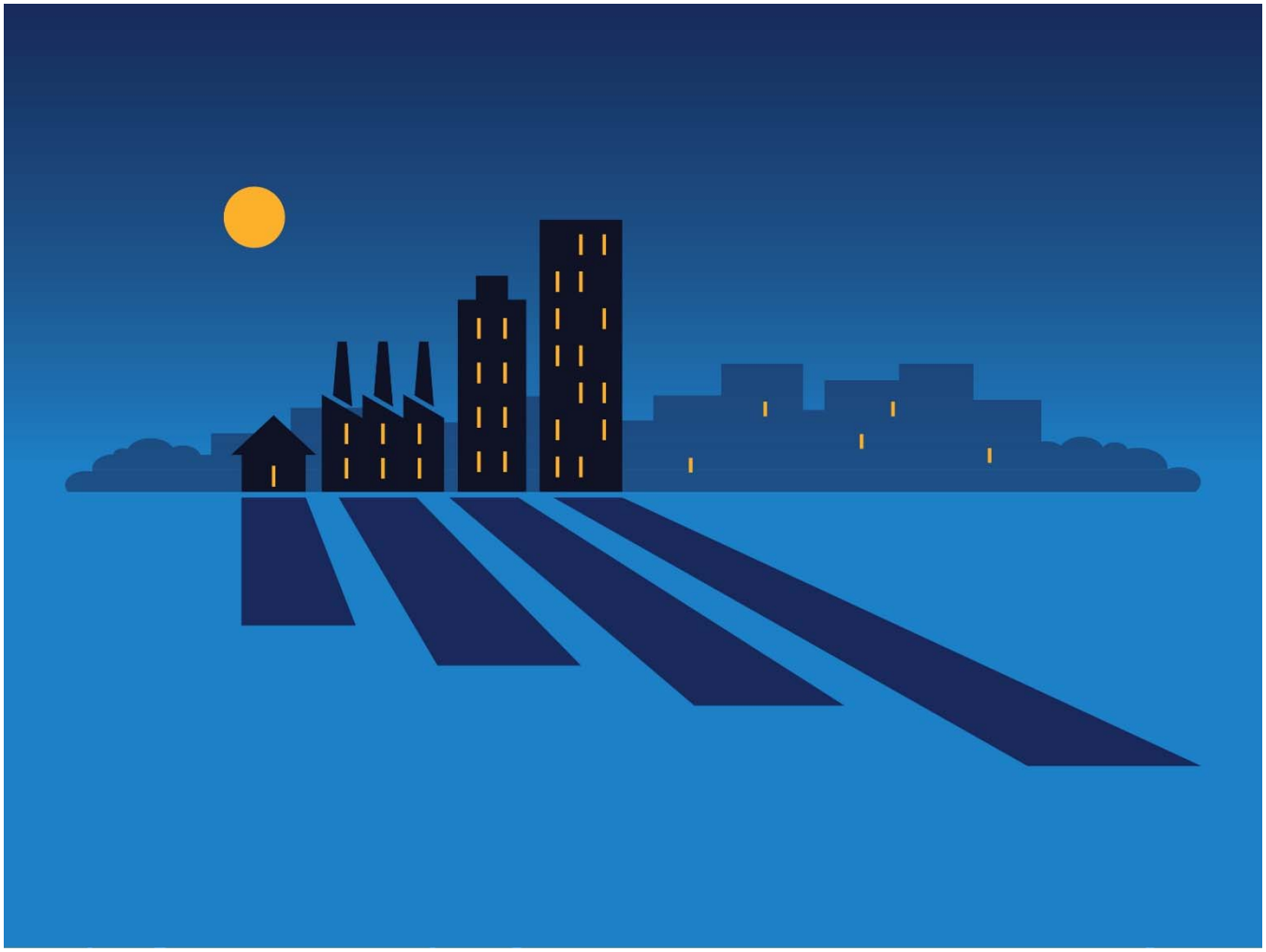
Opinion Dynamics

Boston | Headquarters

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

1000 Winter St
Waltham, MA 02451



National Grid Rhode Island System Reliability Procurement Pilot: 2016 Annual Evaluation Report

FINAL

Antje Flanders
Vice President

June 6, 2017

Contributors

Seth Wayland, Director

Jennifer Watters, Senior Analyst

Kai Zhou, Energy Data Scientist

Jayden Wilson, Senior Analyst

Table of Contents

Executive Summary 1
Impact Results 1
Other Findings 2
Recommendations 5
1. Introduction 7
1.1 Program Overview 7
1.2 2016 Targets and Planning Projections 9
1.3 2016 Evaluation Activities 10
1.4 Organization of Report 11
2. Participation Analysis 13
2.1 Participation Summary 13
2.2 EnergyWise Program 13
2.3 DemandLink Thermostat Program 16
2.4 Window AC Rebate Program 19
2.5 Heat Pump Water Heater Program 21
3. EnergyWise Impact Analysis 23
3.1 EnergyWise Gross Impact Analysis 23
3.2 EnergyWise Net Impact Analysis 25
4. DemandLink Demand Response Event Analysis 27
4.1 Analysis of Demand Response Event Participation 27
4.2 Demand Response Impact Analysis 31
4.3 Demand Response Event Follow-Up Analysis 37
5. Marketing Effectiveness Analysis 42
5.1 General Recall of Messaging 42
5.2 Recall and Clarity of Specific Marketing Materials 44
Appendix A. EnergyWise Load Impact Analysis – Additional Details 51
Appendix B. DemandLink Evaluation – Additional Details 53
Appendix C. Marketing Effectiveness Survey 70
Appendix D. Survey Sampling and Dispositions 81

Table of Tables

Table ES-1. Summary of kW SRP Impacts Compared to Targets – Cumulative through 2016 2
Table 1-1. Equipment Installations Compared to 2016 Planning Projections and Cumulative Targets 10
Table 3-1. Energy Wise Installed Measures and Ex Ante Gross Peak Load Reduction: March 2012-2016 24
Table 3-2. 2012-2016 EnergyWise Incremental Load Impacts by Measure Category 26
Table 4-1. Summary of Central AC Log File Analysis 29
Table 4-2. Summary of Window AC Log File Analysis 31
Table 4-3. Central AC Demand Response Impact 32
Table 4-4. Hourly DemandLink Impact Results 36
Table 4-5. Estimation of Per-Thermostat Reduction for 2016 37
Table 4-6. Window AC Demand Response Impact 37
Table 4-7. Window AC Demand Response Impact 40
Table 5-1. 2016 Marketing Materials Assessed 44
Table A-1. EnergyWise 2016 Load Impact Factors 52
Table D-1. Marketing Effectiveness Survey Dispositions and Response Rate 81
Table D-2. Weights Reflecting Population of Customers Who Participated in Any Program 82
Table D-3. DemandLink Participant Survey Response Rates 82

Table of Figures

Figure 1-1. 2016 Demand Response Events 8
Figure 1-2. 2016 Pilot Area Achievements 9
Figure 2-1. 2016 Pilot Area Participation 13
Figure 2-2. EnergyWise Asssessment Participants in SRP Pilot Communities (2009-2016) 14
Figure 2-3. EnergyWise Assessments in SRP Pilot Communities by Month (2016) 14
Figure 2-4. Non-Participant Awareness of and Interest in EnergyWise Program 15
Figure 2-5. Barriers to EnergyWise Participation 16
Figure 2-6. DemandLink Thermostat Program Participation in SRP Pilot Communities (2012 -2016) 17
Figure 2-7. Awareness and Interest in DemandLink Program (Non-Participants) 17
Figure 2-8. Barriers to DemandLink Participation 18
Figure 2-9. Window AC Rebate Participation in SRP Pilot Communities (2013-2016) 19
Figure 2-10. Likelihood of ENERGY STAR® Window Air Conditioner Rebate Participation in 2017 20
Figure 2-11. Likelihood of Window AC Recycling Rebate Participation in 2017 20
Figure 2-12. Awareness and Interest in HPWH Rebates (Non-Participants) 21
Figure 2-13. Barriers to HPWH Rebate Participation 22
Figure 4-1. 2016 Demand Response Events 27
Figure 4-2. Overall Hourly Event Day Usage with Baseline 33
Figure 4-3. Event 1, July 7th Hourly Usage with Baseline (Typical Event) 34
Figure 4-4. Event 4, July 18th Hourly Usage with Baseline 34
Figure 4-5. Event 17, August 29th Hourly Usage with Baseline 35
Figure 4-6. Non-event Day Baseline versus Actual AC Run Percentage 36
Figure 5-1. 2016 SRP Marketing Timeline 42
Figure 5-2. Recall of Program-Specific Marketing Messages (Participants) 43
Figure 5-3. Recall of Program-Specific Marketing Messages (Non-Participants) 43
Figure 5-4. Recall of Marketing Materials 45
Figure 5-5. Recall of Information Provided by Marketing Material (By Participation Status) 46
Figure 5-6. Benefits of Offerings and How to Get More Information 47
Figure 5-7. Clarity of DemandLink Messaging for Non-Participants 48
Figure 5-8. Clarity of DemandLink Messaging for Participants 49
Figure 5-9. Interest in More Information About Program (Non-Participant in Program Component) 50
Figure B-1. Example of Run-Time per 5-Minute Interval for One Central AC Unit 54
Figure B-2. Example of Watt Usage per 5-Minute Interval for One Window AC Unit 55
Figure B-3. Event Day and Non-event Day Temperature Profiles 58
Figure B-4. Event Day and Matched Day Temperature Profiles Based on Mahalanobis Distance Matching 59
Figure B-5. Event Day and Matched Day Temperature Profiles Based on Custom Matches 60

Figure B-6. Mean Central AC Runtime versus Temperature for Peak Season Afternoons 61
Figure B-7. Central AC Event 1 (Wednesday, July 6, 2016) 62
Figure B-8. Central AC Event 2 (Thursday, July 7, 2016) 62
Figure B-9. Central AC Event 3 (Friday, July 15, 2016) 63
Figure B-10. Central AC Event 4 (Monday, July 18, 2016) 63
Figure B-11. Central AC Event 5 (Friday, July 22, 2016) 64
Figure B-12. Central AC Event 6 (Monday, July 25, 2016) 64
Figure B-13. Central AC Event 7 (Tuesday, July 26, 2016) 65
Figure B-14. Central AC Event 8 (Wednesday, July 27, 2016) 65
Figure B-15. Central AC Event 9 (Thursday, July 28, 2016) 66
Figure B-16. Central AC Event 10 (Tuesday, August 9, 2016) 66
Figure B-17. Central AC Event 11 (Thursday, August 11, 2016) 67
Figure B-18. Central AC Event 12 (Friday, August 12, 2016) 67
Figure B-19. Central AC Event 13 (Saturday, August 13, 2016) 68
Figure B-20. Central AC Event 14 (Tuesday, August 16, 2016) 68
Figure B-21. Central AC Event 15 (Friday, August 26, 2016) 69
Figure B-22. Central AC Event 16 (Saturday, August 27, 2016) 69
Figure B-23. Central AC Event 17 (Monday, August 29, 2016) 70
Figure B-24. Central AC Event 18 (Friday, September 9, 2016) 70

Executive Summary

This report presents evaluation findings for the fifth year of the Rhode Island System Reliability Procurement (SRP) pilot, conducted by Opinion Dynamics Corporation under contract to National Grid. The SRP pilot was designed to determine whether demand-side management could be an effective method of reducing peak demand on the Tiverton substation (substation feeders 33-34), which serves over 5,000 customers in the pilot communities. Starting in March 2012, National Grid increased marketing and outreach to encourage participation in select statewide energy efficiency programs (the residential EnergyWise Program and the Small Business Direct Install Program) and enrollment in SRP-specific DemandLink offerings (WiFi programmable controllable thermostats and plug devices used to control window AC units). In 2013, the pilot introduced new SRP-specific rebates for the purchase of qualifying window AC units and the recycling of old window AC units. In 2015, the pilot began offering enhanced rebates for electric heat pump water heaters, available for customers who also participate in DemandLink.

This report presents the results of the various research activities and analyses conducted for the 2016 SRP pilot year. Research activities included two primary data collection efforts: an online survey of customers in the pilot area and a telephone survey of DemandLink participants. We conducted analyses of gross impacts for measures installed through the EnergyWise Program and for the 2016 demand response events. We used the "take rate" established in the 2015 Annual Evaluation Report to establish net load impacts for the EnergyWise Program. Finally, we conducted an analysis of marketing effectiveness for key marketing efforts employed in 2016 as well as an analysis of participant experience during the August 29th demand response event.

Impact Results

This evaluation included an analysis of load reduction for the two major pilot offerings: the Energy Wise Program and the DemandLink demand response events. While demand savings were realized by other components of the pilot, these were not included in the evaluation of the 2016 program year.

We estimate 2016 gross demand savings from the EnergyWise Program to be 254 kW. This estimate includes all installations for the pilot-to-date, i.e., it assumes that all rebated measures are still in place. It should also be noted that this is a gross estimate. Since the EnergyWise Program is also offered as a statewide program, some of the installations would have happened even without the pilot's efforts. Our estimate of EnergyWise net demand savings attributable to the pilot is 129 kW. Demand savings from the EnergyWise Program are realized on event and non-event days.

We further estimate 2016 DemandLink event savings of 46 kW for events for central AC participants and 0.018 kW for events for window AC participants. Event savings are based on thermostats and plug devices that were operational during the 2016 cooling season and are realized on event days only.

While estimated peak demand savings for the EnergyWise Program exceeded targets, savings from the demand response events were significantly below targets, largely driven by low counts of participating units due to missing log files and missing data in log files that we did receive.

Table ES-1 summarizes these findings.

Table ES-1. Summary of kW SRP Impacts Compared to Targets – Cumulative through 2016

Program	Estimated Peak Demand Savings (kW)	Target (kW)	% Target
EnergyWise	254	209	121%
DemandLink Demand Response Events (Central AC)	46	147	31%
DemandLink Demand Response Events (Window AC)	0.018	11	0.2%

Other Findings

Below, we present other key findings based on the research activities and analyses conducted for the 2016 program year.

EnergyWise Evaluation

Participation

- In 2016, customers in the pilot area completed 155 assessments which represents a 42% decrease from 2015.

Impacts

- In 2016, the estimated cumulative gross peak load reduction from EnergyWise measures installed during the pilot period is 254 kW; the equivalent cumulative net peak load reduction is 129 kW. LEDs continued to be a predominant measure, although installations declined by over 50% relative to 2015. Participants installed approximately 5,000 LED bulbs which accounted for 83% of new peak load reduction from EnergyWise measures in 2016. Meanwhile, installations of CFLs continued to decline from previous years.

Program Awareness and Interest

- Awareness of the EnergyWise program among those who have not yet participated in the program is high: 70% of non-participants have heard of the program. Pilot-specific marketing over the past five years is likely responsible for this high level of awareness: Over half of non-participants (53%) remembered receiving information about the EnergyWise Program during 2016, most often in the mail.

- Non-participants in the EnergyWise Program report a high likelihood of participation in the program during 2017 (46%). While barriers to participation among non-participants vary, difficulty finding the time to be home for the assessment is one of the most often cited reasons.

DemandLink WiFi Thermostat and Plug Device Evaluation

Participation

- In 2016, 12 new participants signed up to participate in the DemandLink Thermostat Program, bringing the total for the pilot-to-date to 269 participants. Substation participants with central AC installed 13 thermostats and participants with window AC installed 8 plug devices in 2016.

- New participant sign-ups continue to decline. In January 2016, the pilot stopped installing new central AC thermostats in customer's homes and began enrolling new pilot participants through the

statewide Connected Solutions. The pilot also discontinued installation of plug devices in 2016, due to connectivity issues and the resulting low demand response event participation observed in 2014 and 2015.

Impacts

- The pilot called a total of 18 demand response events between July and September 2016. Similar to 2015, the control strategy in 2016 consisted of a 2°F temperature increase for customers with central AC between 3 p.m. and 7 p.m. and a shut-down of customers' window AC units between 4 p.m. and 6 p.m.

- Similar to prior years, the program experienced difficulty with the functionality and connectivity of window AC thermostats and plug devices. A new issue in 2016, however, was the non-availability of a large percentage of window AC log files: For August and September events, we received log files for 77% of installed thermostats; for July events, we received log files for only 49% of installed thermostats. Even the log files we received showed data issues, with between 9% and 10% (depending on the event) of August and September files and none of the July files having any usable data. These data issues are at least partially related to the usage issues (participants no longer use the plug device or do not use it with a window AC unit) and connectivity issues (participants do not reconnect their plug device to their WiFi-enabled thermostat) observed in prior evaluations. As a result, we were able to credit the pilot with event savings for less than one thermostat per event, reducing demand savings to 0.018 kW.

- 2016 also showed log file issues for central AC thermostats. Log files were unavailable for 31% of thermostats during July and for 17% of thermostats during August and September. In addition, 13% of July logs and 14% of August and September logs contained no useable data. As a result, the number of participating units in 2016 averages 115 per event, compared to 155 in 2016. Coupled with lower run-time reduction in 2016 (an average of 10.9% compared to 13.3% in 2015), estimated demand response impacts associated with central AC dropped from 76 kW in 2015 to 46 kW in 2016.

- As is often the case with demand response programs, the first hour of the 2016 demand response events achieved the highest savings, with an average of 0.91 kW across all events. Each subsequent event hour achieved smaller savings. Notably, hourly savings for the fourth event hour were zero across all 18 events, with several events achieving negative savings.

Program Awareness and Interest

- Awareness of the DemandLink Thermostat Program among those who have not yet participated is moderate: 42% of non-participants have heard of the program. Less than a quarter of non-participants (22%) reported being likely to participate in the program in 2017. The most common barriers to participation among non-participants are the perception that they do not use the air conditioning enough to benefit from participation and being uncomfortable with someone else controlling their thermostat.

Event Follow-up

- Awareness of the August 29th event among event-eligible participants was moderate: 57% of those with central AC and 50% of those with window AC were aware that the event had been called. Among event-eligible participants with central AC, close to half (47%) were home during the event and 10% reported having opted-out of the event, citing discomfort or anticipation of discomfort as the

influencing factor. Among event-eligible respondents with window AC, only 17% (2 out of 12) were home during the event, and none opted out.

- Over half of event-eligible participants (65%) recall National Grid calling at least one event over the summer; the average number of events they recalled was 10. These respondents indicated they were home for just over half (59%) of the events they recalled. Notably, only 8% of participants who recalled at least one 2016 event (n=26) thought that National Grid had called too many events. Almost all participants (95%) plan to participate in future events.

- Respondents to the Demand Response Event Follow-up Survey reported continued installation and use of the programmable thermostats during the 2016 cooling season. All 30 survey respondents with central AC and 55% of survey respondents with window AC reported using at least one of their thermostats to control their AC unit. These results, while self-reported by participants and not independently verifiable, appear to contradict the low number of participating units based on the log files and underscores concerns about the large number of missing log files.

- Participants with central AC are highly aware of the various elements of the DemandLink Program; awareness of participants with window AC is systematically lower. For both groups, awareness of the bill credit is significantly lower than awareness of other program elements, a notable finding as survey responses show anecdotal evidence that low awareness of the bill credit might be correlated with a higher likelihood to opt out of an event.

- For window AC participants, awareness of demand response events seems to be correlated with using the plug devices with window AC units: All five respondents with window AC who were unaware of the events did not have a plug device installed; conversely, 87% respondents with window AC who were aware of demand optimization events reported using at least one plug device with their window AC.

Window AC Rebate and Recycling Evaluation

- In 2016, customers received rebates for purchasing 27 new ENERGY STAR® rated units and for recycling 37 old units. Compared to 2015, equipment counts for both types of rebate increased in 2016.

- Awareness of the Window AC and Recycling Programs is moderate. Among non-participants who plan to either use window AC in the summer and/or recycle an unwanted unit, 43% have heard of the purchase rebate while 29% have heard of the recycling rebate.

- Based on survey responses, the potential customer base eligible to receive a rebate for purchasing a new window AC unit is quite large: Almost 4 out of 10 customers (39%) use or plan to use window AC to cool their home in the summer, and 35% of those window AC users (or 14% of all customers) are likely to purchase a new window AC unit in 2017. A large majority of these likely buyers (93%) reported that they are likely to purchase an ENERGY STAR® rated model and apply for a rebate from National Grid.

- Only 19% of customers have window AC units that they no longer use or that they might replace in 2017. Of these, a large majority (87%) are likely to recycle an old unit, and nearly all of these likely recyclers (91%) reported that they are likely to apply for a rebate from National Grid for doing so.

Heat Pump Water Heater Program

- In 2016, 17 DemandLink customers participated in the HPWH Program, up from 10 in 2015.
- Given that the HPWH rebate is a relatively new offering for the pilot, non-participating homeowners report a relatively high awareness of the rebate (36%) and likelihood to purchase a new HPWH through the program (38%). Not surprisingly, those who had previously considered replacing their current water heater (22% of non-participating homeowners) have higher levels of awareness and a significantly higher likelihood to participate than those who had not considering doing so.
- Barriers to participation in the HPWH Program include having recently installed a new water heater (39%), simply not being interested/not needing a new water heater (23%), and using a different type of water heater with no interest is switching (17%).

Marketing Effectiveness

- Participant recall of messaging about components in which they had already participated (in 2016 or prior years) was very high, with 88% of EnergyWise and 93% of DemandLink participants remembering receiving program information in 2016. These participants most often recalled receiving information in the mail (52% and 47%, respectively). Program participants less frequently remembered receiving emails (28% and 30%, respectively) or phone calls (13% and 5%, respectively) from the pilot.
- Non-participant recall of component-specific messaging was lower compared to participants, but still high: 53% of customers who have not yet participated in the EnergyWise Program remembered receiving information about it 2016, most often in the mail. Recall rates for other program components were significantly lower (37% for window AC rebates, 35% for DemandLink, and 26% for HPWH rebates), yet still relatively high. Across all components, non-participants are most likely to remember information they received in the mail.
- Survey questions about three specific pieces of marketing used in 2016 (a newsletter, a post card, and an email) show that the direct mail pieces were more memorable than the emails, and that participants and non-participants tended to recall the materials at similar rates. Recall rates by non-participants are relatively high, at 42% for the newsletter, 41% for the postcard, and 20% for the email.
- Both participants and non-participants generally found the messaging in the three pieces of marketing to be clear. DemandLink participants found the messaging around checking the connectivity of their thermostat to be clearer in the post card, compared to the newsletter, which also including a lot of other topics.
- Of non-participants eligible to participate in the various components, about one-third are interested in seeking more information about window AC rebates (38%), the EnergyWise program (35%), and the HPWH rebate (31%). Significantly fewer DemandLink non-participants are likely to seek more information about the DemandLink Program (23%).

Recommendations

Based on our research and analyses, we provide the following opportunities for program improvement:

- **Explore issues of missing thermostat log files and missing log file data with Ecobee.** During the 2016 cooling season, Opinion Dynamics provided National Grid with regular status updates on the

availability and quality of log files received from Ecobee. Despite these updates, Ecobee was unable to provide a large percentage of log files for window AC thermostats (51% missing for July; 23% missing for August/September) and even for central AC thermostats (31% missing for July; 17% missing for August/September), which had not previously experienced significant connectivity issues. In addition, many log files did not contain any of the data needed for the analysis. Given the significantly lower demand response event impacts in 2016, we recommend that National Grid explore these issues with Ecobee prior to the 2017 cooling season, to avoid another year of low impacts.

- **Discontinue events for window AC, if issues of missing log files and missing log files data cannot be resolved.** Based on the window AC log files provided by Ecobee, it appears that a majority of window AC participants are no longer present in the portal, and therefore cannot receive event signals, when events are called during the cooling season. If the log file issues cannot be resolved, we recommend that National Grid no longer call events for window AC, which might save the pilot administrative costs associated with these events.

- **Consider using a different central AC demand control strategy in 2017.** Our last evaluation had commented on the 2°F temperature offset control strategy used for the first time in 2015 and encouraged the pilot to test different strategies. Findings from this evaluation confirm that the current control strategy is not optimal. Hourly impact results for central AC thermostats show decreasing savings with each passing hour. While this is expected with a 2°F temperature offset control strategy, average 2016 savings during the last event hour are actually zero, meaning that participating thermostats have resumed their baseline state of operation. Given that average event savings are calculated across the four event hours, including this last hour contributes no additional savings but substantially reduces the average savings across the duration of the event. Depending on the pilot area's exact load reduction needs, we recommend that National Grid consider one of the following strategies: (1) keep the 2°F temperature offset strategy but reduce the length of the events to 2 or 3 hours; (2) keep the event length of 4 hours, but increase the offset strategy to 3 or 4°F; (3) keep the 2°F temperature offset strategy and the 4-hour overall event length, but implement rolling events, i.e., do not send the event signal to all participants at the same time.

- **Continue the pre-season messaging to DemandLink participants.** DemandLink participants had a relatively high level of recall (43%) of the post card reminding them to check the connectivity of their thermostat, and they found the messaging to be clear. In contrast, none of the respondents who were asked about the email with similar messaging (n=10) recalled it. While our research was not designed to assess participant actions following receipt of the messaging during the pre-cooling season, survey findings indicate that email messaging is not sufficient in prompting participants to take the desired actions. Our research further found anecdotal evidence that lack of awareness of the bill credit might be correlated with a higher likelihood of opting out. Pre-cooling season messaging should therefore include a reminder that a bill credit is available to those who participate in all events.

- **Offer and advertise EnergyWise assessments in the evenings and on weekends.** Participation in the EnergyWise Program continues to be a cornerstone of savings for the pilot. While non-participant program awareness and interest in participating is high, one of most frequently cited barriers to participation is difficulty finding the time to be home for the assessment. The program should make sure to offer, and advertise in its messaging, options for conducting the assessment at various times, including in the evenings and on weekends.

1. Introduction

This report presents evaluation findings for the fifth year of the Rhode Island System Reliability Procurement (SRP) pilot, conducted by Opinion Dynamics Corporation under contract to National Grid.

1.1 Program Overview

The SRP pilot was designed to determine whether demand-side management could be an effective method of reducing peak demand on the Tiverton substation, which serves over 5,000 customers in the pilot communities of Tiverton and Little Compton.[1] Starting in March 2012, National Grid increased marketing and outreach to encourage participation in select existing statewide energy efficiency programs as well as new programs that are offered exclusively to customers in the Tiverton and Little Compton pilot area.

Pilot-specific Offerings

- **DemandLink Programmable Controllable Thermostat Program**. The DemandLink Thermostat Program provides temperature control devices — WiFi Programmable Controllable Thermostat and plug devices — to customers in Tiverton and Little Compton when they agree to participate in demand optimization events for at least two years. Customers receive an annual bill credit for participating in all demand optimization events. Customers must have a WiFi internet connection and either central air conditioning (central AC) or window air conditioning (window AC) to be eligible. The program supplies all participants with a WiFi-enabled programmable thermostat. Customers with window AC also receive one or more plug devices, which allow the WiFi-enabled thermostat to control their window air conditioners. During 2016, the pilot stopped installing new thermostats in customer's homes. It began enrolling new pilot participants with central AC through the statewide Connected Solutions Demand Response Program and discontinued offering plug devices. National Grid called 18 demand response events in 2016 (see Figure 1-1). Events generally lasted from 3 p.m. to 7 p.m. for central AC units and from 4 p.m. to 6 p.m. for window AC units. For central AC, setpoints were increased by 2 degrees; for window AC, the unit was shut off for the duration of the event.

[1] Not all customers in the towns of Tiverton and Little Compton are served by the two sub-feeders (33 and 34) that are the focus of SRP demand reduction efforts. The analyses in this report are based on customers served by the two sub-feeders only.

Figure 1-1. 2016 Demand Response Events

July						2016
Su	Mo	Tu	We	Th	Fr	Sa
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

August						2016
Su	Mo	Tu	We	Th	Fr	Sa
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

September						2016
Su	Mo	Tu	We	Th	Fr	Sa
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

- **DemandLink Window AC Rebate Program.** Between May 1st and November 1st, 2016 National Grid offered customers in Tiverton and Little Compton a $50 rebate for the purchase of qualifying new window AC units, up to four units per household. Equipment was required to have an energy efficiency ratio (EER) greater than or equal to 10.8 to qualify.

- **DemandLink Window AC Recycling Program.** Between May 1st and November 1st, 2016 National Grid offered customers in Tiverton and Little Compton a $25 rebate for window AC units they recycled, up to four units per household.

Enhanced Statewide Offerings

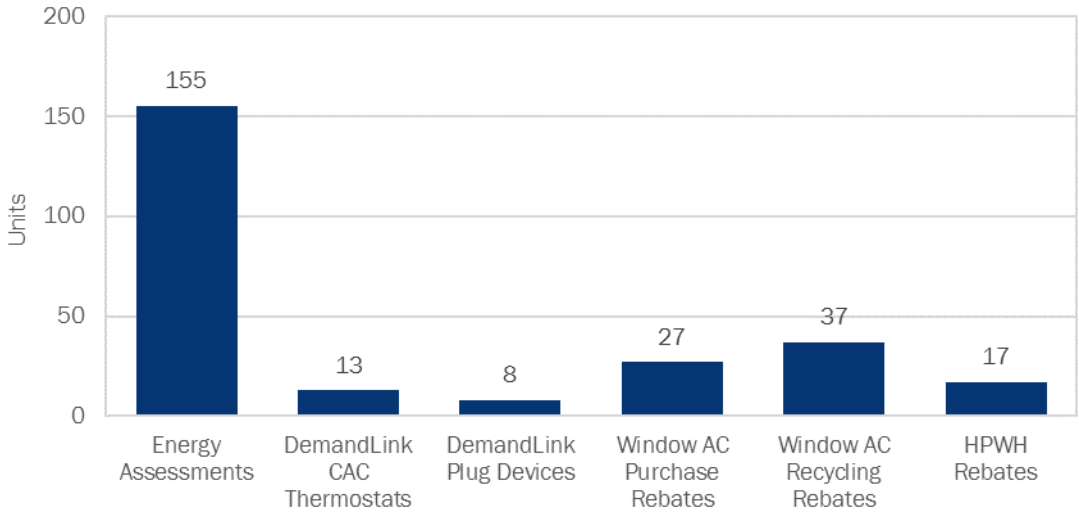
- **EnergyWise Home Energy Assessment Program.** The EnergyWise program provides residential customers with a home energy assessment and a range of direct install measures. It also offers enhanced incentives for additional measures that the customer can install following the assessment. In addition, the program serves as a platform for determining DemandLink eligibility and encouraging DemandLink participation

- **Small Business Direct Install (SBDI) Program.** The SBDI program is the equivalent of the EnergyWise program, but targets small non-residential customers.

- **Electric Heat Pump Water Heater (HPWH) Rebate.** In 2015, National Grid began offering customers an enhance rebate of $1,100 (compared to a $750 rebate offered to all customers statewide) for the purchase of a new electric HPWH. To be eligible for the rebate, customers have to participate in the DemandLink thermostat program.

Figure 1-2 summarizes 2016 achievements of the five residential pilot program components.

Figure 1-2. 2016 Pilot Area Achievements



1.2 2016 Targets and Planning Projections

The most recent cumulative targets for residential equipment installations of WiFi programmable thermostats (among central AC customers) and plug devices among customers served by the Tiverton substation through the end of 2016 were filed in October 2015. For planning purposes, SRP pilot program staff also developed projections for 2016 energy assessments completed through the EnergyWise Program.

In 2016, the pilot fell below planning projections for annual and cumulative equipment installations for energy assessments, DemandLink central AC thermostats, DemandLink plug devices, and HPWH rebates, but exceeded projections for window AC purchase and recycling rebates.

Table 1-1. Equipment Installations Compared to 2016 Planning Projections and Cumulative Targets

Program	Measure	2016 Units		Cumulative Units 2012-2016	
		# Projected	# Achieved	Target	# Achieved
EnergyWise Program	Energy Assessments	251	155	1,143[b]	1,047
DemandLink Thermostat Program	Thermostats for Central AC customers	50	13	303[a]	229
	Plug devices for Window AC customers	60	8	359[a]	300
DL Window AC Rebate and Recycling Program	New ENERGY STAR® Window AC Units	15	27	112[b]	124
	Recycled Window AC Units	30	37	154[b]	161
HPWH Rebate Program	HPWH Units	40	17	50[b]	27

[a] Source: Table S-6 of 2016 System Reliability Procurement Report. The Narragansett Electric Company. October 15, 2015. Docket number 4581.

[b] Calculated as cumulative units achieved in 2012-2015 plus projected units for 2016.

1.3 2016 Evaluation Activities

The evaluation of the 2016 SRP pilot included the following evaluation activities.

Participation Analysis

Using tracking data provided by National Grid, we summarized program participation in the pilot components for 2016 and the pilot to date. This data also served as the basis for sampling for the two surveys conducted in support of the 2016 evaluation.

EnergyWise Load Impact Analysis

We estimated load impacts for the 2016 EnergyWise Program using the same methodology as in prior evaluations: We identified, counted, and assigned ex ante gross load impacts (savings) to all EnergyWise measures installed in the pilot area to-date. We used 2016 load impact factors provided by National Grid for EnergyWise measures. We estimated net load impacts by applying the pilot-to-date "take rate" – established in the 2015 Annual Evaluation Report – to 2016 ex ante savings.

DemandLink Demand Response Event Failure and Opt-Out Analysis

We analyzed thermostat log files for the June through September 2016 peak season, supplied by Ecobee, to understand device connectivity issues and to determine the percentage of signaled devices that were successfully activated during events. We also analyzed the log files to determine how many customers opted out of each event.

DemandLink Demand Response Impact Analysis

We estimated impacts associated with each the 18 demand response events called by National Grid in 2016. For thermostats associated with central AC, we used event-level statistical analysis (regression) to estimate impacts on runtime. For thermostats associated with window AC, we calculated demand impacts by

applying per unit values from the 2014 and 2015 evaluations to participants who successfully received the event signal.

DemandLink Event Follow-Up Survey

We fielded a computer-assisted telephone interviewing (CATI) phone survey with participants who were enrolled in the controllable thermostat program component during the summer of 2016. The survey was conducted in the days following the August 29th demand response event and focused on participant event experience, including awareness of the event, whether the participant was at home, whether they opted out of the event, and the level of comfort (if they were at home).

Marketing Effectiveness Survey

We conducted an online survey with substation customers (program participants and non-participants) to assess a variety of topics: awareness of and interest in the various pilot program offerings, barriers to participation, recall of 2016 marketing activities, and the clarity and effectiveness of common 2016 messaging used in 2016. Appendix D presents details about the survey sampling methodology and survey disposition.

1.4 Organization of Report

The remainder of this report presents the results of the various research activities and analyses conducted in support of the evaluation of the pilot's 2016 program year. It is organized as follows:

- Section 2 presents an overview of 2016 participation in the five key residential pilot program components. This section also includes findings from the Marketing Effectiveness Survey related to program awareness, as well as interest in and barriers to participation among non-participating customers.
- Section 3 presents the EnergyWise gross and net load impact analyses.
- Section 4 presents the analyses of the DemandLink Thermostat Program, including the analysis of demand response event logs and opt-outs, results from the demand response event analyses for central AC and window AC, and findings from the Demand Response Event Follow-up Survey.
- Section 5 presents findings from the Marketing Effectiveness Survey related to customer recall of marketing activities, as well as the clarity and effectiveness of common messaging used in 2016 marketing materials.
- Appendix A provides additional detail on the methodology and results for the EnergyWise load impact analysis.
- Appendix B provides additional detail on the methodology and results for the DemandLink demand response analysis.
- Appendix C provides the detailed results of the Marketing Effectiveness Survey.
- Appendix D presents dispositions and response rates for the online Marketing Effectiveness Survey and the CATI Demand Response Event Follow-up Survey.

Findings in this report cover the period January 1, 2016 through December 31, 2016. In some cases, we provide pilot-to-date values, starting in March 2012.

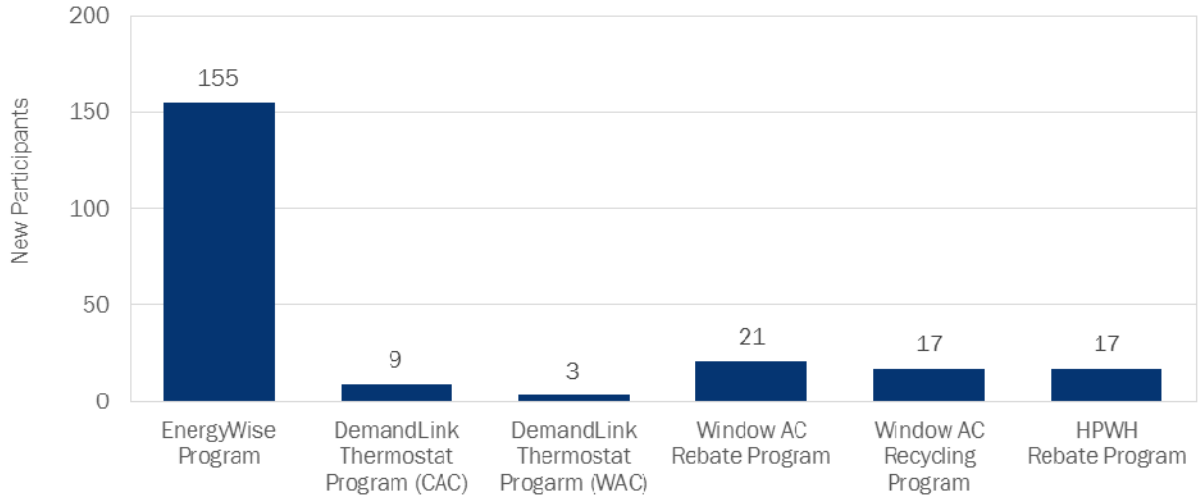
2. Participation Analysis

This section presents participation data for the various components of the pilot – including participation statistics for 2016 and the pilot as a whole – as well as information on program awareness, likelihood to participate, and barriers to participation from the 2016 Marketing Effectiveness Survey.

2.1 Participation Summary

Figure 2-1 provides an overview of the number of new participating households in the residential pilot program components in 2016. The following sections provide additional information for each program component.

Figure 2-1. 2016 Pilot Area Participation



Source: Program Tracking Data

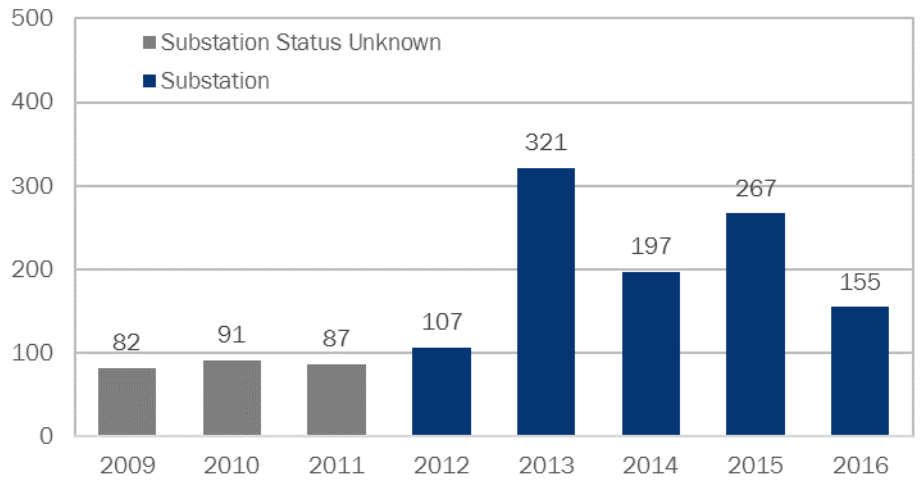
2.2 EnergyWise Program

Participation in the EnergyWise Program is a key measure of the pilot's success and of its potential to recruit participants for the DemandLink Program.

Participation

In 2016, 155 pilot area customers participated in the EnergyWise Program, down from an average of over 260 annual participants between 2013 and 2015. Despite the drop in 2016, participation is still significantly higher compared to pre-pilot levels (2009-2011), when an average of just under 90 pilot area customers participated in the program each year. Figure 2-2 presents annual participation counts in the pilot area.

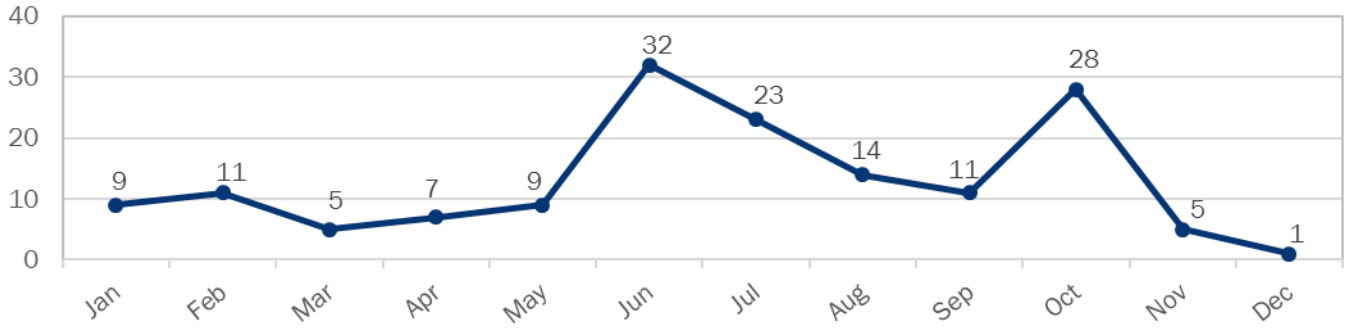
Figure 2-2. EnergyWise Asssessment Participants in SRP Pilot Communities (2009-2016)[a]



Source: Program Tracking Data
[a] Participant counts for the pre-pilot period 2009-2011 include non-substation participants.

Assessment activity was relatively slow between January and May and again at the end of the year. Of the 155 assessments completed in 2016, just over a half (54%) were completed in June, July, and October. June was the busiest month, with 32 assessments completed.

Figure 2-3. EnergyWise Assessments in SRP Pilot Communities by Month (2016)



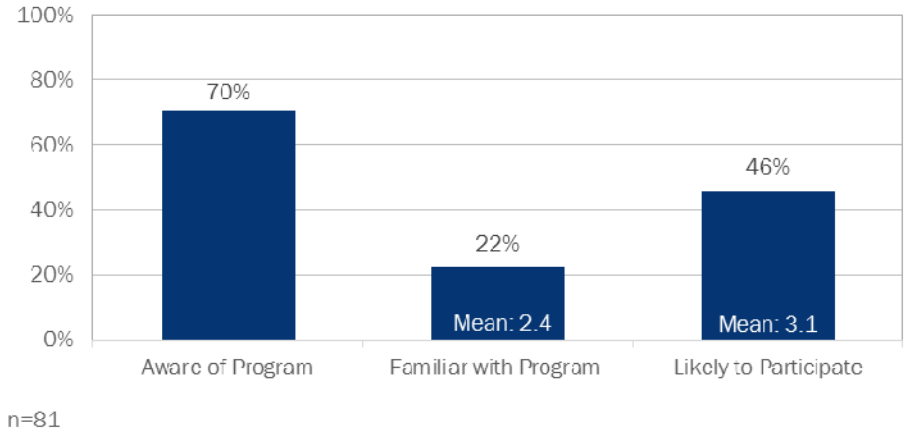
Source: Program Tracking Data

Awareness and Interest

General awareness of the EnergyWise Program is widespread among those who have not yet participated in the program while depth of familiarity is relatively limited: The majority of customers who have not participated in the EnergyWise Program are aware of the program (70%), but fewer than a quarter (22%) are familiar with it.[2] Just under half of those who have not participated (46%) report that they are likely[3] to do so in 2017.

[2] A rating of 4 or 5 on a 5-point scale, where 0 means "not at all familiar" and 5 means "very familiar".

Figure 2-4. Non-Participant Awareness of and Interest in EnergyWise Program



Source: Marketing Effectiveness Survey

Barriers to Participation

EnergyWise non-participants who indicated a low likelihood to participate in the program in 2017[4] were asked to rate their level of agreement with a series of statements regarding barriers to participation. A rating of 4 or 5 on a 5-point scale (where 1 means "very much disagree" and 5 means "very much agree") is defined as agreement while a rating of 1 or 2 is defined as disagreement.

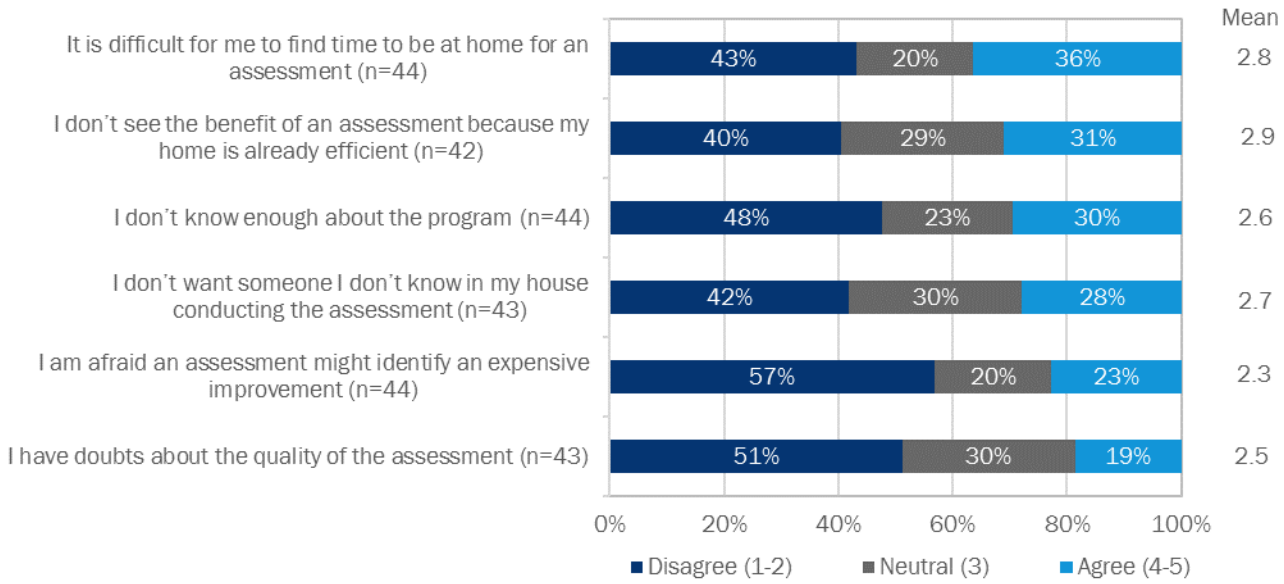
Overall, 82% of EneryWise non-participants agree and one half (50%) very much agree with at least one of the barrier statements. However, the specific barriers vary. Non-participants most often agree with the statement "It is difficult for me to find time to be at home for an assessment" (36%) and "I don't see the benefit of an assessment because my home is already efficient" (31%). Not knowing enough about the program (30% agreement) and not wanting a stranger in their house (28% agreement) are also frequently cited barriers. Fewer non-participants are concerned about discovering expensive improvements (23% agreement) or the quality of the assessment (19% agreement).

Average ratings for the various barriers range from 2.3 to 2.9 (out of a maximum of 5).

[3] A rating of 4 or 5 on a 5-point scale, where 0 means "not at all likely" and 5 means "very likely".

[4] "Low likelihood to participate" is defined as a likelihood rating of less than 4 or a "Don't Know" response.

Figure 2-5. Barriers to EnergyWise Participation



Source: Marketing Effectiveness Survey

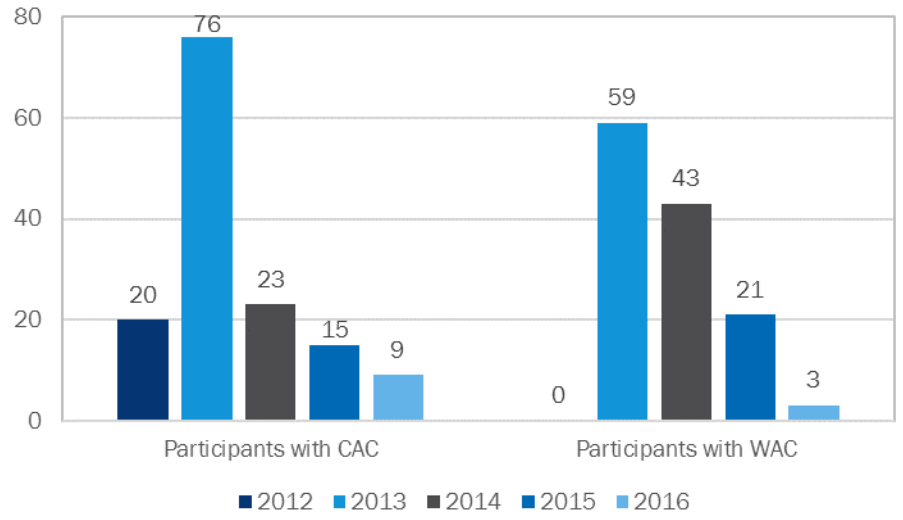
2.3 DemandLink Thermostat Program

Participation

In 2016, 12 new participants signed up to participate in the DemandLink Thermostat Program (9 with central AC and 3 with window AC) bringing the cumulative total to 269 substation participants. All nine new participants with central AC enrolled in the pilot through the Connected Solutions Program. In total, participants with central AC installed 13 thermostats (an average of 1.4 per home) and participants with window AC installed 8 plug devices (an average of 2.7 per home). These participation levels represent a further drop from prior years and are short of the 2016 planning projections of 50 thermostats among central AC users and 60 plug devices among window AC users. However, it should be noted that the program discontinued installation of plug devices in 2016, due to connectivity issues and the resulting low demand response event participation observed in 2014 and 2015.

Figure 2-6 summarizes annual participation in the DemandLink thermostat program component, by type of AC unit and first year of participation.

Figure 2-6. DemandLink Thermostat Program Participation in SRP Pilot Communities (2012 -2016)

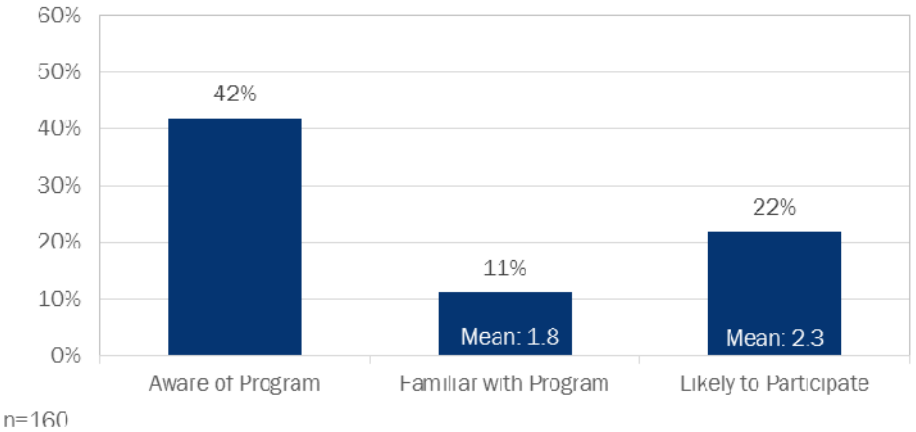


Source: Program Tracking Data

Awareness and Interest

General awareness of the DemandLink Program is robust among those who have not yet participated in the program (but significantly lower than awareness in the EnergyWise Program) but the level of familiarity is low: Fewer than half of non-participants (42%) are aware of the program and only 11% are familiar with it.[5] Just under a quarter of those who have not participated (22%) report that they are likely[6] to do so in 2017.

Figure 2-7. Awareness and Interest in DemandLink Program (Non-Participants)



Source: Marketing Effectiveness Survey

[5] A rating of 4 or 5 on a 5-point scale, where 0 means "not at all familiar" and 5 means "very familiar".

[6] A rating of 4 or 5 on a 5-point scale, where 0 means "not at all likely" and 5 means "very likely".

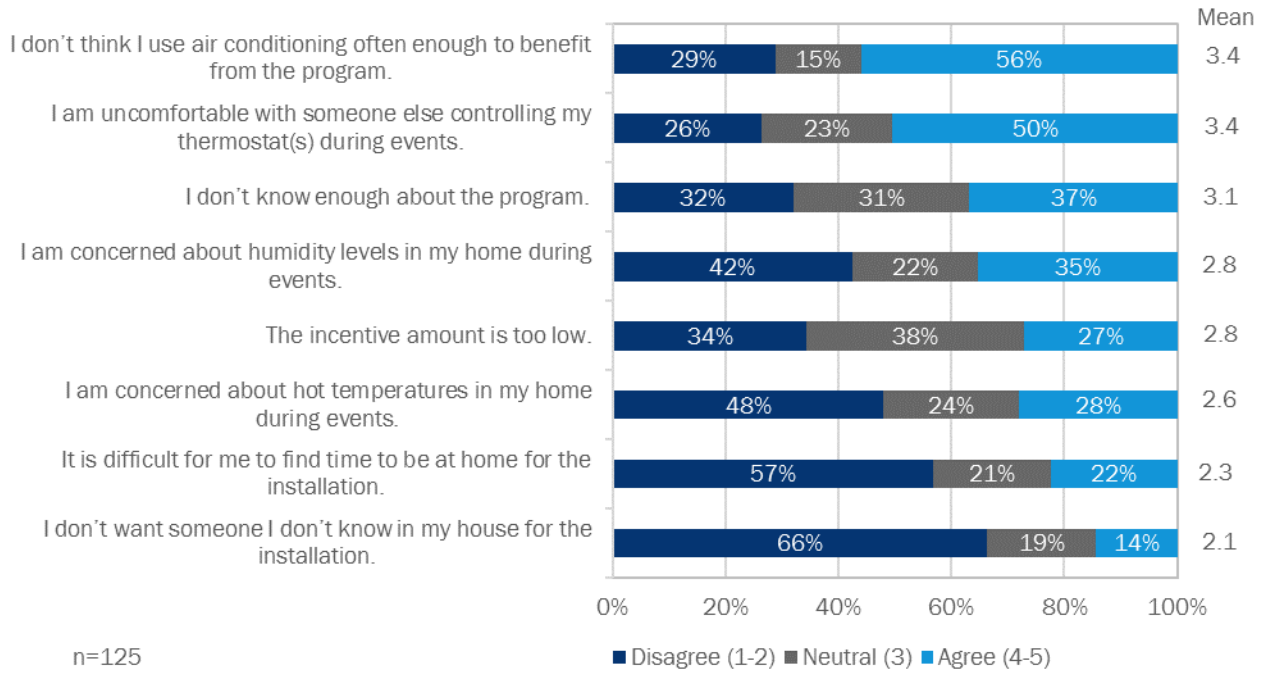
Barriers to Participation

DemandLink non-participants who indicated a low likelihood to participate in the program in 2017[7] were asked to rate their level of agreement with a series of statements regarding barriers to participation. A rating of 4 or 5 on a 5-point scale (where 1 means "very much disagree" and 5 means "very much agree") is defined as agreement while a rating of 1 or 2 is defined as disagreement.

Overall, 93% of DemandLink non-participants agree and 74% very much agree with at least one of the barrier statements. The perception that they do not use air conditioning enough (56% agreement) and being uncomfortable with someone else controlling their air conditioning (50%) were the barriers most often cited. In addition, more than a third of DemandLink non-participants agree with the statements, "I don't know enough about the program" (37%) and "I am concerned about humidity levels in my home during events" (35%).

Average ratings for the various barriers range from 2.3 to 2.9 (out of a maximum of 5).

Figure 2-8. Barriers to DemandLink Participation



Source: Marketing Effectiveness Survey

In addition to the barriers explored in the agreement statements, respondents cited equipment issues as an additional barrier: 13% of DemandLink non-participants do not use any air conditioning, and 10% do not have equipment that would make participation possible, or beneficial (e.g., wireless internet, a Smartphone, or a Smart thermostat-compatible heating system.

[7] "Low likelihood to participate" is defined as a likelihood rating of less than 4 or a "Don't Know" response.

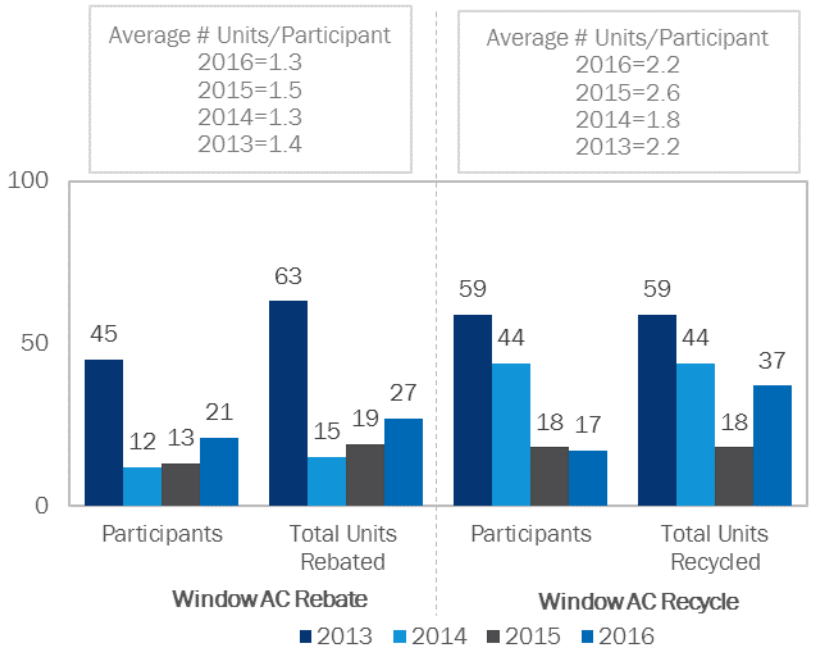
2.4 Window AC Rebate Program

Participation

In 2016, National Grid offered a $50 rebate for the purchase of up to four qualifying new window AC units and a $25 rebate for recycling up to four old units. These rebates were offered between May 1st and November 1st.

Overall, 32 unique customers in the pilot area received window AC rebates in 2016, installing 27 new ENERGY STAR® units and recycling 37 old units. Figure 2-9 shows participation and equipment counts in the pilot area between 2013 and 2016. Equipment counts for both types of rebate increased in 2016 compared with 2015.

Figure 2-9. Window AC Rebate Participation in SRP Pilot Communities (2013-2016)



Awareness and Interest

Applicability of the window AC rebates is limited to customers who have window AC units or are planning to use them during the summer. The Marketing Effectiveness Survey explored awareness of and interest in the window AC rebates among this subset of customers.

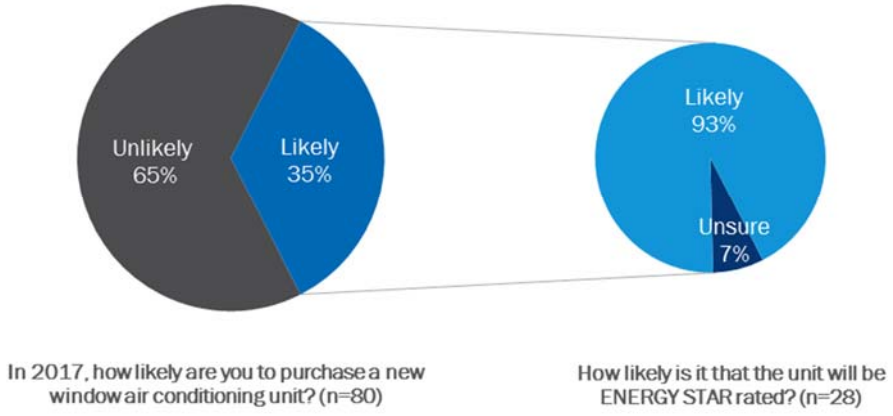
Window AC Purchase Rebate

Based on survey responses, the potential customer base eligible to receive a rebate for purchasing a new window AC unit is quite large: Almost 4 out of 10 customers (39%) use or plan to use window AC to cool their home in the summer, and 35% of those window AC users (or 14% of all customers) are likely[8] to purchase a

[8] A rating of 3 or greater on a 5-point scale, where 1 means "not at all likely" and 5 mean "very likely".

new window AC unit in 2017. A large majority of these likely buyers (93%) reported that they are likely to purchase an ENERGY STAR® rated model and apply for a rebate from National Grid.

Figure 2-10. Likelihood of ENERGY STAR® Window Air Conditioner Rebate Participation in 2017



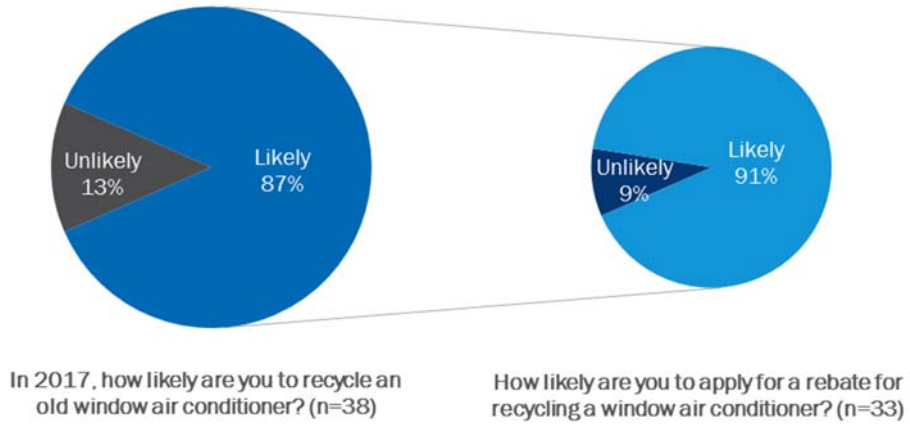
Source: Marketing Effectiveness Survey

However, more than half (57%) of window AC users who have not yet received a window AC rebate from National Grid, were unaware of the available rebates prior to taking the survey.

Window AC Recycling Rebate

Only 19% of customers have window AC units that they no longer use or that they might replace in 2017. Of these, a large majority (87%) are likely[9] to recycle an old unit, and nearly all of these likely recyclers (91%) reported that they are likely to apply for a rebate from National Grid for doing so.

Figure 2-11. Likelihood of Window AC Recycling Rebate Participation in 2017



Source: Marketing Effectiveness Survey

[9] A rating of 3 or greater on a 5-point scale, where 1 means "not at all likely" and 5 mean "very likely".

Awareness of the rebate for recycling window AC units is lower than awareness of the purchase rebate: More than 7 in 10 (71%) of window AC users who have not yet received a window AC rebate from National Grid, were unaware of the available rebates prior to taking the survey.

2.5 Heat Pump Water Heater Program

Participation

2016 was the second year that the pilot offered a $350 rebate for the purchase of an ulta-efficient electric HPWH, which could be combined with a rebate of $750 offered by the state. To be eligible for the rebate, customers have to participate in the DemandLink thermostat program. Overall, 17 DemandLink customers received a rebate for installing an electric HPWH in 2016, a significant increase from the 10 customers who participated in 2015.

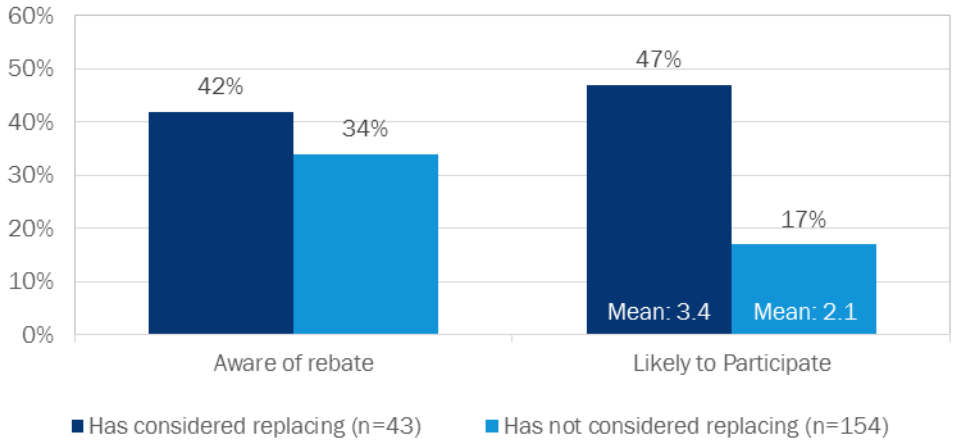
Awareness and Interest

The Marketing Effectiveness Survey explored awareness of and interest in the rebate for purchasing a HPWH among substation customers who own their home and have not yet participated in the program.

Given that the HPWH rebate is a relatively new offering for the pilot, non-participating homeowners report a relatively high awareness of the rebate (36%) and likelihood[10] to purchase a new HPWH through the program (38%). Not surprisingly, those who had previously considered replacing their current water heater (22% of non-participating homeowners) have higher levels of awareness and a significantly higher likelihood to participate than those who had not considering doing so (78% of non-participating homeowners). Still, nearly a two out of five (17%) of those who had not considered replacing their water heater prior to completing the survey indicate that they are likely to participate in the program.

Figure 2-12 compares awareness and likelihood responses of those who have and have not considered replacing their current water heater.

Figure 2-12. Awareness and Interest in HPWH Rebates (Non-Participants)



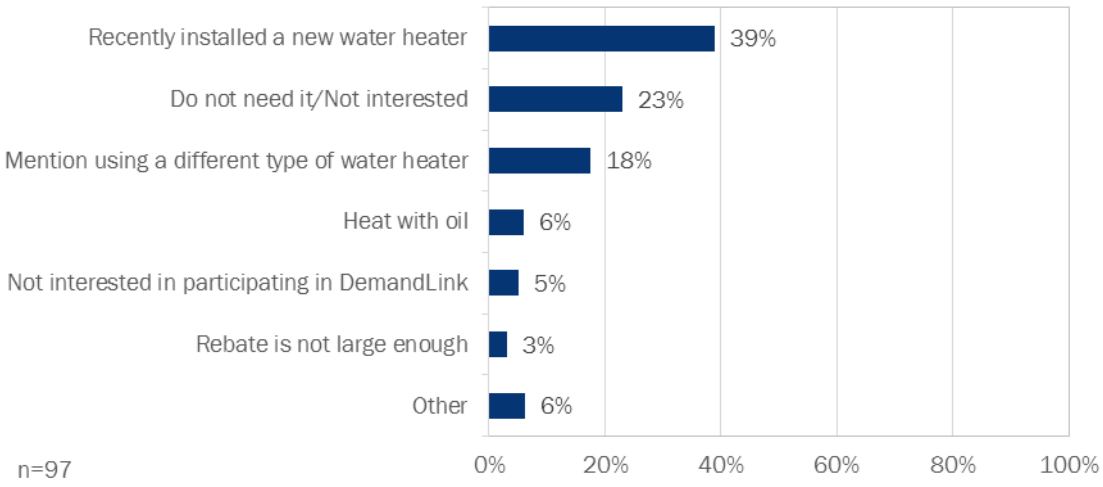
Source: Marketing Effectiveness Survey

[10] A rating of 3 or greater on a 5-point scale, where 1 means “not at all likely” and 5 mean “very likely”.

Barriers to Participation

Non-participating homeowners who indicated a low likelihood[11] to participate in the program in 2017 were asked why they were unlikely to do so. More than a third of these customers have recently installed a new water heater (39%) and nearly another quarter (23%) are simply not interested or do not feel that they need a new water heater. Another 17% indicate they use a different type of water heater and are not interested in switching.

Figure 2-13. Barriers to HPWH Rebate Participation



Source: Marketing Effectiveness Survey

[11] A rating of 1 or 2 on the 5-point scale, where 1 means "not at all likely" and 5 mean "very likely".

3. EnergyWise Impact Analysis

This section presents evaluation results for the EnergyWise Program. The 2016 evaluation included two analyses, presented in this section:

- Development of ex ante gross load impacts from the installation of EnergyWise measures
- Development of ex ante net load impacts from the installation of EnergyWise measures

3.1 EnergyWise Gross Impact Analysis

To determine the gross load impacts in the SRP pilot area from the installation of EnergyWise Program measures, we applied National Grid's 2016 Rhode Island-specific impact factors to the quantity of measures installed during the pilot period (March 2012 through December 2016), using the following formula:

*Peak Load Reduction (kW) = Quantity * per Unit kW Reduction * Summer Diversity Factor*

Table 3-1 shows the quantities and resulting peak kW load impacts for all installations in the pilot area during each year of the pilot period as well as for the pilot-to-date. Total impacts for 2016 installations are 39.8 kW, a 53% decrease relative to the 84.0 kW estimated for 2015 installations.[12] LED installations continue to dominate, both in terms of the quantity of measures installed (89%) and demand savings (83%). However, LED installations declined by over 50% relative to 2015. Smart strips, accounted for the second largest amount of 2016 load impacts (10%). All other measures accounted for 2% of impacts or less.

Total cumulative gross impacts for the pilot-to-date are 253.5 kW.

[12] Note that 2012, 2013, 2014 and 2015 impacts have been re-estimated using 2016 impact factors. The results for these years, presented in this table, are therefore different from those presented in Opinion Dynamics Corporation's report *2015 Annual Evaluation Report*, completed in 2016.

Table 3-1. Energy Wise Installed Measures and Ex Ante Gross Peak Load Reduction: March 2012-2016

Measure Category	Total Measure Quantity [a]						Total Peak Load Reduction (kW)					
	2012 [b]	2013	2014	2015	2016	Pilot to Date	2012 [b]	2013	2014	2015	2016	Pilot to Date
LED Bulb	87	998	3,946	10,973	5,060	21,064	0.6	6.5	25.6	71.3	32.9	136.9
CFL	2,382	8,670	1,867	233	47	13,199	13.6	49.6	10.7	1.3	0.3	75.5
Indoor Fixture	24	95	25	13	18	175	0.2	0.9	0.2	0.1	0.2	1.6
Torchiere	4	1	-	2	-	7	<0.1	<0.1	-	<0.1	-	0.1
Outdoor Fixture	1	11	26	19	31	88	-	-	-	-	-	-
Smart Strip	60	539	363	568	347	1,877	0.7	6.3	4.2	6.6	4.1	21.9
Refrigerator Brush	103	297	191	253	158	1,002	0.5	1.5	1.0	1.3	0.8	5.0
Refrigerator Rebate	3	6	5	4	2	20	0.3	0.6	0.5	0.4	0.2	1.9
Programmable Thermostat (all fuels)	5	41	18	32	25	121	0.2	1.5	1.2	1.2	0.9	4.9
Weatherization (all fuels)[a]	-	31	27	25	11	94	-	1.4	1.2	1.5	0.5	4.7
Ventilation – Other [a]	-	28	23	19	5	75	-	-	-	-	-	-
AC Timer	-	-	1	-	-	1	-	-	-	-	-	-
Aerator	-	65	-	-	3	68	-	0.5	-	-	<0.1	0.5
HPWH 50 Gallon	-	1	-	-	-	1	-	0.2	-	-	-	0.2
DHW Pipe Wrap/Insulation	-	3	12	21	-	36	-	<0.1	<0.1	0.1	-	0.1
Low Flow Showerhead	-	3	3	7	-	13	-	<0.1	<0.1	0.1	-	0.1
TOTAL	2,669	10,789	6,507	12,169	5,707	37,841	16.1	68.9	44.7	84.0	39.8	253.5

[a] Quantities of Ventilation and Weatherization are the accounts of unique participants. All other quantities are measure counts (e.g., count of installed bulbs).

[b] 2012 participation period is between 3/1/2012 and 12/31/2012.

It should be noted that the gross load impact analysis presented above simply applies measure counts to load factors used by National Grid; it does not include a review of the reasonableness of the load factors themselves nor a verification of measure installation and persistence. As such, these gross load impacts should be considered ex ante impacts, rather than ex post impacts.

3.2 EnergyWise Net Impact Analysis

The goal of the net impact analysis is to quantify the influence of the SRP pilot on customers' decisions to participate in the EnergyWise Program. To assess net peak load impacts, we apply a "take rate" to represent the proportion of EnergyWise savings that would not have occurred without incremental SRP marketing efforts.

It should be noted that the take rate applied in this analysis is based on the evaluation of the 2015 program year, which assessed the take rate for the EnergyWise Program between March 2012 and December 2015.[13] The 2015 evaluation developed the take rate based on two components:

1. **Incremental EnergyWise Participation Rate.** We first estimated the incremental EnergyWise participation rate among pilot area customers relative to (a) past participants and (b) participants in nearby communities. We conducted a database analysis of historical and SRP pilot period participation in the EnergyWise Program, to compare participation rates in SRP communities and comparison communities.

2. **SRP Attribution.** We then estimated SRP attribution based on responses to the EnergyWise participant survey. We fielded several waves of an online survey among participants in the EnergyWise Program between 2012 and 2015. The survey collected information on participants' recall of SRP and statewide marketing efforts and the influence of those materials on customer participation. Based on survey responses, we estimated the level of influence of SRP pilot efforts on participation.

We then combined the incremental participation rate and the SRP attribution to determine the overall SRP take rate. This take rate can then be applied to the estimated gross impacts to develop net impacts.

The take rate estimated in the evaluation of the 2015 program year was 51%, which is the mid-point between SRP attribution based on the incremental participation rate (54%) and the EnergyWise surveys (47%). Applying the two rates to the measure-level gross impacts presented in Section 3.1, we estimate that the pilot-to-date has achieved net peak load savings totaling 128.5 kW, with a range of 118.7 to 138.2 kW. Table 3-2 presents the impact ranges for each measure category and the program overall.

[13] Opinion Dynamics Corporation. *National Grid Rhode Island System Reliability Procurement Pilot: 2015 Annual Evaluation Report*. August 3, 2016. Section 2.3.

Table 3-2. 2012-2016 EnergyWise Incremental Load Impacts by Measure Category

Measure Category	3/1/2012 - 12/31/2016	
	Incremental Peak Load Reduction (kW)	Range (kW)
LED Bulbs	69.4	64.1 - 74.7
CFL	38.3	35.4 - 41.2
Indoor Fixtures	0.8	0.8 - 0.9
Torchiere	<0.1	<0.1 - <0.1
Outdoor Fixture	--	--
Smart Strip	11.1	10.3 - 12
Refrigerator Brush	2.5	2.3 - 2.7
Refrigerator Rebate	1.0	0.9 - 1
Programmable Thermostat	2.5	2.3 - 2.7
Weatherization (multiple fuels)	2.4	2.2 - 2.6
Ventilation – Other	--	--
AC Timer	--	--
Aerator	0.2	0.2 - 0.2
HPWH 50 Gallon	0.1	0.1 - 0.1
DHW Pipe Wrap/Insulation	0.1	0.1 - 0.1
Low Flow Showerhead	<0.1	<0.1 - <0.1
TOTAL	128.5	118.7 - 138.2

4. DemandLink Demand Response Event Analysis

This section presents evaluation results for the DemandLink WiFi Thermostat and plug device components of the SRP pilot. The 2016 evaluation included the following analyses, presented in this section:

- An analysis of demand response event participation, based on thermostat log files
- Analyses of demand response event impacts for customers with central AC and window AC
- An analysis of event experience based on our Demand Response Event Follow-up Survey

Appendix B presents additional detail on the DemandLink demand response impact analysis.

4.1 Analysis of Demand Response Event Participation

National Grid called a total of 18 demand response events during the 2016 summer peak season (see Figure 4-1 below). Events lasted from 3 p.m. to 7 p.m. for central AC units and from 4 p.m. to 6 p.m. for window AC units. For central AC, setpoints were increased by 2°F; for window AC, the unit was shut off for the duration of the event.

Figure 4-1. 2016 Demand Response Events

July 2016						
Su	Mo	Tu	We	Th	Fr	Sa
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

August 2016						
Su	Mo	Tu	We	Th	Fr	Sa
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

September 2016						
Su	Mo	Tu	We	Th	Fr	Sa
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

To determine participation in these 18 events and to support the impact analysis of the 2016 demand response events, Opinion Dynamics analyzed thermostat log files for the June through September peak season. The following sections summarize this analysis for central AC thermostats and window AC thermostats, respectively.

4.1.1 Log File Analysis for Thermostats Controlling Central AC

For each event, we assigned each central AC thermostat to one of the following categories:

1. **Log file is missing:** We did not receive the log file from Ecobee.
2. **Log file contains no data:** We received a log file that covers the day of the event, but the file does not contain any data for the event. This category includes files that have empty runtime fields or zero (or near zero) runtime across all events. These thermostats were excluded from our impact analysis.
3. **Log file has usable data:** The log files in this category indicate that the central AC was connected to the customer's Wi-Fi and was able to participate in events. On a given event day, a thermostat with usable data can fall into one of the following categories:

a. ***No load to drop:*** The log file shows that the unit was not running prior to the event, i.e., there was no load to drop.

b. ***Event failure:*** We define "event failure" as cases where a thermostat does not respond to the event. This can occur because the thermostat is offline or because the thermostat did not receive the signal to begin the event.

c. ***Event opt-out:*** We define an event "opt-out" if the thermostat received the event signal, but the setting switched out of event mode *and* the AC unit began cooling before the end of the event (the latter condition avoids flagging customers as an opt-out if they *raised* their temperature set-point during the event).

d. ***Event participant:*** The log file shows that the unit was running before the event and that the thermostat received the event signal. The log file shows an increase in temperature settings and there is no indication that the customer overrode the event, i.e., that they opted-out of the event.

Based on program tracking data, 208 thermostats controlling central AC units were in place in the pilot area during the 2016 event season. We received no log files for 36 of these 208 thermostats (17%); for an additional 28 thermostats (13%), we only received log files for August and September, but not for July. Our analysis of the log files we received shows the following:

- A number of log files (27 for July events, 29 for August/September events) contained no data or only zeroes (indicating that the central AC unit was only used for a couple of days or that the thermostat was malfunctioning). These thermostats were dropped from the analysis, leaving 117 thermostats for July events and 143 thermostats for August/September events to be included in our central AC demand response event analysis.
- On average, 13 log files per event showed only zero values before and during the event, meaning the AC was not running and there was no load to drop.
- On average, 11 thermostats per event experienced event failure. The majority of these did not receive a signal; only a handful (between 0 and 6 in a given event) were offline.
- On average, 15 thermostats opted out per event. The number of opt-outs in any event ranged from 7 to 25, representing between 3% and 12% of all installed central AC thermostats. Expressed as a percentage of those who had load to drop and received the event signal, opt-outs ranged from 7% to 22% with an average of 14%.
- Between 80 and 99 thermostats participated in each event, representing between 38% and 48% of all installed central AC thermostats.

Thermostats with the following statuses were included in or demand response event analysis, described in Section 4.2.1: event failure – no signal, event opt-out, and event participant. Thermostats with missing log files, with log files that contained no usable data, with only zero values, or offline were excluded from the demand response event analysis, at the event level.

Table 4-1 summarizes our central AC log file analysis, by event.

Table 4-1. Summary of Central AC Log File Analysis

	Missing Log File		Log File with No Data		Only Zero Values		Event Failure				Event Opt-out		Event Participant	
							Offline		No Signal					
Event	#	%	#	%	#	%	#	%	#	%	#	%	#	%
1	64	31%	27	13%	14	7%	-	0%	2	1%	10	5%	91	44%
2	64	31%	27	13%	15	7%	-	0%	1	0.5%	7	3%	94	45%
3	64	31%	27	13%	5	2%	-	0%	5	2%	15	7%	92	44%
4	64	31%	27	13%	7	3%	1	0.5%	3	1%	9	4%	97	47%
5	64	31%	27	13%	13	6%	1	0.5%	5	2%	18	9%	80	38%
6	64	31%	27	13%	12	6%	2	1%	4	2%	8	4%	91	44%
7	64	31%	27	13%	8	4%	2	1%	6	3%	10	5%	91	44%
8	64	31%	27	13%	9	4%	2	1%	2	1%	12	6%	92	44%
9	64	31%	27	13%	9	4%	2	1%	4	2%	11	5%	91	44%
10	36	17%	29	14%	28	13%	1	0.5%	11	5%	15	7%	88	42%
11	36	17%	29	14%	14	7%	1	0.5%	14	7%	17	8%	97	47%
12	36	17%	29	14%	12	6%	2	1%	13	6%	24	12%	92	44%
13	36	17%	29	14%	7	3%	2	1%	13	6%	22	11%	99	48%
14	36	17%	29	14%	11	5%	5	2%	13	6%	25	12%	89	43%
15	36	17%	29	14%	15	7%	3	1%	12	6%	23	11%	90	43%
16	36	17%	29	14%	15	7%	3	1%	15	7%	20	10%	90	43%
17	36	17%	29	14%	23	11%	4	2%	16	8%	10	5%	90	43%
18	36	17%	29	14%	16	8%	6	3%	13	6%	22	11%	86	41%
Mean	**50**	**24%**	**28**	**13%**	**13**	**6%**	**2**	**1%**	**8**	**4%**	**15**	**7%**	**91**	**44%**

4.1.2 Log File Analysis for Thermostats Controlling Window AC

For each event, we assigned each window AC thermostat to one of the following categories:

1. **Log file is missing:** We did not receive the log file from Ecobee.
2. **Log file contains no data:** We received a log file that covers the day of the event, but the file does not contain any data for the event. This category includes files that are either missing the field(s) that contain plug usage or that have the plug usage field(s) but they are empty. In addition, this category includes files that are missing records during the event (i.e., there is a data gap).
3. **Log file has usable data:** The log files in this category have some data, suggesting that the unit is connected to the customer's Wi-Fi and is able to participate in events. On a given event day, a thermostat with usable data can fall into one of the following categories:
    a. ***No load to drop:*** The log file shows that the unit was not running prior to the event, i.e., there was no load to drop. This category also includes log files that show very small, non-zero plug usage values during the event, indicating that something other than a window AC was plugged into the plug device.
    b. ***Event failure:*** We define "event failure" as cases where a thermostat does not respond to the event. This can occur because the thermostat is offline or because the thermostat did not receive the signal to begin the event.

c. ***Event opt-out:*** For window AC thermostats, we define an event "opt-out" if the thermostat received the event signal, but the log file shows positive plug usage before the end of the event.

d. ***Event Participant:*** The log file shows that the unit was running before the event and that the thermostat received the event signal. The log file shows zero plug usage for the duration of the event.

Based on program tracking data, 158 thermostats controlling window AC units were in place in the pilot area during the 2016 event season. We received no log files for 36 of these 158 thermostats (23%); for an additional 44 thermostats (28%), we only received log files for August and September, but not for July. Our analysis of the log files we received shows the following:

July Events (Events 1 through 9)

- None of the 78 log files received for the July events (Events 1 through 9) contained any data. In most of these log files, the fields that contain plug usage were missing; in a few cases, a header for one or more plug usage fields was present, but the field(s) contained no data.
- Given these findings, we cannot verify that any plug devices participated in July events. The demand response savings from these events are therefore assumed to be zero.

August/September Events (Events 10 through 18)

- For all August and September events, either 107 or 108 of the 122 log files received (88-89%, or 68% of all window AC thermostats) contained no data. Similar to the July events, in most cases there the plug usage fields were missing; in a few cases, a header for one or more plug usage fields was present, but the field(s) contained no data.
- The remaining files, representing between 9% and 10% of all window AC thermostats, contained mostly zero values. Two thermostats had non-zero values that were too small to be a window AC, indicating that the participants had plugged something other than a window AC into the plug device. Only one of the 158 window AC thermostats (0.6%) showed plug usage data consistent with a window AC for seven out of the nine August/September events. This participant opted out of all seven events.
- Based on these results, we can verify demand response savings from an average of 0.8 thermostats for August and September events.[14]

Averaging findings from the July and August/September events, we can verify demand response savings from an average of 0.4 units per event.

Table 4-2 summarizes our window AC log file analysis, by event.

[14] We apply the per-unit event savings value to opt-outs because our 2014 and 2015 demand response analyses included opt-outs in developing the per-unit savings estimate. As such the per-unit savings value reflects both full participants and opt-outs and should be applied to both.

Table 4-2. Summary of Window AC Log File Analysis

Event	Missing Log File		Log File with No Data		Only Zero Values		Event Failure		Event Opt-out		Event Participant	
	#	%	#	%	#	%	#	%	#	%	#	%
1	80	51%	78	49%	-	0%	-	0%	-	0%	-	0%
2	80	51%	78	49%	-	0%	-	0%	-	0%	-	0%
3	80	51%	78	49%	-	0%	-	0%	-	0%	-	0%
4	80	51%	78	49%	-	0%	-	0%	-	0%	-	0%
5	80	51%	78	49%	-	0%	-	0%	-	0%	-	0%
6	80	51%	78	49%	-	0%	-	0%	-	0%	-	0%
7	80	51%	78	49%	-	0%	-	0%	-	0%	-	0%
8	80	51%	78	49%	-	0%	-	0%	-	0%	-	0%
9	80	51%	78	49%	-	0%	-	0%	-	0%	-	0%
Mean-July	*80*	*51%*	*78*	*49%*	*-*	*0%*	*-*	*0%*	*-*	*0%*	*-*	*0%*
10	36	23%	108	68%	14	9%	-	0%	-	0%	-	0%
11	36	23%	108	68%	13	8%	-	0%	1	0.6%	-	0%
12	36	23%	107	68%	14	9%	-	0%	1	0.6%	-	0%
13	36	23%	108	68%	13	8%	-	0%	1	0.6%	-	0%
14	36	23%	108	68%	13	8%	-	0%	1	0.6%	-	0%
15	36	23%	108	68%	13	8%	-	0%	1	0.6%	-	0%
16	36	23%	108	68%	13	8%	-	0%	1	0.6%	-	0%
17	36	23%	108	68%	14	9%	-	0%	-	0%	-	0%
18	36	23%	107	68%	14	9%	-	0%	1	0.6%	-	0%
Mean-Aug/Sep	*36*	*23%*	*108*	*68%*	*13*	*9%*	*-*	*0%*	*0.8*	*0.5%*	*-*	*0%*
Mean-Total	58	37%	93	59%	7	4%	-	0%	0.4	0.2%	-	0%

4.2 Demand Response Impact Analysis

4.2.1 Demand Response Impacts – Central Air Conditioning

This section presents the demand response impact results for participants with central AC. Table 4-3 presents the demand response impacts for the eighteen events called in 2016. Each event has between eight and thirteen matched comparison days that we used to develop the modeled baseline. Opinion Dynamics also estimated impacts for an overall event that uses data from all 18 events. Note that the result for the overall event is not a simple average of the eighteen single events. Rather, the baseline used to calculate the overall event impacts is slightly different than that used for each event because we included all comparison days in the model. As a result, the impact estimate is not exactly the same as if we had averaged the eighteen events. Estimated impacts for each event hour are presented later in this section.

Table 4-3. Central AC Demand Response Impact

	Per-Thermostat Impact		# of Participating Thermostats	Program Impact	Average Temperature During Event Hours
	Runtime Reduction	kW		kW	
Overall	**10.9%**	**0.40**	**115**	**46**	**81°F**
Wed 7/6	10.7%	0.40	103	41	82°F
Thur 7/7	15.1%	0.56	102	57	75°F
Fri 7/15	8.3%	0.31	112	34	83°F
Mon 7/18	17.8%	0.66	109	72	78°F
Fri 7/22	10.0%	0.37	103	38	78°F
Mon 7/25	14.4%	0.53	103	55	77°F
Tue 7/26	13.9%	0.51	107	55	89°F
Wed 7/27	15.1%	0.56	106	59	81°F
Thur 7/28	16.7%	0.62	106	65	80°F
Tues 8/9	14.1%	0.52	114	59	80°F
Thur 8/11	15.3%	0.57	128	72	82°F
Fri 8/12	13.8%	0.51	129	66	80°F
Sat 8/13	11.4%	0.42	134	56	83°F
Tue 8/16	16.2%	0.60	127	76	80°F
Fri 8/26	13.4%	0.50	125	62	82°F
Sat 8/27	10.5%	0.39	125	48	80°F
Mon 8/29	8.0%	0.30	116	34	86°F
Fri 9/9	9.7%	0.36	121	43	87°F

We used a linear fixed-effects regression modeling approach for the demand response impact analysis. The models estimate the percentage of hourly runtime on a per-thermostat level. Event savings are the mean difference between the baseline runtime and the event runtime over the event period multiplied by mean full load demand. We used an average estimate of full load central AC demand of 3.69 kW at full load to estimate the kW savings per thermostat. Not all thermostats had logs for all of the event periods, so we only applied savings for those thermostats where we could confirm operation. The program total impact is the product of the per-thermostat kW impact averaged over the event period and the number of participating thermostats. All operational thermostats were included in the model, including those who received no signal and those who opted out of the event. The impact estimates therefore include the effect of any participant opt-outs.

Opinion Dynamics calculated the full load kW demand for an average central AC unit in Rhode Island based on Equation 4-1 which uses deemed average equipment cooling capacity (in Btu per hour) and equipment efficiency (EER) values from the RI Technical Reference Manual (TRM). The resulting full load demand per central AC unit is 3,692 watts, or 3.69 kW.

Equation 4-1. Full Load kW for Central AC

Full load kW = Capacity / EER

Where:

Capacity = 3 tons or 36,000 Btu/hr[15]

EER (Btu/watt-hr) = 9.75[16]

Figure 4-2 depicts the hourly event usage and baseline usage for the overall average event. The event period shows significant runtime reduction, with a small snapback in the two hours after the event ends. The snapbacks are largely similar to those observed in 2015, and larger than those in 2014.

Figure 4-2. Overall Hourly Event Day Usage with Baseline

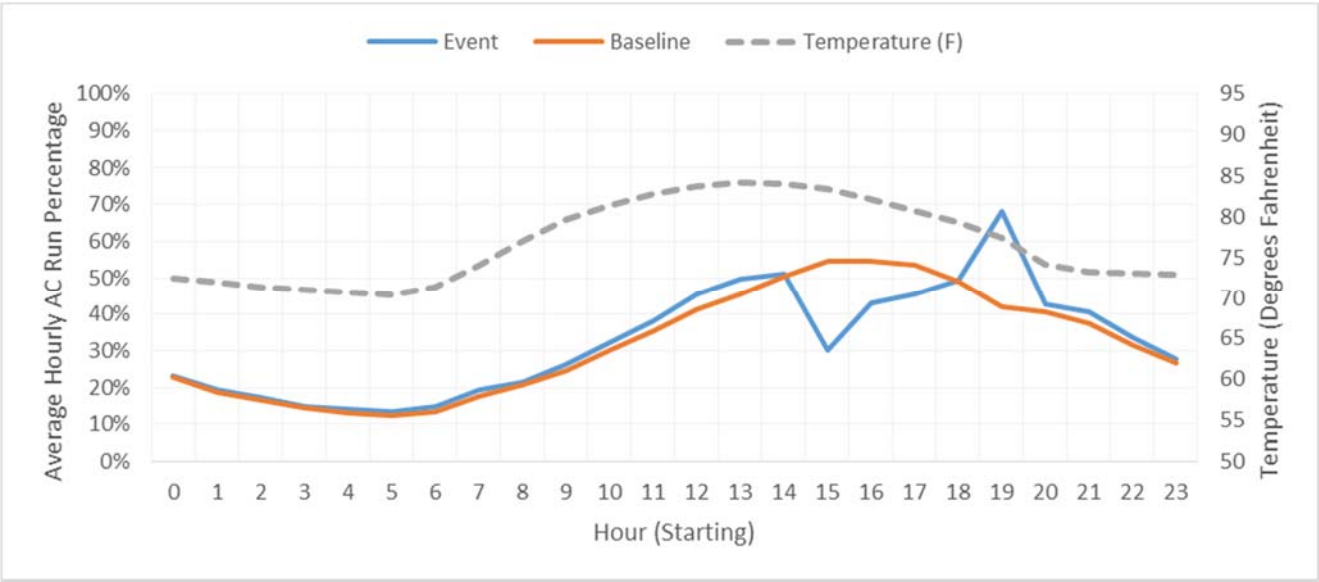


Figure 4-3, Figure 4-4, and Figure 4-5 show the runtime percentage along with the baseline used to calculate demand impact for three events of interest: one typical event with savings close to the overall average (Wednesday, July 7), the event with the highest savings (Monday, July 18), and the event with the lowest savings (Monday, August 29). In all three events, there is significant demand reduction during the event hours followed by a short snapback period of increased demand.

Although we cannot definitively explain the differences in savings across these three events with the available data, the differences in load curves shapes during the event periods are striking. Savings for the

[15] RI PY2014 TRM Central AC page M-25: Tons = deemed average equipment cooling capacity: 3 tons

[16] The RI PY2014 TRM has measures for traditional AC replacement (page M-25) and early replacement central AC replacement (M-40). The EER used for this analysis assumes an average (i.e., 9.75) between the baseline EER of new equipment (EER = 11: page M-25), and the baseline EER of early replacement equipment (EER = 8.5: page M-40). If we only used the current baseline of new equipment (EER 11) we would be underestimating savings since there are likely older pieces of equipment in use that do not meet current baseline requirements. If we assumed only the early replacement baseline (EER 8.5), we would likely be overestimating savings as there are likely newer pieces of equipment that have a higher efficiency. Taking the average appears to be a more accurate estimate and can be verified through future data collection efforts that analyze the exact capacity and efficiency of the units participating in the program.

August 29 event decrease sharply in the later hours of the event. This is surprising given that this event does not have an unusually high opt-out rate. Perhaps the more important question is not how many participants opted out, but what participants did *after* opting out. Did they simply return their thermostats to normal, or did they aggressively crank up their AC units?

Figure 4-3. Event 1, July 7th Hourly Usage with Baseline (Typical Event)

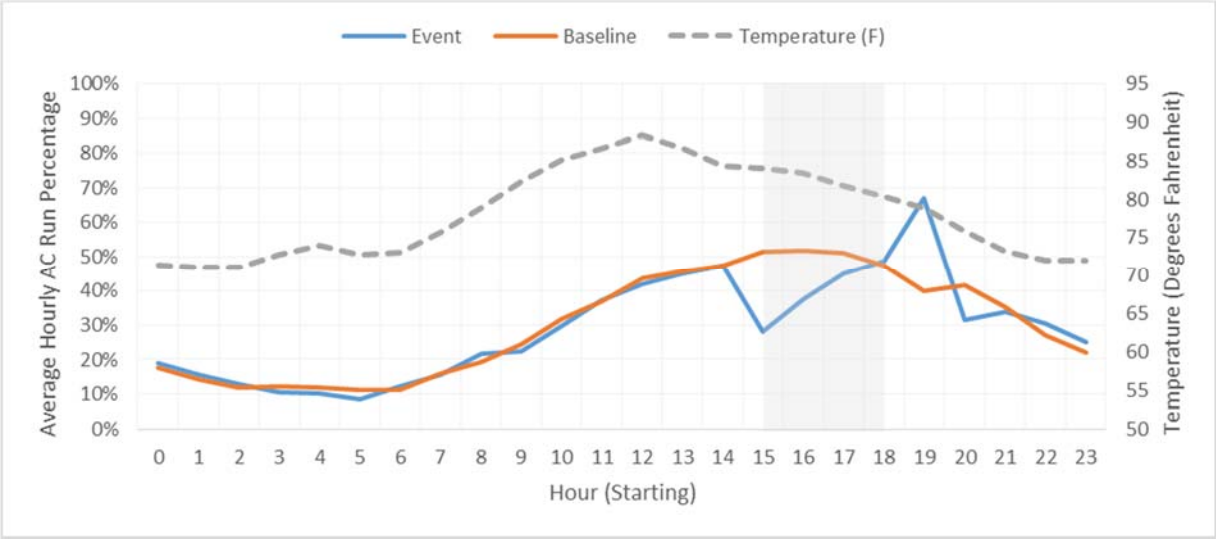


Figure 4-4. Event 4, July 18th Hourly Usage with Baseline

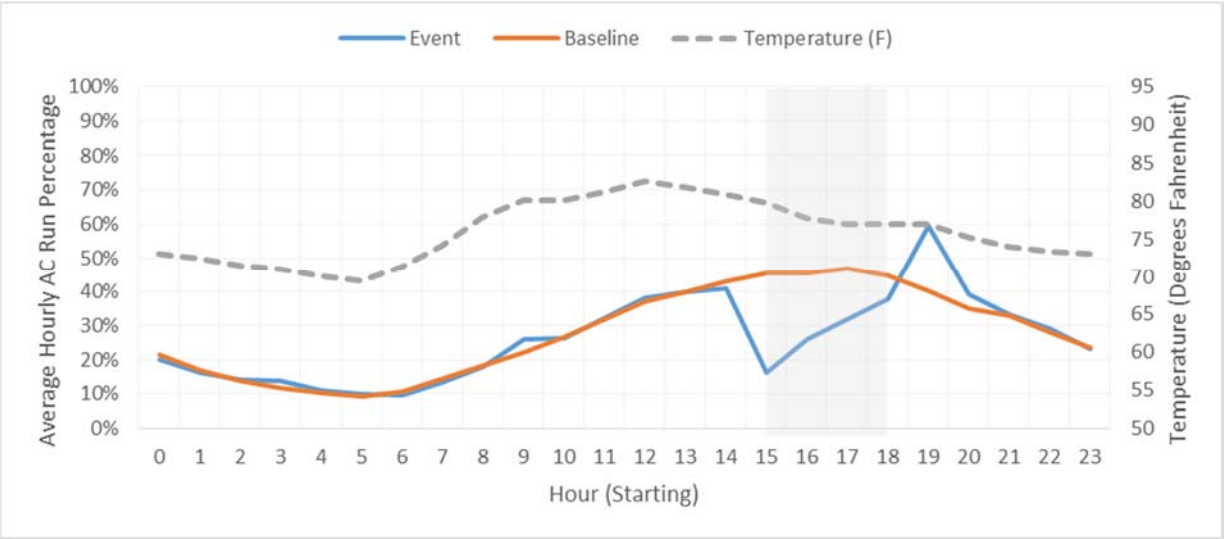
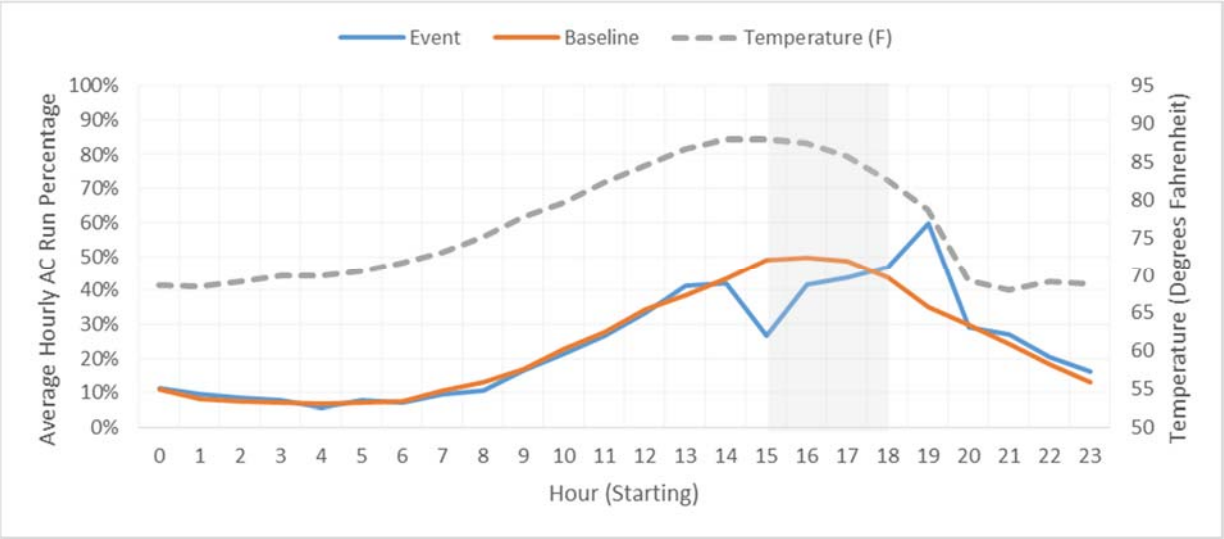


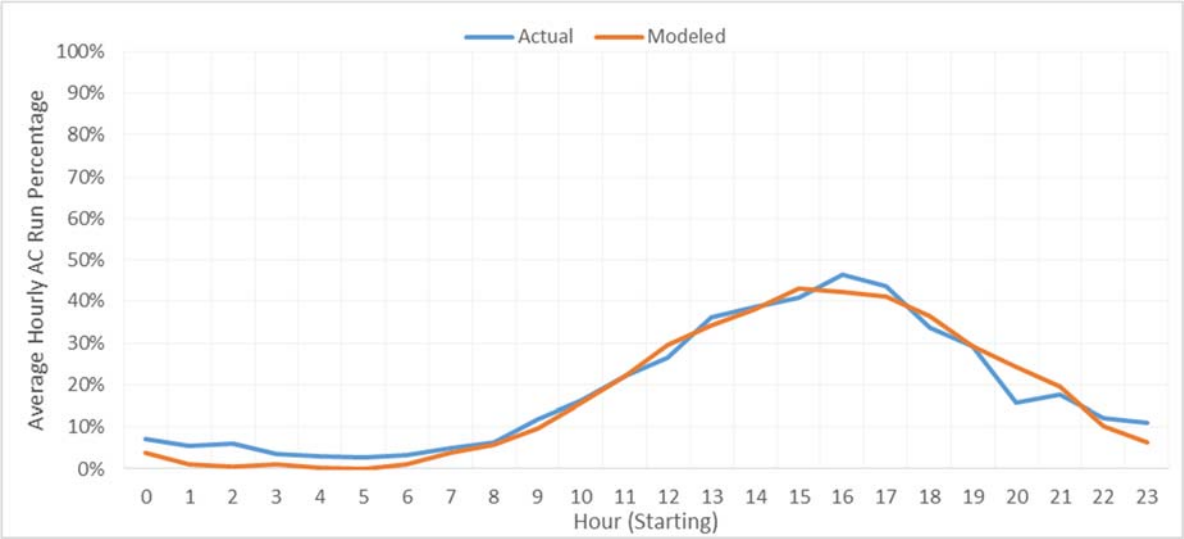
Figure 4-5. Event 17, August 29th Hourly Usage with Baseline



Model Validation

The primary method for evaluating the validity of a linear fixed effects model is to compare actual, logged run time to the baseline runtime predicted by the model. When actual and baseline are similar, especially on non-event days with weather similar to event days, it shows that the model is effectively estimating the baseline. The primary reason for the model is to estimate a baseline on event days, so matching non-event day usage is the best way to demonstrate model effectiveness. However, there was no single non-event day that truly approximated event day temperatures. Most event days had a rapid increase in temperature in the late morning, while the hottest non-event days were relatively hot all day. As a result, we validated the model using a combination of two days: one that was hot throughout and one that had a temperature increase comparable to that of an event day. Figure 4-6 shows the modeled baseline on a non-event day. The modeled baseline matches to within 3% of actual runtime. The close match of the modeled baseline and actual usage in the hours leading up to the event in Figure 4-2 increases our confidence that the model estimates baseline usage accurately.

Figure 4-6. Non-event Day Baseline versus Actual AC Run Percentage



Hourly Event Results

The table below provides hourly per-thermostat savings estimates and standard errors (SE) for each of the 18 2016 demand response events. As is often the case with demand response programs, the first hour of the event achieved the highest savings, with an average of 0.91 kW across all events. Each subsequent event hour achieved smaller savings. The largest instantaneous per-thermostat reduction of the 2016 season occurred during the first hour of Event 8. During that hour, the average load reduction by central AC thermostats was 1.20 kW. Notably, hourly savings for the fourth event hour were zero across all 18 events, with several events achieving negative savings.

Table 4-4. Hourly DemandLink Impact Results

Event	Date	Time	Hour 1		Hour 2		Hour 3		Hour 4	
			kW	*SE*	kW	*SE*	kW	*SE*	kW	*SE*
Overall			**0.91**	**0.10**	**0.42**	**0.11**	**0.30**	**0.10**	**-0.01**	**0.09**
1	Wed 7/6	3-7pm	0.87	0.12	0.53	0.13	0.22	0.12	-0.04	0.11
2	Thur 7/7	3-7pm	0.76	0.13	0.64	0.12	0.63	0.10	0.21	0.10
3	Fri 7/15	3-7pm	0.82	0.13	0.30	0.13	0.28	0.12	-0.16	0.11
4	Mon 7/18	3-7pm	1.09	0.10	0.73	0.10	0.56	0.11	0.26	0.11
5	Fri 7/22	3-7pm	0.81	0.13	0.39	0.12	0.28	0.13	0.01	0.12
6	Mon 7/25	3-7pm	0.87	0.13	0.59	0.12	0.40	0.11	0.27	0.11
7	Tue 7/26	3-7pm	1.15	0.13	0.56	0.13	0.31	0.13	0.02	0.13
8	Wed 7/27	3-7pm	1.20	0.10	0.64	0.11	0.36	0.12	0.04	0.12
9	Thur 7/28	3-7pm	1.11	0.12	0.61	0.12	0.54	0.12	0.20	0.11
10	Tues 8/9	3-7pm	0.92	0.12	0.54	0.12	0.53	0.12	0.08	0.11
11	Thur 8/11	3-7pm	1.12	0.10	0.65	0.11	0.44	0.11	0.05	0.10
12	Fri 8/12	3-7pm	0.84	0.11	0.39	0.11	0.53	0.10	0.29	0.10
13	Sat 8/13	3-7pm	0.83	0.12	0.39	0.11	0.34	0.11	0.13	0.11
14	Tue 8/16	3-7pm	1.16	0.09	0.64	0.10	0.43	0.10	0.17	0.10

Event	Date	Time	Hour 1		Hour 2		Hour 3		Hour 4	
			kW	*SE*	kW	*SE*	kW	*SE*	kW	*SE*
15	Fri 8/26	3-7pm	0.98	0.09	0.48	0.10	0.41	0.10	0.11	0.09
16	Sat 8/27	3-7pm	0.69	0.12	0.42	0.11	0.27	0.11	0.17	0.10
17	Mon 8/29	3-7pm	0.82	0.11	0.30	0.12	0.18	0.11	-0.12	0.11
18	Fri 9/9	3-7pm	0.82	0.13	0.34	0.14	0.19	0.14	0.10	0.12

4.2.2 Demand Response Impacts – Window Air Conditioning

Our 2014 and 2015 demand response impact analyses for window AC units were based on linear fixed effects models, similar to those used for the analyses for central AC events. However, due to the small number of operating window AC units, it was decided to forgo development of a new model for the 2016 evaluation and to instead apply per-unit savings values from the prior analyses to units that participated in 2016.

We developed a per-unit savings value for 2016 events by taking the average of 2014 and 2015 results, weighted by the number of events in each year. This approach represents a close approximation of likely results, had we combined the events of both years into one model. Using this approach, we estimate the 2016 per-thermostat demand savings to be 0.045 kW.

Table 4-5 presents the data for 2014 and 2015 and the resulting weighted average.

Table 4-5. Estimation of Per-Thermostat Reduction for 2016

	Per-Thermostat Reduction (kW)	Number of Events
2014	0.07	3
2015	0.04	15
Weighted Average	0.045	

As described in Section 4.1.2, based on the log files available for window AC thermostats, we estimate that, on average, 0.4 thermostats participated per 2016 event. Multiplying this value by the 2016 per-thermostat value of 0.045 kW yields demand response event savings for window AC units of 0.018 kW.

Table 4-6 summarizes these results.

Table 4-6. Window AC Demand Response Impact

	Per-Thermostat Reduction (kW)	Participating Thermostats	Program Impact (kW)
2016 Events	0.045	0.4	0.018

4.3 Demand Response Event Follow-Up Analysis

This section presents results from the Demand Response Event Follow-up Survey, conducted between August 30th and September 1st, following the SRP demand response event called on August 29th. The survey targeted all residential participants who were enrolled in the DemandLink controllable thermostat component during the 2016 cooling season. The survey focused on the following topics:

1. Verification of continued installation and use of the program-provided thermostat and plug devices (for customers with window air conditioning);

2. General awareness of event processes, including customer notification, bill credits, and opt-out option;

3. Participant experience during the August 29th event, including awareness of the event, whether the participant was at home during the event, whether they opted out, and the level of comfort (if they were at home); and

4. Overall recall of 2016 events and likelihood to participate in the future.

Overall, 52 SRP participants completed the event follow-up survey, including two who did not recall receiving the program-provided equipment. The following subsections summarize responses of the 50 participants who confirmed receiving the program-provided equipment. Of these 50 respondents, 28 use their thermostats to control central AC systems, 20 use their thermostats to control window AC units, and two use their thermostats to control both.[17]

4.3.1 Equipment Installation and Use

Overall, participants reported continued installation and use of the programmable thermostats during the 2016 cooling season. The 50 survey respondents received a total of 74 thermostats through the pilot. All but one of these thermostats (73, or 99%) were still installed during the August 29th demand response event. In addition, all 30 respondents with central AC reported using at least one of their thermostats to control their central AC system.

The 22 respondents with window AC received a total of 63 plug devices. Not surprisingly, these participants reported lower rates of installation and continued use of their plug devices. Of the 22 respondents:

- 36% (8 out of 22) had none of their plug devices installed during the August 29th demand response event.
- 64% (14 out of 22) had one or more plug device installed during the August 29th demand response event. Of these:
  - 86% (12 out of 14) used at least one of them to control a window AC unit;
  - 29% (4 out of 14) had something other than an AC unit plugged into at least one plug device, including computers, televisions, lamps, and powerstrips.
- 73% (16 out of 22) had one or more plug devices not in use during the August 29th event. Not having or not needing a window AC unit was the most common reason for not using a plug device with an AC unit, cited by 43% (7 out of 16). In addition, 18% (3 out of 16) of those not using the plug device to control their window AC cited connectivity or technical problems.

Of the 63 plug devices received by participants with window AC:

- 57% (36 out of 63) were not installed during the April 29th event.
- 43% (27 out of 63) were installed during the April 29th event. Of these:
  - 74% (20 out of 27) were used with a window AC unit;

[17] The two respondents who use their thermostats to control both window AC units and central AC systems are included in both air conditioning categories in the analyses that follow.

  - 26% (7 out of 27) were used with something else.
- 68% (43 out of 63) were not in use or were used with something other than a window AC unit during the August 29th event. Of these:
  - 35% (15 out of 43) had been used with a window AC unit in a previous summer.

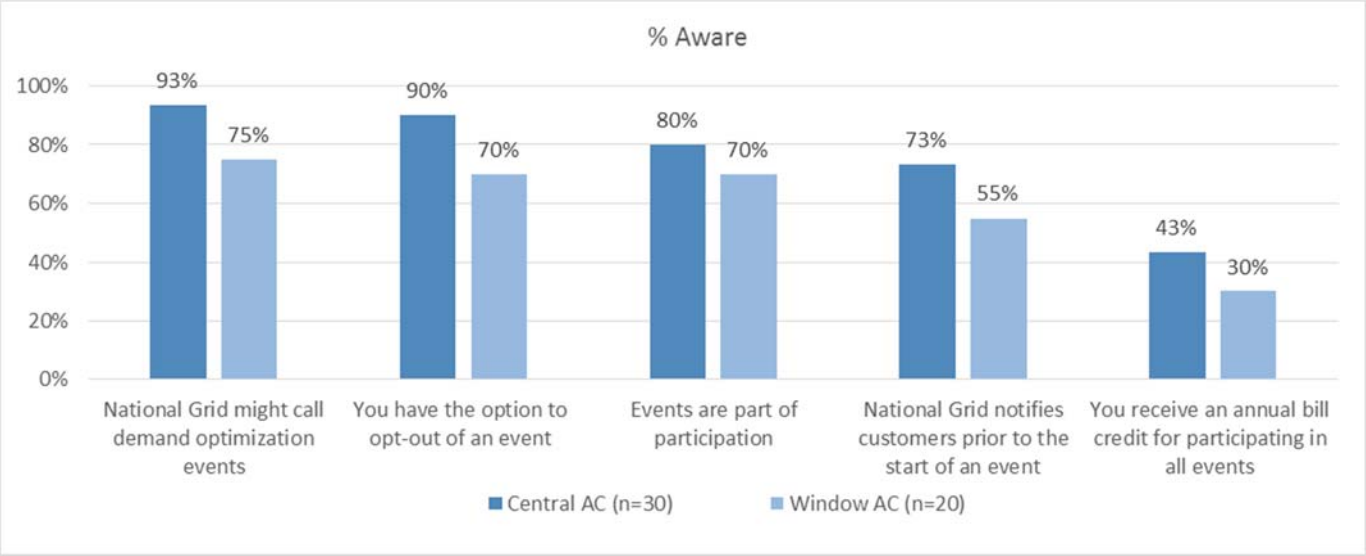
4.3.2 Awareness of Event Processes

Participants with central AC are highly aware of the various elements of the DemandLink Program, including that National Grid might call events (93%), that participants can opt out of events (90%), that events are part of program participation (80%), and that National Grid notifies participants before the start of each event (73%). In comparison, awareness of the annual bill credit for participation in all events is significantly lower (43%).

Awareness of the various program elements by participants with window AC follows the same patterns, with general awareness of events the highest (75%) and awareness of the bill credit the lowest (30%). However, for all elements, awareness of participants with window AC is lower compared to participants with central AC.[18]

Figure 4-7 summarizes responses to the questions about awareness of different DemandLink Program elements.

Figure 4-7. Awareness of Event Processes



Source: Demand Response Event Follow-Up Survey

The relatively low awareness of the annual bill credit for participation in all events is notable as it might be correlated with a higher likelihood to opt-out of an event (if participants consider the monetary reward important). While sample sizes are small, survey responses provide anecdotal evidence that such a

[18] At 90% confidence, the difference between the two groups is statistically significant for awareness that National Grid might call demand optimization events and awareness that participants can opt-out of the events.

correlation might exist: All three respondents who reported having opted out of the August 29th event (see discussion below) were unaware of the bill credit. Conversely, 67% of respondents who did not opt out of the event (12 out of 18) were aware of the annual bill credit.

For window AC participants, knowledge of demand response events seems to be correlated with using the plug devices with window AC units: All five respondents with window AC who were unaware of the events did not have a plug device installed; conversely, 87% respondents with window AC who were aware of demand optimization events (13 out of 15) reported using at least one plug device with their window AC.

4.3.3 Participant Experience during the August 29th Event

The analysis of participant event experience is based on respondents who used their devices to control their air conditioning at the time of the August 29th event (hereafter referred to as "event-eligible participants"). As summarized in Section 4.3.1, 30 participants with central AC and 12 participants with window AC met this criterion.

Awareness of the August 29th event among event-eligible participants was moderate: 57% of those with central AC and 50% of those with window AC were aware that the event had been called. Among event-eligible participants with central AC, close to half (47%) were home during the event and 10% reported having opted-out of the event, citing discomfort or anticipation of discomfort as the influencing factor. Among event-eligible respondents with window AC, only 17% (2 out of 12) were home during the event, and none opted out.

Table 4-7 summarizes rates of event awareness, home occupancy, and opt-outs for the August 29th event, by AC type.

Table 4-7. Window AC Demand Response Impact

	Central AC *(n=30)*		Window AC *(n=12)*	
	#	%	#	%
Participant was aware of August 29th event	17	57%	6	50%
Household was occupied during event	14	47%	2	17%
Participant opted out	3	10%	0	0%

Source: Demand Response Event Follow-Up Survey

Approximately two-thirds (11 out of 16) event-eligible participants who were both home during the August 29th event and aware of the event reported noticing at least some temperature difference, with 38% reporting that they definitely noticed the temperature changing (all 38% are central AC users). Among event-eligible respondents who were not aware of the August 29th event, more than half (10 out of 17) indicated that the home was occupied during the time of the event.[19] Unaware respondents who were home themselves during the event generally did not notice a change in temperature.

4.3.4 Overall Event Recall and Likelihood to Participate in Future Events

Over half of event-eligible participants (65%) recall National Grid calling at least one event over the summer; the average number of events they recalled was 10. These respondents indicated they were home for just

[19] Six were home themselves and four indicated that another member of the household was home.

over half (59%) of the events they recalled. Notably, only 8% of participants who recalled at least one 2016 event (n=26) thought that National Grid had called too many events.

Almost all participants (95%) plan to participate in future events.[20] Over half of participants (56%) are aware that energy efficiency programs offered though National Grid, such as the DemandLink Program, are funded through a surcharge on the electric bills of Rhode Island customers. For 54% of participants this knowledge has no impact on their likelihood to participate in National Grid's energy efficiency programs, while it increases the likelihood to participate for 30% and reduces it for 6%.[21]

[20] The other 5% did not know if they would participate again.

[21] An additional 10% of respondents did not provide a valid response to this question.

5. Marketing Effectiveness Analysis

Similar to prior years, the pilot conducted a range of marketing and outreach activities during 2016. Efforts included direct mail newsletters in April and October; postcards in May, July, August, and November; email blasts in September and December; and two rounds of outbound telemarketing between May and September. Postcards and emails contained messages that were specifically tailored for DemandLink participants and non-participants, respectively. In addition, community volunteers promoted the EnergyWise Home Energy Assessment at local organizations and community events throughout Little Compton and Tiverton in conjunction with the Rhode Island Energy Challenge. The different outreach activities promoted all five key pilot program components to varying degrees.

Figure 5-1 presents the 2016 marketing timeline for the pilot.

Figure 5-1. 2016 SRP Marketing Timeline

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Newsletter				■						■		
Postcard					■		■	■			■	
Email									■			■
Telemarketing					■	■		■	■			
Community Outreach						■	■	■	■			

To assess the effectiveness of the pilot's marketing and outreach activities in 2016, we conducted a survey with pilot area residents, both participants and non-participants. The survey included questions about customer recall of marketing activities, as well as the clarity and effectiveness of common messaging used in 2016 marketing materials.

This section summarizes findings from the survey. Appendix C contains detailed survey responses.

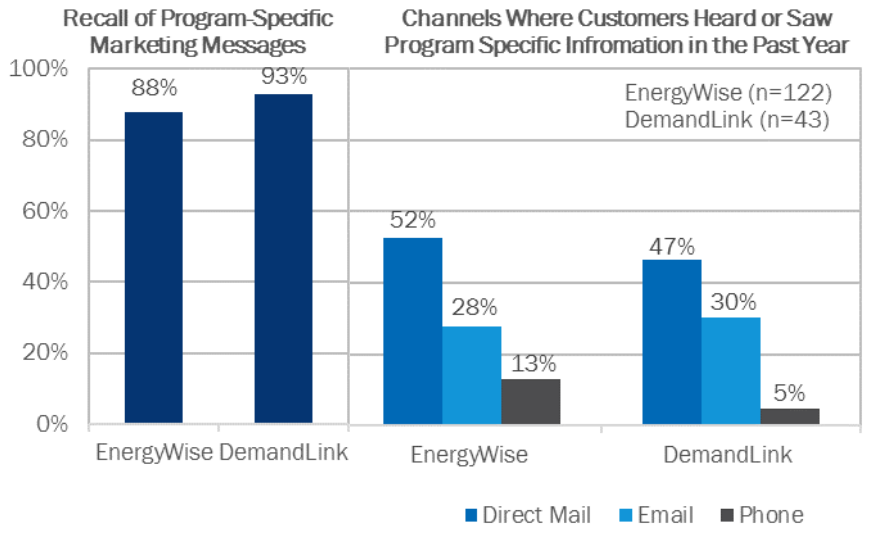
5.1 General Recall of Messaging

The first set of questions asked customers if they recalled hearing or seeing any information about each program component in the past year. These questions were only asked of customers who had heard of the program component prior to the survey. Customers who do not own their home did not receive questions about the HPWH rebate, and customers who do not plan to use window AC or to recycle a window AC unit in 2017 did not receive questions about window AC rebates.

Participant recall of messaging about components in which they had already participated (in 2016 or prior years) was very high, with 88% of EnergyWise and 93% of DemandLink participants remembering receiving program information in 2016. These participants most often recalled receiving information in the mail (52% and 47%, respectively). Program participants less frequently remembered receiving emails (28% and 30%, respectively) or phone calls (13% and 5%, respectively) from the pilot.

Figure 5-2 summarizes these findings.

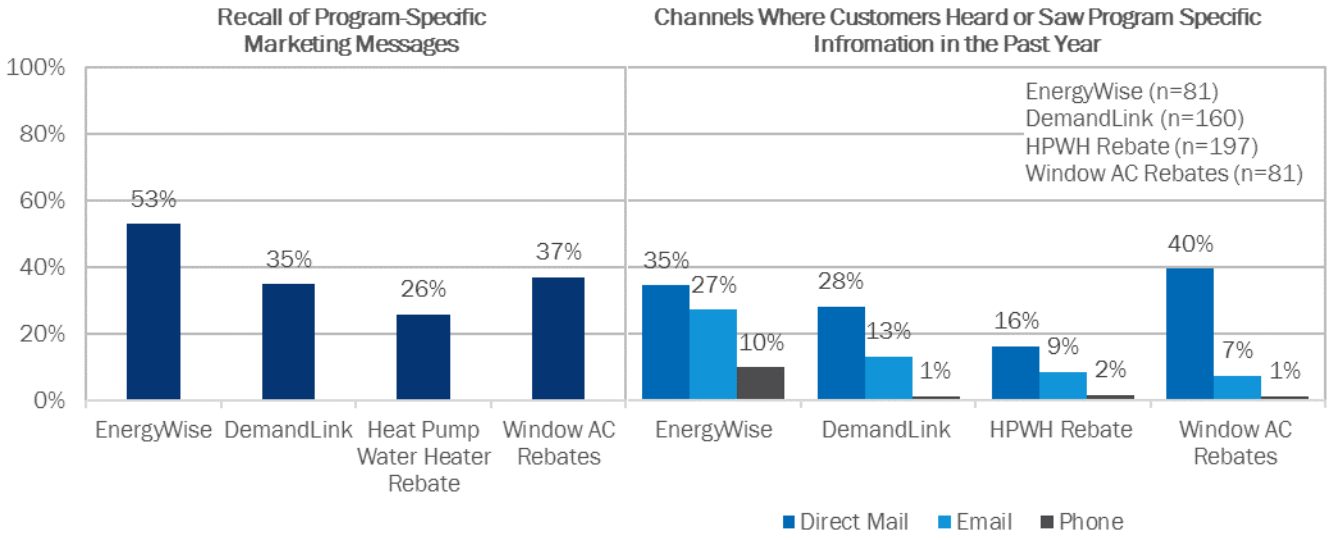
Figure 5-2. Recall of Program-Specific Marketing Messages (Participants)



Source: Marketing Effectiveness Survey

Recall of component-specific messaging among non-participants was lower compared to participants, but still high: 53% of customers who have not yet participated in the EnergyWise Program remembered receiving information about it 2016, most often in the mail. Recall rates for other program components were significantly lower (37% for window AC rebates, 35% for DemandLink, and 26% for HPWH rebates), yet still relatively high. Across all components, non-participants are most likely to remember information they received in the mail.

Figure 5-3. Recall of Program-Specific Marketing Messages (Non-Participants)



Source: Marketing Effectiveness Survey

5.2 Recall and Clarity of Specific Marketing Materials

To assess the effectiveness of messaging used by the pilot in 2016, the online survey included detailed questions about three key marketing pieces: a postcard sent in August, a newsletter sent in October, and an email sent in December. DemandLink participants and non-participants received different versions of the postcard and email, each with messaging tailored to their participation status.

The survey assessed customer recall of the specific materials as well as prior familiarity with the content and clarity of the messaging. We randomly assigned survey respondents to review and answer questions about one of the three outreach efforts. Table 5-1 describes the marketing pieces included in the survey, including the month the materials were distributed, key messaging, and the number of survey respondents who responded to the questions on the item. We provide images of the materials in Appendix C.

Table 5-1. 2016 Marketing Materials Assessed

Recipient	Distribution Month	Messaging	Count of Respondents
Newsletter			
All customers	October 2016	• Summary of participation to date among the pilot communities • In-depth summaries of the rebates available for purchasing and recycling window AC and rebates for purchasing an efficient HPWH • Overview of the DemandLink Thermostat program • Reminder to those already participating in DemandLink to connect their thermostats to their WiFi network	75
Postcard			
DemandLink Participant	August 2016	• Reminder of how DemandLink works and to connect thermostats to the WiFi network • Promotion of the rebates available for purchasing and recycling window AC, and for purchasing an efficient HPWH	10
DemandLink Non-Participant		• DemandLink as a way to stay cool and save energy in the summer • Promotion of the rebates available for purchasing and recycling window AC, and for purchasing an efficient HPWH	49
Email			
DemandLink Participant	December 2016	• Promotion of the rebates for purchasing an efficient HPWH	19
DemandLink Non-Participant		• Promotion of the rebates available to DemandLink participants for purchasing an efficient HPWH • DemandLink as a way to take control of the home's heating and cooling expense.	56

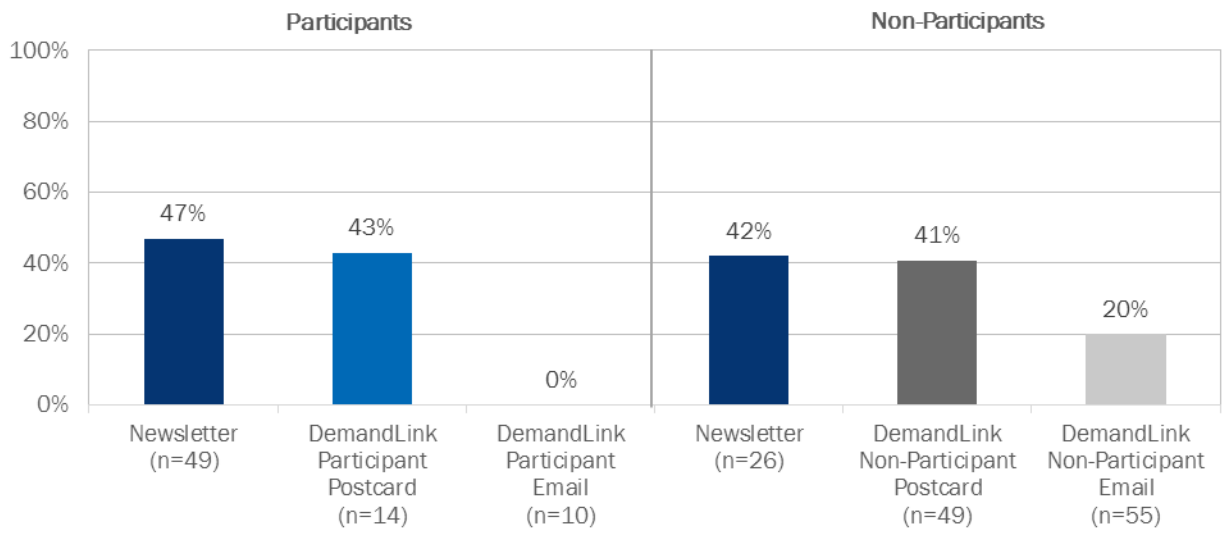
The remainder of this section summarizes responses to the questions about these materials. Because DemandLink participants and non-participants reviewed different versions of the email and postcard, we present separate results for these two groups. For the newsletter, unless otherwise noted, we present separate results for respondents who have participated in one or more of the pilot's five program components and those who have not participated in any of the five components.

Recall of Materials

Figure 5-4 shows respondent recall of the key marketing pieces. In general, the direct mail pieces were more memorable than the emails, and participants and non-participants tended to recall the materials at similar

rates. Recall rates by non-participants are relatively high, at 42% for the newsletter, 41% for the postcard, and 20% for the email.[22]

Figure 5-4. Recall of Marketing Materials



Source: Marketing Effectiveness Survey

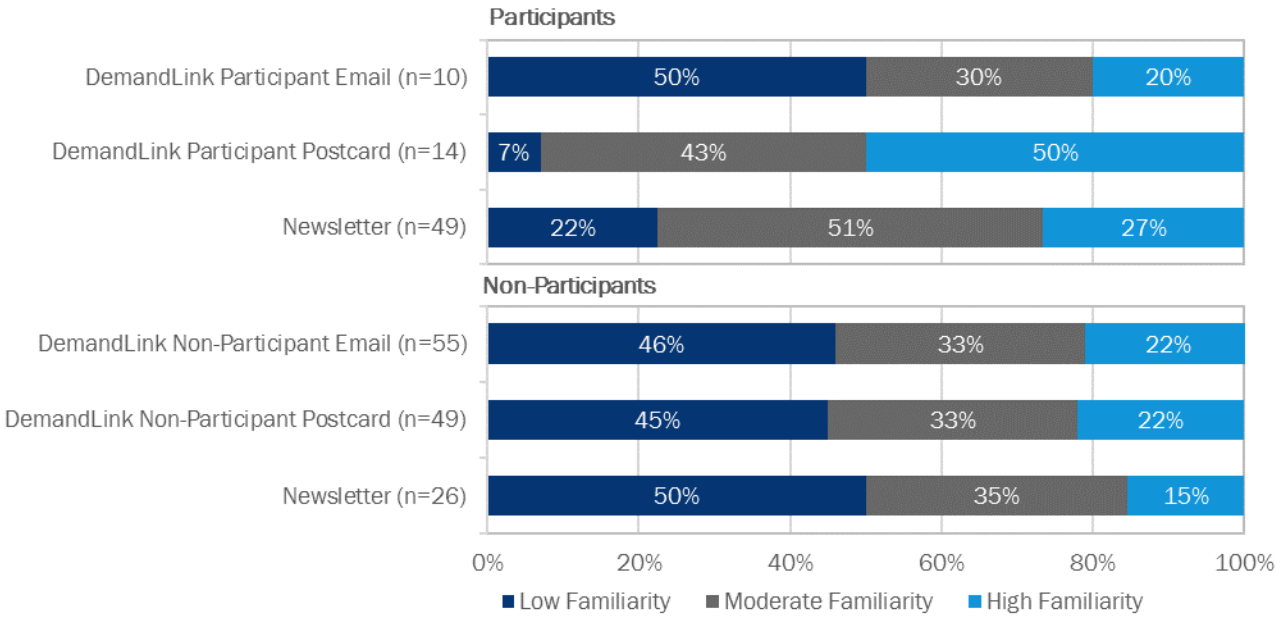
Recall of Messaging

After reviewing the materials, respondents were asked how much of the information in the images was new to them. We used this question to assess the degree to which past program messaging is remembered by customers. We categorize customers who indicated that none or very little of the information was new as having "high familiarity" while those who indicated that most or all of the information was new as having "low familiarity".

Overall, DemandLink participants have the highest level of familiarity with the content of the postcard (50% high familiarity; 43% moderate familiarity), followed by participant familiarity with the content of the newsletter (27% high familiarity; 51% moderate familiarity). Non-participant familiarity is relatively consistent across the three outreach channels and comparable to DemandLink participant familiarity with the content of the email: all have a level of high familiarity between 15% and 22% and a level of low familiarity between 45% and 50%.

[22] The IOU industry standard for email open rates is (22%). Considering a customer has to open an email to recall it, a recall rate of 20% suggest an open rate that is in line with, or exceeds, what would be expected for email outreach. (Source: Questline, 2015 Energy Utility Email Benchmarks Report available at: https://cdn.questline.com/asset/get/47a2f0f7-f0fd-4917-b7b6-2625e84ef911)

Figure 5-5. Recall of Information Provided by Marketing Material (By Participation Status)



Source: Marketing Effectiveness Survey

Clarity of Messaging

In addition to familiarity of the messages, we also tested respondents' understanding of messaging used in the marketing materials, using a five-point clarity scale where 1 means "Not at all clear" and 5 means "Very clear". The survey asked respondents to rate the clarity of messaging around the following topics:

- Why someone would want to sign up for the offerings
- How to get more information about the offerings
- What DemandLink is
- That customers have to sign up for DemandLink to be eligible for the HPWH rebate
- That National Grid wants DemandLink participants to make sure their thermostat is connected to their Wi-Fi network
- Why DemandLink participants' thermostats need to be connected to their Wi-Fi network

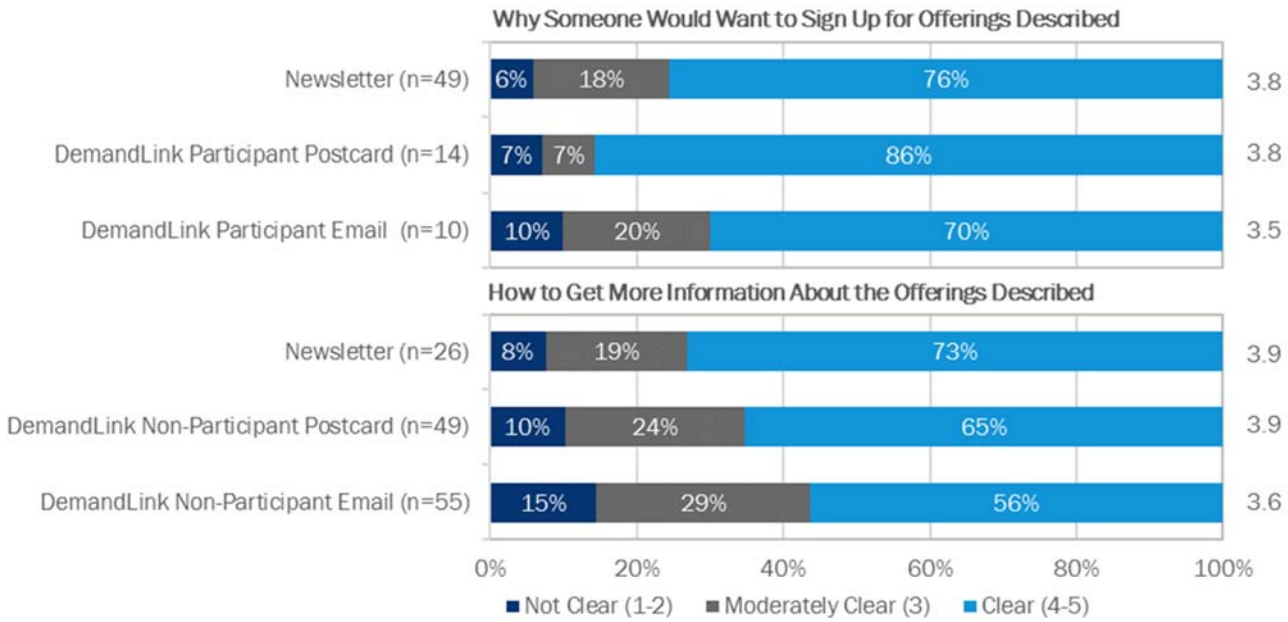
Responses to these questions are summarized below.

Benefits of Offerings and How to Get More Information

Customers reported high clarity of the messaging about the benefits of the different offerings and how to get more information (see Figure 5-6). With average clarity ratings ranging from 3.5 to 3.9, respondents found the materials similarly clear in explaining why someone would want to sign up for the offerings and how to

get more information. Clarity ratings for the email tended to be lower compared to the newsletter and postcard, although the differences are not statistically significant at 90% confidence.

Figure 5-6. Benefits of Offerings and How to Get More Information



Source: Marketing Effectiveness Survey

DemandLink Messaging for Non-Participants

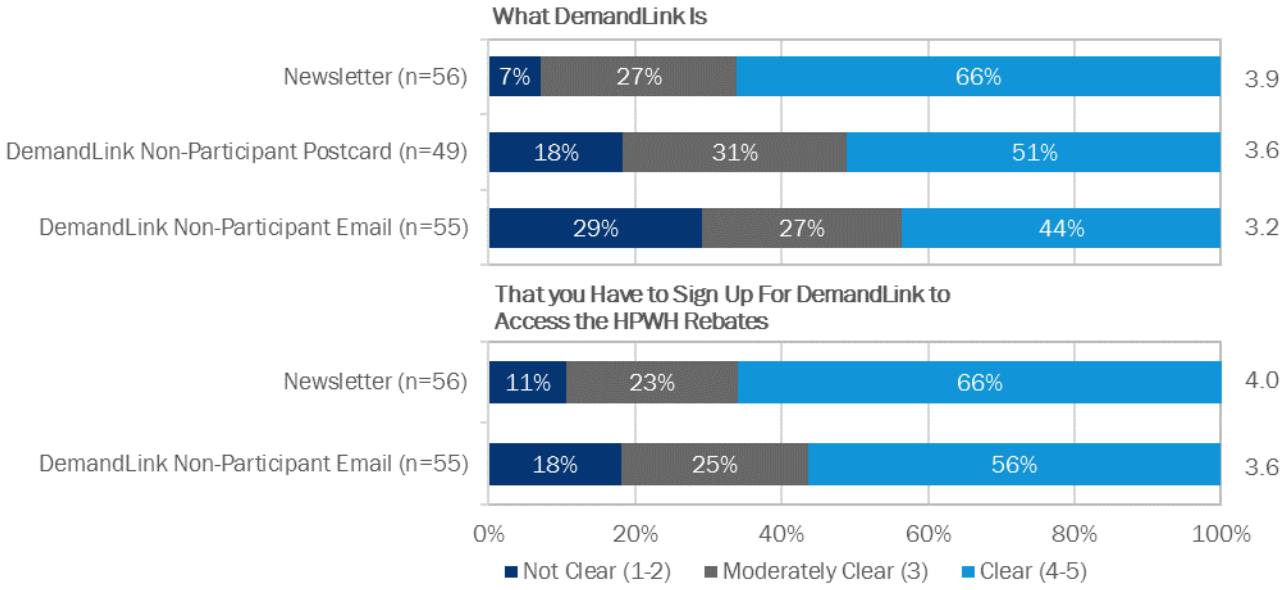
Customers who had not yet participated in the DemandLink thermostat program received targeting messaging in 2016, via a postcard and email, designed to inform them of the program and encourage participation. The newsletter, sent to both participants and non-participants, also contained these messages. We asked DemandLink non-participants to assess clarity of messaging surrounding the DemandLink offering in these three materials. Survey responses indicate that the newsletter more clearly explains what DemandLink is (66% provided a "clear" rating) than the postcard (51%) or email (44%).[23]

In addition, the newsletter and the non-participant targeted email promoted the HPWH rebates, noting that participation in the DemandLink program is a requirement for receiving this rebate. As shown in Figure 5-7, respondents found the newsletter slightly clearer in explaining the HPWH eligibility requirement (66% of respondents report it was "clear"), compared to the email (56%), although this difference is not significant at 90% confidence.

Given that participation in DemandLink is a requirement for receiving a HPWH rebate, clear messaging about what DemandLink is will be important if the pilot wishes to continue increasing its participation in the HPWH program.

[23] Only the difference between the newsletter and the email is significant at 90% confidence.

Figure 5-7. Clarity of DemandLink Messaging for Non-Participants

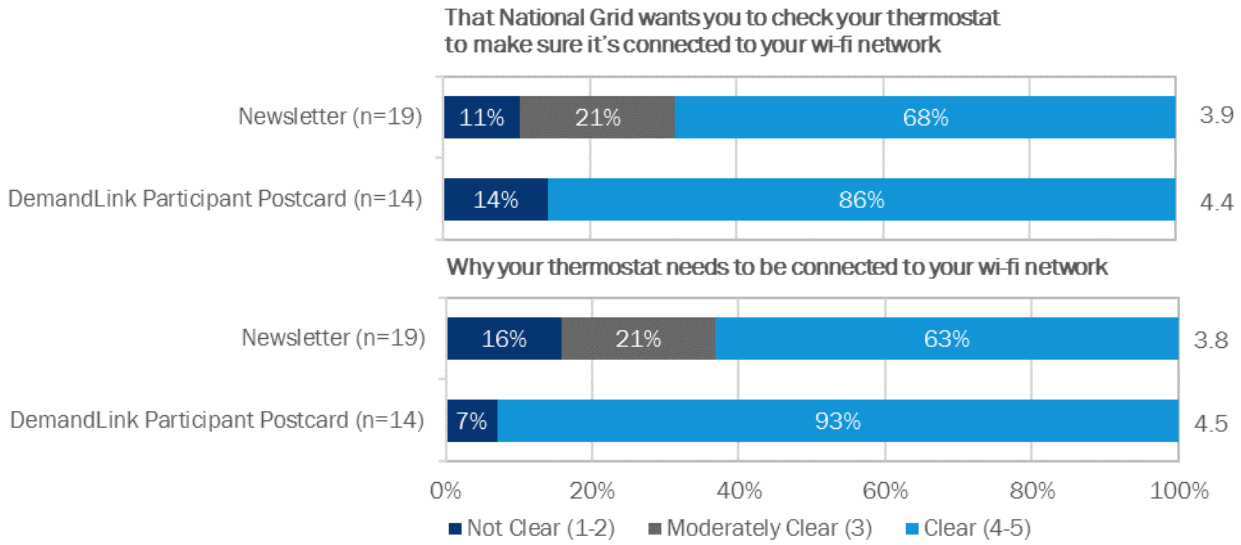


Source: Marketing Effectiveness Survey

DemandLink Messaging for Participants

Customers who had already participated in the DemandLink thermostat program also received targeting messaging in 2016, via the postcard. One of the main purposes of the postcard was encourage participants to check that their AC units were connected to their Wi-Fi – a necessary condition to be able to participate in demand response events. The newsletter also contained this message. Not surprisingly, given its focus on this topic, respondents found the post card clearer in conveying this message: 86% of DemandLink participants thought that the post card was clear in conveying that National Grid wants them to check their thermostat connectivity, and 93% thought the post card made it clear why it was important to do so. This message was slightly less clear in the newsletter, which also contained a lot of other messaging. Figure 5-8 summarizes these findings.

Figure 5-8. Clarity of DemandLink Messaging for Participants



Source: Marketing Effectiveness Survey

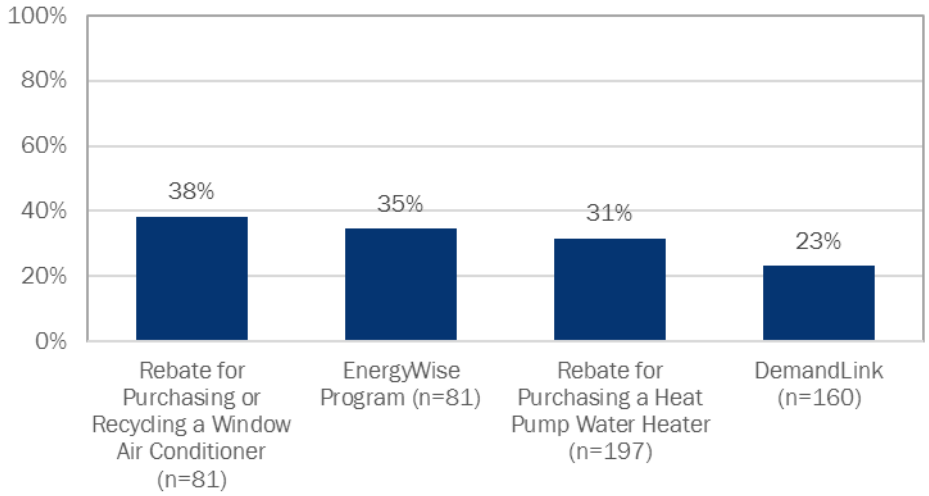
Interest in Programs after Review of Messaging

The final set of questions in the Marketing Effectiveness Survey assessed customers' likelihood to visit the pilot's website or get more information about one or more of the offerings, following their review of the materials. Overall, 48% of respondents reported being likely[24] to seek out more information.

Of non-participants eligible to participate in the various components, about one-third are interested in seeking more information about window AC rebates (38%), the EnergyWise program (35%), and the HPWH rebate (31%). Significantly fewer DemandLink non-participants are likely to seek more information about the DemandLink Program (23%).

[24] A rating of 3 or greater on a 5-point scale, where 1 means "not at all likely" and 5 means "very likely".

Figure 5-9. Interest in More Information About Program (Non-Participant in Program Component)



Source: Marketing Effectiveness Survey

Appendix A. EnergyWise Load Impact Analysis – Additional Details

For each EnergyWise measure category, we calculated load impacts as the total quantity of measures installed in the pilot area, multiplied by coincident peak kW savings:

*Peak kW Savings = Quantity * kW Reduction per Unit * Summer Diversity Factor*

To develop incremental SRP load impacts, we then multiplied total peak kW savings by the take rate developed as part of the 2015 evaluation. The following are key inputs into this analysis:

A. **Measure category:** The EnergyWise participation data included a measure category for each installation record. Peak savings are not assigned in the participation database, and therefore must be assigned based on deemed factors.
B. **Pilot Quantity:** Measure quantity comes from the program tracking data. We assigned measures to the 2016 program year based on the paid date, matching how National Grid counts savings in each year. We only included measures installed by substation customers, based on account numbers provided by National Grid.
C. **Peak kW Reduction Factors:** National Grid provided deemed load reduction values and diversity factors for each EnergyWise measure category. The factors that National Grid provided are the same load assumptions that National Grid is currently using for cost-effectiveness tests of the EnergyWise Single-Family program in Rhode Island. Since these assumptions are specific to the EnergyWise Program, they may differ from assumptions for analogous measures in the 2016 Rhode Island TRM.
D. **Take Rate:** The take rate is the percentage of measure installations that can be attributed to the SRP Pilot efforts – i.e., measure installations that would not have occurred in the absence of SRP Pilot marketing efforts. Since the 2016 evaluation did not include estimation of the take rate, we used the take rate developed as part of the 2015 evaluation. (See discussion in Section 3.2 above.)

The following table shows gross kW reduction assumptions and summer peak diversity factors for EnergyWise measures.

Table A-1. EnergyWise 2016 Load Impact Factors

Measure Category	Gross kW Reduction per unit	Summer Diversity Factor	Average Peak Summer Load Reduction (kW)
LED Bulb	0.050	0.13	0.007
CFL Bulb	0.044	0.13	0.006
Indoor Fixture	0.072	0.13	0.009
Torchiere	0.060	0.13	0.008
Outdoor fixture	1.000	0.00	0.000
Smart Strip	0.016	0.73	0.012
Refrigerator Rebate	0.095	1.00	0.095
Refrigerator Brush	0.005	1.00	0.005
Programmable Thermostat - Electric Heat	0.180	0.20	0.036
Programmable Thermostat - Non-Electric Heat	0.231	1.00	0.231
WiFi Thermostat - Electric Heat	0.060	0.20	0.012
WiFi Thermostat - Non-Electric Heat	0.231	1.00	0.231
Weatherization - Electric Heat	0.832	0.20	0.166
Weatherization - Gas Heat	0.134	0.20	0.027
Weatherization - Oil Heat	0.179	0.20	0.036
Ventilation – Other	0.000	1.00	0.000
AC Timer	0.000	1.00	0.000
Aerator - Electric Heat	0.007	1.00	0.007
Aerator - Non-Electric Heat	0.000	0.58	0.000
HPWH 50 Gallon - Electric Heat	0.370	0.58	0.215
HPWH 50 Gallon - Non-Electric Heat	0.370	0.47	0.174
DHW Pipe Wrap/Insulation - Electric Heat	0.016	1.00	0.016
DHW Pipe Wrap/Insulation - Non-Electric Heat	0.000	1.00	0.000
Low Flow Showerhead - Electric Heat	0.033	1.00	0.033
Low Flow Showerhead - Non-Electric Heat	0.000	0.58	0.000

Appendix B. DemandLink Evaluation – Additional Details

This appendix provides additional information on the DemandLink impact evaluation, including a description of the thermostat log files, a more detailed discussion of the methodology used to assess impacts from central AC demand response events, and additional analysis results for individual events.

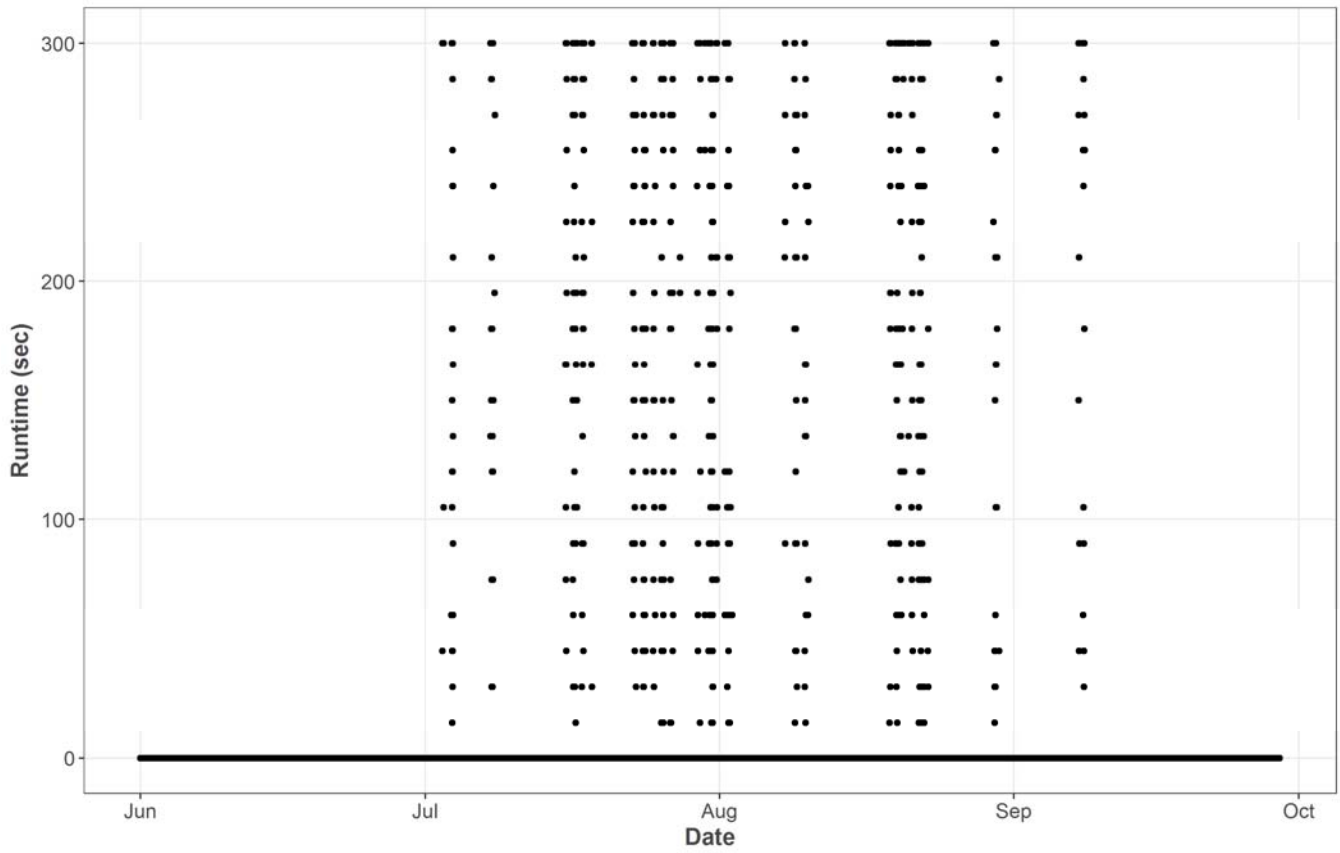
Description of Log Files

Central AC Logs

The logs for thermostats associated with central AC contain data record at five-minute intervals. During each of those intervals, the log records the run-time of the AC unit, the temperature setting, the indoor temperature, an event code, and several other variables. The central AC impact analysis uses the unit's run-time as the dependent (or primary) variable.

Figure B-1 shows peak season central AC run-time from one of the central AC thermostat logs. Each dot on the chart shows the run-time for a five-minute period. When the plotted run-time is 300 seconds (i.e., five minutes), the AC was running continuously for that period. The solid line at the bottom of the graph reflects many individual readings of zero, i.e., periods when the unit was not running. It indicates that while the unit was not running, it was online continuously. An interrupted line represents periods of disconnectivity. Based on the dots in Figure B-1 the unit was online continuously between June and October but was running only intermittently from July through early September.

Figure B-1. Example of Run-Time per 5-Minute Interval for One Central AC Unit



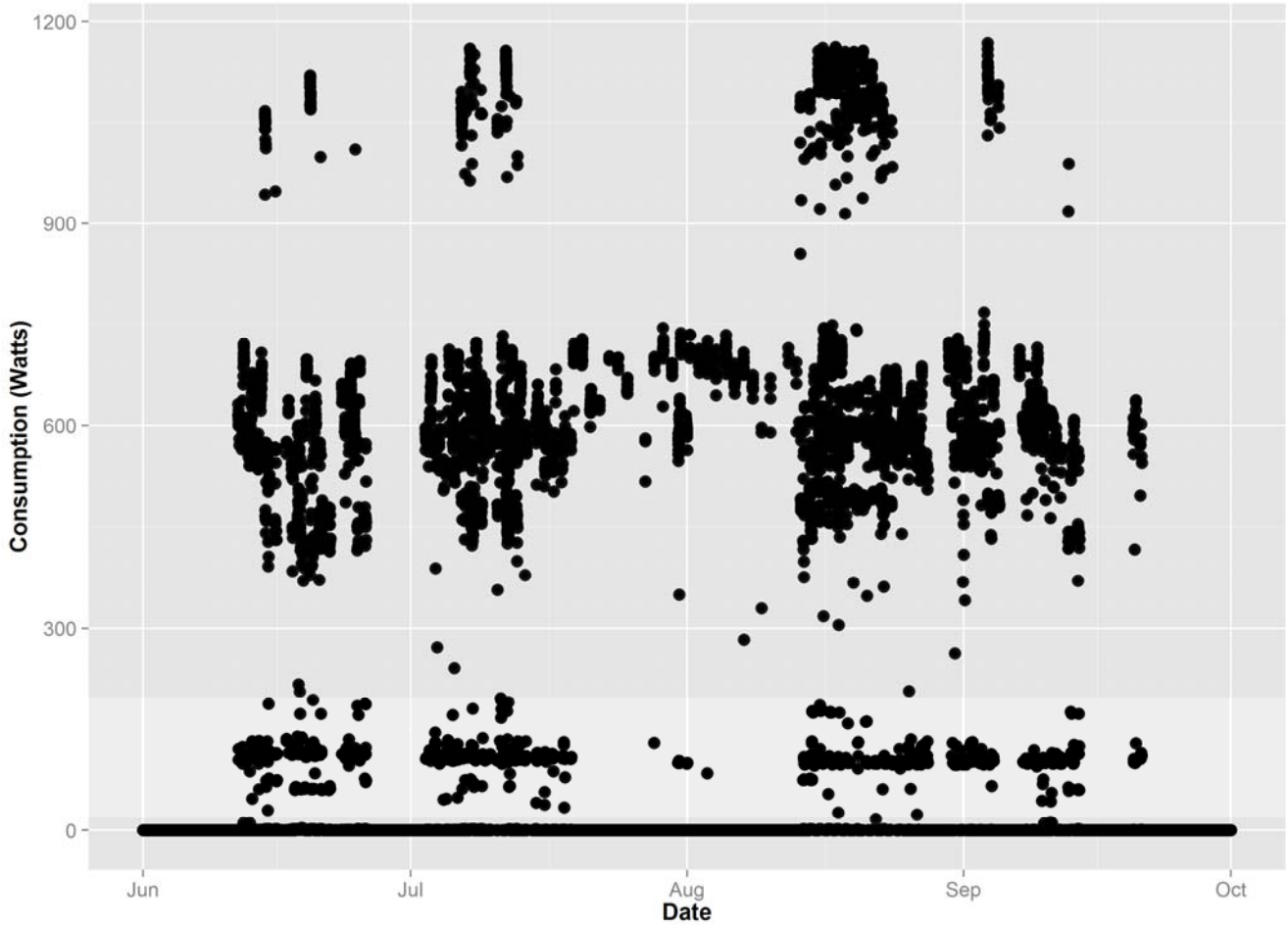
Window AC Logs

The logs for thermostats associated with window AC units contain similar types of five-minute interval data as logs for central AC thermostats. In addition, the window AC thermostat logs record the Watt consumption of up to five window AC units (each plugged into a separate plug device). The window AC impact analysis uses the total AC demand (in kW) as the dependent variable.

Figure B-2 shows an example of window AC consumption in Watts per 5-minute interval for a thermostats that successfully controlled a window AC during the peak season. The log shows data from mid-June until the end of the season.[25]

[25] Similar to central AC thermostats, there are gaps in the data, although most are too small to be visible in the figure.

Figure B-2. Example of Watt Usage per 5-Minute Interval for One Window AC Unit



Impact Methodology for Central AC Demand Response Impact Analysis

Opinion Dynamics used regression modeling combined with day matching to estimate the demand response runtime reduction for central AC participants. The load impacts for central AC events are then calculated by multiplying the runtime reduction by the mean full load demand, to arrive at the demand reduction attributable to the event. We describe our regression modeling and day matching methods below.

Model Specification

We used a linear fixed-effects regression (LFER) modeling approach for the demand response impact analysis. This model accounts for the time-invariant, household-level factors affecting energy use without measuring those factors and entering them explicitly in the models. These factors are contained in a household-specific intercept, i.e., the constant term in the regression equation.

We selected the regression model specification to predict referential load during event days to address specific event day characteristics. The model incorporates weather variables with weather as the major predictor of energy consumption. Cooling degree hours (CDH) with base 65 is included in the model as the primary weather variable. The model also includes the hour of the day, as time of day is highly predictive of usage. Terms for month, day of week, morning load, and month by hour further correct for differences between the event day and the non-event days used as comparison days for the model.

As is standard practice for demand response impact analysis, we tested many models. We selected the final models based on fit with actual usage, especially during the hours leading up to the event. We judged the ultimately selected model fit primarily on replication of actual usage during non-event hours, especially the hours before the event, so there is a high level of confidence in the reference points during event hours.

We fit separate regressions for each central AC event, using the same model specification for each individual event. We used a slightly different model specification for the overall estimate in order to better account for the complexity of including weekday and weekend events in a single model. The two linear fixed-effects regression (LFER) model specifications are as follows:

Equation B-1. Individual Event Regression Model

$$kw_{it} = \alpha_o + \alpha_i + \beta_{event} \cdot Event + \sum_{h=1}^{23} \beta_{hour\ h} \cdot Hour_h + \sum_{h=1}^{23} \beta_{event\ hour\ h} \cdot Event \cdot Hour_h +$$

$$\beta_{CDH} \cdot CDH_t + \beta_{dewpoint} \cdot Dew\ Point_t + \beta_{mornload} \cdot MornLoad_i + \sum_{h=1}^{23} \beta_{mornload\ hour\ h} \cdot Hour_h \cdot MornLoad_i$$

$$+ \beta_{nightload} \cdot NightLoad_i + \sum_{h=1}^{23} \beta_{nightload\ hour\ h} \cdot Hour_h \cdot NightLoad_i + \varepsilon_{it}$$

Where:

α_o = Overall intercept

α_i = Participant specific intercept

ε_{it} = Error term

Event = Indicator variable for event day

Hour = Set of 23 indicator variables for the hours of the day

Month = Set of 3 indicator variables for the months of the program (June-Sept)

CDH = Base 65 cooling degree hours

Dew Point = Dew point

MornLoad = The mean load for participant i for the hours of midnight through noon for the day

NightLoad = The mean load temperature for participant i for the hours of 10 p.m. to midnight for the day

Equation B-2. Overall Regression Model

$$kw_{it} = \alpha_o + \alpha_i + \beta_{event} \cdot Event + \sum_{h=1}^{23} \beta_{hour\ h} \cdot Hour_h + \sum_{h=1}^{23} \beta_{event\ hour\ h} \cdot Event \cdot Hour_h +$$

$$\beta_{CDH} \cdot CDH_t + \beta_{dewpoint} \cdot Dew\ Point_t + \beta_{mornload} \cdot MornLoad_i + \sum_{h=1}^{23} \beta_{mornload\ hour\ h} \cdot Hour_h \cdot MornLoad_i$$

$$+ \beta_{nightload} \cdot NightLoad_i + \sum_{h=1}^{23} \beta_{nightload\ hour\ h} \cdot Hour_h \cdot NightLoad_i$$

$$+ \sum_{w=1}^{6} \beta_{weekday\ w} \cdot Day\ of\ Week + \sum_{w=1}^{6} \beta_{event\ weekday\ w} \cdot Event + \varepsilon_{it}$$

Where:

α_o = Overall intercept

α_i = Participant specific intercept

ε_{it} = Error term

Event = Indicator variable for event day

Hour = Set of 23 indicator variables for the hours of the day

Month = Set of 3 indicator variables for the months of the program (June-Sept)

CDH = Base 65 cooling degree hours

Dew Point = Dew point

MornLoad = The mean load for participant i for the hours of midnight through noon for the day

NightLoad = The mean load temperature for participant i for the hours of 10 p.m. to midnight for the day

Day = Set of 6 indicator variables for the day of the week (Sunday – Saturday)

Day by event = The interaction of day of the week and event day

In addition to the model selected, we tested other variables and interactions for possible inclusion in the model specification. These included:

- CDH^2 – Cooling degree hours squared
- HDH – Heating degree hours
- Month – Month of the peak season, May through September
- Month by Hour – The interaction of month and hour of the day (adjusts for differences in average hourly load across months)
- Month by HDH – The interaction of month and HDH (adjusts for differences in average weather response across months)

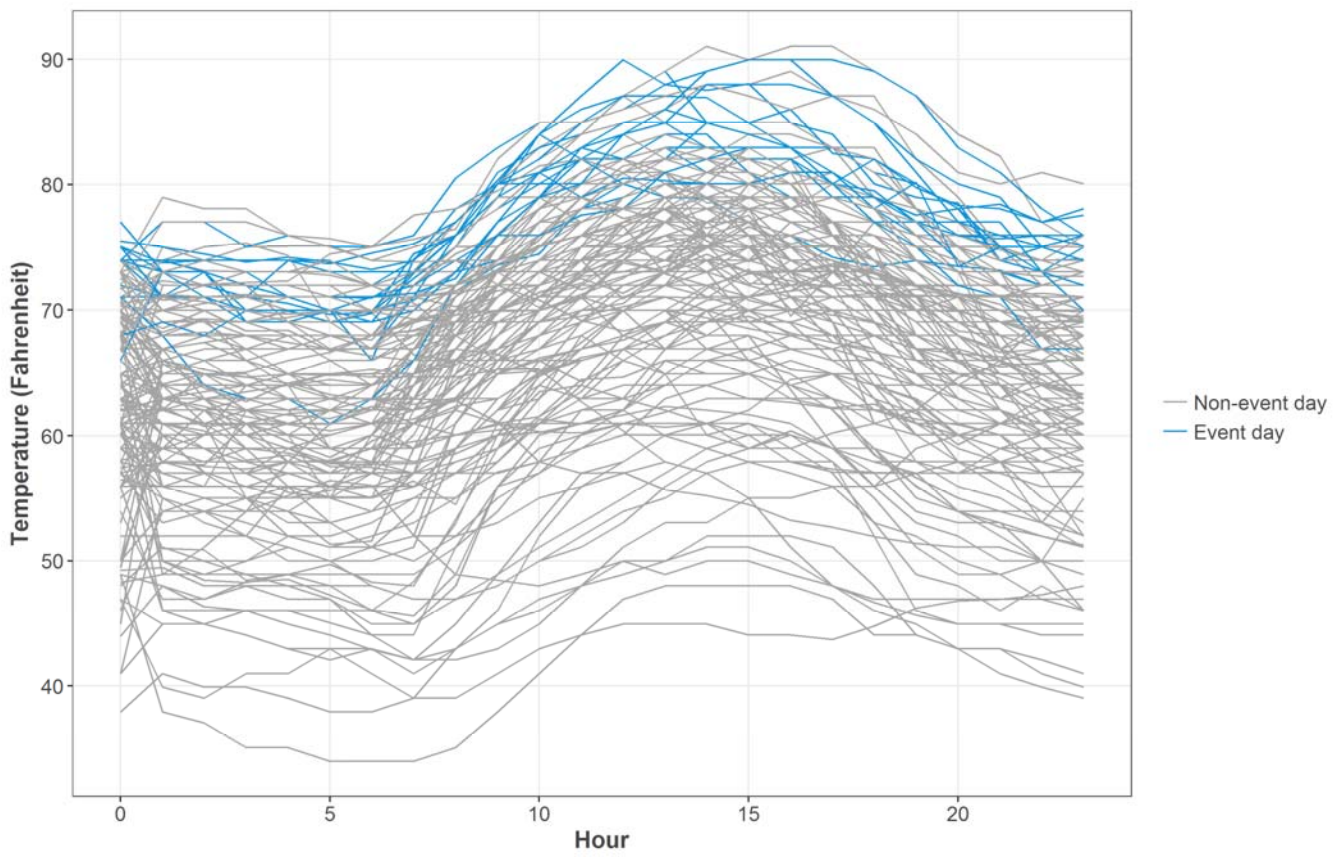
- Day by Hour – The interaction of day of week and hour of the day (adjusts for differences in average hourly load across days of the week)
- Event by CDH – The interaction of event and CDH (adjusts for different hourly load on event days based on weather)

These terms do not appear in the final model specification, as the variables and interactions already in the model are effective at correcting for differences in the actual usage and the modeled usage for non-event hours that serve as comparison. It is very important that the final model correctly replicate load during non-event hours, so the counterfactual baseline usage during the event is reliable. It is also important to remove terms and interactions that do not improve the actual and baseline model fit, as they will unnecessarily increase variance in the estimates.

Day Matching

Not all days are included in the data used in the regression model. Including cool days, when air conditioning is not used, does not add useful information for modeling what happens on the hottest days, when events are called. Figure B-3 shows the hourly temperature on event days (blue) and non-event days (gray) for all cooling season days.

Figure B-3. Event Day and Non-event Day Temperature Profiles

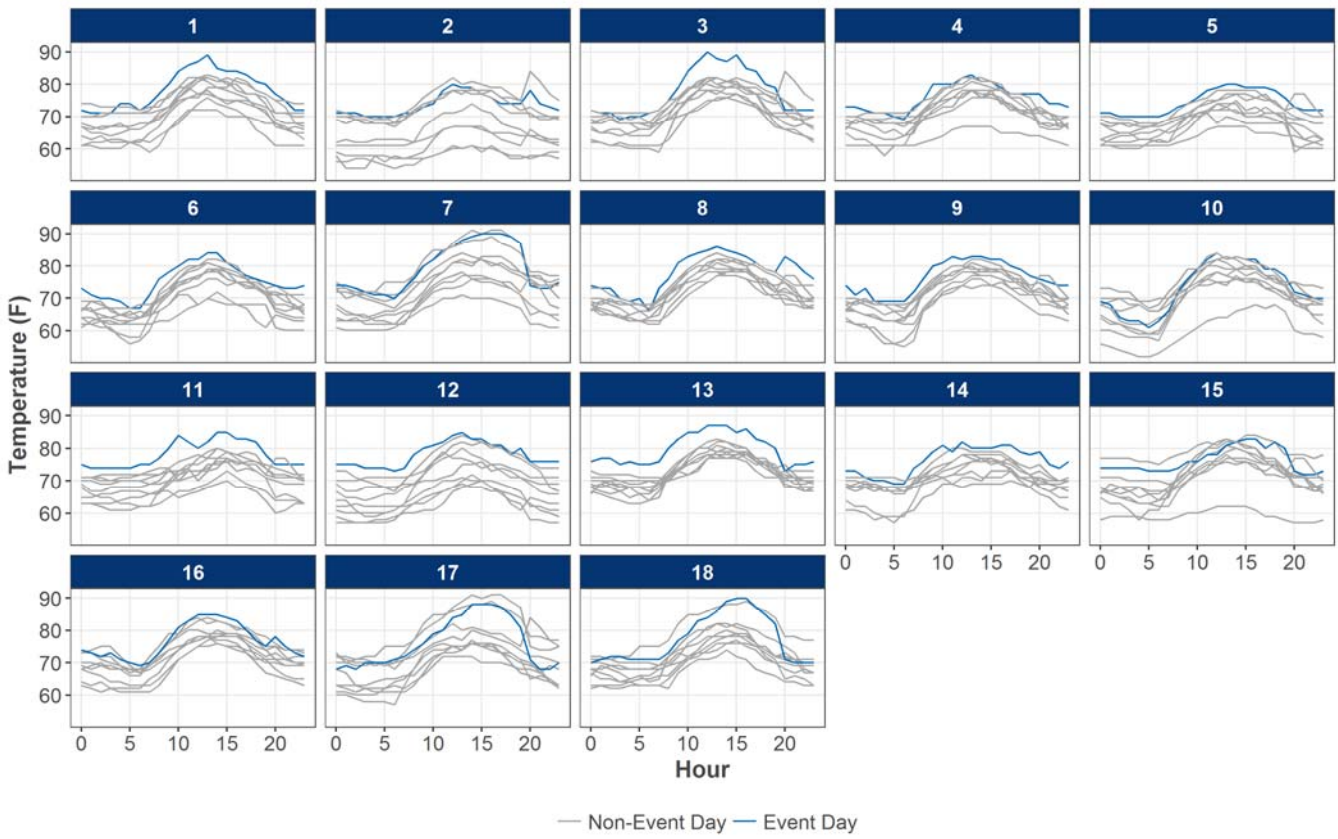


We tested several methods of day matching to find the best way of selecting comparison days that cover the range of temperatures experienced on event days. In past years, Mahalanobis distance matching – which

minimizes the difference between the event and non-event day temperatures at each hour, corrected for the measured variation in temperature at that hour and the correlation of the temperature between hours – has performed best. However, as Figure B-4 shows, Mahalanobis distance matching sometimes did not select any days that were as hot or hotter than the event day (e.g., Events 1, 3, 11, and 13). We therefore used an alternative matching strategy based on minimizing root mean squared error (RMSE) between event day and non-event day temperatures between noon and 8 p.m., and including three particularly warm days (July 23, August 14, and August 15) in all models. For most days, we included the top five matches based on RMSE, for a total of eight matches per event. For Events 11, 12, 14, and 17, we used the top 10 matches based on RMSE because the models seemed to be producing biased estimates when only the top five matches were included.[26]

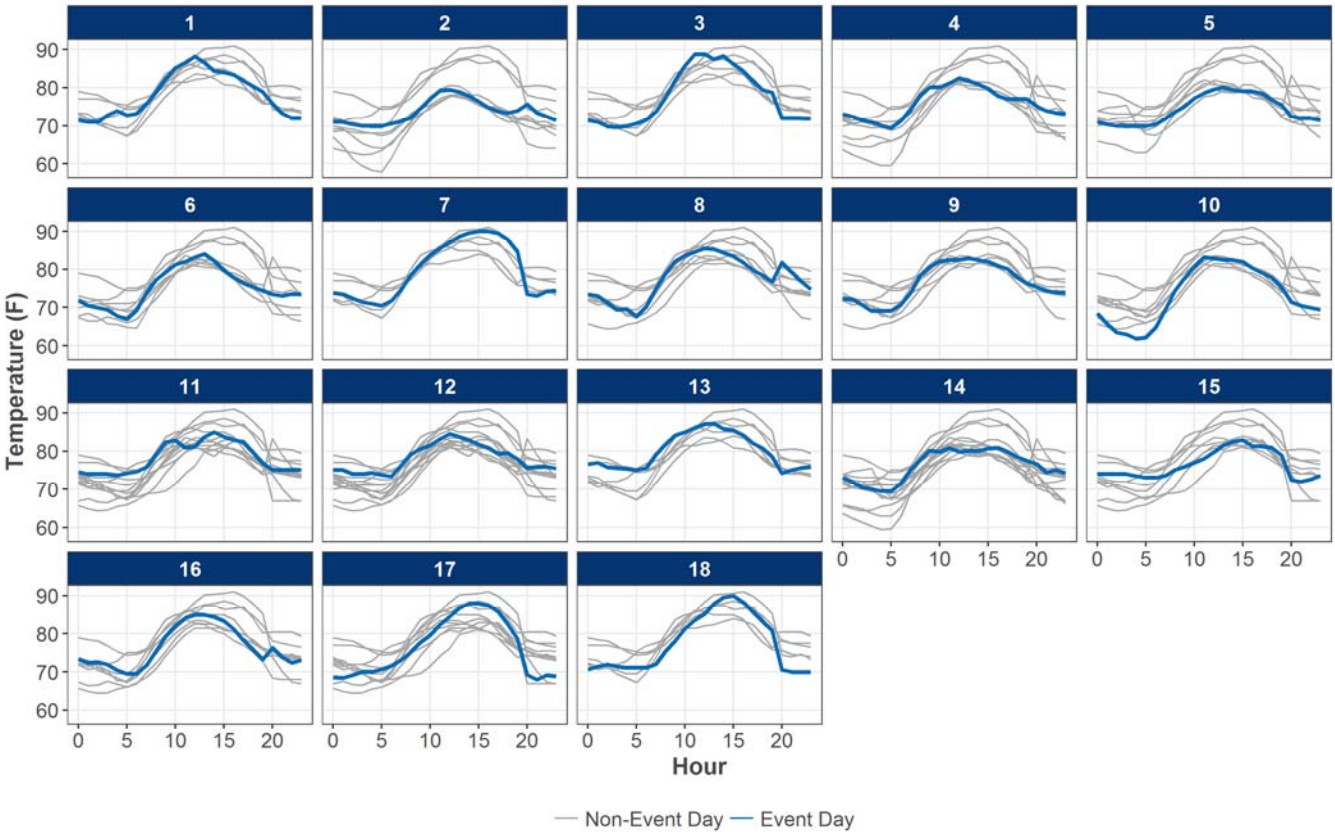
Figure B-5 shows the final set of matches used for each event.

Figure B-4. Event Day and Matched Day Temperature Profiles Based on Mahalanobis Distance Matching



[26] We determined this based on how well the models predicted runtime on non-event days not included in the original model.

Figure B-5. Event Day and Matched Day Temperature Profiles Based on Custom Matches

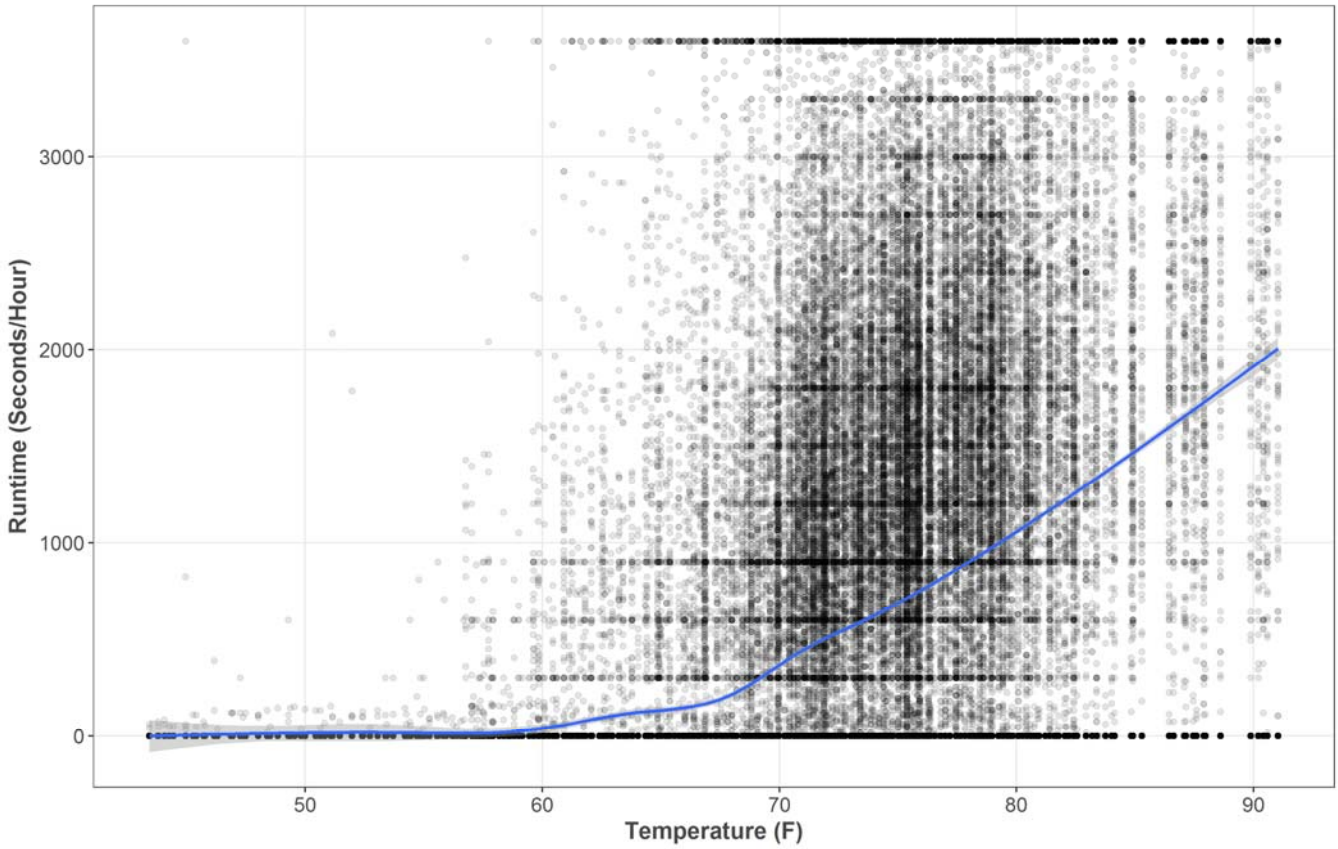


Weather Data

Opinion Dynamics gathered weather data from the National Oceanic and Atmospheric Administration's National Climactic Data Center, which houses the Integrated Surface Database of hourly weather measurements from thousands of locations across the country. We used participant addresses to geocode the locations of all participants and found that the weather station at the Newport State Airport was the closest to all pilot participants. We downloaded the hourly weather data from that station for 2016 and merged it with the thermostat logs. We then calculated cooling degree hours with an outdoor base temperature of 65 degrees for use in the model. We chose 65 degrees as the base temperature because 65 degrees is approximately the point at which participants start using their central AC units during summer afternoons.

Figure B-6 shows the average runtime versus temperature for peak season afternoons between noon and 8 p.m. Based on the modeled line, either 60 or 65 degrees could serve as a base for cooling degree hours. Consistent with our analyses of prior program years, we chose 65 degrees, which is a standard temperature for this type of analysis.

Figure B-6. Mean Central AC Runtime versus Temperature for Peak Season Afternoons



Individual Event Results – Central AC

The figures in this section show the runtime percentage along with the baseline used to calculate demand impacts for each of the 18 demand response events called in 2016. All 2016 events began at 3 p.m. and ended at 7 p.m.

Figure B-7. Central AC Event 1 (Wednesday, July 6, 2016)

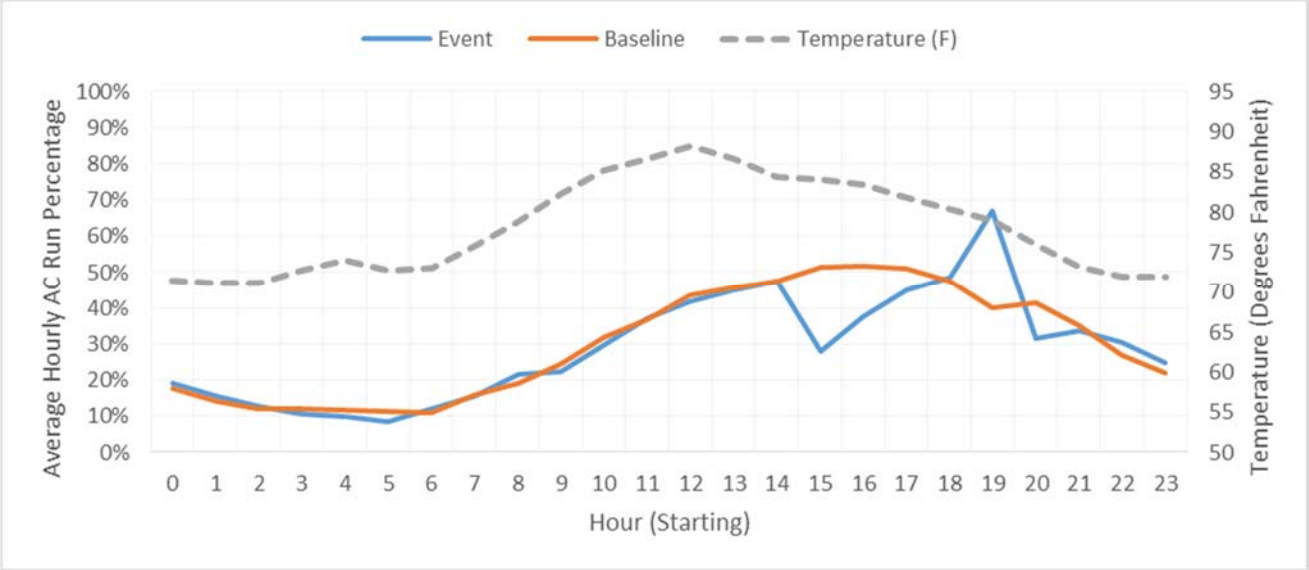


Figure B-8. Central AC Event 2 (Thursday, July 7, 2016)

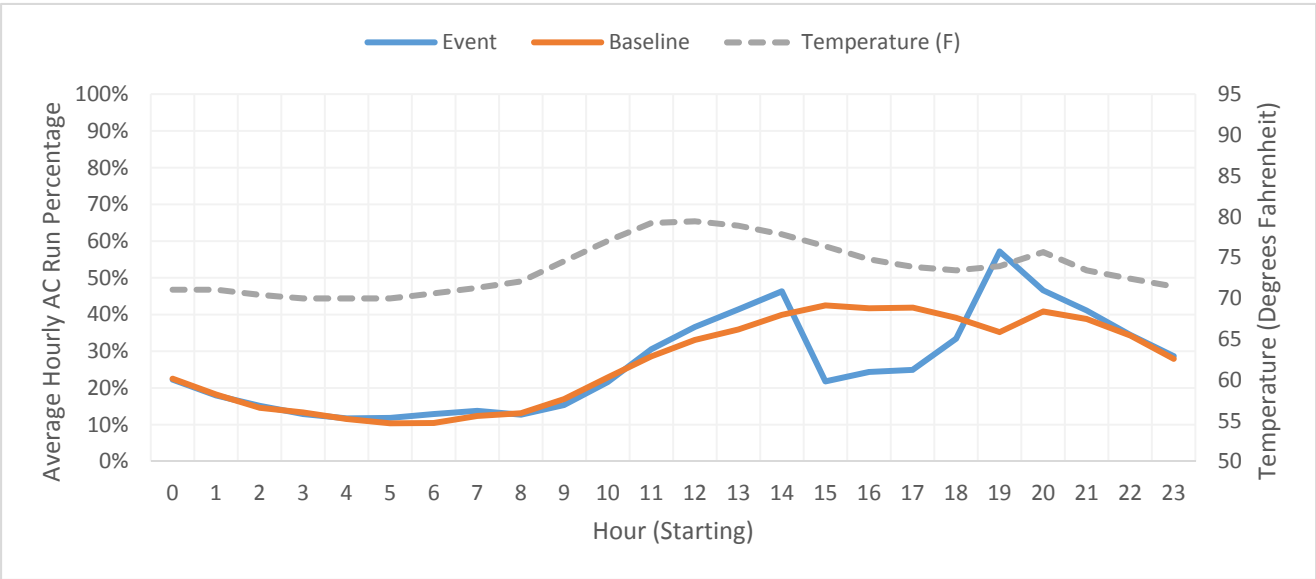


Figure B-9. Central AC Event 3 (Friday, July 15, 2016)

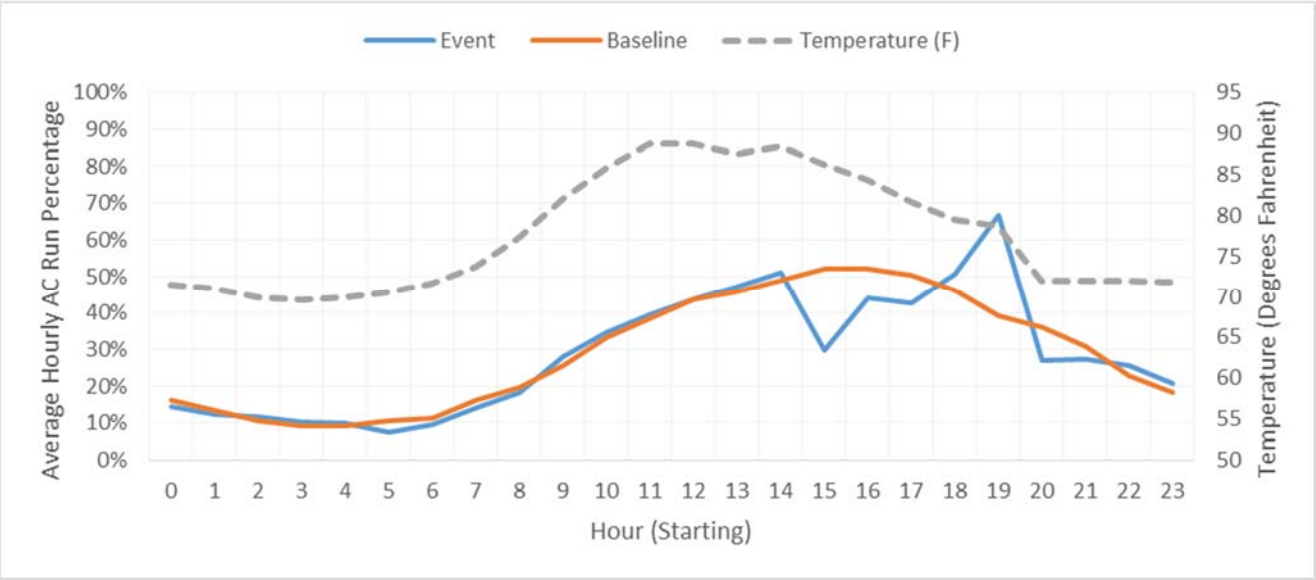


Figure B-10. Central AC Event 4 (Monday, July 18, 2016)

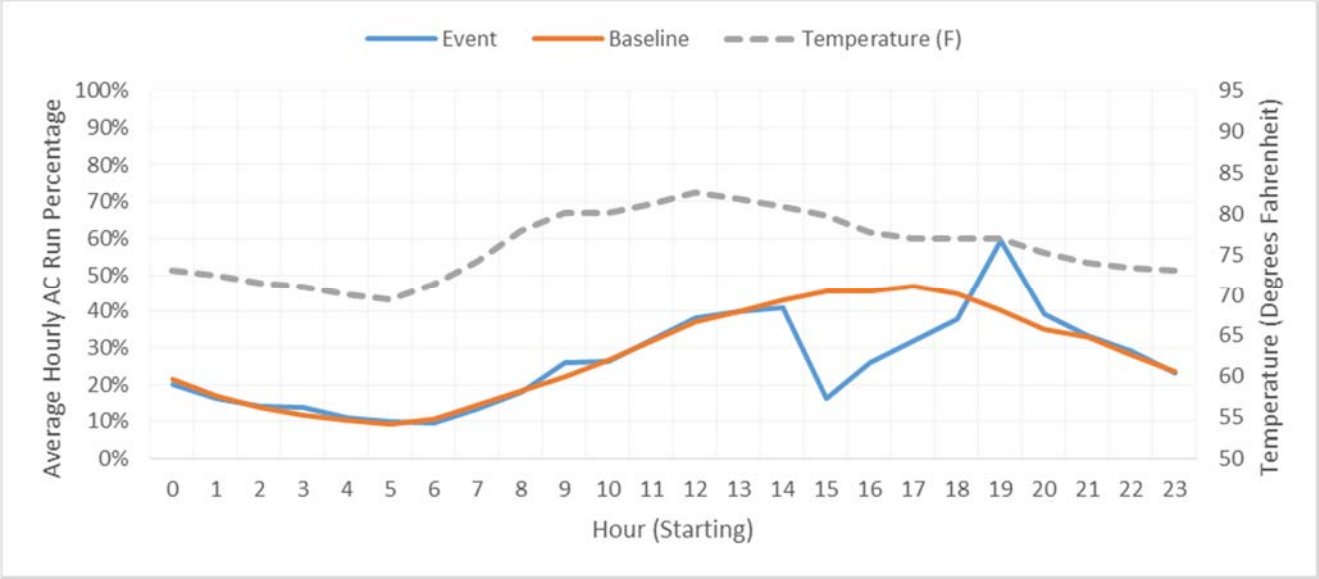


Figure B-11. Central AC Event 5 (Friday, July 22, 2016)

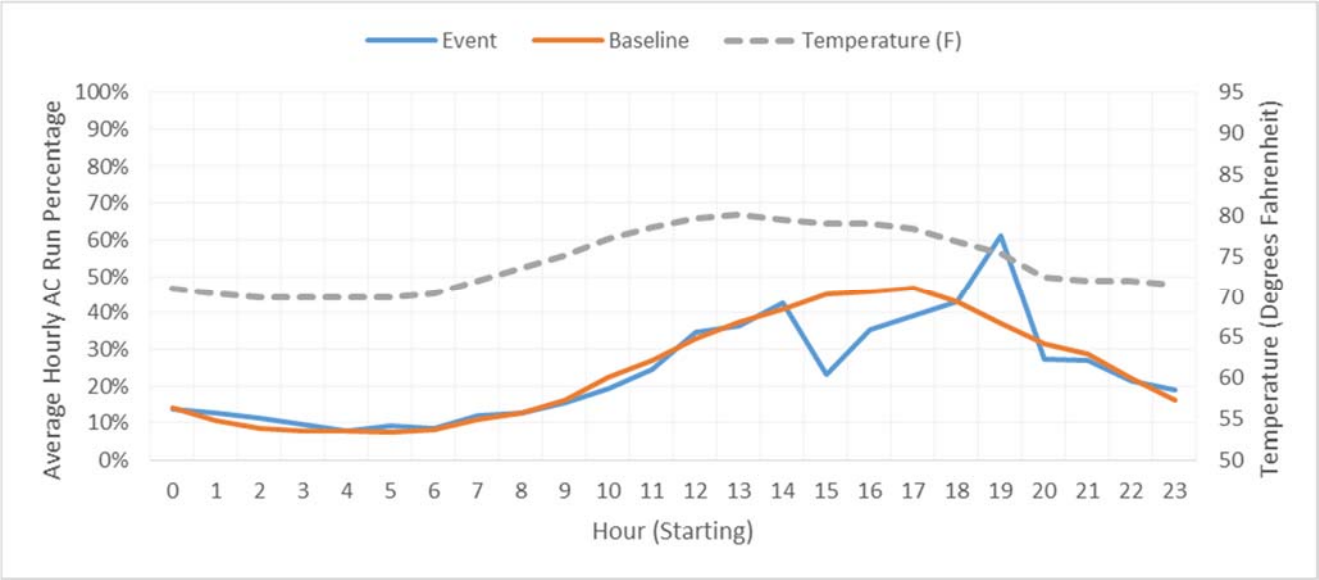


Figure B-12. Central AC Event 6 (Monday, July 25, 2016)

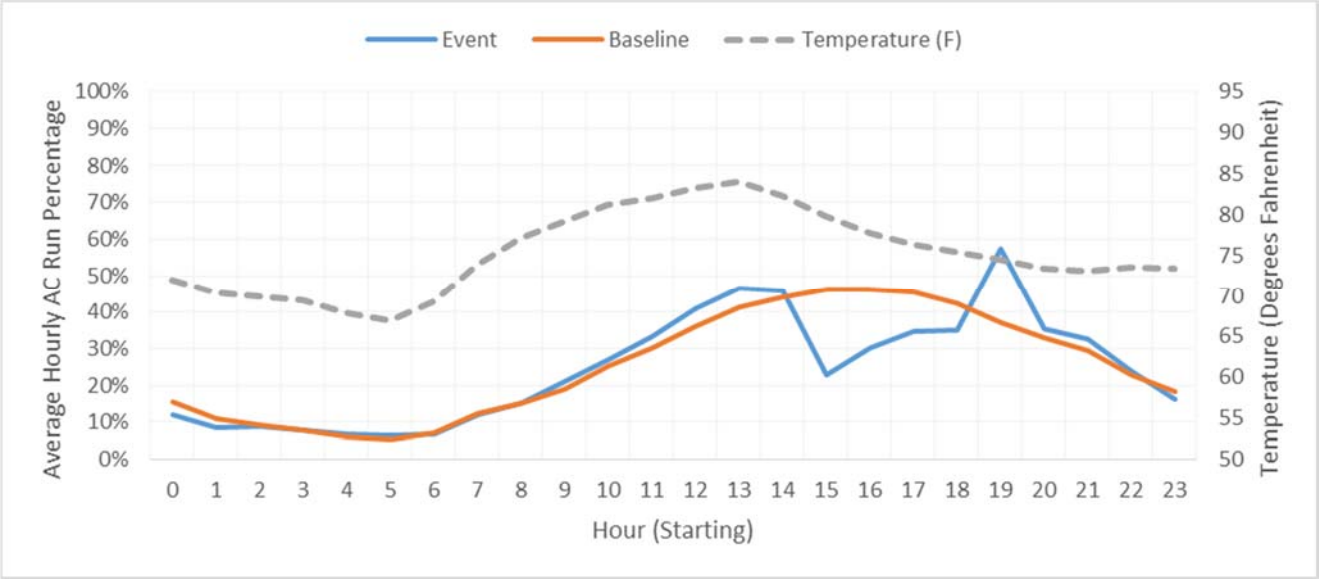


Figure B-13. Central AC Event 7 (Tuesday, July 26, 2016)

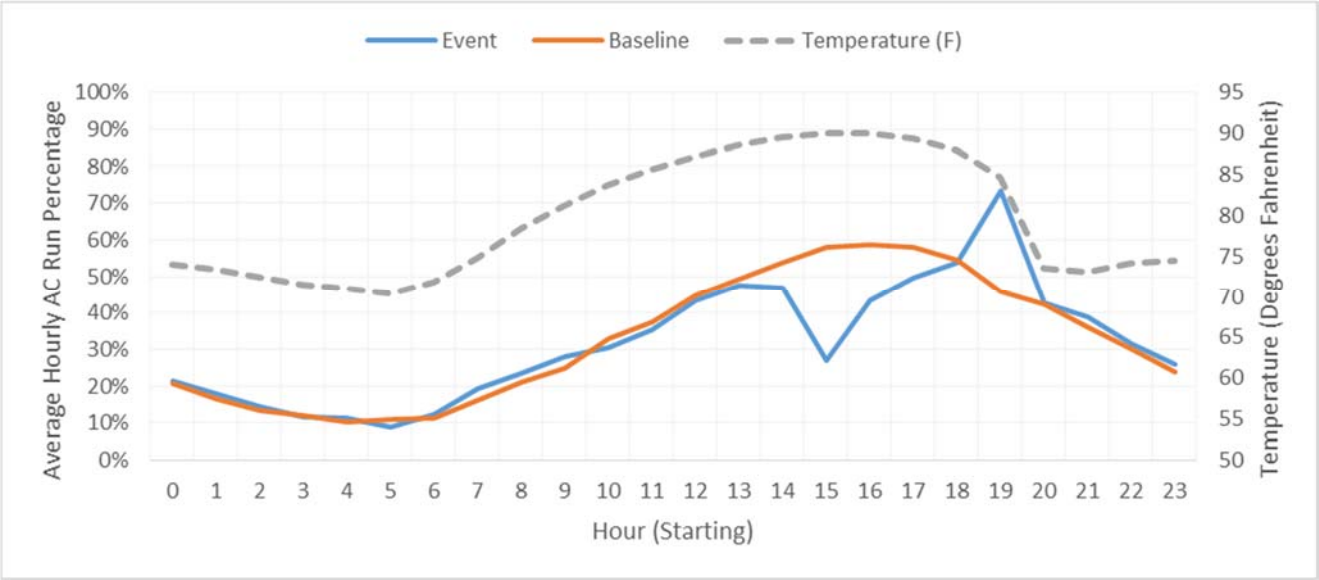


Figure B-14. Central AC Event 8 (Wednesday, July 27, 2016)

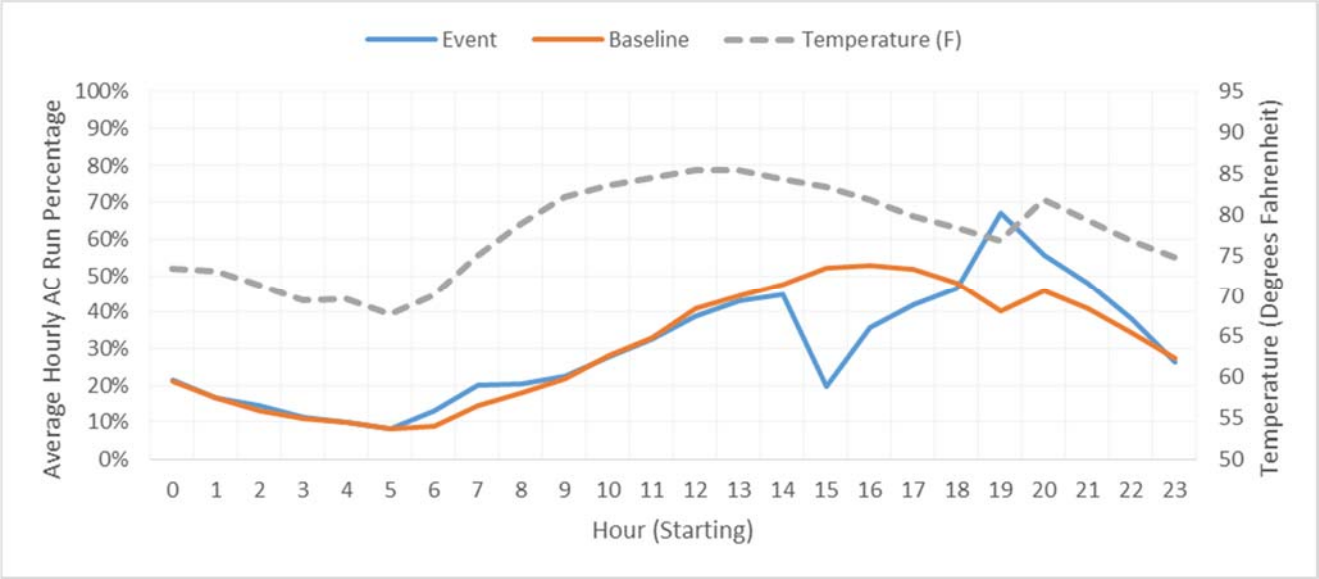


Figure B-15. Central AC Event 9 (Thursday, July 28, 2016)

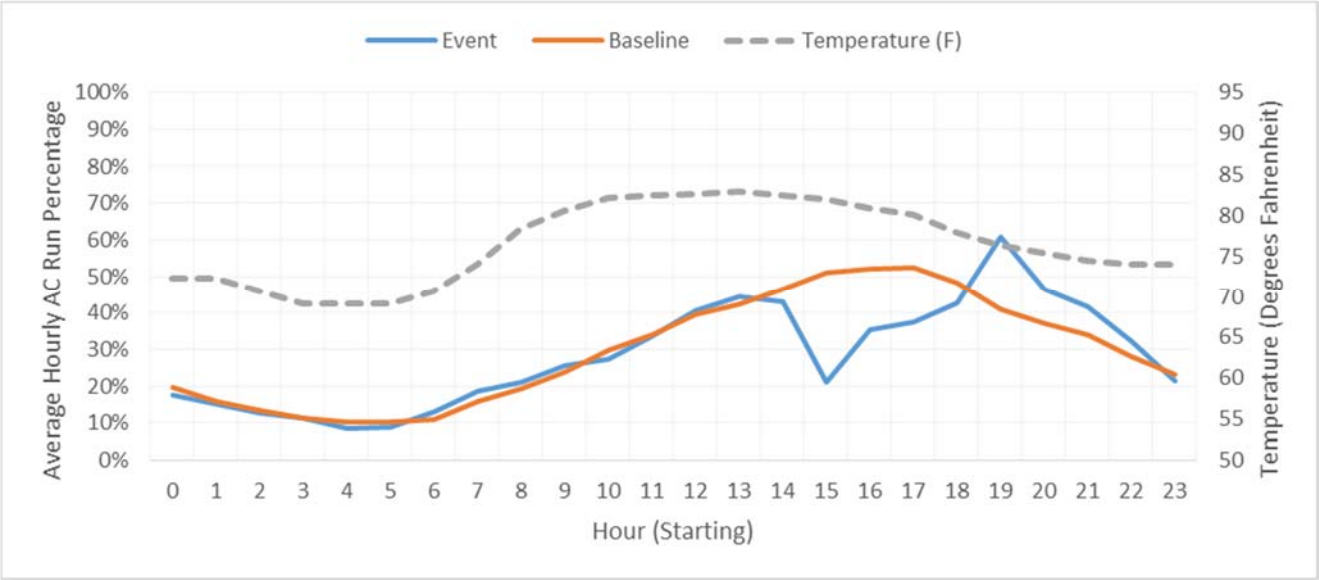


Figure B-16. Central AC Event 10 (Tuesday, August 9, 2016)

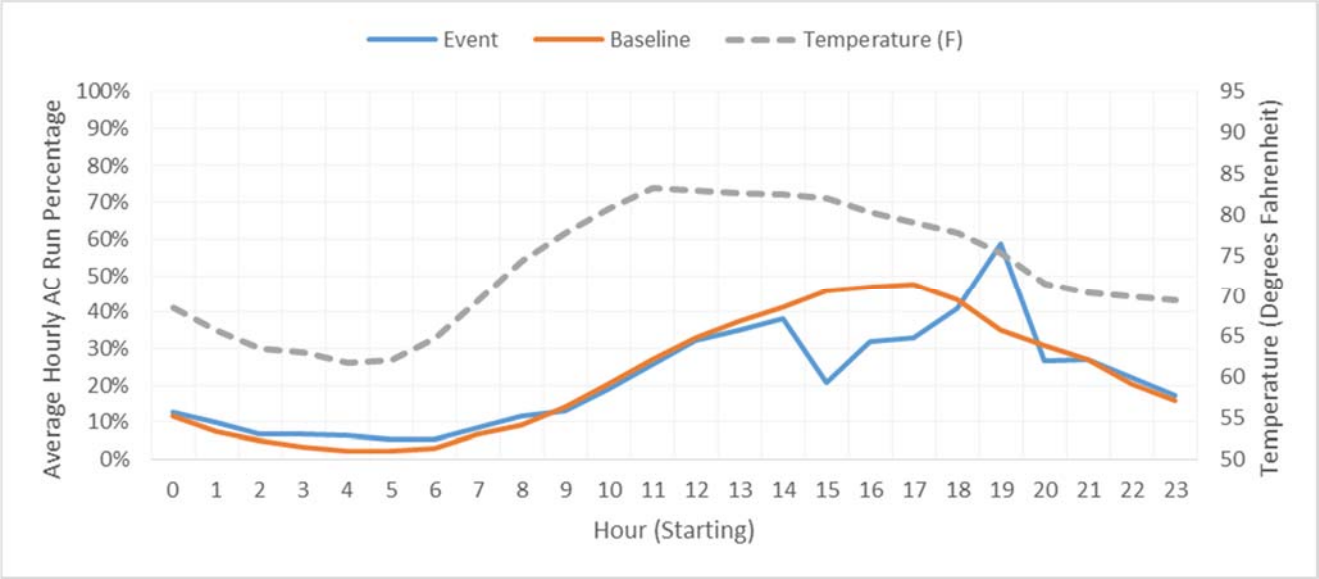


Figure B-17. Central AC Event 11 (Thursday, August 11, 2016)

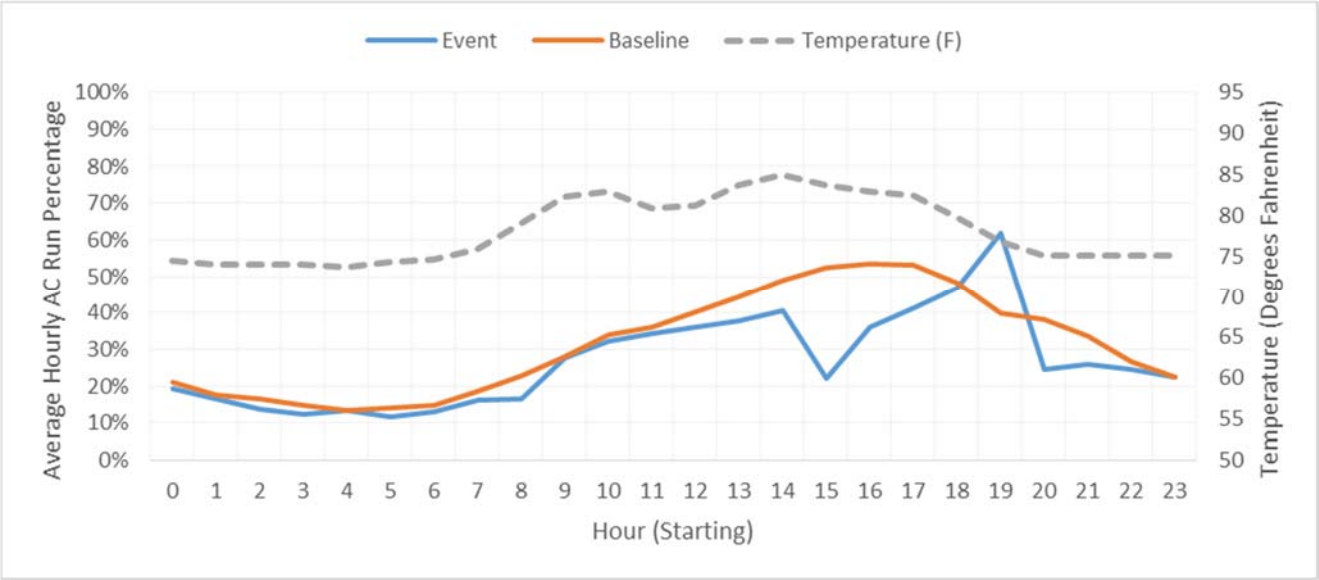


Figure B-18. Central AC Event 12 (Friday, August 12, 2016)

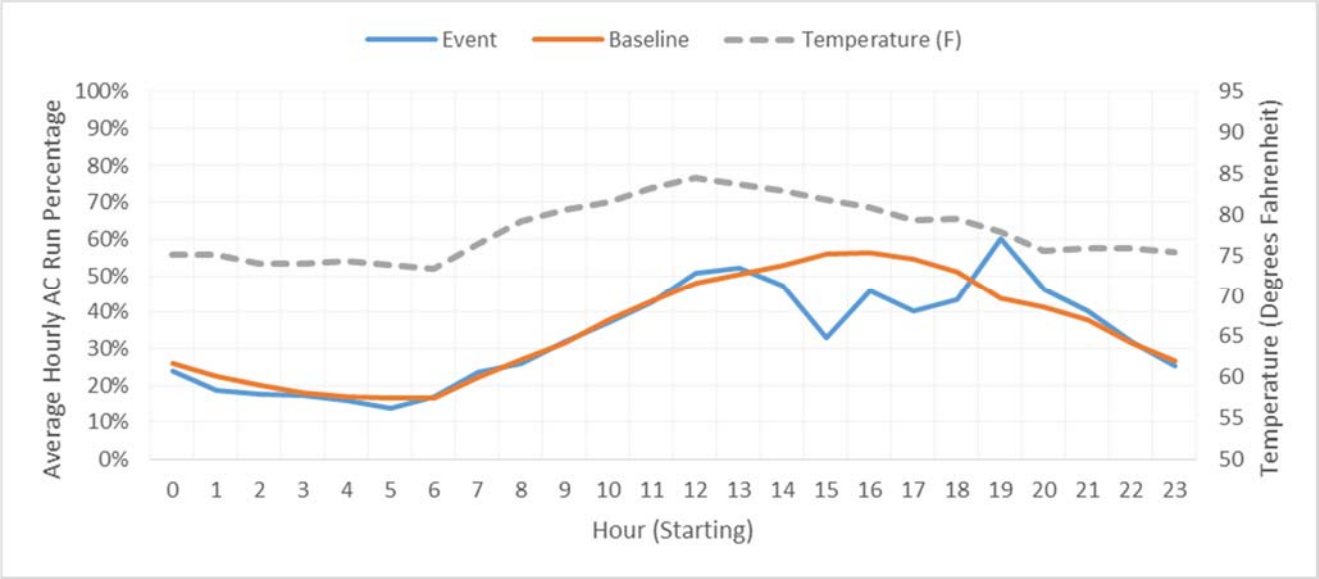


Figure B-19. Central AC Event 13 (Saturday, August 13, 2016)

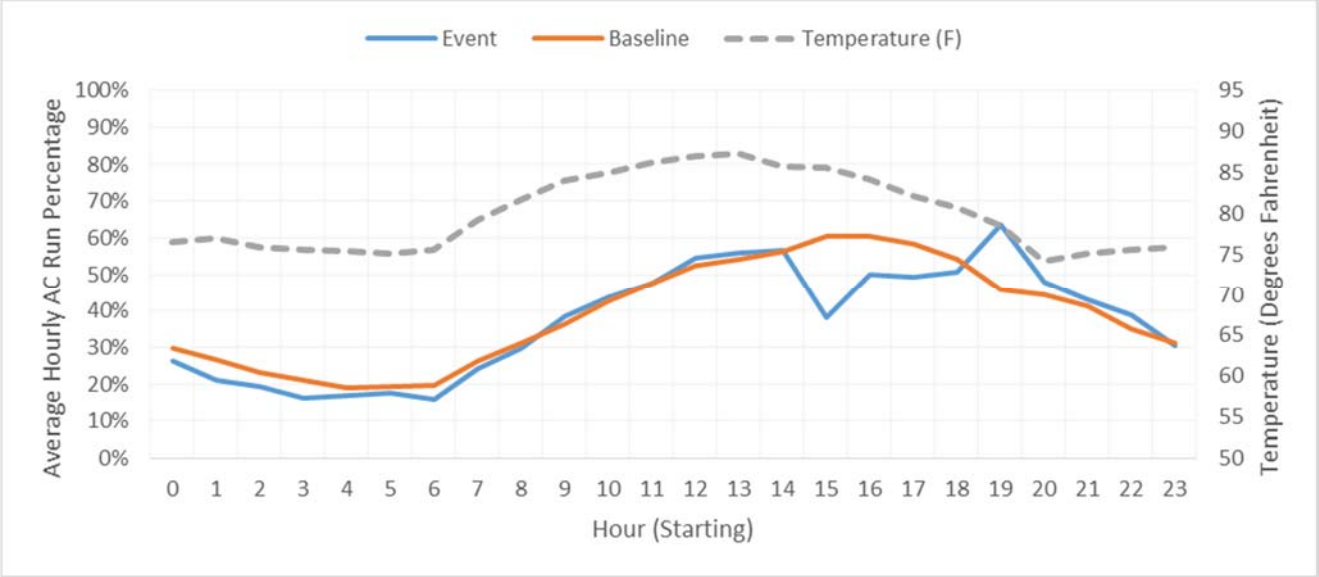


Figure B-20. Central AC Event 14 (Tuesday, August 16, 2016)

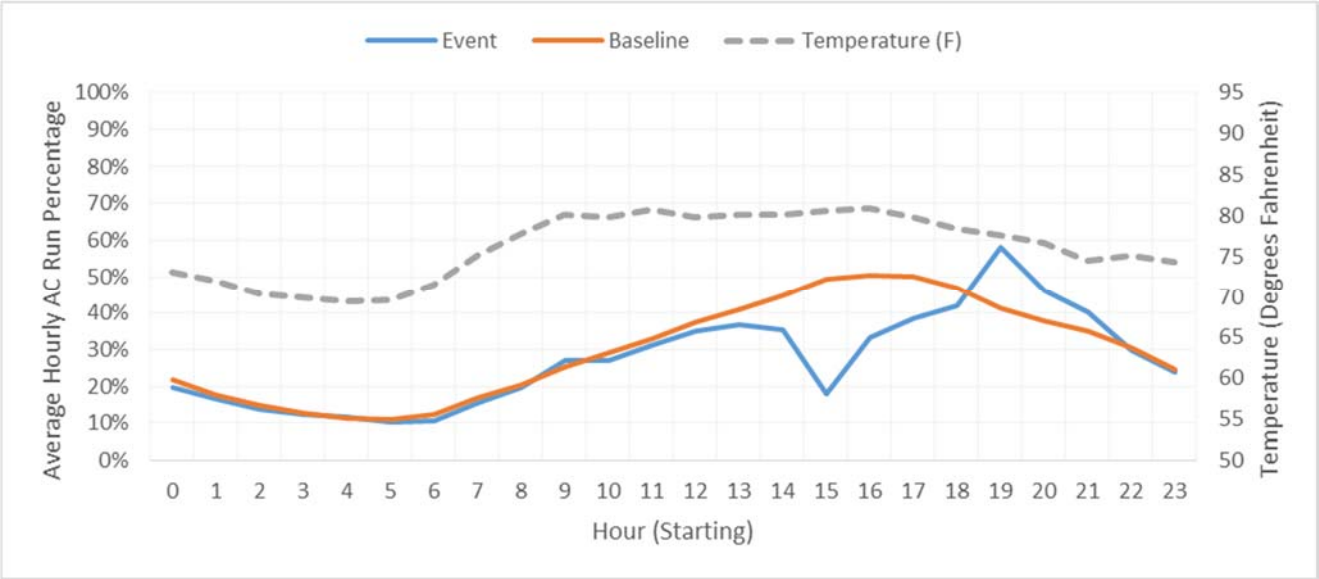


Figure B-21. Central AC Event 15 (Friday, August 26, 2016)

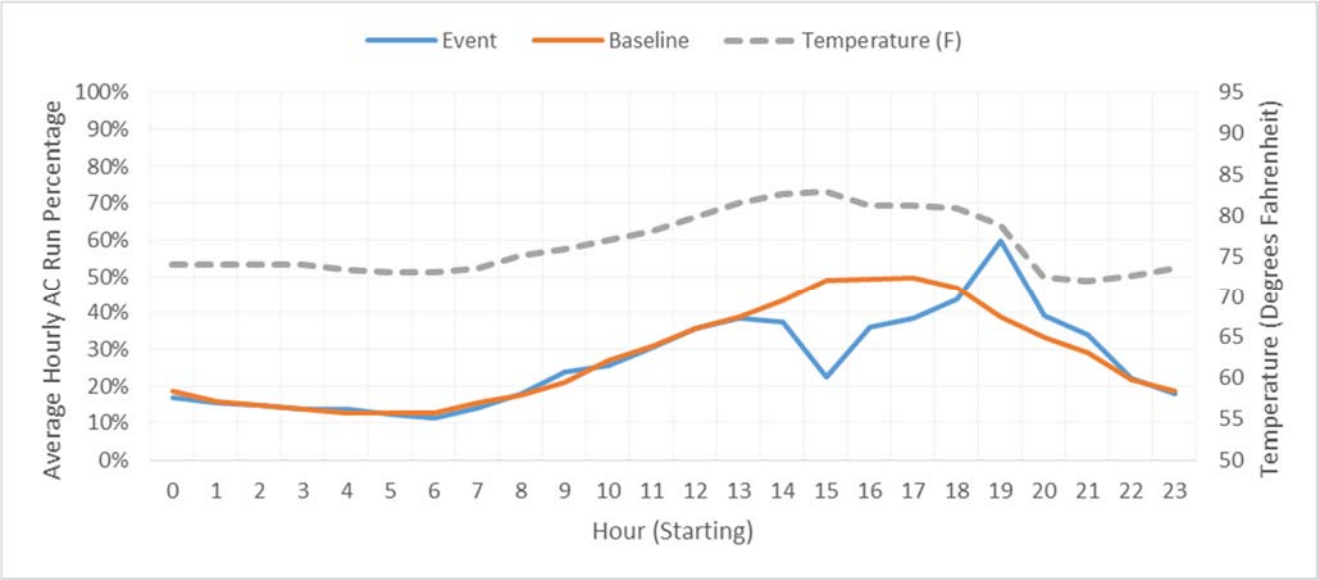


Figure B-22. Central AC Event 16 (Saturday, August 27, 2016)

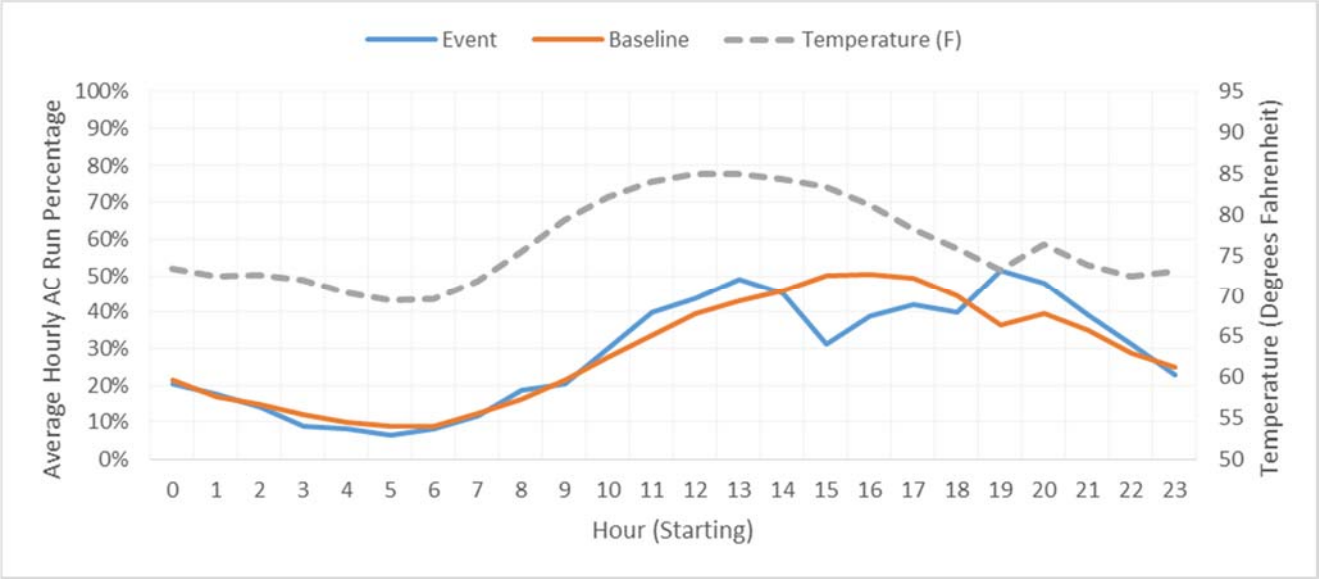


Figure B-23. Central AC Event 17 (Monday, August 29, 2016)

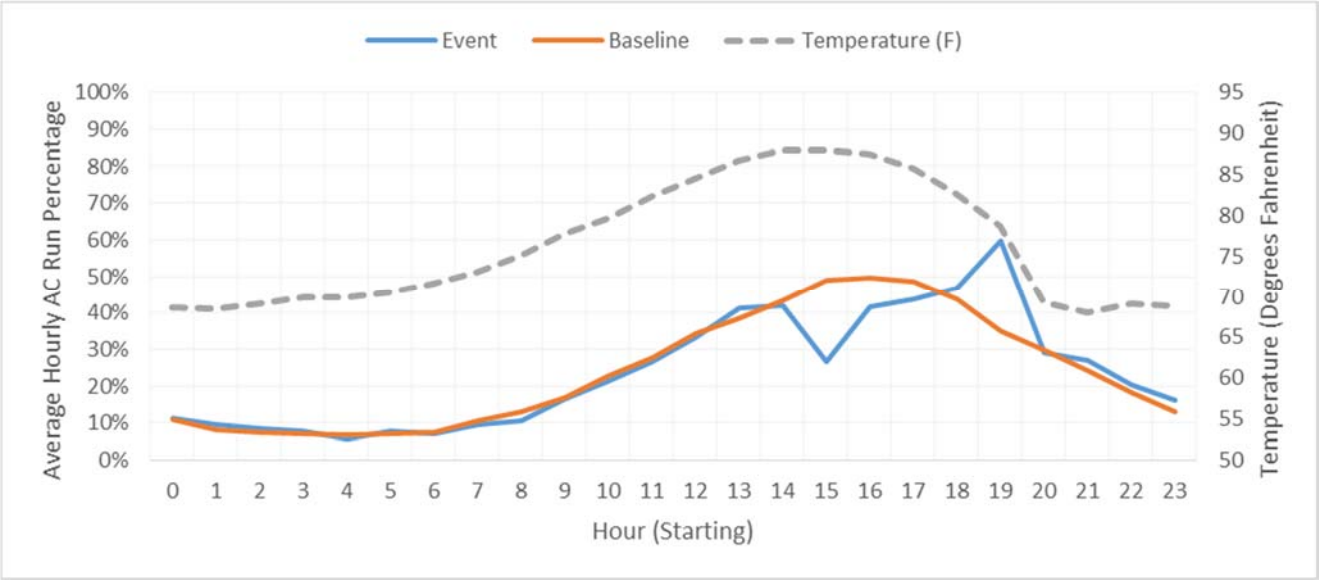
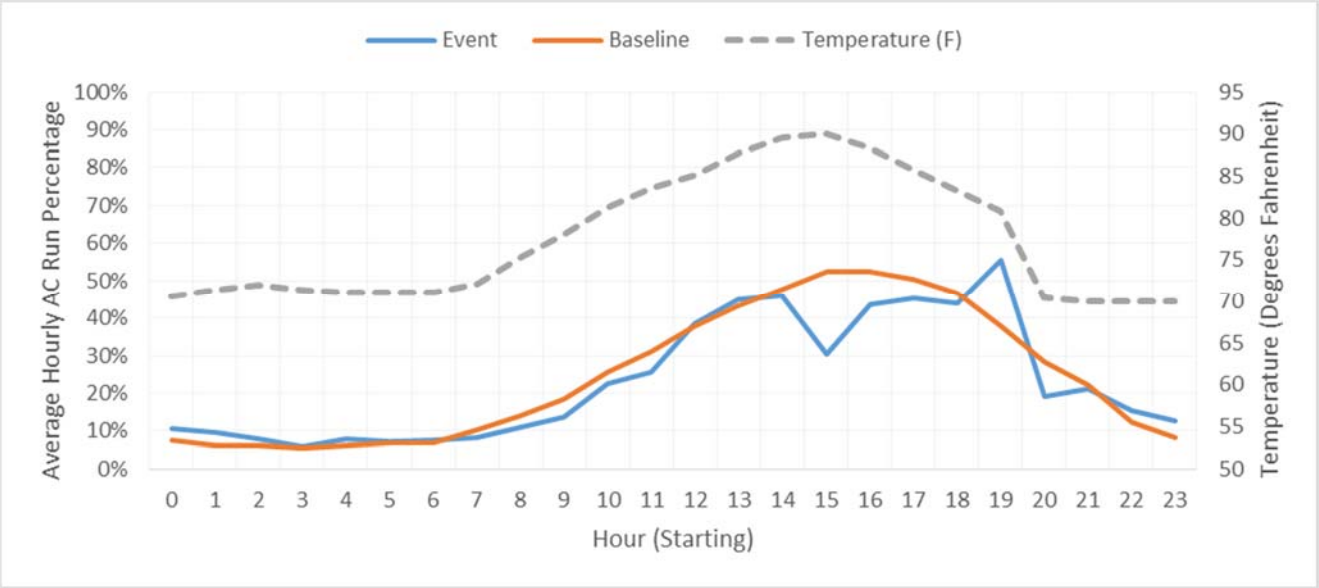


Figure B-24. Central AC Event 18 (Friday, September 9, 2016)



Appendix C. Marketing Effectiveness Survey

Section 5 summarized results from the Marketing Effectiveness Survey conducted with both participants and non-participants in the pilot program. This appendix provides more detailed responses to questions about the pilot's marketing and outreach efforts in 2016.

Awareness of National Grid Energy Efficiency Programs' Funding Source

D0. Before taking this survey, were you aware that energy efficiency programs offered by National Grid are funded through a surcharge on the electric bills of Rhode Island customers? (n=203; Weighted)

1	Yes	40%
2	No	60%

D0a. Does your awareness of this information influence the likelihood that you will participate in any of these programs? (n=203; Weighted)

1	Yes	44%
2	No	56%

Recall of EnergyWise Messaging

[SKIP IF E1=2]

E6. Thinking about the past year, do you recall hearing or seeing any information about the EnergyWise Program?

		EnergyWise Participant (n=122)	EnergyWise Non-Participant (n=57)
1	Yes	88%	75%
2	No	12%	25%

[ASK IF E6=1]

E7. Where did you hear or see information about the EnergyWise Program in the past year? Please select all that apply.

		EnergyWise Participant (n=107)	EnergyWise Non-Participant (n=43)
1	Information in the mail from National Grid	60%	65%
2	Email from National Grid	32%	51%
3	Phone call from National Grid	15%	19%
4	National Grid website	10%	19%
5	Table display at a community event	6%	14%
6	Email from an elected official or other community representative	1%	2%
00	Other: Previous participation	4%	-
00	Other: Word of mouth	1%	2%
00	Other	5%	5%
98	I don't recall where I saw or heard something about the program	11%	7%

Recall of DemandLink Thermostat Program Messaging

[SKIP IF DL1=2]

DL6. Thinking about the past year, do you recall hearing or seeing any information about the DemandLink Program?

		DemandLink Participant (n=43)	DemandLink Non-Participant (n=67)
1	Yes	93%	84%
2	No	7%	16%

[ASK IF DL6=1]

DL7. Where did you hear or see information about the DemandLink Program in the past year? Please select all that apply.

		DemandLink Participant (n=40)	DemandLink Non-Participant (n=56)
1	Information in the mail from National Grid	50%	80%
2	Email from National Grid	33%	38%
3	Phone call from National Grid	5%	4%
00	Other: Current Participant	15%	-
00	Other: Word of mouth	3%	2%
00	Other: Table display at a local event	-	5%
00	Other	-	4%
98	I don't recall where I saw or heard something about the program	10%	5%

Recall of Heat Pump Water Heater Rebate Messaging

[SKIP IF H1=2]

H4. Thinking about the past year, do you recall hearing or seeing anything about the rebate National Grid offers for purchasing a heat pump water heater? (n=72)

1	Yes	72%
2	No	28%

[ASK IF H4=1]

H5. Where did you hear or see information about the rebates in the past year? Please select all that apply. (n=52)

1	Information in the mail from National Grid	64%
2	Email from National Grid	34%
3	Phone call from National Grid	6%
00	Other: Word of mouth	6%
00	Other	2%
98	I don't recall where I saw or heard something about the program	10%

Recall of Rebates for Purchasing or Recycling Window Air Conditioners

[SKIP IF R1a=2 and R1b=2]

R4. Thinking about the past year, do you recall hearing or seeing any information about the rebates National Grid offers for purchasing or recycling window air conditioners? (n=47)

1	Yes	85%
2	No	15%

[ASK IF R4=1]

R5. Where did you hear or see information about the rebates in the past year? Please select all that apply. (n=40)

1	Information in the mail from National Grid	80%
2	Email from National Grid	15%
3	Phone call from National Grid	3%
4	National Grid website	23%
00	Other: Previous participation	5%
98	I don't recall where I saw or heard something about the program	8%

Awareness of "RI Energy Challenge" and "Find Your Four!"

F1. Have you ever heard of "The Rhode Island Energy Challenge"? (n=203; Weighted)

1	Yes	24%
2	No	76%

F2. Have you ever heard the slogan "Find Your Four!"? (n=203; Weighted)

1	Yes	5%
2	No	95%

Recall of Presence at Community Events

F3. This past summer and fall, community volunteers promoted The Rhode Island Energy Challenge, Find Your Four, and the EnergyWise Home Energy Assessment at local organizations and community events throughout Little Compton and Tiverton. These volunteers staffed information tables, similar to the ones shown in the pictures below.

Do you recall seeing any information tables or interacting with the community volunteers? (n=203; Weighted)

1	Yes	10%
2	No	90%

[ASK IF F3=1]

F4. Where did you see the information table? **[OPEN END]** (n=22; Weighted)

1	Church	28%
2	Library	16%
3	Pardon Gray Days	12%
4	Town Fair	14%

98	I don't recall	4%
0	Other, specify	26%

Recall and Clarity of Marketing Materials: Postcard

	Postcard – DemandLink Participants (n=14)	Postcard – DemandLink Non-Participants (n=49)
Front		
Back		
P2	How much of the information provided by this image is new to you?	
	1 None 21% 2 Very Little 29% 3 Some 43% 4 Most 7% 5 All 0% 8 Can't see image 0%	1 None 8% 2 Very Little 14% 3 Some 33% 4 Most 26% 5 All 18% 8 Can't see image 0%

	Postcard – DemandLink Participants (n=14)		Postcard – DemandLink Non-Participants (n=49)	
P3	**Based on the information provided on the postcard, to what extent is it clear …**			
	a. what DemandLink is?			
	Not asked of participants.		1 – Not at all clear 2 3 4 5 – Very clear	2% 16% 31% 25% 27%
	b. why someone would want to sign up for the offerings described?			
	1 – Not at all clear 2 3 4 5 – Very clear	0% 7% 7% 29% 57%	1 – Not at all clear 2 3 4 5 – Very clear	2% 10% 20% 39% 29%
	c. how to get more information about the offerings described?			
	1 – Not at all clear 2 3 4 5 – Very clear	0% 14% 7% 36% 43%	1 – Not at all clear 2 3 4 5 – Very clear	2% 8% 25% 31% 35%
	d. that National Grid wants you to check your thermostat to make sure it's connected to your Wi-Fi network?			
	1 – Not at all clear 2 3 4 5 – Very clear	0% 14% 0% 21% 64%	*Not asked of non-participants.*	
	e. why your thermostat needs to be connected to your Wi-Fi network?			
	1 – Not at all clear 2 3 4 5 – Very clear	0% 7% 0% 29% 64%	*Not asked of non-participants.*	
P1	**Do you recall receiving a postcard like this last summer?**			
	1 Yes 2 No	43% 57%	1 Yes 2 No	41% 59%

Recall and Clarity of Marketing Materials: Newsletter

Newsletter – Participants and Non-Participants	
Page 1	Page 2
Page 3	

	Newsletter –Participant in Any Program (n=49)		Newsletter –Non-Participant in All Programs (n=26)	
N2	**How much of the information provided by this image is new to you?**			
	1 None	12%	1 None	12%
	2 Very Little	14%	2 Very Little	4%
	3 Some	51%	3 Some	35%
	4 Most	12%	4 Most	35%
	5 All	10%	5 All	15%
	8 Can't see image	0%	8 Can't see image	0%
N3	**Based on the information provided on the postcard, to what extent is it clear …**			
	a. what DemandLink is?			
	Asked of DemandLink Non-Participants (n=30)		*Asked of DemandLink Non-Participants (n=26)*	
	1 – Not at all clear	*0%*	1 – Not at all clear	8%
	2	*3%*	2	4%
	3	*33%*	3	19%
	4	*27%*	4	35%
	5 – Very clear	*36%*	5 – Very clear	35%
	b. why someone would want to sign up for the offerings described?			
	1 – Not at all clear	5%	1 – Not at all clear	7%
	2	0%	2	4%
	3	5%	3	30%
	4	37%	4	21%
	5 – Very clear	53%	5 – Very clear	39%
	c. how to get more information about the offerings described?			
	1 – Not at all clear	5%	1 – Not at all clear	6%
	2	0%	2	1%
	3	11%	3	19%
	4	32%	4	34%
	5 – Very clear	53%	5 – Very clear	39%
	d. that National Grid wants you to check your thermostat to make sure it's connected to your Wi-Fi network?			
	Asked of DemandLink Participants (n=19)		*Not asked of non-participants.*	
	1 – Not at all clear	5%		
	2	5%		
	3	21%		
	4	32%		
	5 – Very clear	37%		
	e. why your thermostat needs to be connected to your Wi-Fi network?			
	Asked of DemandLink Participants (n=19)		*Not asked of non-participants.*	
	1 – Not at all clear	5%		
	2	11%		
	3	21%		
	4	21%		
	5 – Very clear	42%		
	f. that you have to sign up for DemandLink in order to access the water heater rebates?			
	1 – Not at all clear	0%	1 – Not at all clear	8%
	2	3%	2	12%
	3	23%	3	23%

	Newsletter –Participant in Any Program (n=49)		Newsletter –Non-Participant in All Programs (n=26)	
	4 5 – Very clear	17% 57%	4 5 – Very clear	23% 35%
N1	Do you recall receiving a postcard like this last summer?			
	1 Yes 2 No	47% 53%	1 Yes 2 No	42% 58%

Recall and Clarity of Marketing Materials: Email

	Email– DemandLink Participants (n=10)		Email – DemandLink Non-Participants (n=55)	
Front				
EM2	How much of the information provided by this image is new to you?			
	1 None 2 Very Little 3 Some 4 Most 5 All 8 Can't see image	10% 10% 30% 30% 20% 0%	1 None 2 Very Little 3 Some 4 Most 5 All 8 Can't see image	13% 9% 33% 15% 31% 0%
EM3	Based on the information provided on the postcard, to what extent is it clear …			
	a. what DemandLink is?			
	Not asked of participants.		1 – Not at all clear 2 3 4 5 – Very clear	20% 9% 27% 20% 24%

	Email– DemandLink Participants (n=10)		Email – DemandLink Non-Participants (n=55)	
	b. why someone would want to sign up for the offerings described?			
	1 – Not at all clear	10%	1 – Not at all clear	13%
	2	0%	2	7%
	3	20%	3	26%
	4	40%	4	27%
	5 – Very clear	30%	5 – Very clear	27%
	c. how to get more information about the offerings described?			
	1 – Not at all clear	10%	1 – Not at all clear	13%
	2	0%	2	2%
	3	20%	3	29%
	4	30%	4	22%
	5 – Very clear	40%	5 – Very clear	35%
	f. that you have to sign up for DemandLink in order to access the water heater rebates?			
	Not asked of non-participants.		1 – Not at all clear	15%
			2	4%
			3	26%
			4	22%
			5 – Very clear	35%
EM1	**Do you recall receiving a postcard like this last summer?**			
	1 Yes	0%	1 Yes	20%
	2 No	100%	2 No	80%

Interest in Programs after Reviewing Materials

[ASK IF P1<>8 & N1<>8 & EM1<>8, ELSE SKIP TO NEXT SECTION]

I1. Based on the information in the **[Postcard/Newsletter/Email]**, how likely would you be to visit the website or call to get more information about one or more of the offerings? **[SCALE: 1-5; 1="Not at all likely" 5="Very likely"]**

Postcard (n=63, Weighted)		**Newsletter** (n=75, Weighted)		**Email** (n=65, Weighted)	
1 – Not at all likely	20%	1 – Not at all likely	29%	1 – Not at all likely	19%
2	16%	2	11%	2	12%
3	31%	3	34%	3	29%
4	19%	4	15%	4	31%
5 – Very likely	13%	5 – Very likely	12%	5 – Very likely	9%

[ASK IF I1>2]

I2. Which of the offerings would you be likely to look into or ask about? Please select all that apply. **[MULTIPLE RESPONSE, ROTATE]** *(asked only of non-participants in each offering)*

01	**[SHOW IF EW_PART=0]** EnergyWise Program	(52%, n=54)
02	**[SHOW IF DL_PART=0]** DemandLink	(37%, n=100)
03	Rebate for purchasing a window air conditioner	(24%, n=128)
04	Rebate for recycling a window air conditioner	(29%, n=128)
05	**[SHOW IF HPWH_PART=0]** Rebate for purchasing a heat pump water heater	(50%, n=127)
96	None of these	(20%, n=128)

Appendix D. Survey Sampling and Dispositions

Below we provide details on the survey dispositions and response rates for the online Marketing Effectiveness Survey and the telephone DemandLink Demand Response Event Follow-Up Survey.

The survey response rate is the number of completed interviews divided by the total number of potentially eligible respondents in the sample. We calculated the response rate using the standards and formulas set forth by the American Association for Public Opinion Research (AAPOR). For various reasons, we were unable to determine the eligibility of all sample units through the survey process and chose to use AAPOR Response Rate 3 (RR3). RR3 includes an estimate of eligibility (e) for these unknown sample units. According to AAPOR's standard definitions, we used two estimates of eligibility, which are presented below. The definitions of the letters used in the formulas are displayed in the tables below.

$$e1 = (I + N) / (I + N + X1)$$

$$e2 = (I + N + X1 + U1) / (I + N + X1 + U1 + X2)$$

$$RR = I / (I + N + e1(U1 + e2*U2))$$

Marketing Effectiveness Survey

The sampling unit for the Marketing Effectiveness Survey was the unique substation customer. The population included 4,776 customers identified as unique from the full database of 5,126 substation accounts. We removed 20 contacts identified as businesses and 1,428 contact without email addresses. The final sample frame consisted of 3,328 unique customers. We attempted to complete the survey with all 3,328 participants (census attempt).

Table D-1 shows the final dispositions for the Marketing Effectiveness survey, fielded between March 3, 2017 and March 24, 2017. We completed a total of 203 interviews, resulting in a response rate of 6.8%.

Table D-1. Marketing Effectiveness Survey Dispositions and Response Rate

Result	n
Sample Frame	3,328
I= Complete Interviews	203
X1=Survey-Ineligible Household	8
U1=Household with Undetermined Eligibility	2,817
X2=Not a Household	248
N=Eligible Incomplete Interview	52
U2=Undetermined if Household	0
e1=estimated proportion of cases of unknown survey eligibility that are eligible	0.970
e2=estimated proportion of cases of unknown household eligibility that are eligible	0.925
Response Rate	**6.8%**

Customers who participated in one or more of the five key pilot program components, responded to the survey at a greater rate than they are represented in the population. We created weights for use in our analysis in instances where results for participants and non-participants are combined. These weights are presented in Table D-1Table D-2.

Table D-2. Weights Reflecting Population of Customers Who Participated in Any Program Participants

	Population	Completed Interviews	Weight
Has not participated in any program component	3,651	74	9.847
Has participated in one or more program component	1,125	129	0.168
Total Unique Customers	**4,776**	**203**	–

DemandLink Demand Response Event Follow-Up Survey

The DemandLink Demand Response Event Follow-Up Survey targeted all participants who were enrolled in the DemandLink controllable thermostat component in 2016 (i.e., any residential customer who received a WiFi-enabled thermostat since the beginning of the pilot). The survey was fielded between August 30th and September 1st, following the SRP demand response event called on August 29th.

Table D-3 shows the final dispositions for the survey. We completed a total of 52 interviews, resulting in a response rate of 21.6%.

Table D-3. DemandLink Participant Survey Response Rates

Result	n
Sample Frame	260
I= Complete Interviews	52
X1=Survey-Ineligible Household	0
U1=Household with Undetermined Eligibility	146
X2=Not a Household	16
N=Eligible Incomplete Interview	4
U2=Undetermined if Household	42
e1=estimated proportion of cases of unknown survey eligibility that are eligible	1
e2=estimated proportion of cases of unknown household eligibility that are eligible	0.927
Response Rate	**21.6%**

This page intentionally left blank

For more information, please contact:

Antje Flanders
Vice President

617 492 1400 tel
617 497 7944 fax
aflanders@opiniondynamics.com

1000 Winter Street
Waltham, MA 02451