BEFORE THE PUBLIC UTILITIES COMMISSION

OF THE STATE OF CALIFORNIA

Order Instituting Rulemaking Regarding Policies, Procedures and Rules for Development of Distribution Resources Plans Pursuant to Public Utilities Code Section 769.	Filed Public Utilities Commission August 14, 2014 San Francisco, CA Rulemaking 14-08-013

RESPONSE OF NEST LABS, INC. TO THE DISTRIBUTION RESOURCES RULEMAKING

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DISTRIBUTION RESOURCES RULEMAKING

In accordance with the directives provided in the August 20, 2014, Order Instituting Rulemaking ("Rulemaking"), Nest Labs, Inc. ("Nest") is pleased to submit these comments to the Public Utilities Commission of the State of California in response to the Order Instituting Rulemaking Regarding Policies, Procedures and Rules for Development of Distribution Resources Plans Pursuant to Public Utilities Code Section 769 ("Order").

Our comments at this stage of the proceeding are focused on sharing our experiences with load management and providing a set of key principles that we hope the Commission will consider as part of this rulemaking - and that we hope will encourage participating parties to think about the provision of load management services differently. We have not sought at this stage to address all of the questions outlined in the Order, but we have closely considered the guidance the Commission is seeking, and we stand ready to provide additional input as needed as this proceeding moves forward.

I. SUMMARY OF PROCEEDING

The Rulemaking was opened by the Commission "to establish policies, procedures, and rules to guide California investor-owned electric utilities ("IOUs") in developing their

Distribution Resources Plan Proposals, which they are required by Public Utilities Code Section 769 to file by July 1, 2015. The Rulemaking will also evaluate the IOUs' existing and future electric distribution infrastructure and planning procedures with respect to incorporating Distributed Energy Resources."[1] The Rulemaking is driven by the passage of Assembly Bill ("AB") 327,[2] which added to the Public Utilities Code a new Section 769, which addresses the IOUs' electric distribution planning and the Commission's obligation to review, modify, and approve the IOUs' Distribution Resources Plan Proposals ("DRPs"). The bill addresses multiple aspects of the provision of regulated utility service and of the energy market, including Net Energy Metering, the Renewables Portfolio Standard, natural gas and electricity rates, and electricity resources.

II. NEST LABS

Founded by Tony Fadell and Matt Rogers in 2010, Nest reinvents unloved but important home products like the thermostat and smoke alarm. The company focuses on providing customers with simple, beautiful and thoughtful hardware, software and services that help reduce energy consumption and keep families comfortable and safe. Today, Nest products are sold in the U.S., U.K. and Canada and are installed in more than 120 countries.

Nest is a wholly-owned subsidiary of Google Inc. and is based in Palo Alto, California.

III. NEST'S EXPERIENCES WITH LOAD MANAGEMENT

Nest has already changed the way people think about their thermostat. Moving forward, our goal is to change the way people think about energy use. Rather than pushing one-size-fits-all demand response or energy efficiency programs on customers, we want to offer customers

[1] Rulemaking, at p. 2.
[2] Stats. 2013, ch. 611.

ways to save while keeping them in control of their own comfort and usage. We want customers to be motivated and engaged participants in energy programs and we aim to provide technology that eases needlessly complicated tasks like programming a thermostat. And we want energy savings to be persistent rather than short-lived.

The Nest Learning Thermostat was released in October 2011 and has experienced significant success with customers. The Nest Thermostat has a variety of hardware and features, including sensors, Wi-Fi capability, and smart-phone grade processing, to help customers consume less energy: it learns their preferences, turns the temperature down when the house is empty, and automatically lowers AC runtime when humidity conditions permit, helping people lower their energy use without sacrificing comfort. The potential energy savings and grid benefits associated with these efficiencies are significant.

We have also started partnering with energy companies to help them realize these benefits at scale. Initially, our energy partnerships focused primarily in the competitive market of Texas, where we worked with Reliant Energy to create a successful customer acquisition-focused program in which Reliant bundled a free Nest Thermostat with an energy plan. In the spring of 2013, we released our first offerings to address utility load management needs. We called these two offerings Rush Hour Rewards and Seasonal Savings.

Rush Hour Rewards is a service that helps customers earn money back from their energy company by using less energy when everyone else is using more. It is typically overlaid on top of a utility's demand response program, but can be deployed as a standalone offering as well. Nest offers a turnkey approach of customer recruitment, enrollment, and deployment of software. For a view of how we communicate about Rush Hour Rewards with our customers, please see http://support.nest.com/article/What-is-Rush-Hour-Rewards.

When dispatched, Nest's Rush Hour Rewards uses unique algorithms to determine the best mix of pre-cooling, cycling, and setbacks for each home on each day based on what we know about each customer's comfort preferences and occupancy patterns, and the thermal characteristics of their home. This combination is customized to each individual home, and is designed to maximize load reduction within the peak window, while preserving the customer's comfort. For example, in a home that is typically unoccupied during the afternoon, load reduction may be much more aggressive than in a neighboring home that is typically very active in the afternoon. This unique balancing of load reduction with customer comfort goes a long way towards increasing customer satisfaction and voluntary participation. The success is demonstrated in very high customer satisfaction ratings and enrollment retention, as well as very low opt-out rates on specific events. By embracing what we know about each customer's home, we harmonize the energy companies' load shedding goals with the customer's financial interest and comfort.

Seasonal Savings automatically tweaks some temperatures in customers' schedules to help them consume energy more efficiently, while still keeping their homes comfortable. Most importantly, this is packaged for customers in a way that keeps them fully apprised of what is going on, getting them further engaged in the process. Customers can change the temperature or adjust their schedules at any time, but if they stick with Seasonal Savings' optimized schedule, our studies show that Nest Thermostat owners can save 5% on HVAC use. These savings are on top of the savings delivered by our other features described above.

We also offer each Nest account holder - free of charge - a customized monthly Energy Report via email that provides thought-provoking information on their energy usage and a summary of how many Nest Leafs (a popular reward badge that shows customers they are saving energy) the customer has earned. More information on the Nest Thermostat's energy saving features can be found on our website at https://nest.com/thermostat/saving-energy/.

We launched Rush Hour Rewards and Seasonal Savings with three energy partners in 2013, including Southern California Edison, and are expanding these programs and adding new partners in 2014. That said, Southern California Edison remains our only utility partner in the state of California. However, we routinely hear, via social media and Nest surveys, that our customers served by other California utilities would like their energy providers to offer Nest energy efficiency programs. We know the demand for these programs in California is significant, and if given the opportunity, we believe these programs can help more people save energy and money across our home state.

In June of this year, we announced the Works with Nest program, in which we opened up Nest application programming interfaces (APIs) to developers so they could integrate third-party products with Nest products, thereby expanding the reach of Nest's energy savings capabilities. Iconic brands like Whirlpool, Mercedes and Logitech have created energy saving integrations that Nest customers can opt to use free of charge. For example, if a customer is signed up for Rush Hour Rewards with a participating energy provider, Nest can let Whirlpool know when an energy rush hour (i.e., a peak demand period) is about to happen, and the customer's washer or dryer will delay the start of the cycle until the rush hour is over. More information about the Works with Nest program can be found on our website at https://nest.com/works-with-nest/.

Since the very beginning, Nest has endeavored to learn from industry thought leaders to design a better experience for our customers. Nest has also contributed to the dialogue around energy efficiency, including engaging with the EPA's ongoing process for Energy Star labeling for climate controls and publishing results from our load management programs, in an effort to promote our objectives of simplicity, customer choice, and meaningful energy savings. Please find attached White Papers outlining some early results from these programs, including results from our partnership with Southern California Edison.[3]

IV. KEY PRINCIPLES FOR RULEMAKING

All too often, load management programs focus on the needs of the grid and work backwards to the needs of customers. At Nest, we start by looking for ways to engage and delight our customers and work from there to the needs of the grid. That's why we believe the customer's point of view should be well represented in any discussion of distributed energy resource programs, and we hope that our experience can help inform the Commission's approach as it moves forward with this proceeding.

Many of the grid issues that the Commission's Order addresses must be solved at residences and in residential neighborhoods, given that many of those issues will be caused by residential generation, storage, and EV charging. This marks a potentially dramatic departure from prior demand management programs which relied mostly on commercial and industrial customers. We believe that a focus on residential customer programs and markets requires a meaningfully different mindset. As an example, the apparent underlying premise of Question 3 in the Order is that decisions about the locations of DERs will be made with grid concerns in mind. This may well be true for some types of DERs, but not for all. We should note that many customers buy a smart thermostat without even knowing that it is capable of acting as a DER, and install it at their home regardless of the value to the grid.

The key points that we would like to include at this stage are as follows:

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[3] See Attachment A, Rush Hour Rewards – Results from Summer 2013 and Attachment B, Seasonal Savings – Results from Summer 2013, attached hereto.

Need for simplicity: The issues being addressed by this proceeding are complex, to be sure. However, as we work through the different approaches, the most elegant solution will be doomed for failure if it is too complex to implement. In order to achieve meaningful levels of customer participation, load management programs must be designed in a simple and transparent manner. Some of this complexity can be mitigated through third-party involvement (as described below), but the underlying structures need to be simple enough that consumers can understand the basic value proposition.

Limitations of price signals as a policy tool: On the other side of the coin, while price signals can play an important role, we believe that overreliance on them risks oversimplifying what are, in fact, highly personal, multifactor residential energy consumption decisions. Much emphasis has been placed on the role of price signals in encouraging customers to adjust their consumption patterns and their purchasing behavior to better conform to the grid's limitations. As intellectually satisfying as this approach is, it assumes that 1) customers will understand the impact of the price signals on their bills, 2) they will have the means to easily adapt their usage and buying patterns based on those signals, and 3) the economics will be compelling enough to warrant that adaptation. Furthermore, such structures could create winners and losers among consumers, penalizing those that are unable to adapt for whatever reason. We believe there is a place for such tariffs and structures, but policies should be built with other alternatives as well.

Role of third parties: We respectfully submit that third parties like Nest can and should play an active role in delivering DERs. Many third parties have customer relationships that extend beyond the energy space. These relationships create communications channels that can be used to more effectively recruit customers and increase their participation in energy efficiency and demand response efforts. Properly incorporated, these capabilities can magnify the impact of California's Distribution Resource Plans.

Data sharing: We believe there should be a very high bar around the sharing of any individualized data from the customer side of the meter for the purpose of DER programs and markets.

Distinction between grid infrastructure and consumer infrastructure. First, we believe that data from grid assets up to and including the meter should be treated separately from data that come from DERs on the customer side of the meter. Even if utilities or others subsidize the purchase of DERs on the customer side of the meter, customers have a natural and deeply-rooted predisposition to consider the devices in their home as private. Our comments below pertain to data from the customer's side of the meter.

Primacy of consumer privacy. There is legitimate debate about what types of data represent private information. However, we respectfully submit that the Commission should err on the side of overprotection in considering potential DER programs to avoid even the perception that consumer data is being shared unnecessarily or in a manner that could intrude on people's privacy.

Appropriate data sharing. The world is still figuring out how to handle the large amounts of data that are being created on a daily basis. In our experience, it is common for companies to want access to all available data, rather than being selective about exactly what type of data is required - even if they don't have a specific use in mind for that data. We believe that any data sharing that might be included in DRPs should be tested to ensure that the appropriate amount of data is being shared.

Distinguish data sharing requests. On a related note, we appreciate that utilities and others involved in the markets and programs resulting from these proceedings may at times have other interests in data streams that are not strictly tied to proper functioning of a DER market or program. For example, a utility may want data from an EV to help in the marketing of other products or services targeting EV drivers. This is not inherently a problem - so long as the provision of that additional data is not a prerequisite for participation in DER markets or programs funded by ratepayer dollars.

V. RULE 6.2 COMPLIANCE

A. Proposed Category

Nest support the Rulemaking's proposed categorization as quasi-legislative.

B. Need for Hearing

Nest concurs that that the issues in the first phase of the Rulemaking may be resolved through comments and workshops without the need for evidentiary hearings.

C. Schedule

Nest believes that the schedule proposed in the Rulemaking is acceptable. We recommend that in order to optimize involvement in this proceeding by third parties such as Nest, the suggested Workshop on Staff Proposal tentatively slated for November should be held. Further, we note the schedule calls for the utility DRPs to be filed, per the statute, on July 1, 2015, with a Commission decision on them to be issued by March, 2016. During the interim period a subsequent ruling should encourage third party comments and replies on the DRPs, as well as provide for the possibility of hearings in the event that disputed issues of fact should arise in connection with the DRPs.

VI. CONCLUSION

We appreciate the opportunity to provide these comments into this proceeding, and look forward to continuing to participate in the ensuing debates and discussions at the Commission.

Respectfully submitted,

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September 5, 2014

Attachment A

Rush Hour Rewards – Results from Summer 2013

WHITE PAPER

Rush Hour Rewards

Results from summer 013

Nest Labs, Inc.

May 014

1. Introduction

Electric grids are sized to accommodate peaks in energy use, which often occur on hot afternoons when everyone turns air conditioning on at the same time. These peaks represent fewer than 100 hours per year (about 1%). As demand increases, energy companies have two options:

1. Build more power plants and distribution infrastructure.

. Take steps to encourage customers to conserve during the peak periods.

This second option, traditionally called "demand response," is cost-effective and environmentally friendly, yet just 6% of households with central AC are currently participating in a demand response program, according to Parks Associates. The reason that demand response has yet to reach mass-market adoption is simple: existing "demand response" strategies are one-size-fits-all and prioritize load reduction over user comfort.

Demand response can only be successful if you personalize the experience and balance comfort with energy savings. To further encourage adoption and mainstream appeal, the marketing and positioning of these programs should be more user-friendly. Finally, customers need to feel comfortable and in control of their temperature at all times, and receive a meaningful incentive in exchange for participation.

Nest has created a unique, personalized solution marketed as Rush Hour Rewards (RHR). RHR is a proprietary Nest service that helps make demand response welcoming and manageable to customers while meeting the needs of energy providers. The program takes into account when people are home or away, their preferred temperatures, the "profile" of the home (how quickly it loses cooling), and only deploys to homes that can help reduce AC use during peak times. And most importantly, Nest RHR customers are always in control of the temperature to ensure their comfort.

In the summer of 013, Nest conducted Rush Hour Rewards events with three energy partners. Austin Energy (AE) ran 1 RHR events. Reliant ran RHR events. Southern California Edison (SCE) ran three RHR events. AE and Reliant events were two hours long, while SCE events were four hours long. In all cases, these events significantly reduced the electrical load while keeping customers comfortable.

Highlights of Nest's summer 013 Rush Hour Rewards programs include:

- Each event reduced a significant amount of electricity and reduced load an average of 55.1% for an average of 1.18 kW per device.
- Results showed that only 14.5% of participants changed the temperature on their thermostat during events. These users still shifted an average of 0.6 kW overall, only reducing the overall load reduction by 8.6%.
- Rush Hour Rewards successfully reduced load while preserving customer comfort. When responding to a survey about comfort during rush hour compared to other hot days, 84% of customers reported minimal impact on comfort.
- The marketing was appealing to customers and led to rapid enrollment upon launch of the Rush Hour Rewards programs. In the first few weeks after the Rush Hour Rewards programs went live, Nest quickly enrolled 1,000 Austin Energy and 1,000 Southern California Edison customers.
- Support costs for Rush Hour Rewards programs are negligible. Across Austin Energy, Southern California Edison, and Reliant customers participating in Rush Hour Rewards, just 0.7% of the enrolled customers contacted Nest Support about Rush Hour Rewards, and most of those calls about how to enroll in the programs.
- When compared to four-hour events, two-hour events had fewer temperature increases, fewer temperature change events, and hifgherr-atleesad shi

2. Methodology

To date, Demand Response providers use a few different strategies for reducing demand during energy rush hours: fixed setbacks, pre-cooling and duty cycle modulation. Rush Hour Rewards uses elements of all three strategies. Rather than pre-cooling by °F before the rush hour and raising the target temperature by °F during the event, Rush Hour Rewards adjusts the target temperature specifically for the home. RHR adjusts based on the indoor temperature, the outside temperature history and forecast, the home's thermal behavior (i.e. the quality of insulation and the size of the air conditioner, calculated from data collected during normal Nest Thermostat operation), user preferences, occupancy and patterns. By modeling the expected air conditioning use with and without Rush Hour Rewards and re-optimizing the strategy throughout the rush hour, both load reduction and comfort can be maximized. In contrast to many other demand response solutions, customers maintain control of their thermostat during RHR events. Customers can change the thermostat to any temperature of their choice. Nest will hold that temperature until the next scheduled set point.

Importantly, RHR optimizes for both customer and energy company needs over the long term. Nest believes that paying attention to the customer experience is important to maintain participation. RHR customers with high trust and satisfaction are likely to encourage others to participate. By establishing a large customer base that trusts Rush Hour Rewards, the potential for long-term load reduction is substantial. The following section presents details on how Nest analyzed the data from RHR this summer.

3. Results

Qualification and Connectivity

Over summer 013, Nest ran RHR events with three energy partners on thousands of devices. Tables 1-3 summarize the results for the thermostats that participated in each event. Note that AE and Reliant events are two hours long while SCE events are four hours long. The outdoor temperature listed in this table is the maximum outdoor temperature during the event, averaged across all customers who ran the event.

These tables show that 9.9 % of devices ran the events. Across all events, an average of 94.8 % of devices received events. The remaining devices did not receive the event when it was sent, most likely because they were not connected to Wi-Fi at the time. An average of 1.8 % of devices did not qualify for events. A device does not qualify for an event if it is in heating mode or if it switches modes between the preannouncement and start time of the event. SCE devices qualified out at a higher rate than Austin Energy and Reliant devices because some SCE customers were running heat the night before the event days.

Table 1: RHR events run by Austin Energy

Date	Outdoor Temp (˚F)	% Devices Started Event	% Devices Did Not Receive	% Devices Did Not Qualify
67013	10	96.0%	3.%	0.8
68013	106	96.3%	3.0%	0.7
711013	10	95.9%	3.3%	0.9
71013	10	95.8%	3.5%	0.7
74013	97	95.%	4.0%	0.8
75013	100	96.1%	3.4%	0.5
731013	10	96.1%	3.6%	0.4
81013	10	95.9%	3.6%	0.5
8013	10	95.1%	4.%	0.8
87013	106	96.3%	3.%	0.5
93013	104	95.6%	3.8%	0.6
94013	10	95.4%	3.9%	0.7
Average	10	95.8%	3.6%	0.7%

Table : RHR events run by Reliant

Date	Outdoor Temp (˚F)	% Devices Started Event	% Devices Did Not Receive	% Devices Did Not Qualify
96013	97	93.5%	5.3%	1.%
91013	96	94.3%	4.6%	1.1
103013	90	9.3%	6.7%	1.0
104013	91	93.8%	5.4%	0.8
Average	93	93.5%	5.5%	1.0%

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Table 3: RHR events run by Southern California Edison

Date	Outdoor Temp (°F)	% Devices Started Event	% Devices Did Not Receive	% Devices Did Not Qualify
7013	89	89.8%	.6%	7.6%
88013	95	63.6%	9.3%	7.0
830013	96	88.6%	.7%	8.8
Average	93	80.7%	11.6%	7.8%

4. Load Reduction

Rush Hour Rewards events are characterized by up to an hour of pre-cooling followed by a period of load reduction. Length varies by utility. Figure 1 is a typical example of the AC load during an RHR event.

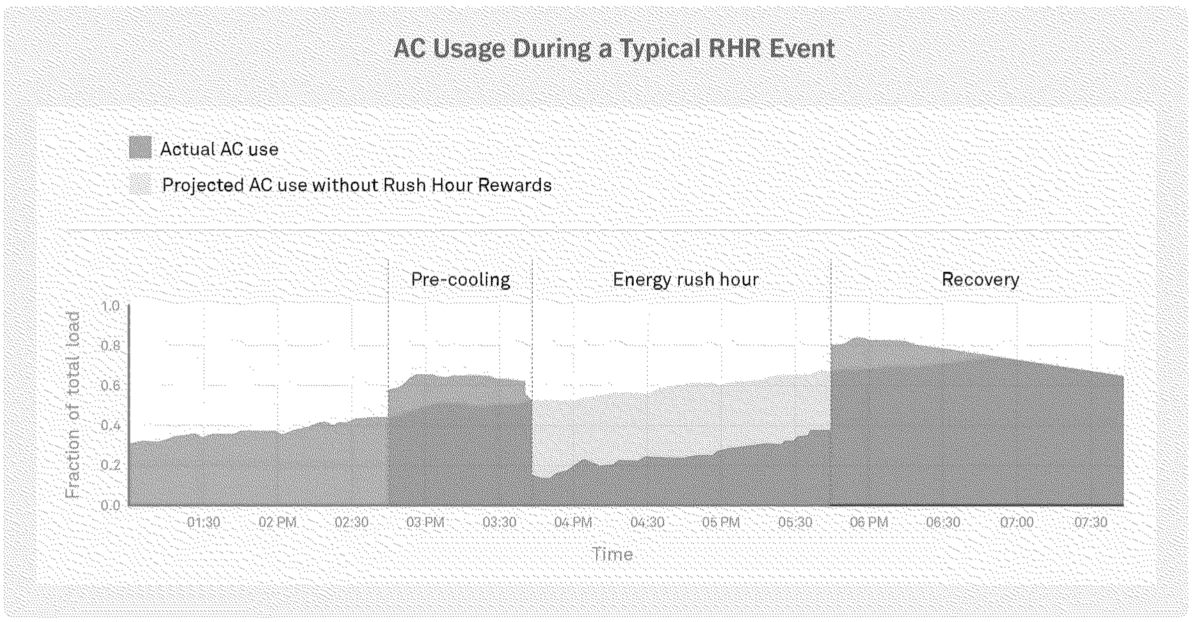

Figure 1: Percentage of air conditioners running over time during a Rush Hour Rewards event. Blue indicates the actual AC usage while Gray is the predicted AC that would have been used if an energy rush hour was not scheduled.

To calculate the load reduced by the RHR event, we compare the actual AC usage with an estimate of the baseline load if there was not an event. We estimate the baseline load using a thermal model to predict the AC usage of each home given the normal set point temperatures. We evaluated the accuracy of the model on days without RHR events. Across these days, the baseline model had an average absolute error of 6% AC runtime, which results in an average error of 0.06 kW device.

Since the baseline AC load is highly variable across devices (from no usage to 100% usage), we present the load reduction in three ways: percentage of AC baseline load reduced, minutes of AC runtime reduced, and estimated power reduction. Tables 4-6 show the load reduction in minutes and percentage averaged over all devices that started the event. Based on the load reduction minutes, we can estimate the kWh saved per device if we know the AC capacity for each device. We assume an average AC capacity of 3.9 kW based on a survey made in Austin [Rhodes et al., 2010] and comparing that data with Nest Thermostat AC runtime data for SCE. These tables show that events reduce a large amount of load: each event reduced an average of 55.1% or an average of 1.18 kW per device.

Table 4: Load reduction of RHR events run by Austin Energy

Date	Outdoor Temp (°F)	Load Reduction (Percentage)	Load Reduction (Minutes Device)	Estimated Power Reduction (kW Device)
67013	10	57.4%	40.7	1.
68013	106	51.1%	39.7	1.
711013	10	57.4%	41.6	1.
71013	10	55.4%	4.	1.
74013	97	6.8%	37.6	1.
75013	100	60.%	4.3	1.
731013	10	58.0%	40.3	1.

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81013	10	53.8%	38.7	1.6
8013	10	56.6%	40.8	1.3
87013	106	54.8%	41.5	1.3
93013	104	54.0%	39.8	1.9
94013	10	51.%	34.0	1.1
Average	10	56.0%	39.9	1.30

Table 5: Load reduction of RHR events run by Reliant

Date	Outdoor Temp (˚F)	Load Reduction (Percentage)	Load Reduction (Minutes Device)	Estimated Power Reduction (kW Device)
96013	97	58.1%	37.4	1.
91013	96	6.7%	41.0	1.3
103013	90	67.0%	3.5	1.0
104013	91	63.8%	37.	1.1
Average	93	6.9%	37.0	1.0

Table 6: Load reduction of RHR events run by Southern California Edison

Date	Outdoor Temp (˚F)	Load Reduction (Percentage)	Load Reduction (Minutes Device)	Estimated Power Reduction (kW Device)
7013	89	43.4%	3.9	0.5
88013	95	47.7%	59.8	0.9
830013	96	31.1%	35.	0.5
Average	93	40.8%	4.6	0.69

5. Analysis

Event length

One major difference between these events is that the Reliant and APS events are two hours while SCE events are four hours long. While a similar number of total AC minutes is reduced with both types of events, the shorter events produce a much higher load reduction percentage and load reduction per hour. For a longer event, the effects of pre-cooling do not last as long and the AC must run more to keep customers from deviating too far from their scheduled temperature. In addition, shorter events provide a better customer experience due to a smaller average temperature increase. During the first two hours of the SCE event, the average load reduction is 5 . % and 0.88 kW, while over the entire four hour event, the load reduction is only 40.8% and 0.69 kW. Two hour events appear to be preferable to four hour events because of both lower temperature deviations and higher load shift rates.

Comparison with other methods

We compared the Rush Hour Rewards algorithm to four other Demand Response approaches.

1) Always run 50% of air conditioners, even if they had normally been off wou

) Restrict devices to be off at least 30 minutes of every hour

3) °F setback during the event

4) °F pre-cooling an hour before the event, then °F setback during the event

Figure shows the simulated load reduction for each approach during each of the RHR events we ran this summer. The results show that the Nest approach reduces more load than any of these approaches. In addition, while Rush Hour Rewards reduces more load, the average indoor temperature deviation is only 0 °F, an amount with two degree setback with pre-cooling or turning half of the air conditioners off

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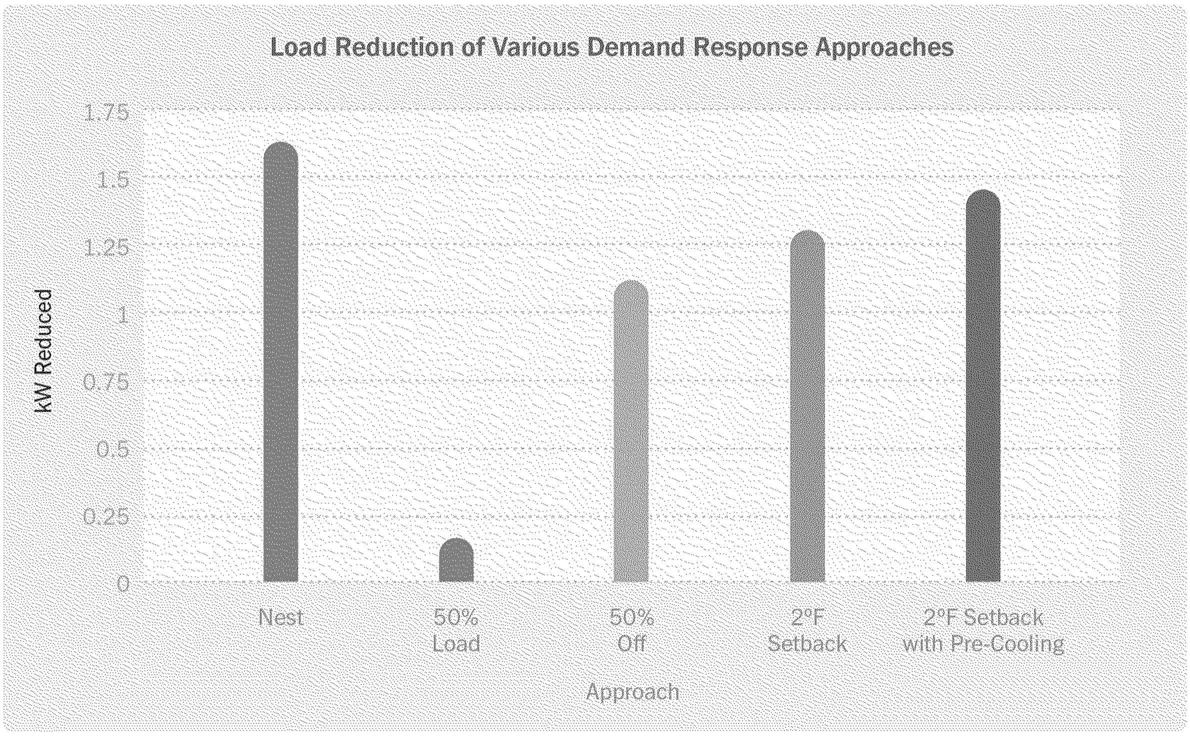

Figure : Load Reduction for Various Demand Response Approaches

Impact of User Temperature Adjustments

Rush Hour Rewards is designed to work while still enabling customers to take manual control at any time. Results show that very few customers take manual control of their devices, and those that do still reduce load overall.

In general, very few customers choose to take manual control of their devices and exit the event. Those who do still reduce a significant amount of load. Figure 7 shows that many users never took manual control during any of the events. A small number of customers consistently made manual changes and accounted for a larger portion of the manual control events.

Table 7: Manual Control Rates across Events

Utility	% of devices that never took manual control during any event	% of manual control events accounted for by top 15% of devices
Austin Energy	49.6%	58.7%
Reliant	73.0%	66.9%
Southern California Edison	54.1%	51.4%

On average, and across all events, providing customers with the ability to change their temperature only increased AC demand by 0.11 kW or 8.1%. Customers exit energy rush hour events at a steady rate over the entire course of the event, therefore many have already reduced load before changing their temperature. Figure 3 shows the AC load during the event for all customers as well as just the customers who completed the event. For this event, the difference between the kW reduced for all the devices and kW reduced for only those who completed the event is only 0.7 kW or 10.9%. This shows that enabling customers to take manual control during events does not greatly reduce the overall load reduction.

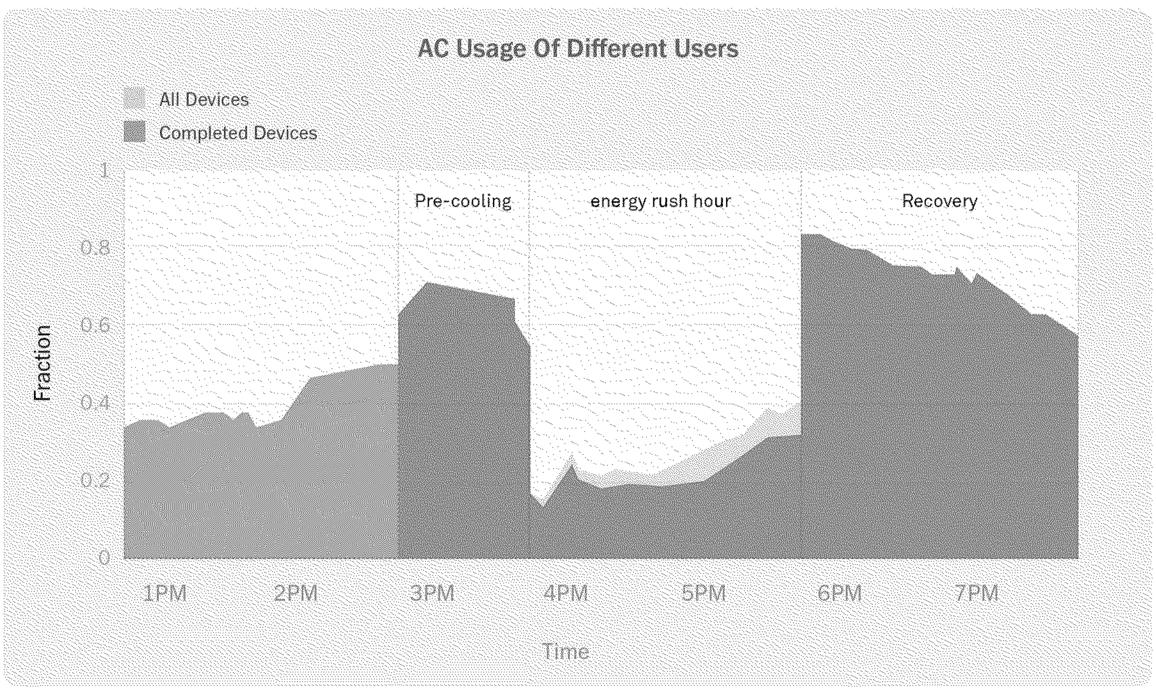

Figure 3: AC load for devices during the AE13RHR event on 940

Table 8 shows the load reduction for users who completed events versus those who took manual control of their devices. Across all events, 85.5% of customers completed the event without taking manual control of their devices. Many of those who took control of their devices kept efficient temperatures or even made their temperature more efficient. The events still shifted a large amount of load even while allowing users to take manual control of their devices.

Table 8: Effects of taking Manual Control during an event

Group	% of Overall Customers	Load Reduction
All Users	100.0%	1.8 kW
Completed Event	85.5%	1.40 kW
Took Manual Control	14.5%	0.61 kW

Using Meter Data to Validate Findings

In addition to Nest air conditioning runtime data, we also used customer meter data from SCE, with customer approval, to verify actual kWh saved. While we have previously showed that the Rush Hour Rewards algorithms reduce AC runtime during events, using meter data enables us to show the number of kWh actually reduced and verify our estimates of kWh reduced, which are based on an assumed capacity of 3.9 kW per AC.

With customer approval, we received meter data from SCE for customers who all ran events. Figure 6 shows the average kWh usage from these customers over the course of the day for an event on August 8. Pre-cooling for the event occurred from 1:00 to 2:00 PM and then the event ran from 2:00 to 6:00 PM. The reduction in electricity usage from the RHR event is clear to see. We fit a 7th order polynomial model to the usage before 1:00 PM and after 8:00 PM to estimate the baseline usage from the data outside of the event. A 7th order polynomial was chosen because it gave the least error. Compared to the baseline, customers used an average of 0.61 kWh extra during pre-cooling, reduced usage by 3.70 kWh during the four hour event, and then used 0.43 kWh extra during the hour after the event.

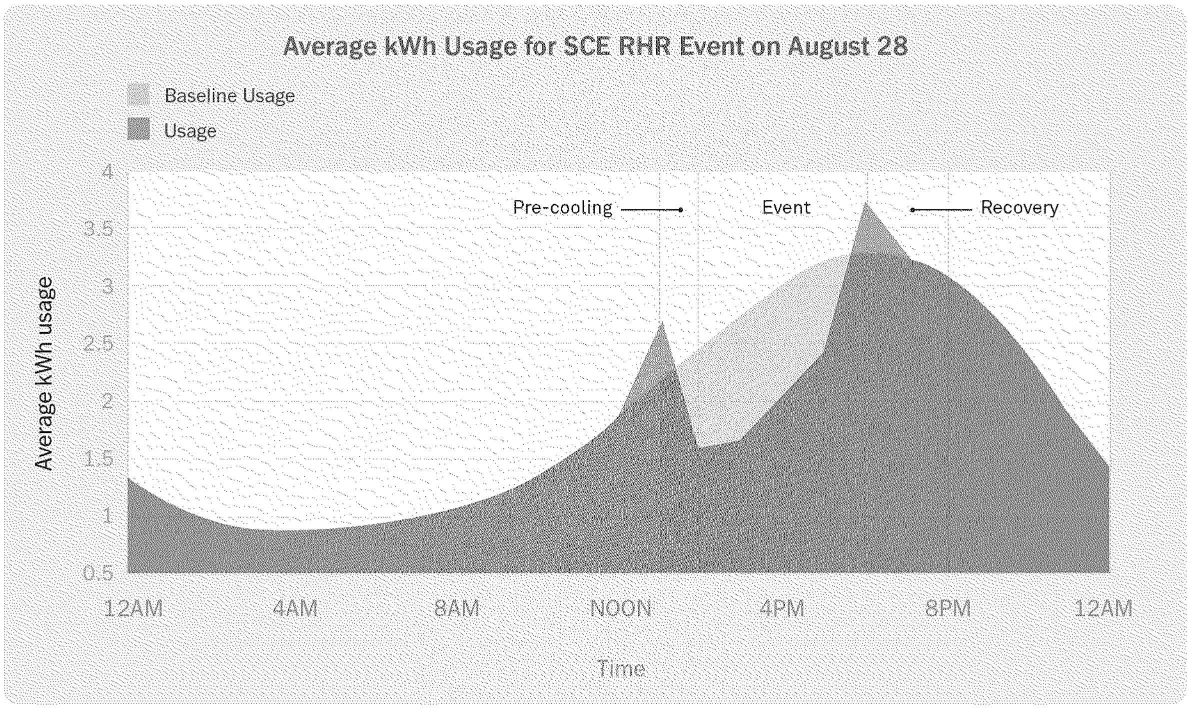

Figure 6: Average kWh usage of meters during an SCE RHR event on August 28

We received SCE meter data for all three RHR events. Table 10 shows the load reduction as calculated from the meter data, compared to the estimated load reduction from the Nest data on reduction in AC minutes. The table shows load reduction per home, accounting for homes with multiple devices, and only includes devices that were in the first RHR event. Similarly, Figure 7 shows a plot of the load reduction calculated both ways for the SCE RHR event on August 28. This table shows that SCE customers generally reduced more load than what was estimated from AC runtime only. This could indicate that customers are turning other devices off during the RHR events or that their AC's are actually larger than 3.9 kW

Table 10: Comparison of load reduction from meter and AC data for homes who started RHR event.

Date	kWh Reduction Estimate Using Meter Data	kWh Reduction Estimate Using Nest Data
7013	.93	.14
88013	3.08	3.88
830013	3.01	.9
Average	3.01	.60

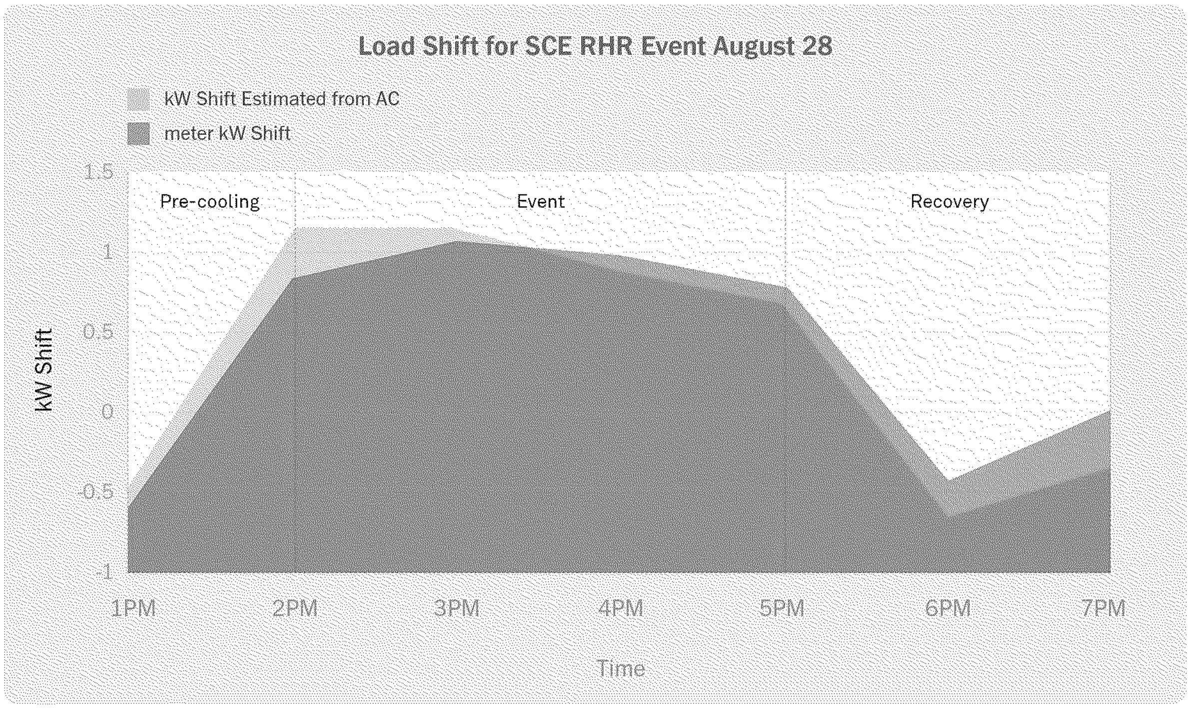

Figure 7: Comparison of load reduction from meter data and from AC data for the SCE RHR event on August 8.

6. Summary

The comparison of load reduction estimates from meter data and from our AC load data show that Nest can predict load reduction even without meter data. It also shows that during the SCE events, customers reduce even more load than the Nest estimated reduction from just the air conditioner. Perhaps indicating the customers are turning other devices off during the Rush Hour Rewards events or that their AC's are actually larger than 3.19 kW.

Impact of Incentive Structure on Load Reduction

Reliant and SCE paid customers on a per-event basis with a credit on their monthly bills. Table 11 shows the average user payment for each of the events. These figures only include customers who started the events. Customers received an average of $1.00 over the entire summer (note that some were only signed up for two events at least). The difference in payments from event to event can largely be attributed to the baseline calculation used by SCE. SCE calculates their payments based on the difference in energy usage on the day of the RHR event the preceding days. The temperatures before the second two RHR event days were much warmer than those of preceding days, resulting in lower payments to customers. Conversely, the SCE RHR event on the 7th was the coolest of the three RHR event days, yet delivered the highest estimated average because of the warmer preceding days.

Table 11: Average user payment for each SCE Event

Event	Average User Payment
July	$7.98
August 8	$3.96
August 30	$3.90

Two different incentive structures were used for Rush Hour Rewards. While SCE and Reliant paid customers per event, AE paid customers an incentive up front for enrolling in RHR for the summer. The findings show that neither per-event or up-front payment increased the percentage of customers completing an event. The 4.5% of users who took manual control of their devices also did not vary significantly between utility payment programs. These results indicate that customers who are paid up-front do not exit events any more frequently than those paid for per-event performance. It is also worth noting the significant increase in enrollment rates seen when up-front payments were offered to customers (see next section).

Impact of Up-Front Incentive on Marketing and Enrollments

Nest utilized a low-lift, inexpensive recruiting method of web pages, emails, and social media to enlist costumers. We succeeded in enrolling a significant portion of the Nest customer population in Austin and southern California over one summer. Nest succeeded in enrolling the first 1,000 Austin Energy and Southern California Edison customers within just a few weeks after the Rush Hour Rewards program launched. We used only one invitation email to existing Nest Thermostat owners, social media, and word of mouth. Rush Hour Rewards enrollments are also completed as a fully "self-serve" platform for customers who do not require a home visit by a contractor. Within weeks of launching a Rush Hour Rewards program, a utility can begin to benefit from its program.

There was a meaningful difference in enrollment rates based on the method of customer payments. In AE, where the first two years of incentives are paid up-front upon enrollment, 39% of Nest's customers enrolled in Rush Hour Rewards. In contrast, only 19% of Southern California Edison's Nest customers enrolled in RHR for SCE's program, where incentives were paid in bill credits on a monthly basis.

Customer Satisfaction

As with any Demand Response program, utilities and vendors are concerned with customer response. Nest Thermostat customers reported having very positive experiences with Rush Hour Rewards..

Of the customers participating in Austin Energy, Southern California Edison, and Reliant Rush Hour Rewards programs, only 0.7% contacted Nest Support about Rush Hour Rewards. Figure 8 shows how customer support calls broke out into categories. Just 11% of calls pertained to to un-enrollment from RHR, resulting in a 0.4% reduction of participating customers over the course of the entire summer.

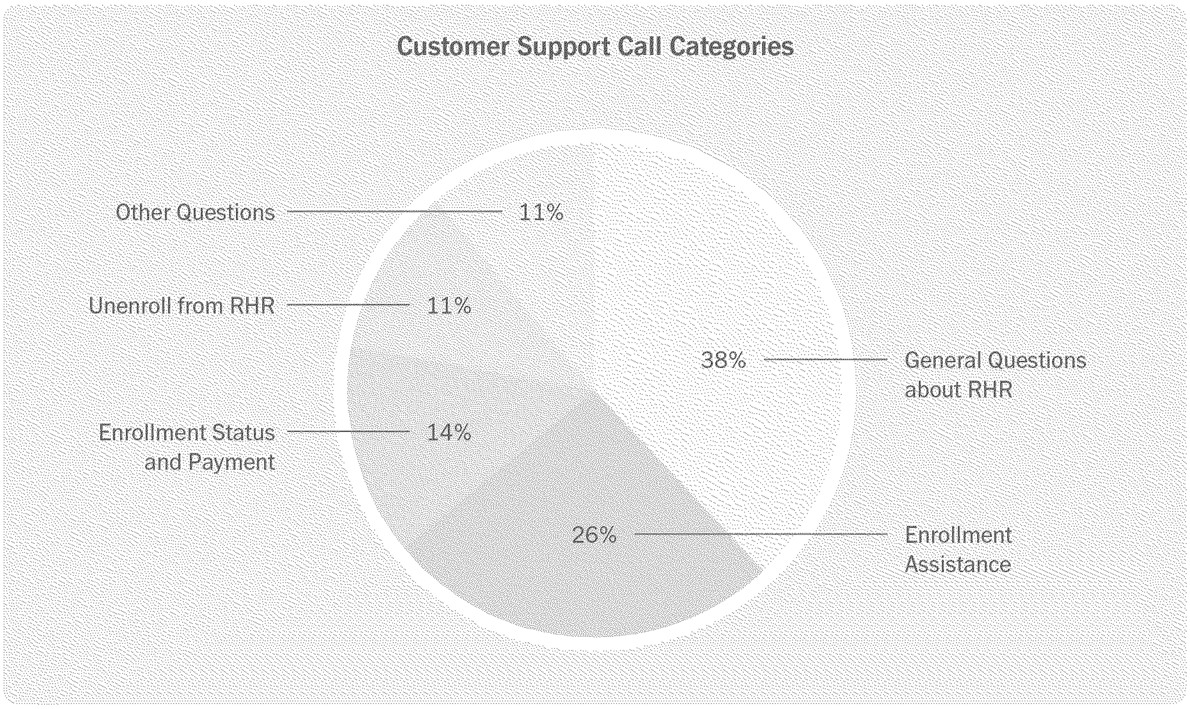

Figure 8: Customer Support Call Categories

Customers participating in Rush Hour Rewards were also presented with a survey at the end of the summer. The survey showed that customers remained comfortable during energy rush hours and enjoyed participating in the program. On the question of how satisfied customers were with the enrollment process, 80.8% of customers rated their experience an 8 or higher on a scale from 1 to 10.

When customers were surveyed about their level of comfort during an energy rush hour compared to any non-event hot day, 84% rated their experience a 3 or higher on a scale of 1 to 5. In addition to the Nest Thermostat helping users reduce, 38% of customers indicated that they also turned off other electricity consuming devices in their home during the event. Overall, the vast majority of customers provided positive feedback. As with all Nest products, Nest will continue to strive to create the best customer experience.

7. Conclusion

Rush Hour Rewards reduces a significant amount of AC load while maintaining a comfortable user experience. Across all events, the RHR program reduced AC load an average of 55.1%, or 1.18 kW per, with 84% of customers noting minimal or no impact on comfort..

If they experience discomfort, customers maintain the ability to adjust their temperature. However, these instances were quite rare. Manual temperature changes during an event resulted in a modest 0.1 kW increase in consumption from projected savings. Lastly, Nest has shown the ability to deliver thousands of customer enrollments within weeks of the launch of a Rush Hour Rewards program through a combination of Nest marketing web pages, emails, and social activity.

Nest is always looking to make improvements. The Rush Hour Rewards platform is no exception. For future programs, Nest will continue to optimize the number of devices receiving and qualifying for events. Work to reduce load, and assure the overall customer experience.

Results show that Rush Hour Rewards is a comprehensive, end-to-end product that significantly reduces AC use during energy rush hours while keeping customers comfortable and in control of their thermostat.

References

J. D. Rhodes, B. Stephens, M. E. Webber, "Using energy audits to investigate the impacts of common air-conditioning design and installation issues on peak power demand and energy consumption in Austin, Texas", Energy and Buildings, 010.

Attachment B

Seasonal Savings – Results from Summer 2013

WHITE PAPER

Seasonal Savings

Results from summer 203

Nest Labs, Inc
May 204

Introduction

Many energy companies offer behavioral change programs, which encourage people to adjust their behavior to help save energy. Traditionally, these programs involve generic flyers reminding people to do things like turn off the lights or shut off the thermostat when they aren't home. While the spirit of these programs is right, they rely on the customer to remember to change the thermostat to do the right thing every day. In many cases, because the flyers are generic and don't take into account the specific home and family profiles, the tips simply don't apply and many people ignore the flyers altogether.

Nest Seasonal Savings is a highly actionable, personalized, and effective program that automatically saves energy without sacrificing comfort or requiring daily behavioral changes. Based on information about each home's associated heating or cooling schedules, Nest determines which customers could benefit from the program and then sends those eligible customers personalized savings estimates. When customers opt into Seasonal Savings, their Nest Learning Thermostat adjusts temperature set points over a period of several weeks to create an efficient schedule while allowing people to adjust temperatures with slight adjustments.

Seasonal Savings uses customer preferences and occupancy patterns to optimize heating and cooling schedules. The program is highly adjustable and settings can still be changed at any time – Seasonal Savings doesn't lock in a schedule and in fact, the program becomes even more personalized when people change the temperature.

In 203, three Nest Energy Partners offered the Seasonal Savings program: Austin Energy (AE) and Southern California Edison (SCE) in May and Green Mountain Energy Company in July. While these results represent actual data from Nest Partner programs, savings may vary based on a number of factors including a customer's energy use, utility rates and plan. Savings numbers are not a guarantee.

Highlights:

- These schedule shifts resulted in a 47% average AC runtime reduction in
- Two months after completing the Seasonal Savings program, customers retained a time-normalized average schedule temperature shift of 05 °F

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- 95% of surveyed customers felt they still had complete control to adjust the temperature. 89% of customers indicated feeling at least as comfortable as before.

2. Methodology

This analysis incorporates any and all changes made by Seasonal Savings as well as those made by the customers. For a Nest Thermostat to qualify for summer 2023 Seasonal Savings, the thermostat had to be in either cooling or range mode, connected to Wi-Fi, and predicted to reduce AC runtime with Seasonal Savings. Upon successful qualification, customers were prompted to agree to start Seasonal Savings. They could select "Accept" or "Not now", which allowed them to start Seasonal Savings anytime within seven days, after which the invitation expired.

Seasonal Savings runs for three weeks, slowly modifying the customer's schedule to preserve comfort while reducing heating or cooling energy. Adjustments vary based on customer interaction and occupancy patterns. Seasonal Savings is designed to respect customer adjustments. When customers change the temperature while Seasonal Savings is running, the Nest Thermostat algorithms learn and adjust future adjustments accordingly. Customers can also manually exit Seasonal Savings by changing mode (going from cooling to heating, for example), or by choosing "STOP" Seasonal Savings in the settings menu. Customers have full control over their thermostat while Seasonal Savings is running.

Meter Data

With customer approval, we compared meter and Nest Thermostat data to analyze customer savings. To calculate savings on whole home electricity usage, we used the standard degree-day fitting approach [Fels 1986]. We split the electricity usage into baseline and weather-related components. Degree-day fitting determines how much extra electricity is used for cooling as outdoor temperatures increase, enabling weather normalization across summers. The Nest team fit a degree-day model to customers' pre-Seasonal Savings electricity usage to determine how much electricity would be used given customers' pre-Seasonal Savings usage patterns. Nest then compared the electricity used predicted by this pre-Seasonal Savings model with actual electricity usage after Seasonal Savings. This degree-day analysis was done for a subset of customers who had their Nest installed by June 0, 202

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3. Results

The Austin Energy and Southern California Edison customers experienced Seasonal Savings at the beginning of summer, starting May 6th; Green Mountain Energy customers participated in the middle of the summer, starting July 1st. AE and SCE customers participated in Seasonal Savings earlier in the summer because those customers would also experience the Rush Hour Rewards program in the middle of the summer. Table shows the percentage of thermostats that received and qualified for Seasonal Savings for each Energy Partner.

Table : Statistics of customers receiving and/or qualifying for Seasonal Savings

Energy Partner	% Received and Qualified	% Received and Not Qualify	% Did Not Receive
Austin Energy	72%	28%	0%
Southern California Edison	43%	57%	0%
Green Mountain Energy	63%	35%	%

The SCE Seasonal Savings event was presented to customers in early May. A large number of devices did not qualify because they were using heat mode and the event targeted a customer's cooling schedule.

89.3% of qualified customers accepted Seasonal Savings. Participating customers fell into three groups: Those who completed the three week event without adjusting their schedule in a less efficient direction. Those who adjusted their schedule in a less efficient direction. And, those who decided to leave Seasonal Savings before the three week run completed. Seasonal Savings dynamically slowed schedule adjustments based on less efficient customer changes.

Table 2 groups devices into habit groups for each Energy Partner. Customers that left early fit into two groups: Those who left because they changed modes (from cooling to heating). And, those that left by requesting to exit Seasonal Savings. Customers left Seasonal Savings at various points throughout the three week period. Participants who left prematurely still received some efficiency gains from schedule shifts.

Table 2: Seasonal Savings Customer Participation

Energy Partner	% Completed without Negative Adjustments	% Completed with Negative Adjustments	% exited due to mode change	% exited by customer request
Austin Energy	69%	3%	9%	8%
Southern California Edison	65%	2%	3%	%
Green Mountain Energy	72%	0%	7%	9%

On average, Seasonal Savings increased the time-normalized mean cooling temperature by 07 °F at the end of the event for all customers that Seasonal Savings started. This temperature change is equivalent to adjusting their weekend/weekday schedule by that amount. Customers who completed Seasonal Savings without adjusting their schedule saw the time-normalized mean schedule temperature change by 0 °F.

Table 3 shows the average and maximum temperature change, and average time of maximum temperature change. The average maximum temperature change across all customer schedules was 9 °F. For maximum savings impact with minimal comfort, changes were scheduled for the middle of the day.

Table 3: Schedule Changes by Group for AE, SCE, and Green Mountain Energy

Group	Average Temp Before Seasonal Savings (°F)	Average Temp After Seasonal Savings (°F)	Average Temp Change (°F)	Max Temp Change (°F)	Time of Max Temp Change
Austin Energy	764	77	07	9	:2
Southern California Edison	776	783	07	9	2:56
Green Mountain Energy	759	766	07	8	2:

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Figure shows how the time-normalized average schedule temperature changed for customers who completed Seasonal Savings without any negative adjustments. Overall, the time-normalized mean schedule temperature change was th 0 °F, customers changing from a change of 0 0 °F to 9 7 °F Because Seasonal Savings moves a schedule by a few degrees, these results show that a handful of customers adjusted their schedule to be even more efficient than the Seasonal Savings program

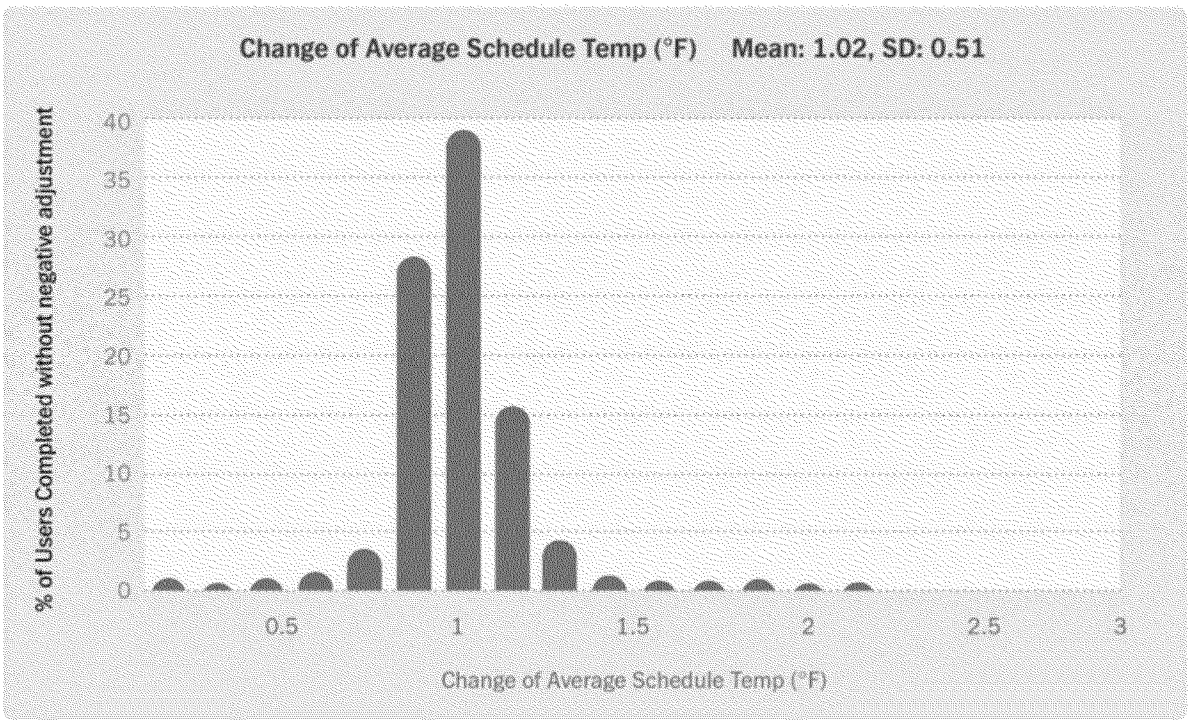

Figure : Time-Normalized Average Schedule Temperature Change for Customers who completed Seasonal Savings without negative adjustment. Note that this histogram does not show % of customers who had schedule changes greater than 3 °F

Figure 2 shows the average temperature change of the schedule by hour of the day. The plot shows that the entire schedule was shifted. The largest shift occurred midday when customers are most likely to be away.

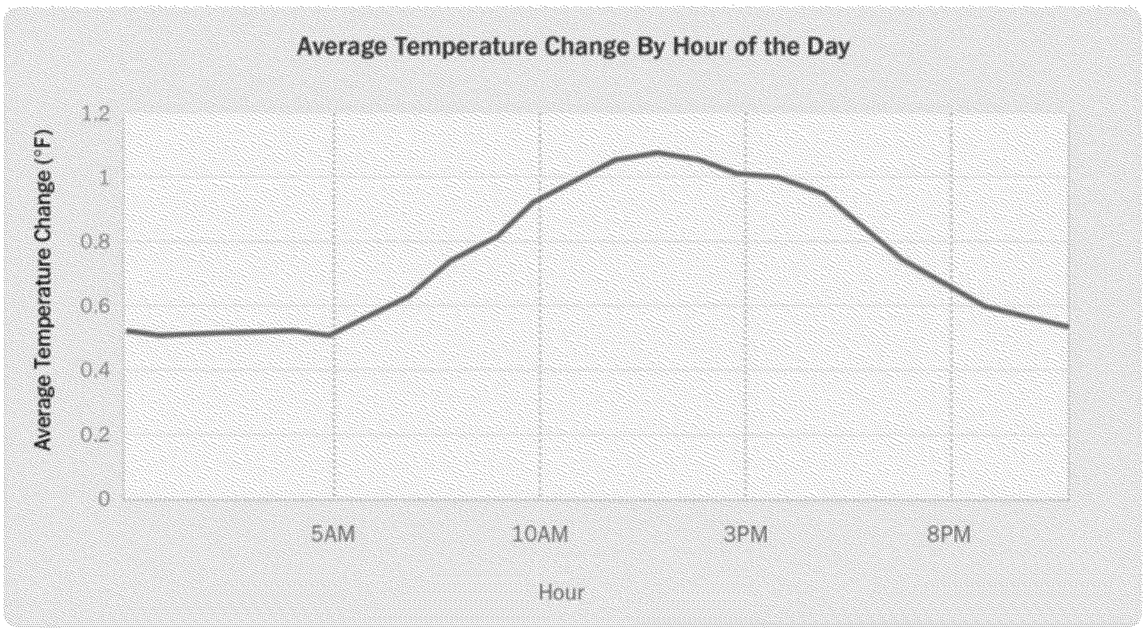

Figure 2: Schedule Change by Hour of Day

Nest utilized a model-based approach to determine the effects of Seasonal Savings schedule changes on air conditioning runtime. Nest fit AC models to homes given the difference between the outdoor temperature and the scheduled temperature. This model was then used to calculate what the AC usage would be with various schedules. Nest then calculated electricity savings assuming an average air conditioner capacity of 3.9 kW based on a survey conducted in Austin [Rhodes et al., 2011], disaggregation and SCE meter data. Table 5 shows the time-normalized average schedule shift. Table 5 also shows two months of projected AC savings for post Seasonal Savings schedules. Table 6 shows the same results only for customers who completed Seasonal Savings without negatively adjusting their schedules.

Table 5: Savings for all customers based on continuing use of the new Seasonal Savings schedules

Energy Partner	Average Schedule Change (°F)	Savings Percentage	Estimated AC Hours Saved (next 2 months)	Estimated kWh Saved (next 2 months)	
Austin Energy	0 7	4	8 %	2 8 5	
Southern California Edison	0	7	0 5 %	2 3	8 3
Green Mountain	0 7	5	3 %	3 3 6	3

Table 6: Savings for customers who completed Seasonal Savings without negative adjustments based on continuing use of the new Seasonal Savings schedules

Energy Partner	Average Schedule Change (°F)	Savings Percentage	Estimated AC Hours Saved (next 2 months)	Estimated kWh Saved (next 2 months)	
Austin Energy		0 6	5 %	3 8 3	4 9
Southern California Edison		0	6 8 %	2 7 7	0 8
Green Mountain Energy		0 6	3 %	3 8 9	5 2

Nest continued to examine over the following two months how well customers retained their new schedules. As with typical Nest Thermostats, schedules can be modified both manually by the customer and automatically by Nest's learning. Figure 3 shows the time-normalized change in mean schedule temp. This was averaged across all customers, shown during the Seasonal Savings period and in the two months following Seasonal Savings, with the Seasonal Savings period highlighted. This figure shows that while the customers do regress some of their savings, on average they maintain a schedule shift of 0 5 °F

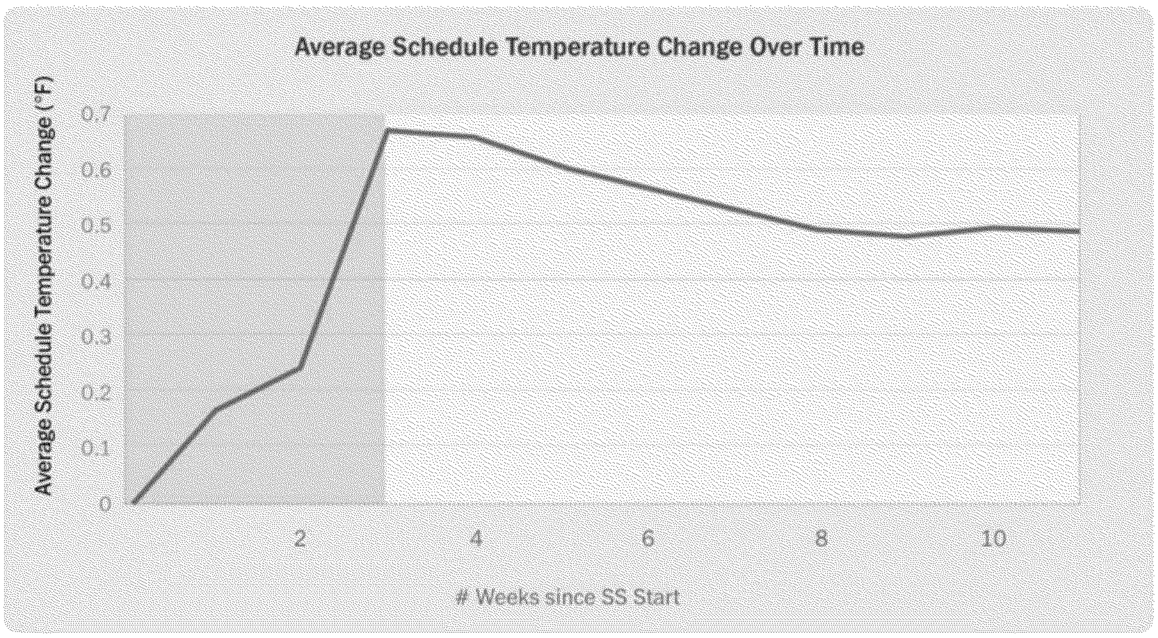

Figure 3: Change of Time-Normalized Average Schedule Temperature. The time of the Seasonal Savings event is indicated by the shaded area

Table 7 shows the savings percentage, AC hours saved, and kWh saved based on customer schedules over the two months following Seasonal Savings. Figure 4 shows the AC runtime savings percentage that customers achieved during the two months following Seasonal Savings. These results show that customers save a significant amount of AC runtime, even as their schedules revert to previous settings over the course of the summer.

Table 7: Savings based on schedules throughout the two months following Seasonal Savings

Energy Partner	Average Schedule Change (°F)	Savings Percentage	AC Hours Saved	Estimated kWh Saved
Austin Energy	0 5	3 3 %	2 0 4	8 0
Southern California Edison	0 6	6 %	4	5 5
Green Mountain Energy	0 7	3 7 %	2 6 5	0 3

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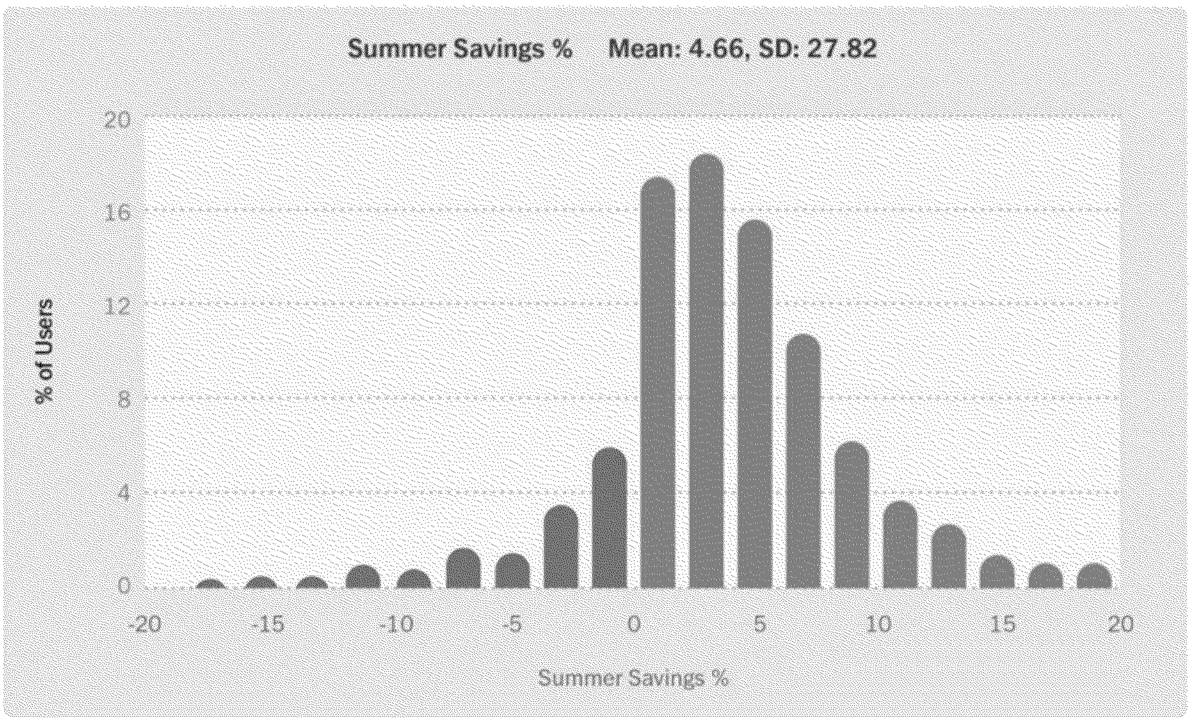

Figure 4: Savings Percentage for customers who ran Seasonal Savings

Meter Data

As described in the Methodology section, the Nest team used a degree-day model to analyze savings from Seasonal Savings based on meter data, with the approval from the customer. This analysis was done for a subset of Southern California Edison customers who had installed their Nest by June 0, 202 summer. Throughout Seasonal Savings, these customers used an average 2 3 kWh/day less than they would have with their pre-Seasonal Savings usage patterns. This change accounts for savings of 2 3 % of their total electricity usage and 4 4 % of the disaggregated portion of their AC electricity usage. Figure 5 shows a histogram of the AC savings for all percentage customers. The Seasonal Savings air conditioning savings based upon meter data was 4 4 %, while the savings calculated using the degree-day methodology with Nest data was 6 0 %. The measured electricity bill savings were likely to be lower due to other seasonal electricity devices such as pool pumps.

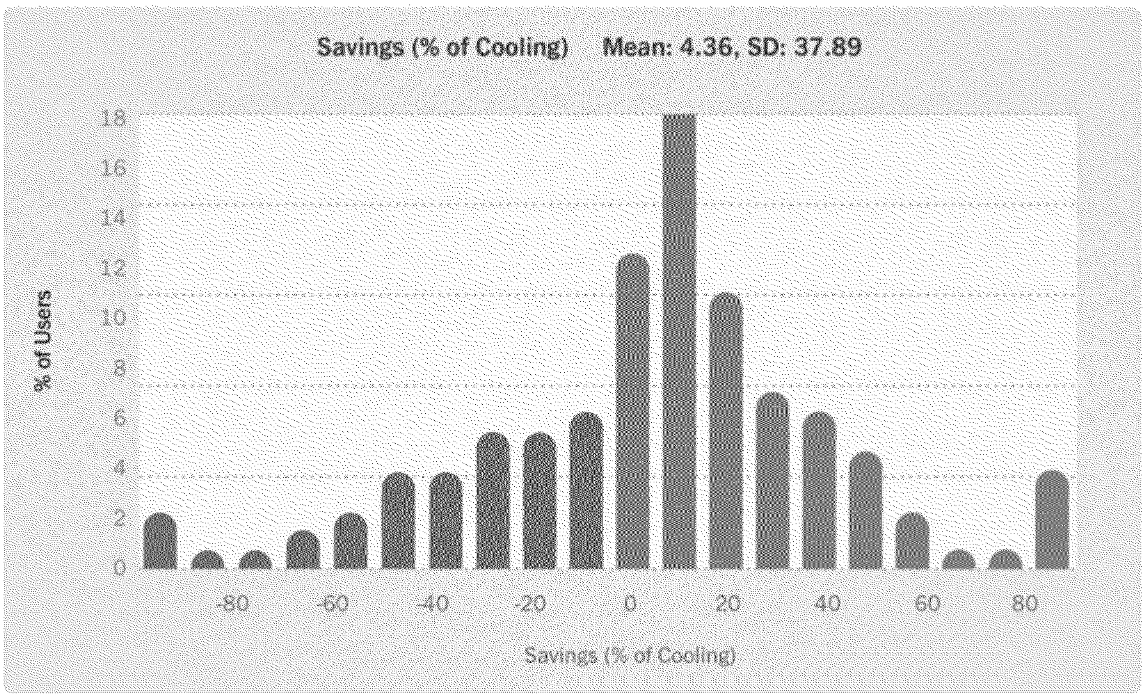

Figure 5: Histogram of savings on the AC portion of electricity bills customers after Seasonal Savings

Survey Results

Nest Support received a total of seven customer calls tied to Seasonal Savings that summer. Five customers wanted Seasonal Savings, but were not customers of a participating partner. The remaining two were from customers that had manually exited Seasonal Savings and wanted to know how to re-start.

Once completed, Nest sent a brief survey to all qualified customers to understand their experience with Seasonal Savings. 95% of surveyed customers felt they still had complete control to adjust the temperature while Seasonal Savings was running. Figure 6 shows that two thirds of customers felt that Seasonal Savings adjusted their schedules the right amount". Upon completion of Seasonal Savings, only % indicated feeling less comfortable than before.

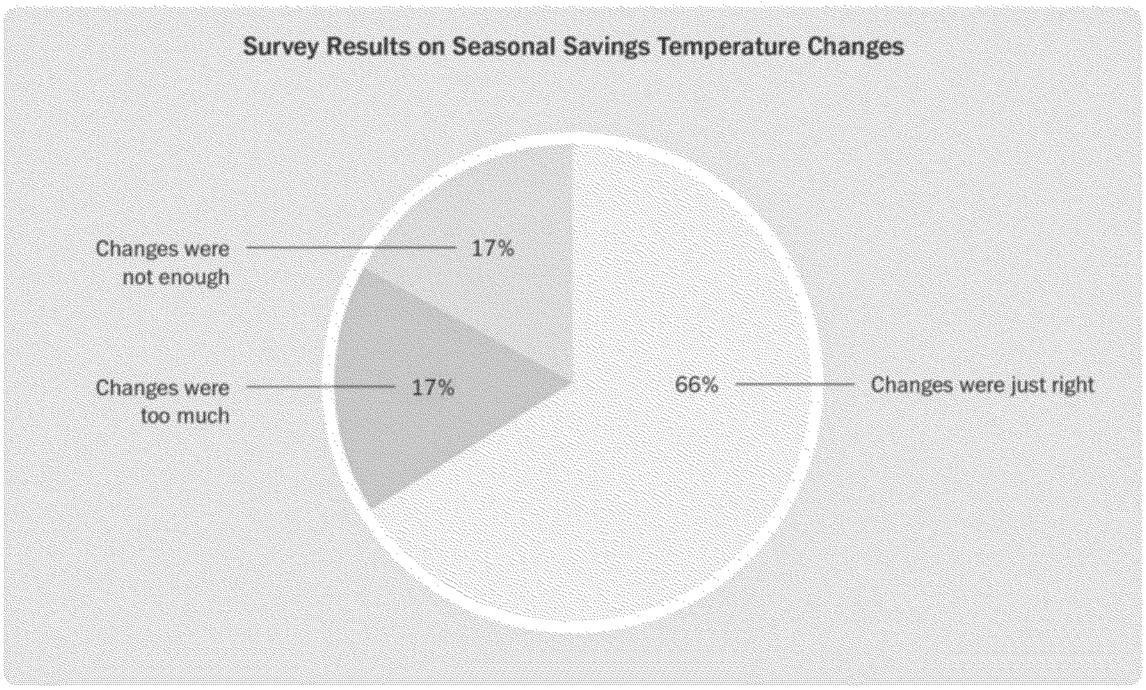

Figure 6: Survey Results on Seasonal Savings Temperature Change

4 Conclusion

Results show that Seasonal Savings successfully and seamlessly saved energy for participating customers. Over the two months following Seasonal Savings, customers reduced their AC runtime by an average of 47%, saving an average of 7 kWh. In a survey, 95% of customers felt that they still had complete control of the temperature. Upon completion of Seasonal Savings, 89% indicated that they felt at least as comfortable as before. In addition, these same Austin Energy, Southern California Edison, and Green Mountain Energy customers are also expected to reduce their heating use by 5–10% when Seasonal Savings is offered in the winter of 2013-2014 [Nest Labs, 2013].

Customer experience feedback was positive. Nest Support contact volume was low. Results show that Seasonal Savings is a comprehensive product that reduces energy while keeping costumers comfortable and in control.

References

M Fels, "PRISM: An Introduction", Energy and Buildings 9, #-2, pp 5-8, 986

Nest Labs, "Seasonal Savings", April 203

JD Rhodes, B Stephens, ME Webber, "Using energy audits to investigate the impacts of common air-conditioning design and installation issues on peak power demand and energy consumption in Austin, Texas", Energy and Buildings, 200

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