the Power Sector Transformation initiative. The Company's initiatives were not compared to each other using their benefit-cost ratios as the criteria. Furthermore, for each of the Company's initiatives, the Company has also assessed and described important benefits that are not currently quantifiable but which must be considered in evaluating the merits of each proposal. To that end, a comparison of the Company's initiatives based solely on their respective benefit-cost scores is of limited value.

The Benefit Cost Analysis (BCA) tool was not used to create budget estimates for the Electric Heat Initiative (or the other initiatives). To the extent the BCA was used in the design process, it was to adjust iteratively the project scope, targets, and estimated budget to improve the cost-effectiveness of the initiative with respect to policy and system objectives.

(This response is identical to the Company's response to Division 8-20 in Docket No. 4780.)

Division 25-21

Request:

Regarding the responses to Division 5-12 and 5-9, please break the max utility shareholder incentive into the following components: a) return on investment, b) return of incentive, and c) performance incentive. If any component is not included in the current max utility shareholder incentive, please provide the dollar value for the component separately.

Response:

Similar to the return on investment expected through the other Power Sector Transformation Initiatives, the max utility shareholder incentive of the Electric Heat Initiative is envisioned as being above and beyond the return on investment expected through the Ground-Source Heat Pump program of the Electric Heat Initiative.

In other words, the Company envisions earning both a) a return on investment and c) a performance incentive. The Company does not propose to earn a "return on incentive" as stated in b) above.

(This response is identical to the Company's response to Division 8-21 in Docket No. 4780.)

Division 25-22

Request:

Regarding the responses to Division 5-12, please explain why the shareholder incentives substantially different by program (i.e., 3% of GSHP costs and 9% of Equipment Incentive program costs)?

Response:

The Company proposes to earn a single shareholder incentive across the entire Electric Heat Initiative, rather than separate sub-incentives for the Ground-Source Heat Pump and Equipment Incentive programs. The level of total shareholder incentives is calculated to be proportional to the total net benefits of both programs together.

The specific variation noted in this data request is an artifact of how the Company's response to Division 5-12 (Docket 4780) was calculated. Division 5-12 asked the Company to "break out costs" by year for each program. Rather than using program costs as the basis for approximating shareholder incentives attributable to each program, the Company used the central program outcome (CO₂ emissions reduction) as the basis, in keeping with the intent to link incentives more tightly to performance. In the year that the Ground-Source Heat Pump project goes into service, it is expected to contribute roughly 25 percent of the avoided CO₂ of the entire Electric Heat Initiative in that year. The Company used this 25 percent share as the basis for apportioning 25 percent of that year's Max Incentive of two basis points to the Ground-Source Heat Pump program.

(This response is identical to the Company's response to Division 8-22 in Docket No. 4780.)

Division 25-23

Request:

Regarding the response to Division 5-22, why are the performance incentives low relative to other investment categories if this is the most cost-effective category?

Response:

- a. Please refer to Schedule PST – 1, Chapter 9 – Performance, Section 4.2 Distributed Energy Resources (Bates Pages 181-182 of PST Book 1). The performance incentives for the Electric Heat Initiative are not low relative to other investment categories when measured as a share of quantified net benefits. As stated in Section 4.2:

“While the quantified net benefits of the Electric Heat Initiative suggest that customers would retain only about 25% of the net benefits, the Company believes that the proposed maximum incentive equal to two basis points annually is warranted given that the Electric Heat Initiative provides important economic development benefits that have not been quantified in the BCA. In particular, the program will support the growth in the state of a labor intensive sector with a direct positive impact on the building trades.”

(This response is identical to the Company's response to Division 8-23 in Docket No. 4780.)

Division 25-24

Request:

Refer to PST Panel Book 2, Bates 288, which states "Electric Heat Program: measured reductions in carbon in short tons per year". Please reconcile this with Schedule PST-1, Bates 173, which lists the metric as "Metric Tons CO₂." Is the Company's proposal for the metric to be quantified in terms of short tons or metric tons, and is the pollutant measured as carbon, or as carbon dioxide?

Response:

The referenced statement from Appendix 10.10, Bates Page 288 of PST Book 2 is incorrect. The correct proposed metric is metric tons of carbon dioxide (CO₂) per year.

Denominating the target in metric tons of CO₂ maintains consistency with unit conventions in the Rhode Island Greenhouse Gas Emissions Inventory, the Rhode Island Greenhouse Gas Emissions Reduction Plan, and with conventions used by the Energy Information Administration in reporting state and sectoral emissions.

In the process of responding to this data request and to Division 25-18 (Division 8-18 in Docket No. 4780), errors were found in the calculation of the metric tons calculation. Please refer to the Company's response to Division 25-18 (Division 8-18 in Docket No. 4780) for corrected targets.

(This response is identical to the Company's response to Division 8-24 in Docket No. 4780.)