2012 Residential Direct Load Control Precooling Study

Final Report

July 1, 2013

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Executive Summary

The objective of this study was to determine how different precooling strategies initiated prior to direct load control events would affect hourly load impacts, overall energy use, and participant comfort. Effects were considered in light of outdoor temperatures and the level of ceiling insulation in participating homes. Findings were used to create bill and load impact scenarios for different electricity rates and insulation levels, and to provide recommendations for future program offerings.

In August and September of 2012, three different precooling treatments were rotated among 175 residential customers prior to a 3-hour 3°F peak load shed event:

- **P0** was the business-as-usual treatment of no precooling before the event
- **P2** was a 2-hour precool at 4°F below the minimum peak setpoint
- **P6** was a 6-hour precool at 2°F below the minimum peak setpoint

Rotation of these three treatments across three groups of participants allowed direct comparison of the strategies to each other. In addition, regression analysis of event and non-event days made possible comparison to a modeled baseline of what the load would have been in the absence of an event.

The main findings of this study are as follows.

1. **Hourly load impacts**
    a. Precooling significantly increased loads prior to the event period. In the 2 hours before the event, P2 increased average participant loads by 1.5 kW (+73%), and P6 increased average loads by 0.39 kW (+19%).
    b. Load shed – averaging 1.0 kW for P0 (-35%), 1.1 kW for P2 (-37%), and 1.3 kW for P6 (-43%)—was statistically significant in all 3 event-hours for all 3 treatments. P6 precooling, higher insulation levels, and higher temperatures increased load impacts at the average summer 2012 event temperature. At lower than average event temperatures, load shed following P6 was significantly deeper than the load sheds following P2 or P0. At higher than average temperatures, P0, P2 and P6 had similar load sheds. Thus, from a system standpoint, precooling for 2 hours by 4 degrees on the hottest days did not improve demand response (as shown in Tables 15-17) - presumably because it was so hot that the precooling benefits disappeared almost immediately.

c. Post-peak rebound – averaging 0.30 (+15%) for P0 and 0.26 kW (+12%) for the precooling treatments—was statistically significant in the five hours after the event ended for all treatments. Precooling, higher insulation levels, and lower temperatures reduced this effect.

2. Energy, comfort and bill impacts

a. On average, P0 reduced energy use while P2 and P6 increased energy use; however, P6 precooling reduced overall energy use for participants with higher levels of ceiling insulation (at least R38).
b. Participants were most comfortable under the P6 precooling strategy. Compared to a benchmark day with no precooling or offset, the P6 comfort levels were statistically similar, whereas comfort ratings for P0 and P2 precooling strategies were significantly worse than the benchmark ratings.
c. The eight events did not significantly affect monthly energy use or bills for PowerStat® participants, who were all on SMUD's standard residential rate.
d. Under SMUD's SmartSacramento® Pricing Pilot TOU rate, customers with higher insulation levels could precool every weekday to achieve energy and bill savings without discomfort.

Figure 1 illustrates the effects of the three precooling treatments followed by a 3°F temperature increase during the 4-7 p.m. peak period. Treatment and baseline loads—modeled from the actual 2012 PowerStat® event and non-event day data, respectively—are plotted as hourly averages across the eight event days. Note the expected precooling impacts, the visibly lower peak loads for P6 under average temperature and insulation conditions, and similar rebound effects.

FIGURE 1. AVERAGE HOURLY IMPACTS DURING 2012 POWERSTAT® EVENT DAYS

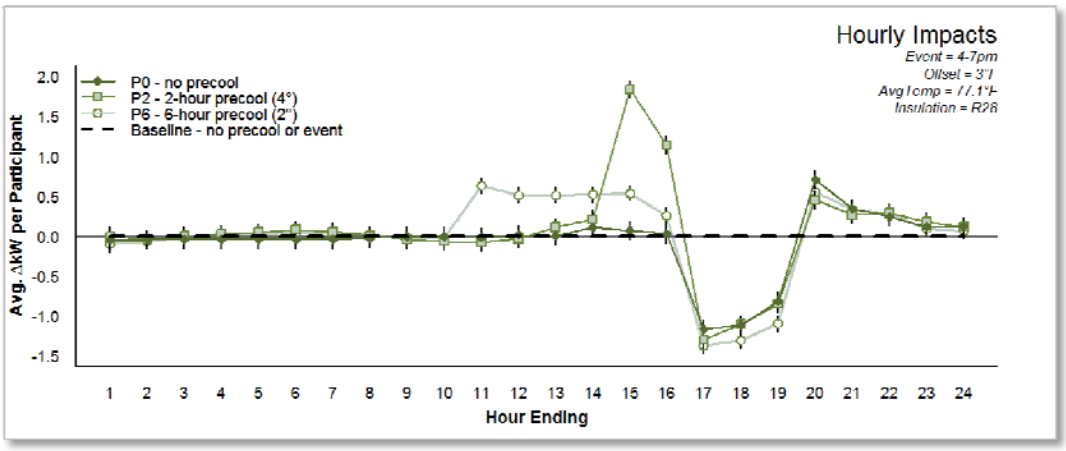


Figure 2 shows that, on average, peak loads following the P6 precooling were roughly 17% lower than loads following the P2 precooling strategy, and 22% lower than load following P0. These differences are statistically significant. (Note that, to be consistent with load shape graphs, savings are plotted throughout the report as negative load values.)

FIGURE 2. AVERAGE PEAK IMPACTS ON 2012 POWERSTAT® EVENT DAYS

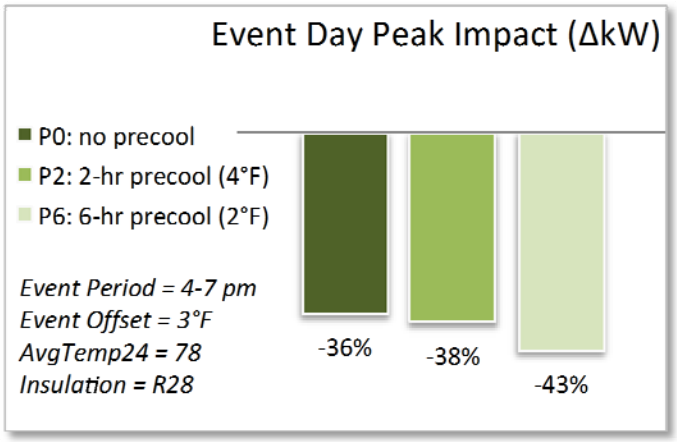
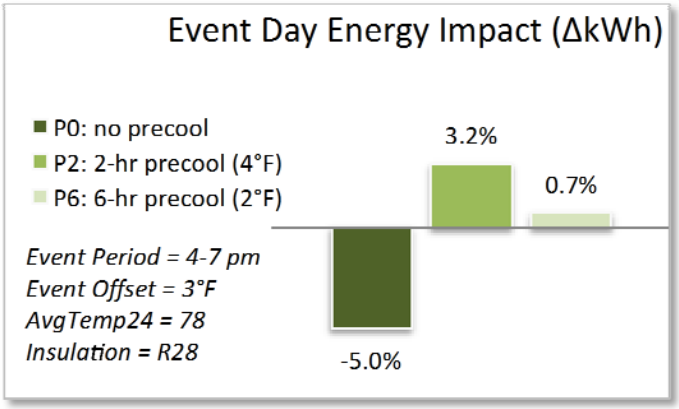


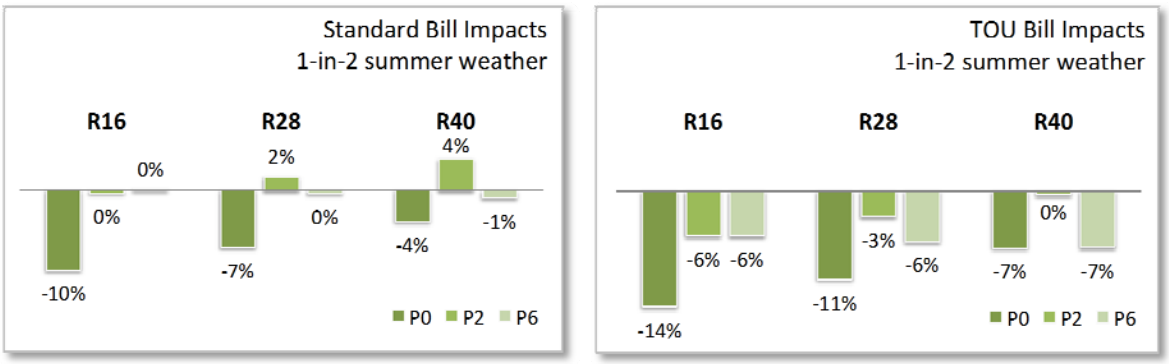
Figure 3 shows that only P0 saved energy at the average PowerStat® insulation level (R28) and the average outdoor event day temperature over a 24 hour period (78°F). These results change on cooler days and at higher insulation levels. For example, where the average temperature is at or below the average 2012 event temperatures, homes with at least R38 ceiling insulation showed energy *reductions* under P6 precooling. This implies that the P6 precooling strategy could be used to save energy and reduce peak on non-event weekdays, while the P0 strategy may be more effective—but probably less comfortable—on the hottest event days.

FIGURE 3. AVERAGE ENERGY IMPACTS ON 2012 POWERSTAT® EVENT DAYS



Finally, bills were calculated under several scenarios with varying temperatures and insulation levels. Figure 4 shows that participants would save more money on SMUD's SmartSacramento® Pricing Pilot TOU rate than they would on the Standard 2-tier rate, regardless of the precooling strategy or insulation level. These results imply that customers would save even more money on a TOU-CPP rate such as SMUD's SmartSacramento® Pricing Pilot Combined Time of Use and Critical Peak Rate. (See Appendix I. Residential Rates for rate details.)

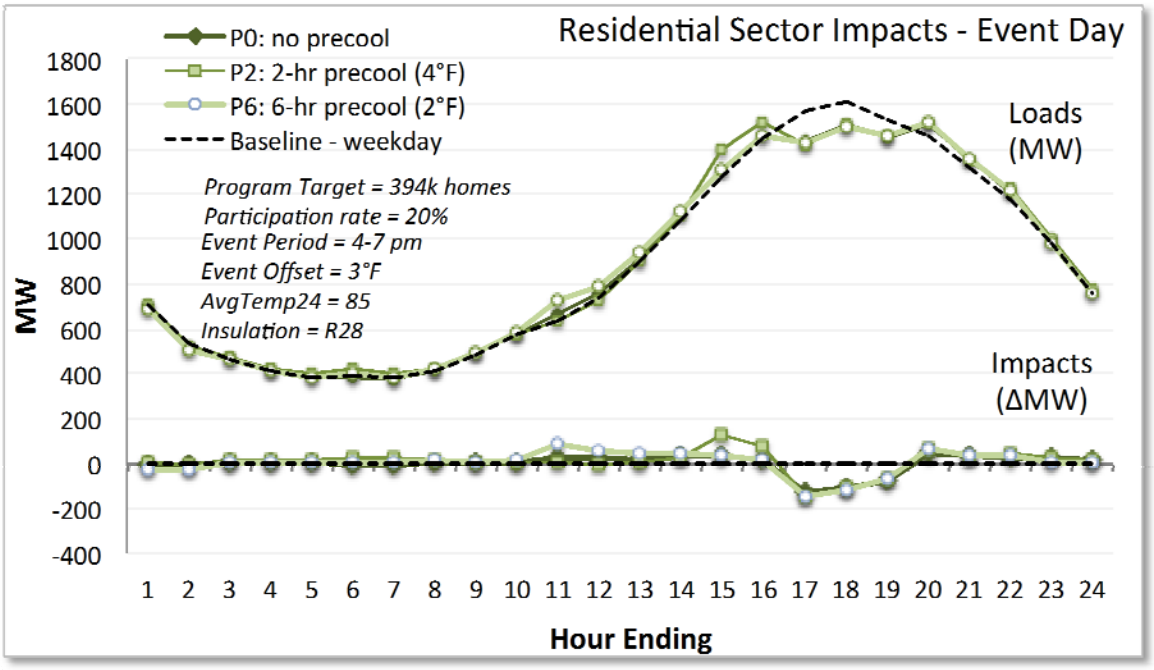
FIGURE 4. AVERAGE BILL IMPACTS WITH DAILY AC CONTROL: STANDARD VS. TOU RATES



On average, the P0 strategy saved the most money, however, P6 showed similar bill savings at higher insulation levels. Since comfort levels for the P6 precooling strategy were statistically similar to a benchmark (non-event) day, this implies that many or most customers with higher insulation levels could save money on TOU rate without discomfort by initiating a long, shallow P6-like precool every weekday. This hypothesis is supported by anecdotal evidence found in a separate but concurrent study at SMUD, where participants were encouraged but not required to precool before peak periods: several participants commented on surveys that the precooling during the inexpensive off-peak period allowed them to maintain comfort throughout the high-priced peak periods without increasing their bills (Herter Energy Research Solutions 2013).

Figure 5 provides an illustrative example of an extrapolation of these results to the roughly 400,000 eligible single-family homes in the SMUD service territory. Under this scenario, which assumes a 1-in-2 peak day, average insulation levels, and a 20% participation rate, the P6 strategy would provide the greatest average peak impacts of 96 MW while increasing the energy use for the day by 104 MWh. In comparison, the P0 treatment would reduce average peak loads by 94 MW and increase overall energy use by just 4.4 MWh. P2 would be the least beneficial strategy of the three, with 95 MW peak load shed and 187 MWh daily energy increase.

FIGURE 5. EXTRAPOLATION OF RESULTS TO SMUD'S RESIDENTIAL SECTOR LOADS, 1-IN-2 PEAK DAY



1-in-2 event day: max temp 106°F, min temp 67°F. Prior day: max temp 104°F, min temp 65°F

Recommendations

The findings suggest that SMUD and their customers may benefit from offering one or more of the following programs:

1) **A Demand Response program** combined with the following features:
   a) Increased ceiling insulation to at least R38
   b) A thermostat that facilitates precooling and peak offset, to avoid occasional demand response events. For event response, the thermostat *must be* a communicating thermostat.
   c) Participants with at least R38 insulation should be encouraged to program their thermostat to precool 2 degrees, 6 hours prior to events.

2) A **TOU rate** similar to SMUD's SmartSacramento® Pricing Pilot TOU rate, combined with the following features:
   a) Increased ceiling insulation to at least R38
   b) A thermostat that facilitates precooling and peak offset every weekday, to avoid the peak TOU rate. For daily peak reduction, the thermostat *need not be* a communicating thermostat.
   c) Participants with at least R38 insulation should be encouraged to program their thermostat to precool 2 degrees, 6 hours prior to the peak period every weekday.

3) A **TOU-CPP rate** similar to SMUD's SmartSacramento® Pricing Pilot Combined Time of Use and Critical Peak Rate, with the following features:
   a) Increased ceiling insulation to at least R38
   b) A thermostat that facilitates precooling and peak offset every weekday, and also responds to occasional demand response events. For event response, the thermostat *must be* a communicating thermostat.
   c) Participants with at least R38 insulation should be encouraged to program their thermostat to precool 2 degrees, 6 hours prior to the peak period every weekday.

Other recommendations:

1) Technology
   a) A programmable communicating thermostat similar to the one used in this study would not be suitable for a portion of the customers that have zoned HVAC systems in their home. Thus, other technologies should be explored that may be suited for these types of systems to increase the market potential of a load control demand response program (including the use of switches).

b) As revealed in this study, there was no way to ensure that the device was successfully receiving the one-way paging signals. For direct load control programs, strong consideration should be given to two-way communication with acknowledgement capabilities that signals are getting to the device. This is not necessary for pricing programs, where the customer is responsible for the functioning of the control technology. Two-way technology would also give the utility some indication of the device health (whether it is communicating or not). Other communication channels including smart meter mesh network and broadband should also be explored.
c) The reliability of the signal reaching the device with one-way technology using paging communication is improved when signals are sent out multiple times.

2) Operations
a) For direct load control programs, consider a restoration of load control strategy to ensure that all air conditioners would not come back on simultaneously after the event ends. In order to soften the rebound effect right after event ends, leverage the control strategies in the load management system software to control the number of customers that come out the event by staggering their release over time.
b) For direct load control programs, consider having the load management system operator reset the temperature offset every hour during the event duration. This will keep the temperature from climbing back to the 3 degree offset before getting another control signal to reset. The goal would be to maintain a constant load reduction during the length of the event. This would not be appropriate for pricing programs with customer-controlled thermostats.

3) Analysis
a) Further analysis in areas of resource need and valuation to guide future program design as part of an optimal Demand Response (DR) portfolio of dispatchable and pricing programs. Also, engagement and feedback from SMUD T&D/resource planners, energy trading, and real-time operations is important to help develop DR programs that provide the most value.

Background

In 2009, the Department of Energy announced that over $4 billion in federal grants funded by the American Recovery and Reinvestment Act (ARRA) would be available through the Smart Grid Investment Grant Program (SGIG) and the Smart Grid Demonstration Program (SGDP). The purpose of the SGIG is to stimulate the implementation of smart grid technologies with a goal of modernizing the nation's electricity grid. Later that same year, SMUD submitted an SGIG application and received a grant to implement the SmartSacramento® smart grid project. SMUD's goal is to empower their customers with options for increasing energy efficiency, protecting the environment, reducing global warming and lowering the cost to serve the region.

To date, the SmartSacramento® project has deployed an end-to-end advanced metering infrastructure that covers 100% of the load in SMUD's service territory. When completed, SMUD intends that the new architecture will be a customer-centric system, designed to enable informed participation by customers, improve the reliability and efficiency of utility operations, facilitate integration of distributed and intermittent forms of clean and renewable energy, and optimize asset utilization along the entire energy chain, from electricity generation to customer end uses.

The SmartSacramento® project is comprised of seven major components:

- Smart Meters
- Consumer Behavior Study
- Demand Response
- Customer Applications
- Distribution Automation
- Cyber Security
- Smart Grid Infrastructure

SMUD's demand response efforts under the SGIG funding include implementation of a demand response management system, the implementation of automated demand response programs for medium and large commercial customers, and direct load control programs for residential and small commercial customers. This report describes the efforts and results of the 2012 Residential Direct Load Control Precooling Study.

Study Overview

Scope and Objectives

The objective of this study was to determine how different precooling strategies prior to direct load control events affect hourly load impacts and participant comfort. In August and September of 2012, two precooling strategies were tested in addition to a business-as-usual scenario of "no precool." One precooling strategy was a "long-shallow" precool of 6 hours at 2°F, and the other was a "short-deep" precool of 2 hours at an offset 4°F below the minimum peak setpoint. This design allowed us to compare precooling strategies of differing length and magnitude to each other, to the business-as-usual case, and also to a baseline case of no precooling, no event.

Experimental Design

Table 1 summarizes the load control strategies applied as treatments in this study.

TABLE 1. EXPERIMENTAL TREATMENTS

Treatment	Precool Duration*	Precool Offset	Peak Duration*	Peak Offset
P0	0 hours	-0 °F	3 hours	+3 °F
P2	2 hours	-4 °F	3 hours	+3 °F
P6	6 hours	-2 °F	3 hours	+3 °F

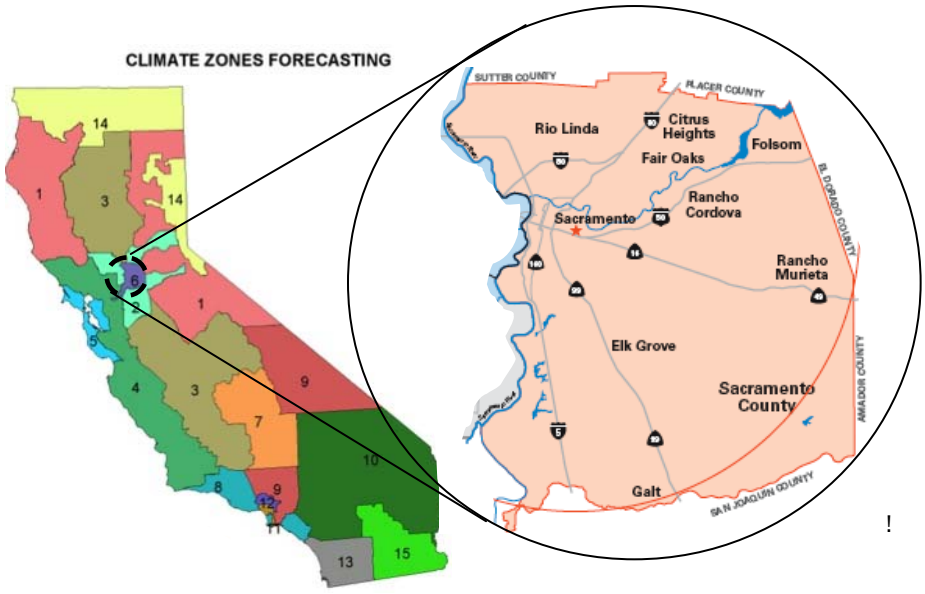
* Peak period for all treatments was 4-7 p.m., and precool periods immediately preceded the peak period.

Study Area

This study takes place in the in the Sacramento Municipal Utility District (SMUD) service territory, which is located in California's central valley, covering the state capital of Sacramento and surrounding suburban areas (Figure 6). SMUD is currently the sixth largest community-owned electric utility in the nation, spanning 900 square miles and serving over half a million residential customers.

Sacramento weather is characterized by rainy, mild winters and hot, dry summers. On average, the maximum daily temperature exceeds 90°F on 74 days annually, and exceeds 100°F on 15 days annually.

FIGURE 6. SMUD SERVICE TERRITORY



Metering System

SMUD installed an advanced interval metering system between 2009 and 2012. The new residential and small commercial meters can be configured to collect energy use data at 5, 15, 30, and 60-minute intervals. SMUD's residential meters record energy use hourly and upload the data every four hours.

Peak Load Programs

SMUD's only residential demand response program is Peak Corps, an air-conditioning load control program that uses private VHF communication to signal air-conditioning compressor switches during events. The program is considered an "emergency only"

resource, and is not used to manage system peak loads on a regular basis. More than 93,000 of SMUD's residential customers (about 20%) receive incentives of $2, $4 or $6 per event, depending upon cycling intensity, to allow the District to cycle their air conditioner during critical hours between June 1 and September 30 each year.

In addition to the precooling study described in this document, SMUD is running several other residential pilots to test time-based pricing and real-time information devices intended to lower energy use and peak demand.

Schedule and Staffing

Table 2 outlines the major phases of project activity in 2012 and corresponding research tasks.

TABLE 2. PROJECT SCHEDULE

Task	Dates	Activities
Field Study Preparation	March 2012 – June 2012	Project design and planning Recruitment materials Website
Recruitment	June 2012	Invitation mailings and follow-up Participant database
Installation & Survey	July 2012	Install thermostats Inventory database Pre-treatment surveys
Field Study	August 2012 – September 2012	Call 8 events Interim (post-event) surveys Customer service
Final Evaluation	October 2012 – May 2013	Satisfaction surveys Retrieve load database Data analysis and reporting

TABLE 3. PROJECT RESOURCES

Resource	Tasks
SMUD Senior Project Manager	Project design and oversight; Evaluation report
SMUD Project Manager	Project design and planning; Evaluation report
SMUD Product Services Coordinator	Project planning; Customer service; Inventory
SMUD Market Research Specialist	Surveys and survey evaluation
SMUD Marketing Specialist	Recruitment materials; Website
SMUD Principal Market Analyst	Customer lists; Market evaluation
Outside Vendor – Metro Mailing	Print; assemble; mail recruitment materials
Outside Vendor – GoodCents	Schedule, service and install thermostats
Outside Vendor – Cooper Power Systems	Load Management System, Support, Paging System, Web Portal
Outside Vendor – True North Research	Participant surveys and survey data analysis
Outside Vendor – Herter Energy Research Solutions	Project design; Load impact evaluation; Evaluation report

Project Costs

From late 2011 through early 2013, a total of $680,271.63 was spent on the pilot. The project was funded with grant monies from the Department of Energy and co-funded by SMUD. Labor costs were the primary driver because of the indirect labor assessments applied to direct labor charges. Table 4 is a breakdown of the various project costs.

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TABLE 4. SUMMARY OF PROJECT COSTS

COSTS	2011	2012	2013
SMUD Labor	$250.00	$407,697.00	$25,340.00
Management	$250.00	$213,440.00	$17,858.00
Marketing & Market Research		$26,733.00	$576.00
Operations		$157,364.00	$5,906.00
Other (Rates, R&D, IT)		$10,160.00	$0.00
Outside Services	$6,820.00	$129,639.16	$70,658.77
Load Management System	$6,820.00	$27,173.68	$0.00
Thermostat Installation/Service		$35,160.00	$0.00
Customer Surveys & Response Summary		$28,200.00	$4,900.00
Mail House & Postage		$11,092.74	$0.00
Program Design & Research Plan		$23,188.93	$0.00
Impact Evaluation & Final Report		$4,823.81	$65,758.77
Equipment		$39,866.70	$0.00
Thermostats		$37,007.30	$0.00
Misc. Equipment		$2,859.40	$0.00
TOTAL PILOT COSTS	$7,070.00	$577,202.86	$95,998.77

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Study Components

Participant Benefits and Costs

The 2012 PowerStat® Pilot offered customers the following benefits:

- *A smart thermostat*. Customers received a new 7-day programmable thermostat with a large touch screen display and backlighting. Along with standard thermostat functionality, the thermostat unit provided event notification and automated event response. A supporting Internet website provided remote access to settings, schedules, and event opt outs. Paper copies of the UtilityPro user guide were given to participants at installation and were made available on the PowerStat® website. The unit and installation were free of cost to participants.
- *Good will*. For many customers, participation makes them feel that they are doing something good for the community: reducing strain on the electric grid during peak times to improve electric reliability and keep system costs down.

Customer costs included:

- Scheduling and being present for the thermostat installation
- Getting a thermostat that they liked less than their old one (this was very uncommon)
- A very slight bill increase due to precooling (generally less than $1 per month)

Residential Electricity Rate

Throughout the pilot, participants remained on SMUD's standard residential rate, a three-season, two-tier, inclining block rate. About half of the residential population exceeds the Tier 2 threshold of 700 kWh per month during the summer season. Although California's electricity rates are some of the highest in the country, SMUD's rates are about 27% lower than rates in the surrounding areas.

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Load Management System

This section provides a brief description of the information carried on the various communication paths within the load management system, as configured for SMUD's PowerStat® pilot. Figure 7 is a graphic representation of the PowerStat® load management system infrastructure.

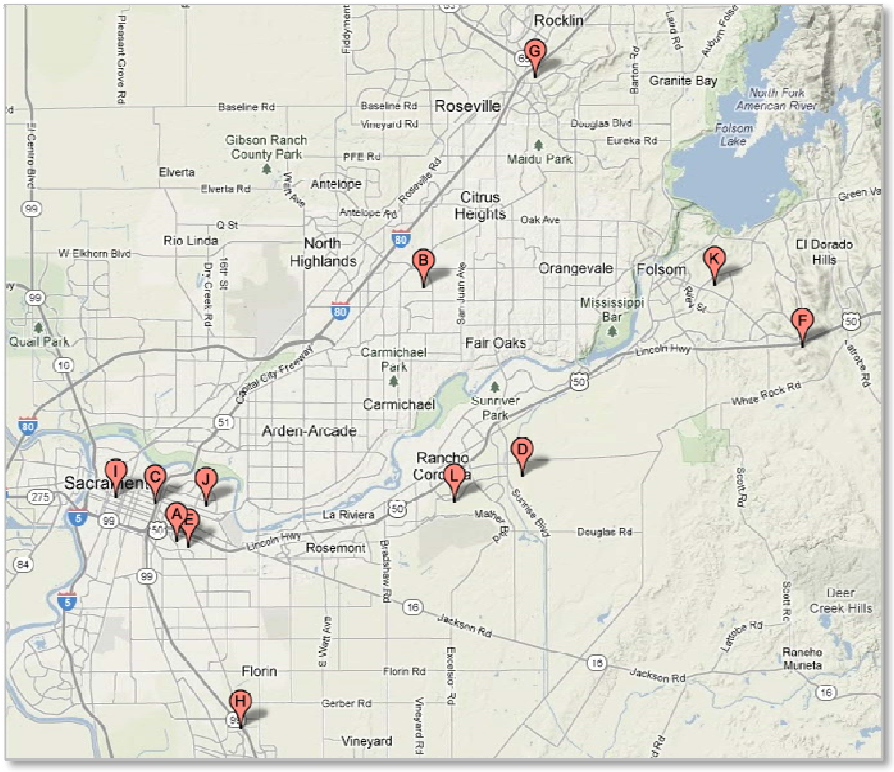
FIGURE 7. SCHEMATIC OF THE POWERSTAT® LOAD MANAGEMENT SYSTEM

- **Installer to Load Management System.** GoodCents staff set up customers in the load management system through the administrative web portal.
- **Utility to Load Management System.** Utility staff uses the administrative web portal to view customer set-up information, run reports, trigger events, and initiate opt outs on behalf of customers.
- **Customer to Load Management System.** The customer can use a customer web portal to program thermostat temperature settings and schedules, check to see whether an event is happening, opt out of events, and view opt-out history.
- **Load Management System to Paging Controller to Thermostats.** The load management system communicates information to the paging controller, which then forwards signals to customer thermostats. The paging system in Sacramento uses a 900 MHz channel to communicate to the one-way receivers in the thermostats.
- **Customer to Thermostat.** Customers can manage most thermostat settings at the device. Event opt outs cannot be managed at the device.

Paging System

There are 12 paging communication towers in the Sacramento area, as shown in Figure 8. These towers transmit signals to the thermostats installed in participant homes.

FIGURE 8. PAGING TOWERS IN THE SACRAMENTO AREA



Thermostats

Each participant in the PowerStat® Pilot received a Honeywell UtilityPro touch screen thermostat with the ability to receive control signals and display messages from the load management system. Information in the load management system can be changed through the administrative web portal for all customers by both the installer and the utility. Customers were each provided a password-protected customer web portal to manage their own thermostats.

On event days, the thermostats displayed messages to indicate that a control strategy was in progress. The thermostat displayed “PRE-COOL” when a precooling offset was in effect, “SAVINGS” when the peak offset was in effect, and “RECOVERY” at the end of the event until the customer’s normal temperature setting was attained. During events, adjustments at the thermostat were not possible, but customers could opt out of events through a password protected web portal.

Field Study Activities

Recruitment, Enrollment, and Participant Sample

A residential sample was randomly selected and screened to exclude customers enrolled in the following programs and rates:

- PV Rate
- CBS sample
- Smart charging sample
- Low Income Energy Management sample
- Med Rate
- Budget Billing
- Master meter
- Summer Solutions study
- Third-party notification
- Solar customers

Recruitment packages were mailed to 14,221 customers. The packages included a letter (Appendix H), a brochure, a Participation Application (see Appendix A), a Participation Agreement (see Appendix B), and a return envelope. The recruitment letter provided an introduction to the pilot, noting a schedule, the process for enrollment, and contact information for inquiries. The letter instructed customers to return the completed and signed agreement and application to SMUD within a 10-day period, indicating that customers would be enrolled on a "first-come, first-served" basis.

The brochure described the pilot, the potential benefits of participation, the thermostat, and how to sign up. Eligibility requirements listed on the Participation Agreement included that customer must have only one thermostat in the home, have internet access, and own their home.

The final recruitment and enrollment results are provided in Table 5.

TABLE 5. RECRUITMENT RESULTS

	Homes	% of Invited	% of Applications
Customers Invited	14,221		
Applications received	771	5.4%	
- Rejected	120		16%
- Enrolled	180		23%
- Waitlisted	471		61%
Clean Applications	651	4.6%	

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The 180 participants were divided into three groups of 60 for the purpose of treatment rotation to reduce group characteristic bias. Over the course of the summer, five participants dropped out. Upon investigation of the summer load data, 15 Group 2 and 26 Group 3 participants were re-categorized as Group 1 participants. The miscategorization resulted when the thermostats at these 41 participant sites did not receive their group assignment via the paging communication. As a result, these 41 thermostats remained in the default Group 1 rather than being set to Group 2 or 3, as was intended. Another 23 sites were excluded from the analysis because their Group number could not be determined.

Figure 9 maps the locations of the 180 enrolled participants, by status, as follows:

- 111 “good” sites included in the analysis as originally assigned
- 15 “2-to-1” sites assigned to Group 2, but controlled according to the Group 1 schedule
- 26 “3-to-1” sites assigned to Group 3, but controlled according to the Group 1 schedule
- 23 “bad” sites for which the Group number could not be determined
- 5 “drop” sites, who dropped out of the program before the end of the summer

FIGURE 9. MAP OF ORIGINAL 180 POWERSTAT® PARTICIPANTS, BY STATUS

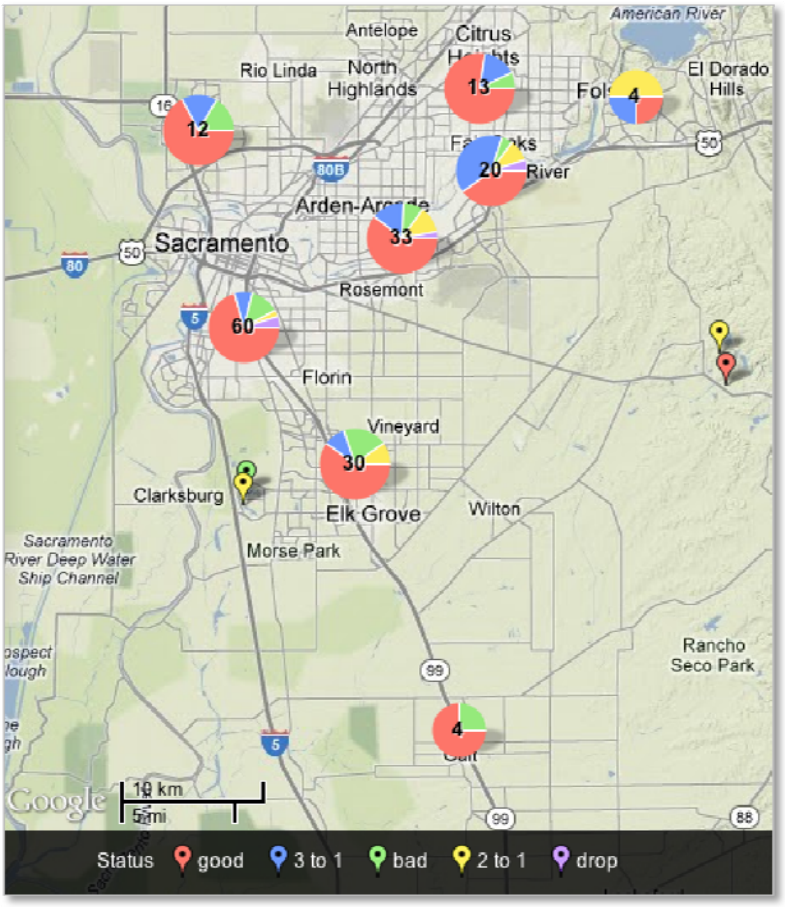
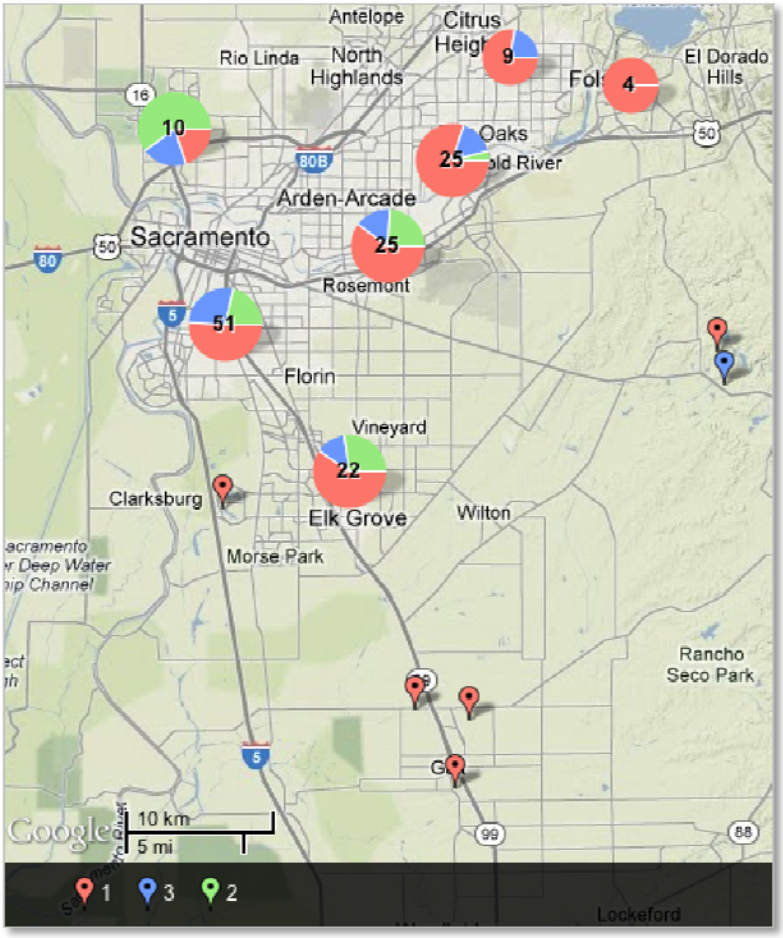


Figure 10 maps the locations of the final 152 participants included in the analysis: 92 participants in Group 1, 30 participants in Group 2, and 30 participants in Group 3.

FIGURE 10. MAP OF FINAL 152 POWERSTAT® PARTICIPANTS, BY ROTATION GROUP



The final three rotation groups, as analyzed, are described in Table 6.

TABLE 6. PARTICIPANT CHARACTERISTICS, BY GROUP

Rotation Group	Homes	Completed surveys	Mean Insulation R-Value	Mean Home Size (ft^2)	Mean # of occupants	# Homes with occupants <2 years old	% Homes occupied 10 am – 4 pm
1	92	77	28.0	1724	2.41	3	75.3
2	30	24	28.2	1754	2.33	0	75.0
3	30	28	26.6	1773	2.21	1	89.3
All	**152**	**129**	**27.7**	**1740**	**2.35**	**4**	**78.3**

Thermostat installation

Installation appointments were scheduled as a four-hour window in which the installer would arrive at the customer's home. On average, installation took about one hour.

The installation contractor removed the customer's existing thermostat and installed the new UtilityPro thermostat. Thermostats that contained mercury were disposed of as required by AB 2347. Old thermostats that did not contain mercury were put into the UtilityPro thermostat box and handed to the customer. At any time during the pilot agreement, the participant could request that the old thermostat be reinstalled, a service provided at no cost to the customer.

In situations where the HVAC unit did not already have a common wire, which is required by the UtilityPro thermostat, a wiring module was installed. Of the 180 installations, 41 required a wiring module. Of these, most were split system HVAC units as opposed to roof-mounted package units.

Each installer was responsible for completion of a work order before leaving the home. Information captured denoted the customer installation status (i.e. installed, cancelled, not compatible, etc), and data about the building and air conditioning system characteristics. The work order was then delivered to the installer office for processing of the relevant information and then forwarded onto SMUD for data retention. Of primary importance was the square footage of the premise and the ceiling insulation R-value. Where an R-value could not be ascertained it was estimated. The R-value was used in conjunction with the precooling treatment for analysis in this report. A copy of the work order is located in Appendix K.

Participant Education and Support

Installer Interaction

The installer provided the customer with a brief tutorial on the operation of the installed thermostat, including familiarizing them with the default temperature schedules. If the customer requested a different setting the installer would provide hands-on help with the setting modification.

Welcome Kit

At the time of installation, the participant received a Welcome Kit with the following components:

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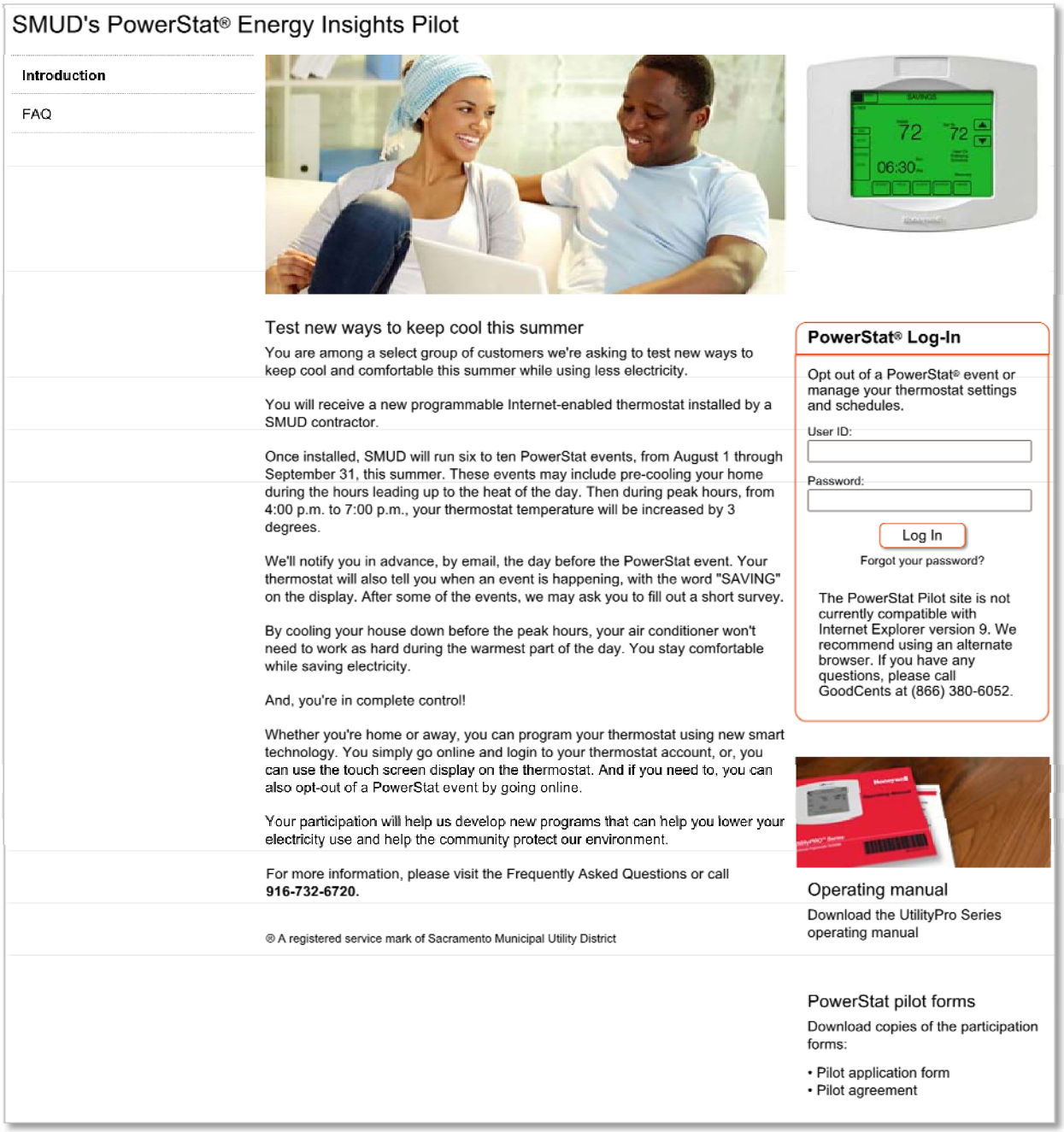
- Welcome Letter – Noted important dates and survey distribution, contacts for targeted inquiries, instructions for account access, and a tutorial on peak hours and PowerStat® event days.
- Thermostat quick guide card – Noted features of the interface with call outs for navigation.
- Thermostat user manual – A detailed guide supplied as part of the thermostat package.

PowerStat® Website

The PowerStat® website provided participants with a general overview of the program, answers to some frequently asked questions, contact information, and a link to the thermostat operating manual (Figure 11). The website also provided access to the Cooper website, where participants could change their thermostat settings, check whether an event was occurring, opt out of events, and view their opt-out history.

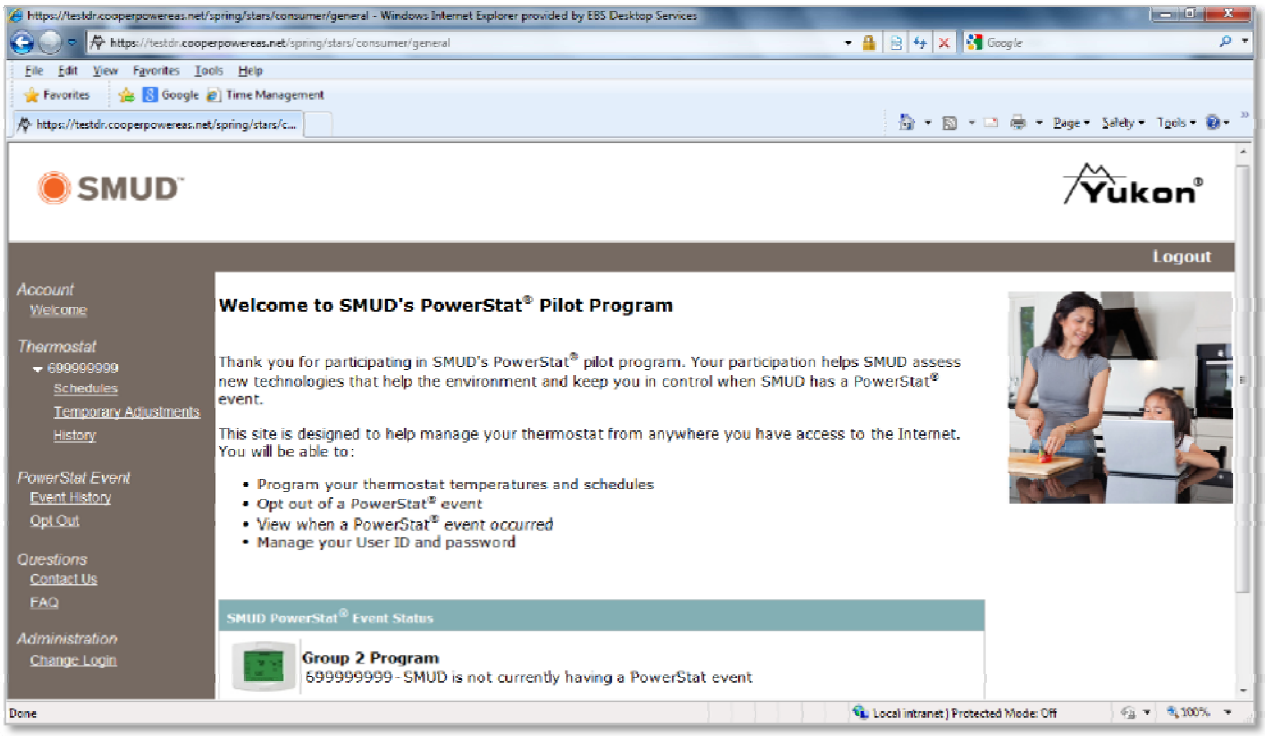
FIGURE 11. POWERSTAT® WEBSITE



Customer Portal to Program Thermostat and Opt-Out Feature

Customer can enter the Cooper Power Systems portal through SMUD's PowerStat® home page. Once the customer logged in, they would see the following page. Figure 12 shows the main landing page. One key feature is whether an event is in progress or not. This page also has a navigation bar on the left where customers can choose to opt out of events, change temperature settings and schedules.

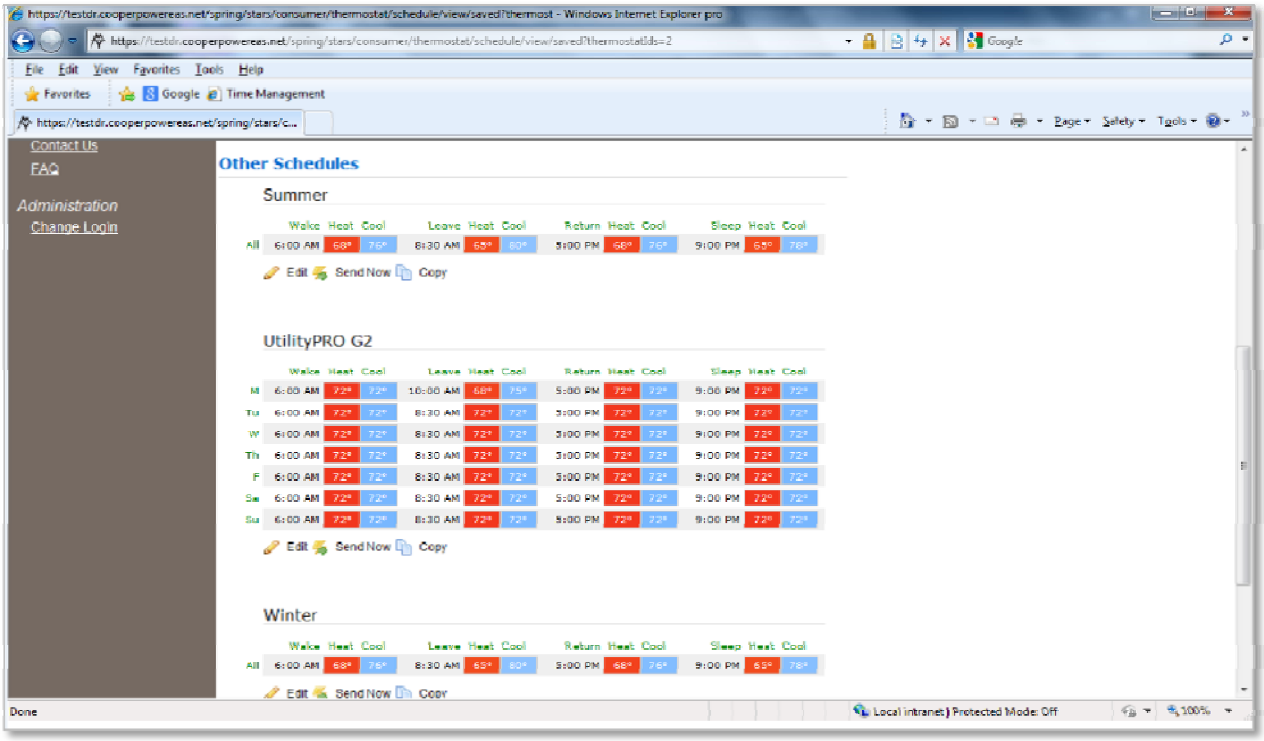
FIGURE 12. CUSTOMER PORTAL



Temperature and Schedule Changes Via the Internet

Figure 13 shows how the customer had access to change any of the four schedules (Wake, Leave, Return, Sleep). Specifically, they have the option to adjust the schedule time and heat and cool temperature for each. Schedules could be set up for each day of the week if the customer sought flexibility in addition to one, basic schedule for everyday of the week. The customer must select Send Now after making any changes to their schedule, which will then send a signal to their thermostat with the new value(s). The signal, on average, took three minutes for the changes to take effect.

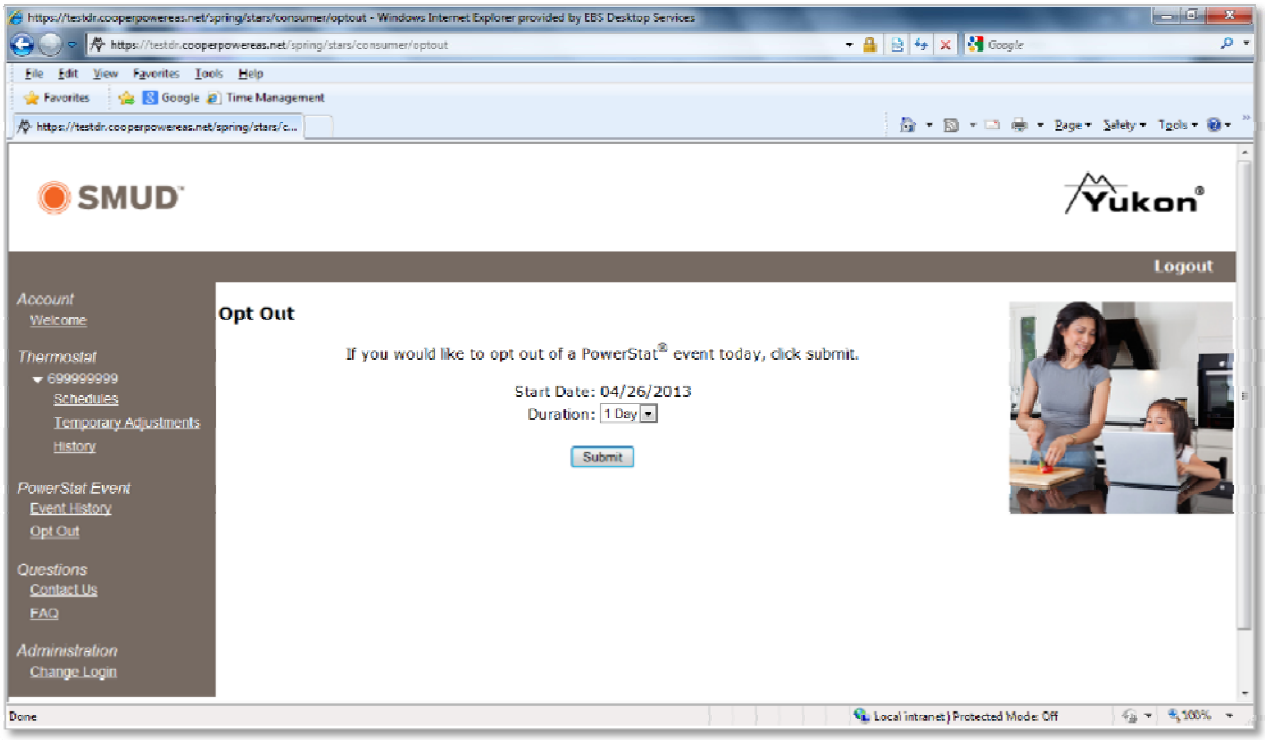
FIGURE 13. TEMPERATURE AND SCHEDULE CHANGES



Event Opt-Out Functionality

Customers were allowed an unlimited number of opt outs during the duration of the evaluation period that covered eight PowerStat® Events. There were two ways in which the customer could opt out of a PowerStat® Event: Accessing the web portal in Yukon or contacting SMUD, who would perform the task for them. Once the PowerStat® Event began, the temperature could not be adjusted downward from the device. Customers were provided day-ahead notification of an impending PowerStat® Event but opting out by the customer had to take place the day of the actual PowerStat® Event and covered a period of one day (24 hours), from midnight to midnight. Thus, the window to opt out of the PowerStat® Event before air conditioning control was initiated for precooling or peak offset was opened at midnight the day of the event day. Figure 14 shows the web page that customers used to opt out of events via the Internet.

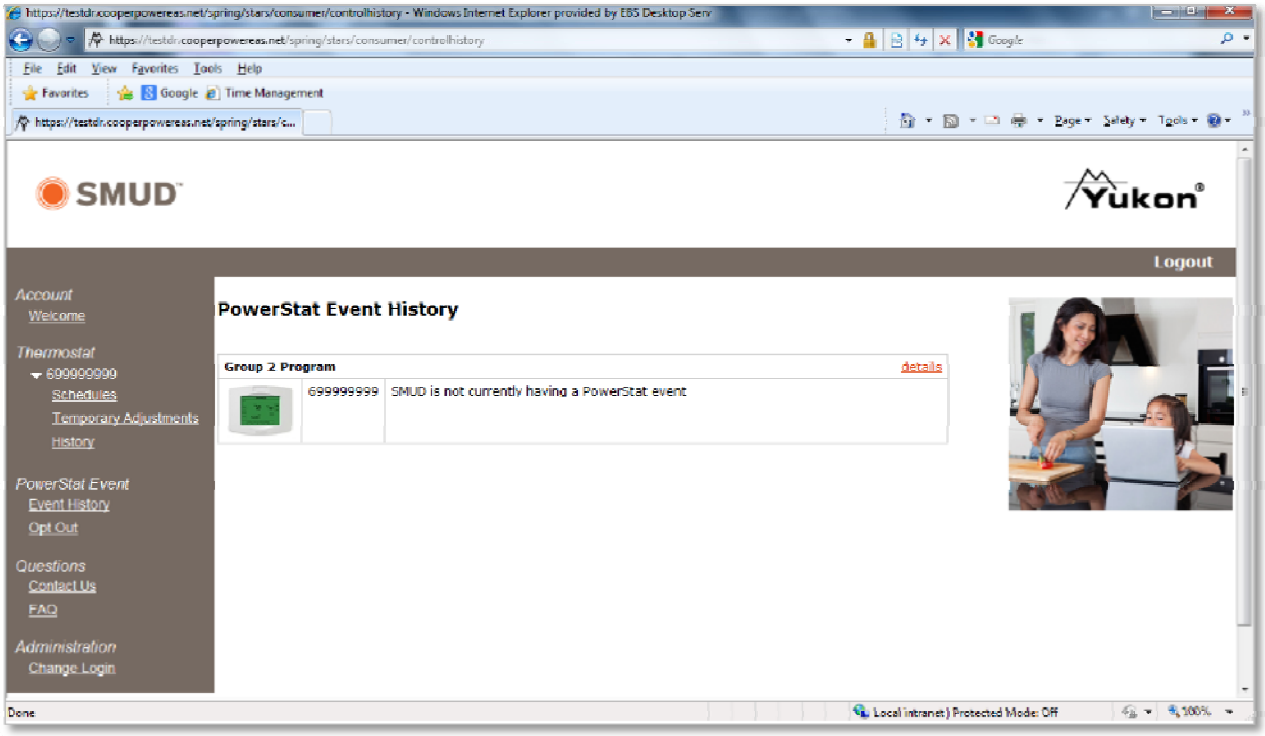
FIGURE 14. OPT-OUT SCREEN



Opt-Out Event History

Customer can view a web page (Figure 15) that would show them the days and time periods an event had occurred. It would also show whether an event is in progress or not.

FIGURE 15. OPT-OUT EVENT HISTORY



Surveys

Three types of surveys were administered to participants: a pre-treatment survey collected before the first event to capture pre-treatment conditions, four separate event surveys collected the day after each pair of similar events to captured comfort ratings, and a post treatment survey, collected after the final event to capture satisfaction ratings.

Events

Events were called on 5 weekdays in August and 3 weekdays in September, as listed in Table 7. Participants were notified by email on the day before each event.

TABLE 7. EVENT DATES AND TEMPERATURES

Date	Day of the Week	Minimum Temperature	Maximum Temperature	AvgTemp24
August 9, 2012	Thursday	59°F	103°F	80°F
August 13, 2012	Monday	65°F	105°F	84°F
August 15, 2012	Wednesday	69°F	96°F	79°F
August 17, 2012	Friday	60°F	95°F	76°F
August 23, 2012	Wednesday	58°F	91°F	73°F
September 4, 2012	Tuesday	56°F	95°F	75°F
September 12, 2012	Wednesday	56°F	91°F	74°F
September 14, 2012	Friday	60°F	92°F	76°F

Before the peak period, thermostats were directed to perform one of the three experimental precooling strategies: P0, P2, or P6, as described previously. These three strategies were evenly rotated among participants in sets of two, such that each participant received the same precooling strategy for two consecutive events, as shown in Table 8.

TABLE 8. TREATMENT SCHEDULE

Rotation Group	Event 1 *8/9*	Event 2 *8/13*	Event 3 *8/15*	Event 4 *8/17*	Event 5 *8/23*	Event 6 *9/4*	Event 7 *9/12*	Event 8 *9/14*
1	P6	P6	P2	P2	P0	P0	P6	P6
2	P2	P2	P0	P0	P6	P6	P2	P2
3	P0	P0	P6	P6	P2	P2	P0	P0

Immediately following the precooling strategy, at 4:00 p.m. on event days, participant thermostats were raised 3 degrees higher than the minimum scheduled setpoint for the peak period. This new temperature setting was maintained until 7:00 p.m., when the thermostat returned to its normal customer-programmed temperature schedule.

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Data Collection

Multiple types of information were collected from study participants at several points in the project. Initially, basic information was pulled from SMUD's customer database to conduct recruitment efforts. More detailed customer, building, and comfort information was collected through the surveys. Throughout the study, SMUD collected hourly electricity use data. At the end of the study, participant perceptions of the program were documented in their End of Summer Survey answers. A summary of these and other datasets and sources utilized for this study is presented in Table 9.

TABLE 9. SUMMARY OF DATA COLLECTED

Source	Data	Use(s)
SMUD customer database	Name, address, etc.	Screening and Recruitment
Participant Survey	Ceiling R-value	Evaluation: Load impacts
	Satisfaction ratings	Evaluation: Customer Experience
Cooper Power Systems	Log of interactions with website	Evaluation: Opt Outs
Interim Surveys	Comfort ratings	Evaluation: Customer Experience
Interval Meters	Hourly electricity use	Evaluation: Load impacts Evaluation: Bill impacts
MesoWest.utah.edu	Hourly temperatures	Evaluation: Load impacts
End-of-Summer Survey	Satisfaction ratings	Evaluation: Customer Experience

Load and Bill Impacts

Observed Loads and Temperatures

Hourly electric loads are collected from all residential customers in the SMUD service territory. At the end of the summer 2012, the hourly loads for the 152 participating PowerStat® homes were pulled and analyzed to determine the effects of the events on their electricity use. Figure 16 shows the mean hourly loads for all 152 homes combined. Clearly visible are the eight load control events, which are labeled with their corresponding maximum temperature for that day.

FIGURE 16. MEAN HOURLY LOADS FOR ALL 152 POWERSTAT® PARTICIPANTS—EVENT DAYS LABELED WITH MAXIMUM DAILY TEMPERATURE

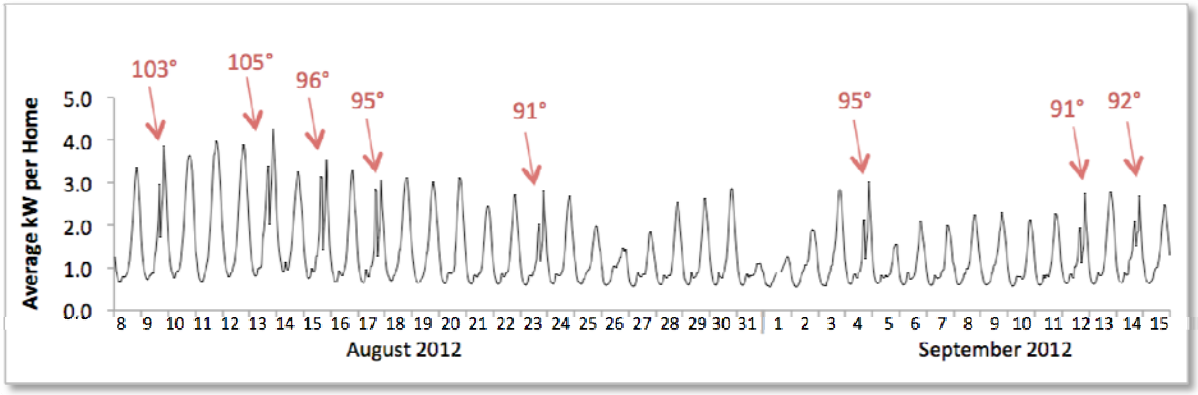
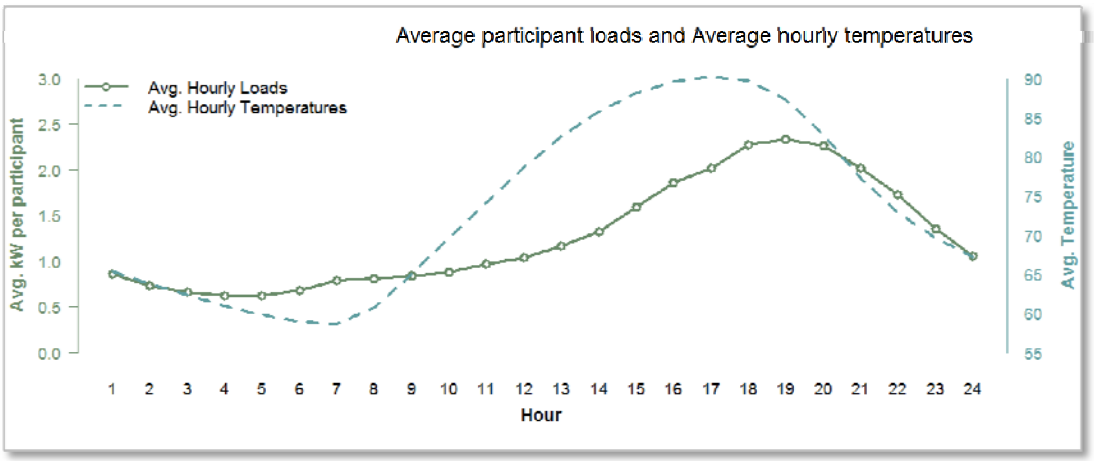


Figure 17 plots the average hourly kW loads in Summer 2012 along with average hourly temperatures—both actual and shifted. Note that shifting actual hourly temperatures by 2-hours increases the correlation between temperature and load from 0.83 to 0.95.

FIGURE 17. AVERAGE HOURLY TEMPERATURES AND PARTICIPANT LOADS



Load Impacts

Following are the results of analyses used to estimate the hourly load impacts for PowerStat® participants on event days. All results are presented by precooling treatment—P0, P2, or P6—to highlight the effects of the different precooling strategies on the pre-peak load increase, peak load shed, and subsequent post-peak rebound.

Hourly kilowatt (kW) values measured at the individual customer level were analyzed using a mixed-effects model, also known as a hierarchical or multilevel model. AvgTemp24 interaction with R-value, hour and treatment is included in the model to capture the effect of the insulation level in the ceiling and the effect of outside temperatures on the load shape and load impacts for different treatments.

$$kw_{ijk} = \beta_{(hour)ijk} hour_{ijk} + \beta_{(CDH)ijk} CDH_{ijk} + \beta_{(AvgTemp24)ijk} AvgTemp24_{ijk} + \beta_{(Rvalue)i} Rvalue_i + \beta_{(hour*AvgTemp24*Rvalue_i*treat)ijk} hour_{ijk} * AvgTemp24 * Rvalue_i * treat + ri + rij + \varepsilon ijk$$

kw_{ijk}: kilowatt load for customer i on day j at hour k

$hour_{ijk}$: categorical variables (1-24) indicating the hour of the day, where hour 1 spans the period from midnight to 1:00 a.m. and hour 24 spans the period from 11:00 p.m. to midnight.

CDH_{ijk}: cooling degree hour on day j at hour k (see description below)

$AvgTemp24_{ijk}$: average temperature from noon on day j-1 to noon on day j (see below)

$Rvalue_i$: observed ceiling insulation R-value for customer i

$treat$: categorical variable for treatment with 4 levels (P0, P2, P6, none)

r_i: random effects for customer $\sim N(0, \varphi_1)$, assumed to be independent for i

r_{ij}: random effects for day $\sim N(0, \varphi_2)$, assumed to be independent for different i or j and to be independent of r_i.

ε_{ijk}: error terms $\sim N(0, \delta^2 I)$, assumed to be independent for different i or j and to be independent of random effects.

Cooling Degree Hour (CDH) is the variable used to account for the hourly outside temperature, calculated as the number of degrees above 75°F. CDH is set to zero for all hourly temperature values less than or equal to 75°F. Base 75°F was used for CDH as it was determined that the model produced was the best one to describe the actual data. The resulting CDH values were shifted two hours forward in time to account for the lag in the transfer of outside temperatures into the building.

All impacts are estimated relative to baselines modeled using non-event day loads corrected to reflect event day temperatures. For consistency and ease of comparison, all impacts are presented in units of average kilowatt-hours per hour (kWh/h),

abbreviated in most cases to kW. Positive values indicate an increase in energy use relative to the baseline, whereas negative impact values indicate energy savings. Note that the convention for presenting overall energy impacts is kWh rather than kW, but the hourly kW values presented here are easily converted to kWh through multiplication by the number of hours across the desired time period. For detailed output of the mixed model, see Appendix E.

How did precooling and peak offset impact loads?

Figure 18 illustrates the modeled average participant loads and impacts for the three treatments, corrected for the average event-day temperature profile. Load impacts are estimated relative to a weather-corrected non-event day baseline. Error bars represent 95% confidence intervals for the impacts.

Relative to the no-precooling base case (P0), the P6 strategy induces a fairly stable 6-hour load increase from the hour ending 11 am through the hour ending at 4 pm, when the peak period begins. During the load-shed event, the P6 strategy outperforms the base-case by about 25%.

The 2-hour precooling strategy, in comparison, spikes at the hour ending at 3 p.m. and then drops off noticeably in the second hour of precooling. During the peak period, the P2 strategy is nearly identical to the P0 strategy.

FIGURE 18. HOURLY LOADS AND IMPACTS, BY PRECOOLING STRATEGY

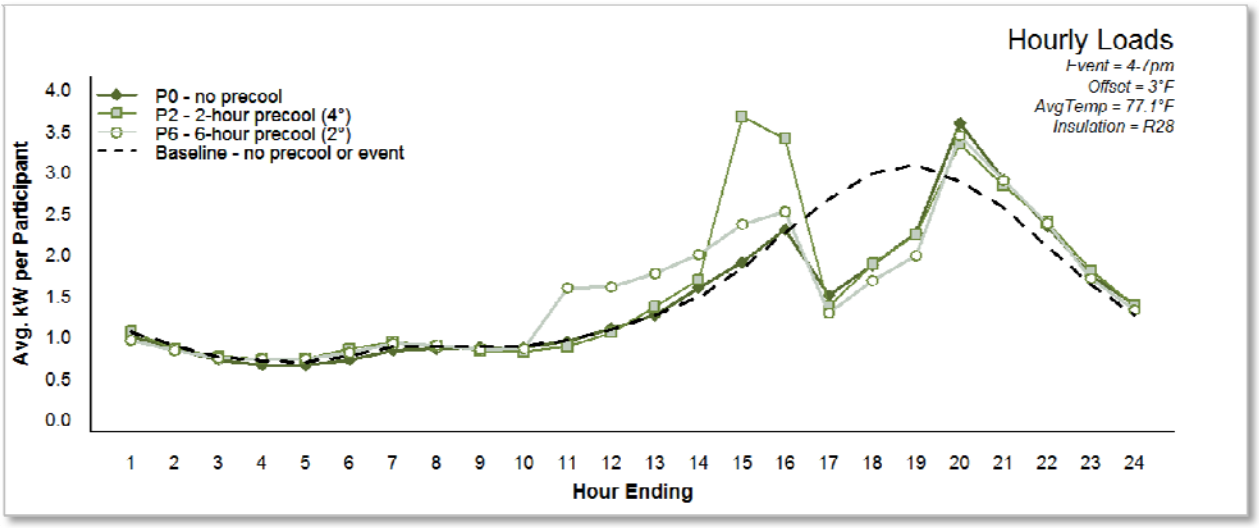


Table 10 represents the estimated load impacts for each of the three treatments for the average event-day temperature profile. Negative kW values indicate the average hourly savings relative to the weather-corrected non-event day baseline. Significant impacts are marked with an asterisk (*).

TABLE 10. AVERAGE LOAD IMPACTS (MODELED)

	N	Unit	Off-Peak (hours 1-14)	Pre-peak (hours 15-16)	Peak (hours 17-19)	Post-peak (hours 20-24)	Total (hours 1-24)
P0	152	kW	-0.019	0.048	-1.03*	0.30*	-0.073*
		%	(-2.0%)	(2.4%)	(-35%)	(15%)	(-4.8%)
P2	152	kW	0.017	1.48*	-1.08*	0.26*	0.052
		%	(1.9%)	(73%)	(-37%)	(12%)	(3.4%)
P6	152	kW	0.15*	0.39*	-1.26*	0.26*	0.016
		%	(16%)	(19%)	(-43%)	(12%)	(1.1%)

* Statistically significant (α = 0.05)

To determine difference between treatments, hourly load data for event days was aggregated into four periods as follows:

- Off-peak = Hours ending 1-14
- Pre-Peak = Hours ending 15-16
- Peak = Hours ending 17-19
- Post-peak = Hours ending 20-24

Contrast analysis was used to compare the effects of the precooling treatments on loads during the four daily periods described above. Table 11 provides results of the between-treatment comparisons for each period. Results show that the P6 treatment shed significantly more load during the peak period than did P0 or P2.

TABLE 11. COMPARISON OF LOAD IMPACTS BY TREATMENT

Treatment Comparison	Off-Peak (hours 1-14)	Pre-Peak (hours 15-16)	Peak (hours 17-19)	Post-peak (hours 20-24)	Total (hours 1-24)
P2-P0	0.04	1.44*	-0.05	-0.04	0.12*
P6-P0	0.17*	0.35*	-0.23*	-0.04	0.09*
P6-P2	0.13*	-1.09*	-0.18*	0.00	-0.04

* Statistically significant (α = 0.05)

Results further indicate the following:

- In the Off-peak hours, P6 used significantly more energy than P0 or P2.
- In the Pre-peak hours, P2 energy use was the highest, followed by P6 and then P0 as the lowest.

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- In the Peak hours, P6 demand was lowest, while P2 and P0 were not significantly different.
- There were no significant differences in the Post-peak hours.
- Total daily energy use was lowest under the P0 treatment, while P2 and P6 were not statistically different.

How did load impacts change with insulation level?

Well-insulated buildings, by definition, slow heat transfer between the interior and exterior of the building. Theoretically then, one might posit that precooling and offset strategies would use less energy and have greater impacts in homes with higher levels of insulation. To test this theory, ceiling insulation R-values were observed from 130 of the 180 homes visited for thermostat installation. The distribution of observed ceiling R-values is provided in Appendix C.

Using the mixed model described previously, hourly impacts by treatment were compared at different insulation levels. The results indicate that homes with higher insulation levels attained deeper load shed and smaller rebound effects than those with the lower insulation levels. Effects of insulation on hourly loads and impacts for P0 are shown in Figure 19 and Table 12, effects for P2 are shown in Figure 20 and Table 13, and effects for P6 are shown in Figure 21 and Table 14.

FIGURE 19. EFFECT OF INSULATION ON P0 LOADS

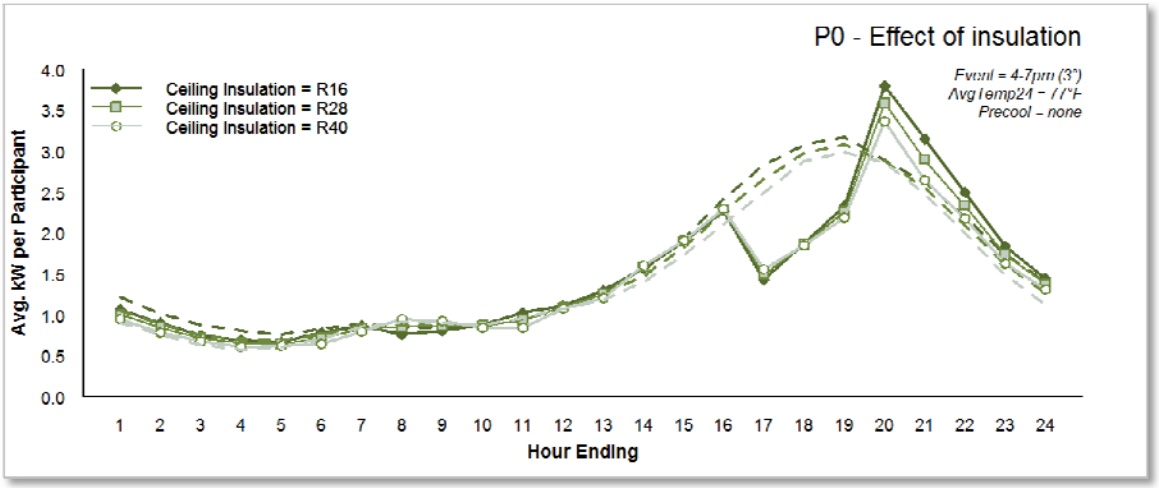

TABLE 12. EFFECT OF INSULATION ON P0 LOAD IMPACTS

Insulation Level	Off-Peak (hours 1-14)	Pre - Peak (hours 15-16)	Peak (hours 17-19)	Post-Peak (hours 20-24)	Total (hours 1-24)
R16	-0.05	-0.08	-1.15*	0.37*	-0.10*
R28	-0.02	0.05	-1.03*	0.30*	-0.07*
R40	0.01	0.18	-0.91*	0.24*	-0.04

* Statistically significant (α = 0.05)

FIGURE 20. EFFECT OF INSULATION ON P2 LOADS

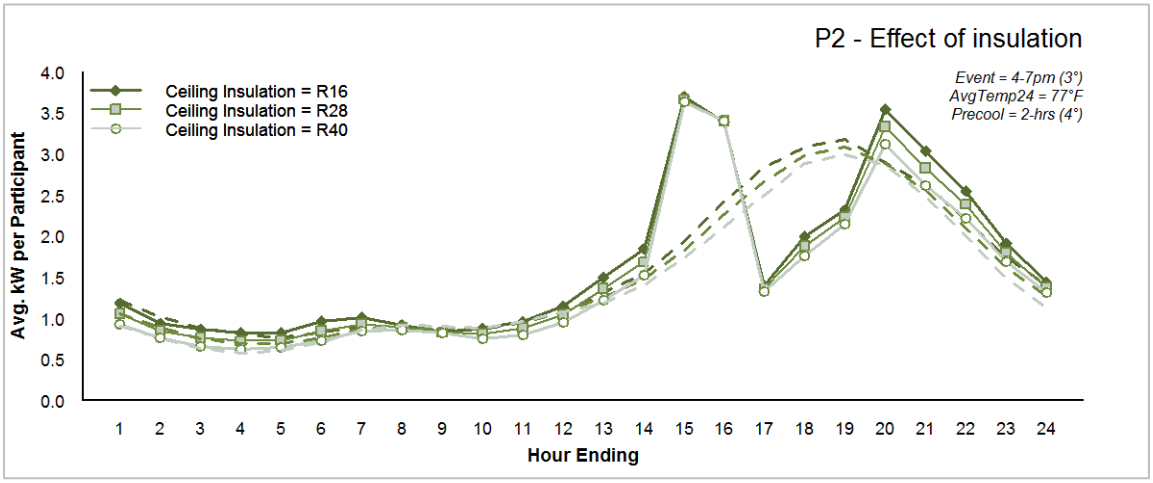

TABLE 13. EFFECT OF INSULATION ON P2 LOAD IMPACTS

Insulation Level	Off-Peak (hours 1-14)	Pre - Peak (hours 15-16)	Peak (hours 17-19)	Post-Peak (hours 20-24)	Total (hours 1-24)
R16	0.06	1.37*	-1.13*	0.32*	0.07
R28	0.02	1.48*	-1.08*	0.26*	0.05
R40	-0.02	1.59*	-1.04*	0.20*	0.03

* Statistically significant difference (α = 0.05)

FIGURE 21. EFFECT OF INSULATION ON P6 LOADS

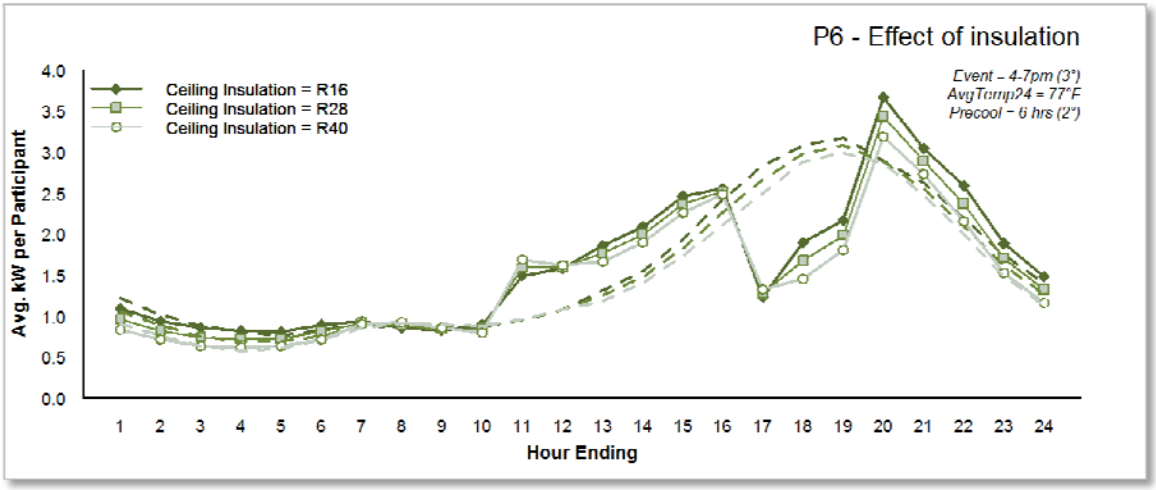

TABLE 14. EFFECT OF INSULATION ON P6 LOAD IMPACTS

Insulation Level	Off-Peak (hours 1-14)	Pre - Peak (hours 15-16)	Peak (hours 17-19)	Post-Peak (hours 20-24)	Total (hours 1-24)
R16	0.15*	0.34*	-1.27*	0.36*	0.030
R28	0.15*	0.39*	-1.26*	0.26*	0.016
R40	0.15*	0.45*	-1.25*	0.16*	0.002

* Statistically significant (α = 0.05)

How did load impacts change with outdoor temperature?

Previous research has shown that higher outdoor temperatures result in higher demand, which translates to greater peak impacts during demand response events (e.g. Herter 2007). This section considers the effect of outdoor temperatures on the hourly loads and, in particular, during the pre-peak, peak, and post-peak periods.

To model these results, the mixed model for both event and non-event days was populated with 4 different temperature profiles, defined by maximum and minimum hourly temperatures along with the variable *AvgTemp24*.[1] In all cases, results show that higher temperatures increase pre-peak and post peak loads and lower peak loads relative to the baseline loads.

Figure 22 plots the modeled hourly impacts for P0, with separate lines for days with maximum temperatures ranging from 93 °F to 110 °F. In general, higher temperatures result in deeper load shed and higher post-peak rebound, as expected. Unexpected, however, are the positive impacts (increased loads) prior to the peak period at hotter temperatures. Since precooling was not supposed to be initiated at all for P0, the source of these positive impacts is unknown. Reviewing the actual loads for each event, it appears that the hottest two events, on 8/9 and 8/13, are the source of this pre-peak load increase (see Appendix D). One possible explanation is that some customers chose to precool manually on the hottest days.

[1] As described previously, AvgTemp24 is calculated as the average 24-hour temperature from noon on the previous day to noon on the current day, and is used as a basic indicator of heat gain in the building mass.

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FIGURE 22. EFFECTS OF TEMPERATURE ON HOURLY P0 IMPACTS

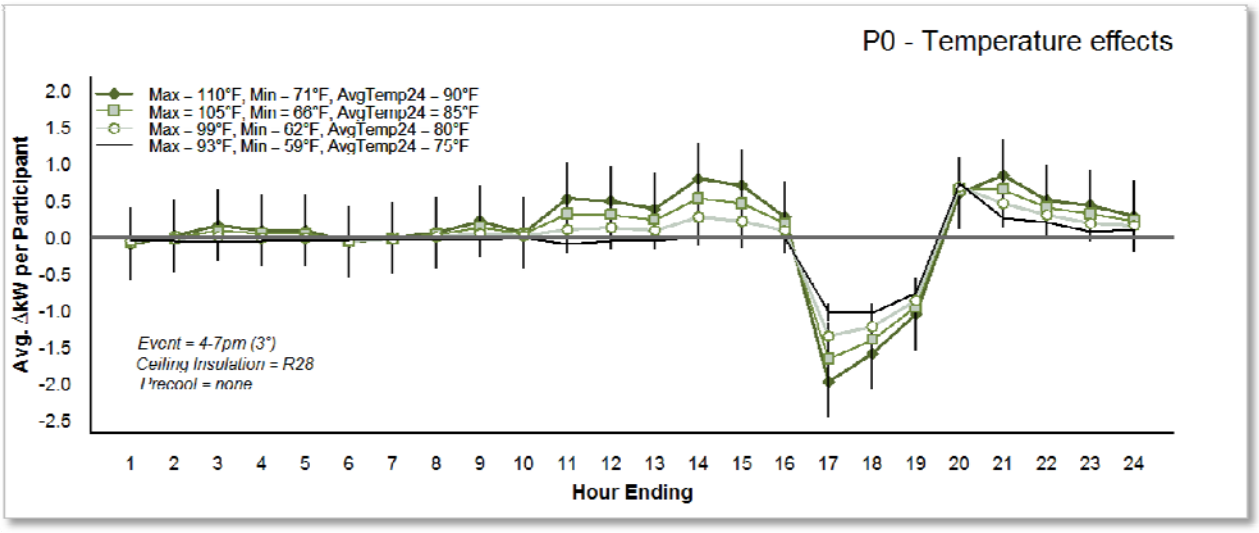


Table 15 summarizes the P0 impacts for the pre-peak, peak, and post-peak periods, as well as the total daily impact. Note that on cooler days, where AvgTemp24 is 75, the P0 treatment significantly reduced overall energy use on event days.

TABLE 15. EFFECT OF OUTDOOR TEMPERATURE ON P0 IMPACTS

AvgTemp24 (°F)	Off-Peak (hours 1-14)	Pre-Peak (hours 15-16)	Peak (hours 17-19)	Post-Peak (hours 20-24)	Total (hours 1-24)
75	-0.05	-0.02	-0.95*	0.27*	-0.10*
80	0.03	0.15	-1.15*	0.35*	-0.04
85	0.11	0.31*	-1.35*	0.44*	0.01
90	0.19	0.48*	-1.54*	0.53*	0.07

* Statistically significant (α = 0.05)

Figure 23 illustrates the P2 precooling case for the four different temperature profiles.

FIGURE 23. EFFECTS OF TEMPERATURE ON HOURLY P2 IMPACTS

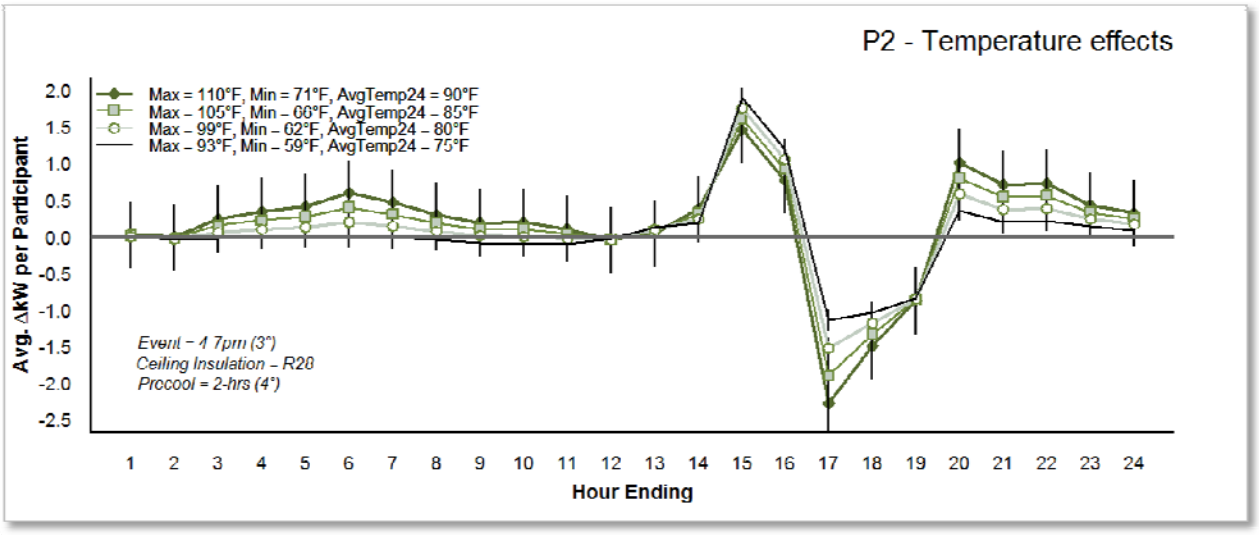


Table 16 summarizes the P2 impacts for the pre-peak, peak, and post-peak periods, as well as the total daily impact. At all temperatures, P2 uses significantly more energy pre-peak and post-peak, and significantly less energy during the peak.

TABLE 16. EFFECT OF OUTDOOR TEMPERATURE ON P2 LOADS

AvgTemp24 (°F)	Off-Peak (hours 1-14)	Pre-Peak (hours 15-16)	Peak (hours 17-19)	Post-Peak (hours 20-24)	Total (hours 1-24)
75	-0.02	1.54*	-1.01*	0.20*	0.03
80	0.06	1.40*	-1.19*	0.34*	0.08*
85	0.15	1.26*	-1.37*	0.49*	0.12
90	0.23	1.12*	-1.55*	0.64*	0.16

* Statistically significant (α = 0.05)

Figure 24 illustrates the P6 precooling case for the four different temperature profiles. Once again, higher temperatures are associated with higher pre-peak loads, deeper load sheds, and higher post-peak rebound.

FIGURE 24. EFFECTS OF TEMPERATURE ON HOURLY P6 IMPACTS

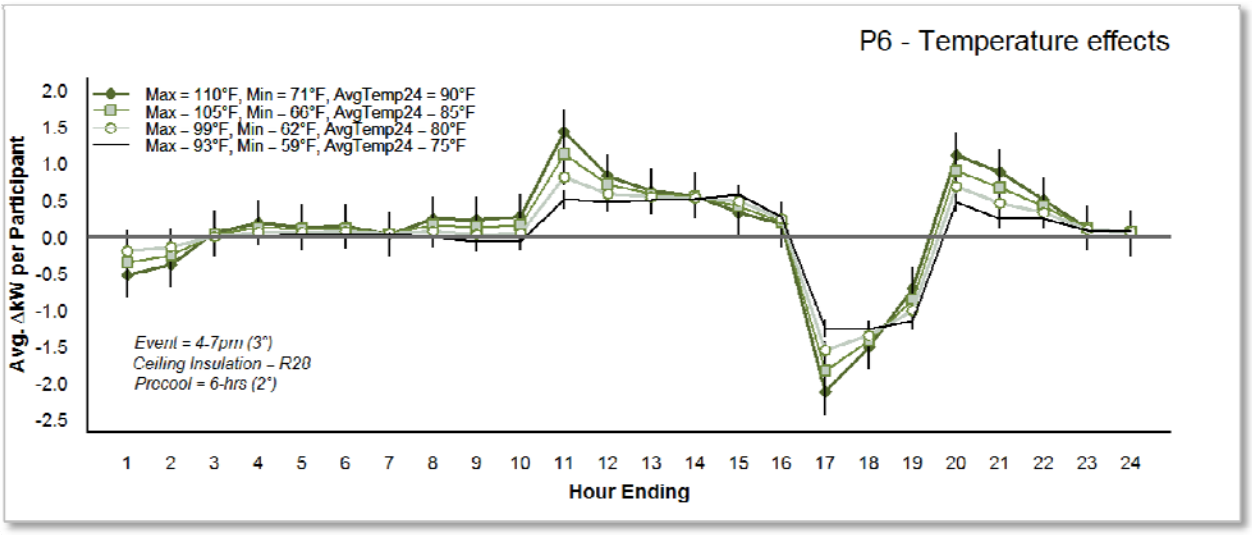


Table 17 summarizes the P6 impacts for the pre-peak, peak, and post-peak periods, as well as the total daily impact.

TABLE 17. EFFECT OF OUTDOOR TEMPERATURE ON P6 IMPACTS

AvgTemp24 (°F)	Off-Peak (hours 1-14)	Pre-Peak (hours 15-16)	Peak (hours 17-19)	Post-Peak (hours 20-24)	Total (hours 1-24)
75	0.13*	0.42*	-1.23*	0.22*	0.00
80	0.18*	0.36*	-1.30*	0.32*	0.04
85	0.22*	0.30*	-1.38*	0.42*	0.07
90	0.27*	0.24	-1.45*	0.53*	0.11

* Statistically significant (α = 0.05)

How did load impacts change with customer characteristics?

Table 18 provides correlation coefficients for precooling treatments and customer-specific peak impacts on event days. For all treatments, homes occupied between 10 am and 4 pm provided deeper load sheds than homes that were unoccupied during that time, but this effect was statistically significant only for P0 and P6. In general, homes with more occupants shed more load during peak events, but this effect was statistically significant only for P6.

TABLE 18. PEARSON'S PRODUCT-MOMENT CORRELATIONS WITH EVENT IMPACTS

	Square footage of home	People living in home	Occupant <2 yrs old	Occupant >65 yrs old	Home occupied 10am-4pm
P0	-0.15	-0.17	0.05	-0.09	-0.20*
P2	-0.11	-0.12	0.00	-0.15	-0.11
P6	-0.15	-0.21*	0.07	0.09	-0.22*

* Statistically significant (α = 0.05)

How did comfort change with load impacts?

Table 19 shows the correlations between peak impacts and comfort levels for different treatments. In general, more savings during the peak hours were correlated with colder pre-peak hours and hotter peak hours.

TABLE 19. IMPACTS AND COMFORT CORRELATIONS, BY TREATMENT

Treatment	Time Period	correlation
P0	2-4 pm	0.05
P0	4-7 pm	-0.30*
P2	2-4 pm	0.06
P2	4-7 pm	-0.23*
P6	2-4 pm	0.21*
P6	4-7 pm	-0.03

* Statistically significant (α = 0.05)

Bill Impacts

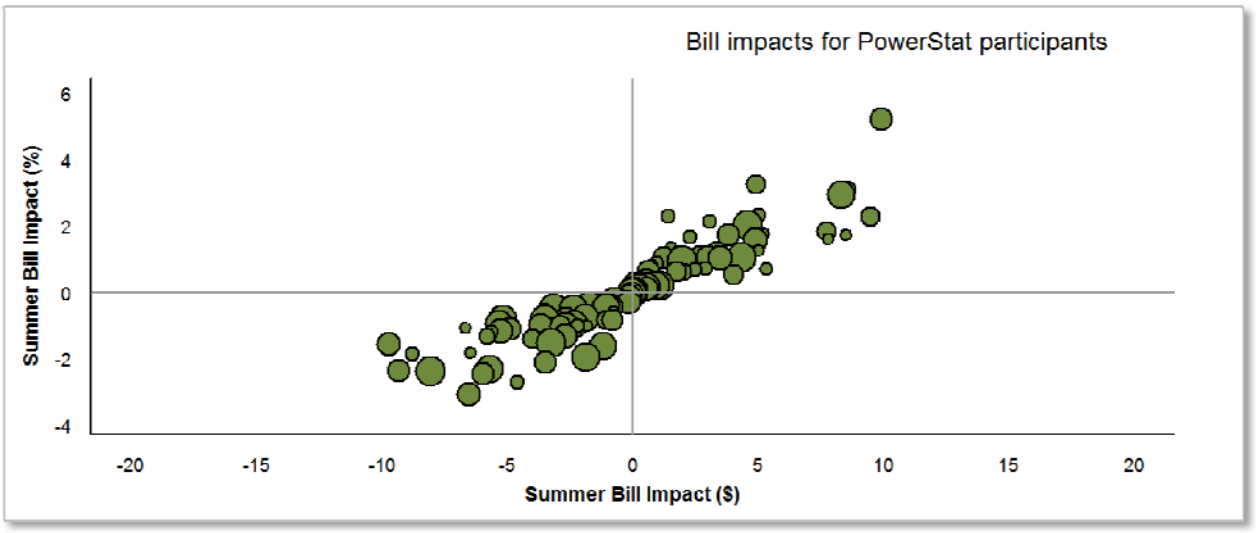
Average monthly bill impacts for PowerStat® participants were not statistically significant, ranging from a $2 monthly bill savings (-1.2%) to a $0.55 monthly bill increase (+0.5%), as shown in Table 20.

TABLE 20. AVERAGE MONTHLY BILL IMPACTS

Treatment	Average Monthly Bill Impact ($)	% Bill Impact
P0	- $2.03	- 1.2 %
P2	+ $0.55	+ 0.5 %
P6	- $0.20	- 0.1 %

Figure 25 plots the bill impact estimates for all 152 customers for August and September of 2012. Excluding the two outliers at the high and low ends, bill impact estimates ranged from -$10 to $10 for the summer, representing between -3% and +5% of the August-September bills.

FIGURE 25. DISTRIBUTION OF ESTIMATED 2012 POWERSTAT® BILL IMPACTS



Could customers on a time-of-use rate save money by precooling every weekday?

All PowerStat® participants were on SMUD's standard residential rate, which provides no incentive to shift electricity use out of the peak period on non-event days. Under a time-of-use rate like SMUD's SmartSacramento® Pricing Pilot TOU rate (Table 21), customers have the opportunity to use precooling and peak offset to save money every weekday, not just on event days.

TABLE 21. STANDARD RESIDENTIAL RATE AND THE SPO TOU RATE

Period	Schedule	Tier	Standard Summer Rate *($/kWh)*	SmartSacramento® Summer TOU Rate *($/kWh)*	% of Time
On-peak	4:00 - 7:00 p.m. Non-holiday weekdays	Base Plus	$ 0.1859	$ 0.2700	9%
		Base	$ 0.1045		
Off-peak	All other hours	Base Plus	$ 0.1859	$ 0.1660	91%
		Base	$ 0.1045	$ 0.0846	

A program that supplied customers with a thermostat that could be easily programmed to avoid peak prices every weekday could have significant impacts, not only on hourly loads, but also on bills. Results would depend on the weather, the precooling strategy, and the insulation level of the home.

Figure 26 shows the average monthly bill impacts for customers who practice the P0, P2 or P6 air-conditioning control strategy every weekday on the Standard rate (left) and on the TOU rate (right). These charts imply that customers on the Standard rate save money only if they shed load during peak without precooling, regardless of their insulation level. In contrast, customers on the TOU rate save more than 5% on their monthly bills in all cases except the P2 case. With a ceiling insulation level of R40, bill savings are roughly the same for peak load shed under P0 or P6—meaning precooling is worth it to the customer if they find that it improves their comfort during the peak.

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FIGURE 26. AVERAGE MONTHLY BILL IMPACTS - PRECOOLING PLUS PEAK LOAD SHED EVERY WEEKDAY

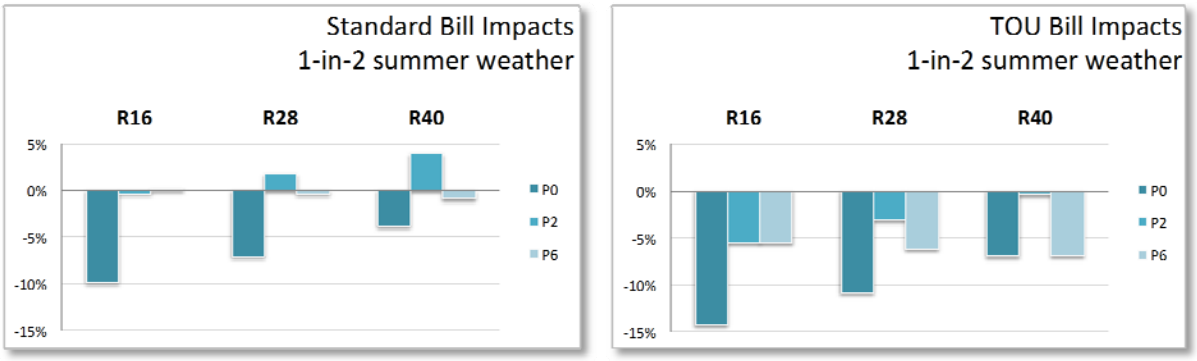
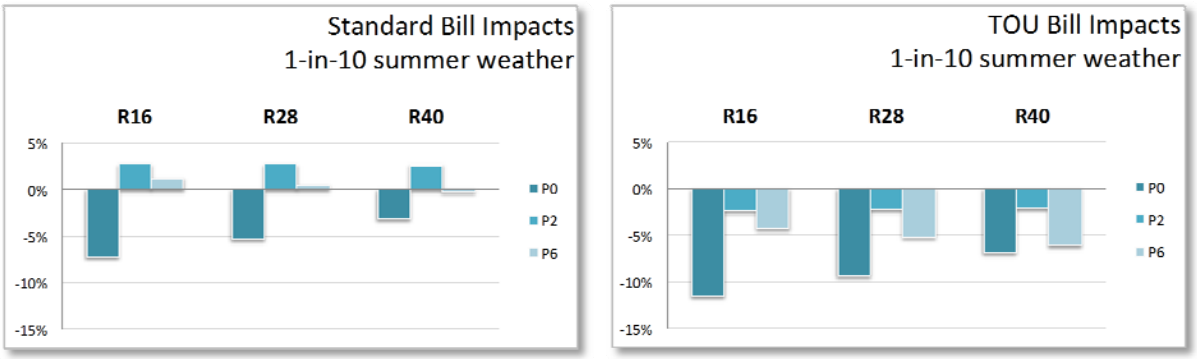


Figure 27 also shows average monthly bill impacts for the Standard and TOU rates under different precooling and insulation scenarios, but this time, for a very hot summer—one that happens only once in 10 years. While results do not change substantially, impacts are generally reduced compared to the average 1-in-2 temperature scenario.

FIGURE 27. AVERAGE MONTHLY BILL IMPACTS—PRECOOLING PLUS PEAK LOAD SHED EVERY WEEKDAY



Event Opt Outs

Participants were provided a password protected web-portal where they could opt out of events before or during the control period. Throughout the summer, the Yukon system logged opt outs by date, time, and participant. The logs show that just 18 of the 152 participants (12%) accounted for all 45 opt outs, while the vast majority of the participants (88%) accepted SMUD's control of their thermostat for all 8 events (Figure 28).

FIGURE 28. PERCENTAGE OF PARTICIPANTS THAT INITIATED OPT OUTS

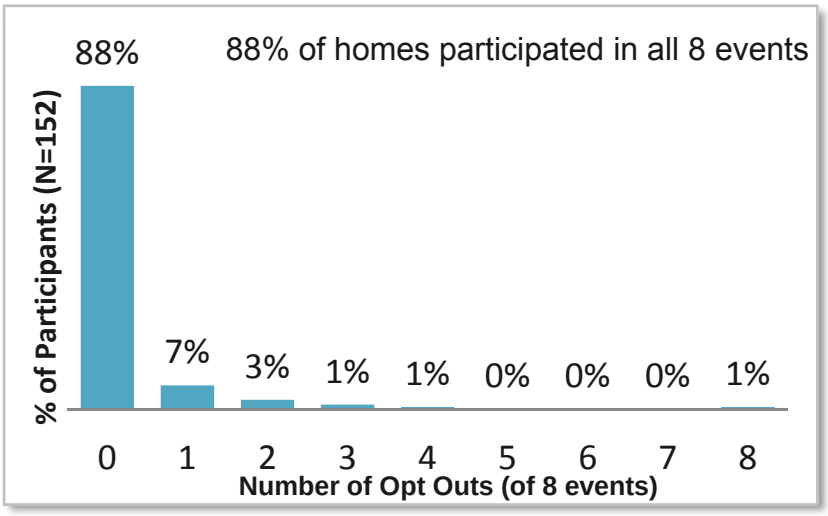


Table 22 shows the number of opt outs by event and temperature.

TABLE 22. NUMBER OF OPT OUTS BY EVENT

Event	Date	Maximum Temperature	Opt Outs	% Opt Outs
1	8/9/12	103	3	2.0%
2	8/13/12	105	4	2.6%
3	8/15/12	96	11	7.2%
4	8/17/12	95	6	3.9%
5	8/23/12	91	6	3.9%
6	9/4/12	95	4	2.6%
7	9/12/12	91	2	1.3%
8	9/14/12	92	9	5.9%

Table 23 summarizes the event opt outs by treatment, as logged by Yukon during the course of the eight summer events. On average, opt outs hovered around 3% to 4% for each treatment—a low percentage considering the fact that the number of allowed opt outs was unlimited.

TABLE 23. EVENT OPT OUTS, BY TREATMENT

Treatment	Potential Opt Outs	Opt Outs	% Opt Outs
P0	364	12	3.3%
P2	364	15	4.1%
P6	488	18	3.7%
Total	**1216**	**45**	**3.7%**

Because participants were provided day-ahead notification of impending events, they had the opportunity to opt out of the event well before AC control was initiated for precooling or peak offset. Table 24 shows the number of opt outs in each of the three possible control circumstances: *Before Control*, when customers had only been notified of an impending event by no AC control action had yet taken place, *During Precool*, which occurred from 10 am to 4 pm for treatment P6 and from 2 pm to 4 pm for treatment P2, and *During Peak*, which occurred from 4 pm to 7 pm for all participants.

TABLE 24. EVENT OPT OUTS, BY STATUS OF AC CONTROL AND TREATMENT

Control Status	Total	%
Before Control	22	49%
During Precool	5	9%
During Peak	18	40%
Total	**45**	**100%**

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Customer Experience

This section summarizes the results of the *2012 Residential Direct Load Control Pilot Customer Experience Report* prepared for SMUD by True North Research (2013). For the complete report, see Appendix L.

Comfort Ratings

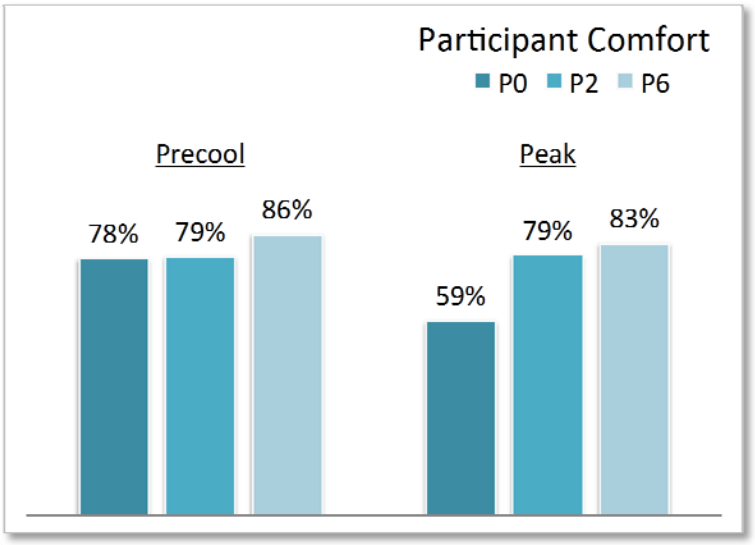
Surveys collected just after each event—including a "benchmark" event where no temperature changes were initiated—asked participants about their comfort during the precooling and peak time periods by asking:

1. How would you rate the temperature in your home on [event day] between 2PM and 4PM?
2. How would you rate the temperature in your home on [event day] between 4PM and 7PM?

Participants were directed to choose from the following possibilities: "Much too cold", "A bit too cold", "About right/comfortable", "A bit too hot", or "Much too hot."

Figure 29 summarizes the comparison between the survey responses from the benchmark event and the actual events. Overall, PowerStat participants under the P6 precooling strategy were most likely to say that they were as or more comfortable than they were on the benchmark event day. Statistical analysis showed that participant comfort under the P6 precooling strategy was statistically similar to a normal non-event day, while comfort under the P2 and P0 precooling strategies were significantly worse. The P6 precooling strategy was also the least likely to elicit negative comments from other household occupants.

FIGURE 29. MORE PARTICIPANTS SAID THEY WERE COMFORTABLE ON P6 EVENT DAYS



Reasons for Participating

Participants who answered the pre-pilot survey most commonly cited using less energy (41%) or saving money (38%) as their reasons for participating. These answers are intriguing because the program is not designed to reduce energy *or* bills, and was not marketed as such. One-third of participants (33%) said they signed up for the free thermostat, which, as designed, was the only tangible program benefit.

The vast majority customers who answered the pre-pilot survey said that they expected to learn how to better conserve electricity (95%), use less energy (92%), or have more control over their electricity bill (91%) by participating in the pilot. Between 75% and 85% of customers who answered the post-pilot survey said the program had improved their knowledge about ways to reduce their household's electricity use, gave them more control over their electricity bill, and reduced their electricity use. Based on the load impact analysis presented in this report, these perceptions are not accurate.

Satisfaction

Satisfaction with the Program

More than 90% of participants who responded to the post-pilot survey indicated they were very (68%) or somewhat (25%) satisfied with their PowerStat® program experience. More than 90% of participants were also somewhat or very satisfied when surveyed just after each event. When asked if they would recommend the PowerStat® program to a friend, 86% of respondents said yes, 3% said no, and 12% were unsure.

Nearly three quarters of customers said they would definitely or probably sign up again next summer.

Satisfaction with SMUD

Nearly all participants who answered the pre-pilot survey indicated they were somewhat (21%) or very (78%) satisfied with SMUD's efforts to provide electricity services. In the same survey, 75% of participants indicated that their participation in the program to that point had positively impacted their opinion of SMUD.

Responses to identical questions in the post-survey changed slightly, with more respondents indicating they were somewhat satisfied (28%), and fewer saying that they were very satisfied (72%) with SMUD. Despite this relative downturn in satisfaction levels, 75% of respondents said that their participation had positively impacted their opinion of SMUD. Since the actual satisfaction values did not increase, one might speculate one or more of the following: (1) responses to the second question reflected the desired response rather than the actual case, (2) the positive impact was too small to push their satisfaction score for SMUD to the next level, or (3) they had already scored SMUD a 5 out of 5, and the positive impact could not be expressed beyond the highest satisfaction level.

Satisfaction with Thermostat Installation

All of the participants who answered the pre-pilot survey were either very (95%) or somewhat (5%) satisfied with the installation of their new PowerStat® thermostat. In all cases, 99-100 percent of respondents agreed that:

- the installation technician explained the basics of how to use the thermostat
- the work site was left clean after the installation was complete
- the length of time it took to install the device was reasonable
- the technician arrived on time for the appointment
- there was no damage to their property during the installation process
- the technician explained the installation process prior to starting the work.

Satisfaction with the Thermostat

At the end of the study, 80% of respondents said the PowerStat® thermostat was much better than their prior thermostat, and 20% said it was about the same.

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Lessons Learned

Technology

Paging Communication System

Observation: There are areas of Sacramento County where one-way 900 MHz paging coverage areas appear to be limited when compared against other areas. This could be due to the placement of the communication paging towers, terrain, obstructions, etc. As a result, the paging signal might not be as reliable and the thermostat might not receive a full signal for demand response events.

Recommendations: Consider using two separate paging communication service providers. Consider using an alternative communication service (i.e. not paging).

Observation: The paging communication system is a one-way communication system from the utility to the thermostat. There is no communication path from the thermostat back to the utility.

Recommendation: Consider using a two-way communication service. Having a two-way communication system would provide the utility and customer acknowledgment that the thermostat is or is not connected to the network. Such reporting could help streamline investigations into causes.

Initial Thermostat Group Programming

Observation: The Honeywell UtilityPro thermostat has something called a "splinter address." During the manufacturing process this is set to a default value; in our case this was "1," which refers to Group 1. Once a customer is enrolled in the Yukon load management system, a paging communication signal is sent automatically to all customers noting their group. This includes those already in Group 1.

After analyzing the participant data, it was determined that 41 participants of the 180 participants had data not representative of their respective group 2 or 3. Their data appeared to look more like Group 1 participants. A number of factors could be causing this (e.g. poor thermostat receiver sensitivity, weak paging signal, obstructions, etc).

We consulted with Cooper Power Systems and they indicated that most likely these 41 participants never received the communication page to program them in the correct group. Only one page went out to program the thermostats.

Recommendation: Send three communication pages to each thermostat to ensure that the thermostat received the signal. The only way to tell if the thermostat is programmed with the correct group is to physically look at the thermostat settings. This must be done preferably right after enrollments in order to validate participants are in their correct group because the thermostat stores data only for 3 months.

Time Sync Loss with Thermostat

Observation: An undetermined number of thermostats did not consistently get a paging signal to keep the time synchronized on its communication board. This was primarily due to the paging service communication area having limited coverage in certain spots.

The thermostat has two slots for paging frequency: slot A and slot B. In our case, both slots are set to American Messaging paging. When the thermostat is powered up, it will listen on the "A" slot. If, after 2.5 hours, a paging message from the Yukon load management system is not received, it will reset (and lose its time) and listen on the "B" slot. If it does not hear a Yukon load management system message on B for 2.5 hours, then it will go back to A. The clock will reset with each change in slot movement. To prevent this, an hourly Yukon load management system heartbeat is sent in order to reset the 2.5 hour timer.

Recommendation: After the first two events the following corrective actions were taken to prevent a recurrence:

- Time sync – Every hour between 12:00 AM and 8:00 AM four time sync signals were sent to the thermostat
- Heartbeat – Signal was sent four times every thirty minutes around the clock
- Slot Change – This was moved to 48 hours. The slot change and, thus, time resets that would result, were drastically reduced in chance.

Temperature Offset Basis

Observation: The way the thermostat was originally programmed by some users for the wake, leave, return and sleep temperatures and schedules impacted how the demand response precooling and temperature offset signal was handled. Initially, when the pre-cooling signal was sent, it would look at the lowest value preprogrammed up until the end of the pre-cooling period of 4:00 PM and apply the appropriate strategy. Generally speaking, this would be applied to the "Away" setting of 85 degrees. Thus, the result of the pre-cooling program period would still be above 80 degrees. Optimally, before the pre-cooling signal was dispatched, the system would look out until 7:00 PM and pre-

cool from the lowest value. Again generally speaking, this would be 78 degrees contained in the "Return" schedule. The following is an example:

When a device gets a 6 hour precool command, it will look at the scheduled set points for the next 6 hours and apply the pre-cooling strategy to the lowest value identified. In this case, the temperature was reduced to 83 degrees during the pre-cooling period of 10:00 AM to 4:00 PM

- Leave temperature 85 at 9AM
- Return temperature 78 at 5PM

The process of applying a pre-cool strategy from such a high set point followed by an appropriate temperature offset limited the pre-cooling affects that were sought. In this case, the home was not pre-cooled as intended (from the lowest temperature value from the start of the pre-cool period through the end of the offset period at 7:00 PM). Essentially, the home remained above 80 degrees during the entire pre-cool (83 degrees) and temperature offset (81 degrees) periods.

Recommendation: This issue was mitigated after the first two PowerStat® events by the system looking at the lowest preprogrammed temperature value between the start of the pre-cooling period and the end of the temperature offset period at 7:00 PM and triggering both the pre-cooling strategy and the temperature offset from this value.

Paging Reception by Thermostats

Observation: Approximately 17 participants appear to have had issues in receiving the communication page. As a result of the thermostat not receiving the page, an event was not triggered. A number of factors could have caused this: poor thermostat receiver sensitivity, weak paging signal, obstructions, etc.

Recommendation: Send out the same communication page three or more times in order to increase the likelihood the thermostat receives the communication page.

Thermostats

Observation: The Honeywell UtilityPro thermostat is not compatible with zoned systems. Instances where there is one central HVAC unit with two thermostats installed in the home and one of these thermostats is used to control a damper in the duct, the thermostat is not effective. There are many homes built in the Sacramento region where this is the case.

Recommendation: Explore with thermostat manufacturers how to handle these situations. Also consider only replacing the thermostat that controls the HVAC unit operation and leaving the other thermostat in place.

Process

Recruitment

Observation: Participants recruited for this pilot were solicited from the residential single family home population that were not current participants in SMUD's Peak Corps program (direct load control air conditioning cycling program) and not currently on SMUD's Energy Assistance Program.

Recommendation: Consider running a pilot where recruitment is more representative of the population. Recruit from both Peak Corps and non-Peak Corps participants and include both Energy Assistance Program participants and non-Energy Assistance Program customers. For pilot significance factors, ensure enough qualified participants are recruited in order to extrapolate results to the overall population.

Event Opt-Out Use

Observation: Participants were given unlimited use of event opt outs. Only a small percentage of participants (12%) actually used the feature at least once during the field study. Most participants that used it did so only once or twice and a few consistently.

Recommendation: Consider restructuring the event opt outs so there is some penalty applied for its use. This will firm-up the kW load reduction potential from the utility point of view. From the customers perspective, the small percentage of customers will still have the option to use opt outs but they will have to consider the financial effects.

Messaging

Observation: In all cases, an email message was sent to all participants the day before an event. Most participants thought this feature was helpful and they could plan in advance of the start of the event.

Recommendation: Messaging before the event seemed to be helpful. Consider any future program offering to include participant preferences in regards to message notifications (e.g. email, text, and phone). Any preferences should be built into the enrollment process, especially if automated

Program Design/Rate Consideration

Observation: In this pilot, participants were kept on their current tiered rate structure. If customers precool their home, potential dollar savings could be realized under a time-of-use rate structure whereby precooling could be used during the off-peak hours when energy costs are less.

Recommendation: In future program rollouts, consider offering participants the choice of moving to a time-of-use rate structure and even consider offering a higher price during the critical peak hours when events would be called. As a result, participants can manage their energy use in an improved fashion with an electric rate that complements the program control strategy.

Monitoring and Verification

Observation: Each participant had a smart meter connected to SMUD's meter data management system. Each meter was able to collect hourly interval use data. This data proved to be useful for determining impact savings.

Recommendation: Continue to leverage the interval data from the smart meters. Consider, at a minimum, collecting hourly data and, if possible, collect 15 minute interval data. The more granular the data, the more transparency into customer usage patterns will develop. As a result, better information can be used in developing programs for customers that will meet their, as well as the utilities, needs.

Increased Capacity and Energy before the start of the Event

Observation: The 24 hour loads and impacts profile shows that an increase in capacity is needed before the demand response event beginning. From a load serving capacity and energy point of view, extra capacity and energy would need to be procured. It appears that the 2 hour precool where the thermostat was lowered 4 degrees forced most air conditioners on and drove the increase in load.

Recommendation: Consider having participants use a longer precool period with a smaller temperature offset.

Increased Capacity and Energy after the Event

Observation: The 24 hours loads and impacts profile shows a prominent increase in capacity and energy needed after the event ends. The load management system was

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programmed to bring all air conditioners on at the same time after the event ends to help assess the effects on load and energy.

Recommendation: In a non-pilot type of program structure all air conditioners would not come back on at the same time. In the load management system software configuration, there are options to control the number of customers that come out the event over time. This has the tendency to soften the rebound effects right after the event ends.

Decreasing Load Reduction during the Event

Observation: During the three hour period of 4 pm to 7 pm, the load reduction started to decrease as air conditioning system started to come back on as the 3 degree higher offset value was reached.

Recommendations: Consider having the load management system operator reset the temperature offset every hour during the event duration. This will keep the temperature from climbing back to the 3 degree offset before getting another control signal to reset. The goal would be to maintain a constant load reduction during the length of the event.

Conclusions and Recommendations

SMUD's Residential Direct Load Control Precooling study provided communicating thermostats with assigned air conditioning load shed strategies to 175 residential customers in the summer of 2012 to test the effect of precooling on peak load shed and customer comfort.

The peak load shed consisted of a 3 °F setpoint increase from 4:00 to 7:00 p.m. Prior to this peak period, one of three precooling strategies was initiated: no precooling (P0), a 2-hour, 4-degree precool (P2), and a 6-hour, 2-degree precool (P6). These precooling strategies were rotated among the 175 customers in three groups in an attempt to limit pre-treatment load bias.

The evaluation considered hourly load impacts, overall energy use, bill impact, and participant comfort. Based on eight events during August and September, a regression model and corresponding spreadsheet-based simulation tool were developed for the two pre-cooling strategies and the no precooling baseline.

Load impact results for the event days were promising, with the 1-in-2 Peak day regression model showing an average load reduction of approximately 1 kW per participant. Interactions between precooling treatment, outdoor air temperatures, and ceiling insulation levels significantly affected hourly loads. On average, P0 and P2 had statistically similar peak impacts of -1.0 kW and -1.1 kW, respectively, while P6 showed a peak impact of -1.3 kW. The difference between this and the other two treatments was statistically significant.

In general, higher temperatures elicited larger peak load shed, while higher insulations levels reduced energy use, peak loads, and customer bills. Higher insulation levels also extended the time that the AC unit stayed off during the peak, and reduced the rebound effect directly following the peak. Despite these promising results, precooling is not for everyone. Those with the lower insulation levels (R16) increased overall energy use as a result of precooling under the P2 and P6 precooling strategies, and had higher energy bills than they would have had if they had not precooled (P0).

Based on these results, participants who initiated a 3°F peak offset every weekday during a 1-in-2 weather summer would save between 7% and 14% on their monthly electricity bills under a TOU rate. Participants who initiated P6 precooling in addition to the 3°F peak offset would save between 6% and 7% on their monthly electricity bills under a TOU rate.

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The main findings of this study are as follows.

1. Hourly load impacts

a. Precooling significantly increased loads prior to the event period. In the 2 hours before the event, P2 increased average participant loads by 1.5 kW (+73%), and P6 increased average loads by 0.39 kW (+19%).
b. Load shed – averaging 1.0 kW for P0 (-35%), 1.1 kW for P2 (-37%), and 1.3 kW for P6 (-43%)—was statistically significant in all 3 event-hours for all 3 treatments. P6 precooling, higher insulation levels, and higher temperatures increased load impacts at the average summer 2012 event temperature. At lower than average event temperatures, load shed following P6 was significantly deeper than the load sheds following P2 or P0. At higher than average temperatures, P0, P2 and P6 had similar load sheds. Thus, from a system standpoint, precooling for 2 hours by 4 degrees on the hottest days did not improve demand response (as shown in Tables 15-17) - presumably because it was so hot that the precooling benefits disappeared almost immediately.
c. Post-peak rebound – averaging 0.30 (+15%) for P0 and 0.26 kW (+12%) for the precooling treatments—was statistically significant in the five hours after the event ended for all treatments. Precooling, higher insulation levels, and lower temperatures reduced this effect.

2. Energy, comfort and bill impacts

a. On average, P0 reduced energy use while P2 and P6 increased energy use; however, P6 precooling reduced overall energy use for participants with higher levels of ceiling insulation (at least R38).
b. Participants were most comfortable under the P6 precooling strategy. Compared to a benchmark day with no precooling or offset, the P6 comfort levels were statistically similar, whereas comfort ratings for P0 and P2 precooling strategies were significantly worse than the benchmark ratings.
c. The eight events did not significantly affect monthly energy use or bills for PowerStat® participants, who were all on SMUD's standard residential rate.
d. Under SMUD's SmartSacramento® Pricing Pilot TOU rate, customers with higher insulation levels could precool every weekday to achieve energy and bill savings without discomfort.

3. Technology

A programmable communicating thermostat similar to the one used in this study would not be suitable for a portion of the customers that have zoned HVAC systems in their home. Thus, other technologies should be explored that may be suited for these types

of systems to increase the market potential of a direct load control demand response program (including the use of switches).

The reliability of the communication network is vital to ensure that devices receive signals. As revealed in this study, there was no way to ensure that the device was successfully receiving signals. Strong consideration should be given to two-way communication with acknowledgement capabilities that signals are getting to the device. Two way technology would also give the utility some indication of the device health (whether it is communicating or not). In addition, explore other communication channels including smart meter mesh network and broadband. The reliability of the signal reaching the device with one-way technology using paging communication is improved when signals are sent out multiple times.

4. Operations

Consider a restoration of load control strategy to ensure that all air conditioners would not come back on simultaneously after the event ends. In order to soften the rebound effect right after event ends, leverage the control strategies in the load management system software to control the number of customers that come out the event by staggering their release over time. Consider having the load management system operator reset the temperature offset every hour during the event duration. This will keep the temperature from climbing back to the 3 degree offset before getting another control signal to reset. The goal would be to maintain a constant load reduction during the length of the event.

5. Analysis

Further analysis is needed in areas of resource need and valuation to guide future program design as part of an optimal DR portfolio of dispatchable and pricing programs. This would require engagement and collaboration with SMUD resource planners, energy trading, and real-time operations in order to develop DR programs that provide added value.

The findings suggest that SMUD and their customers may benefit from offering one or more of the following programs:

A Demand Response program combined with the following features:

a) Increased ceiling insulation to at least R38
b) A thermostat that facilitates precooling and peak offset, to avoid occasional demand response events. For event response, the thermostat *must be* a communicating thermostat.

c) Participants with at least R38 insulation should be encouraged to program their thermostat to precool 2 degrees, 6 hours prior to events.

A **TOU rate** similar to SMUD's SmartSacramento® Pricing Pilot TOU rate, combined with the following features:

a) Increased ceiling insulation to at least R38
b) A thermostat that facilitates precooling and peak offset every weekday, to avoid the peak TOU rate. For daily peak reduction, the thermostat *need not be* a communicating thermostat.
c) Participants with at least R38 insulation should be encouraged to program their thermostat to precool 2 degrees, 6 hours prior to the peak period every weekday.

A **TOU-CPP rate** similar to SMUD's SmartSacramento® Pricing Pilot Combined Time of Use and Critical Peak Rate, with the following features:

a) Increased ceiling insulation to at least R38
b) A thermostat that facilitates precooling and peak offset every weekday, and also responds to occasional demand response events. For event response, the thermostat *must be* a communicating thermostat.
c) Participants with at least R38 insulation should be encouraged to program their thermostat to precool 2 degrees, 6 hours prior to the peak period every weekday.

Next Steps

Conduct further direct load control research and consider the following.

1. When given the option, are customers more inclined to participate in an incentive-based or a price-based offering.
2. What types of interactive features and options do customers prefer when participating in demand response programs.
3. Do two-way thermostats provide better load reduction forecasting potential over one-way with traditional impact and forecasting models.
4. How accurate are adaptive learning load reduction models.
5. By using a smart meter mesh network, does signal reliability improve over one-way communication.
6. What is the latency for sending a request to reduce load through a smart meter mesh network. Is it similar to paging or traditional VHF.

7. What is the impact savings for various price-based and incentive-based offerings.
8. What technology issues arise in the field with two-way programmable communicating thermostats with losing connectivity on the smart meter mesh network, installation, provisioning the device to the network.
9. Is it feasible to incorporate precooling and a ceiling insulation program, separately or in conjunction, with residential demand response programs.
10. Are there thermostats that customers prefer better.

References

Herter Energy Research Solutions. 2013a. SMUD's Residential Summer Solutions Study: 2011-2012.

Herter Energy Research Solutions. 2013b. SMUD's 2012 Residential Precooling Study: Load Impact Evaluation.

True North Research. *2012 Residential Direct Load Control Pilot: Customer Experience Survey Report.* Prepared for the Sacramento Municipal Utility District. November 30, 2012.

Appendices

Appendix A. Participation Application

Sign me up for the Energy Insights Pilot – PowerStat®

CUSTOMER:

Customer Name

Street Address (Premises)[1] City Zip

Best Telephone Number E-Mail Address[2]

[1]*Address where PowerStat® thermostat will be installed.*

[2]*Email address will be used to alert you of PowerStat® events and also for important program information. Your information will not be shared outside those persons affiliated with this research project.*

If you meet the eligibility requirements listed in the Participation Agreement, please fill out this application and review the Participation Agreement (signature required) and return both in the postage-paid envelope. Applications will be processed on a first-come, first-served basis, and you'll be notified by mail if your home is selected and contacted to schedule the installation of your PowerStat® thermostat. It is possible that when the SMUD representative arrives to install the thermostat, he or she may find that your home is ineligible if, for example, your heating and air system isn't compatible with the PowerStat® thermostat or if your AC system is not operating properly.

Please enter your name, address and contact information and return this page with the signed Participation Agreement.

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[3] SMUD-3387 6/12 Forms Management

Application for Energy Insights Pilot - PowerStat® Program 1

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Appendix B. Participation Agreement

Participation Agreement – PowerStat® Pilot Program

This Participation Agreement (Agreement) for the PowerStat® Pilot Program (Program) is entered into between the Sacramento Municipal Utility District (SMUD) and _____(Customer), singularly referred to herein as a "Party," collectively as "Parties." The Parties agree as follows:

1. Term. This Agreement is effective upon the date of last execution by the Parties and shall continue until December 31, 2012, unless earlier terminated by default or by either Party on thirty (30) days prior written notice.

2. Scope. SMUD is conducting this Program as a tool to determine the impact of possible savings, understand Customer comfort levels, and provide Customers with education and technologies that will allow for managed energy use. SMUD will provide and install a PowerStat® thermostat (programmable communicating thermostat) free of charge and remove Customer's original thermostat. During the term of this Agreement, SMUD will periodically send remote signals to the PowerStat® thermostat to change its temperature according to section 5.

At the time of installation, Customer will receive educational materials or SMUD-provided training to inform Customer of the Program and the processes involved in the operation and capability of the installed PowerStat® thermostat.

3. Eligibility Requirements. Customer must meet all of the following requirements during the entire term of this Agreement to participate:

a. The central air conditioning unit is in working condition
b. Single-family dwelling (no apartments or mobile homes)
c. Owner-occupied home (no rentals)
d. Access to a personal computer with Internet access to:
   - change temperature settings/schedules
   - enact the override feature
   - take participant surveys before, during (after control day events), and after the Program
e. Only one thermostat that controls air conditioner or heat pump, as applicable
f. Only one central air conditioner per home
g. Not planning to move out of the residence through the end of 2012
h. Not operating a child care or convalescent care business in the home
i. Not on SMUD's Medical Equipment Discount Program
j. Not an active participant on SMUD's Peak Corps program

4. Premises. The PowerStat® thermostat shall be installed at the following Customer address:

_____

(Premises).

5. PowerStat® Event. As used in this Agreement, PowerStat® Event means the use of the PowerStat® to

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Participation Agreement for Energy Insights Pilot-PowerStat Program® 1

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PowerStat® Event Strategy Options*

#	*Precool Offset***	*Event Offset****
1.	Decrease your thermostat setting two (2) degrees from 10:00AM to 4:00PM	Increase your thermostat setting three (3) degrees from 4:00PM to 7:00PM
2.	Decrease your thermostat setting four (4) degrees from 2:00PM to 4:00PM	Increase your thermostat setting three (3) degrees from 4:00PM to 7:00PM
3.	No thermostat change	Increase your thermostat setting three (3) degrees from 4:00PM to 7:00PM

* Only one PowerStat® Event strategy option will be experienced by the Customer per event day
** Temperature setting decrease from customer temperature preset level
*** Temperature setting increase from customer temperature preset level

remotely signal Customer's thermostat to change in any one the following manners: PowerStat® Events can occur periodically during the months of August through September 2012 only. They will not exceed a total of ten (10) days during this period and will happen only on weekdays, excluding Labor Day.

6. Notification of PowerStat Event. SMUD will notify Customer by e-mail the day before a PowerStat® Event. Customer may elect to override a PowerStat® Event via the Internet.

7. Research. To help SMUD assess customer satisfaction, Customer agrees to participate in SMUD online surveys before, during (after PowerStat® events), and after the program (phone surveys may also be used). Customer agrees to have their electricity energy usage data analyzed to assess the impacts of the Program and energy savings potential. SMUD keeps all Customer data confidential.

8. Cost. There is absolutely no cost to the Customer for the PowerStat® thermostat, thermostat installation, and warranty services.

9. Access to Premises. Customer grants SMUD and/or its contractor the right to install, operate, maintain, and perform warranty services on the PowerStat® thermostat at the Premises during the period of the Agreement.

10. Installation. The PowerStat® thermostat shall be installed at the Premises by SMUD and/or its contractor, who shall perform the work as soon as reasonably practical upon approval of this Agreement. SMUD will provide Customer advance notice of installation date. All costs related to installation will be at the sole expense of SMUD. SMUD and/or its contractor will uninstall the original thermostat and install the PowerStat® thermostat in the same visit. SMUD will give the original thermostat to the Customer to keep.

If by the end of the Program the Customer requests the PowerStat® thermostat be removed and Customer's original thermostat be reinstalled, then SMUD shall conduct the work, at no charge, until December 31, 2012. At the time of reinstallation of the original thermostat, the Customer shall decide to either keep the PowerStat® thermostat or request SMUD and/or its contractor to remove the PowerStat® thermostat from the premises.

11. Ownership. Upon installation, Customer shall own the PowerStat® thermostat and it shall be the sole property of the Customer. If at any time the Parties terminate this Agreement or Customer otherwise ceases participation in the PowerStat® Program, SMUD shall remotely deactivate the PowerStat℠ thermostat to prevent future control events without Customer's prior written consent.

The Customer's installed PowerStat® thermostat should function as the Premises thermostat and should not require removal or replacement. Beginning January 1, 2013, the Customer will not have access to program the thermostat via the Internet. However, the Customer can still program the thermostat in their residence from the thermostat controls. Beginning January 1, 2013 or earlier if this Agreement is terminated, the Customer is responsible for all service related work.

12. Warranty. SMUD hereby assigns the manufacturer's warranty for the PowerStat® thermostat to the Customer.

EXCEPT AS EXPRESSLY PROVIDED HEREIN, SMUD MAKES NO WARRANTIES, IMPLIED OR EXPRESS, WRITTEN OR ORAL, WITH RESPECT TO THE GOODS AND SERVICES PROVIDED UNDER THIS AGREEMENT INCLUDING, BUT NOT LIMITED TO, THE WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

13. Maintenance Service. Except as provided by the PowerStat® thermostat warranty, SMUD shall provide service as needed to the PowerStat® during the term of this Agreement. All costs associated with maintenance will be at the sole expense of SMUD. Under no circumstances shall Customer perform maintenance or other services, or remove the PowerStat® thermostat during the Program. If Customer uninstalls the PowerStat® thermostat or performs maintenance or other services on it during or after the Program period for any reason, SMUD will not be responsible for reinstalling or fixing the PowerStat® thermostat or reinstalling the original thermostat. After the Program end date, Customer will be responsible to maintain and service the PowerStat® thermostat and when applicable, work with PowerStat® thermostat directly.

After the Pilot program, the Customer is responsible for any and all service to the PowerStat® thermostat.

14. Liability. SMUD will not be liable for any damage caused by the PowerStat® thermostat.

15. Notices. All written communications or notices under this Agreement shall be directed as follows:

Sacramento Municipal Utility District
P.O. Box 15830, MS A203
Sacramento, CA 95852-1830
Attention: Eugene R. Pinasco

16. Amendments. SMUD reserves the right, at its sole discretion, to amend the terms of this Agreement. SMUD will notify Customer in writing of the amendment, which will become effective on the date stated in the notice.

17. Termination. Each Party may terminate this Agreement with thirty (30) days advance written notice. If Customer terminates this Agreement before January 01, 2013, Customer keeps the PowerStat® thermostat and Customer shall reimburse SMUD for the cost of the PowerStat® thermostat. If SMUD terminates this Agreement, Customer keeps the PowerStat® thermostat and does not have to reimburse SMUD for the cost of the PowerStat® thermostat.

18. Applicable law. This Agreement shall be interpreted, governed by, and construed under the laws of the State of California, as if executed and to be performed wholly within the State of California.

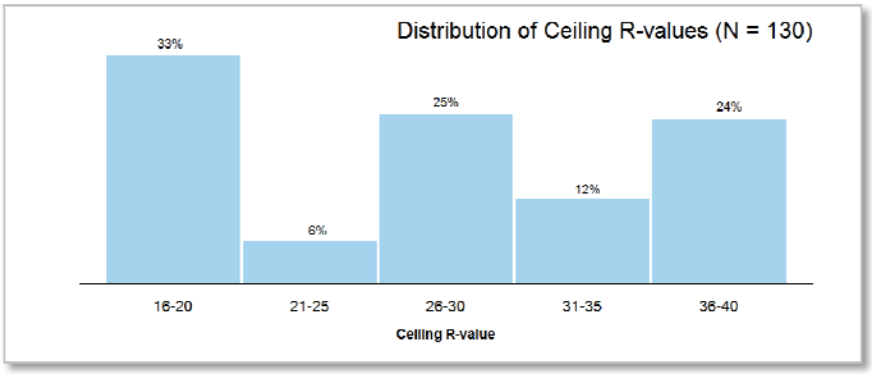
Customer	SMUD
_____ (signature)	_____ (signature)
_____ (print name)	_____ (print name)
_____ (date)	_____ (date)

Appendix C. Household information

R-value

Where possible, ceiling insulation levels for participant homes was documented at the time of thermostat installation. The 130 values collected ranged from R16 to R40, with a mean and median value of R28. Figure 30 shows the distribution of ceiling R-values for these 130 participants.

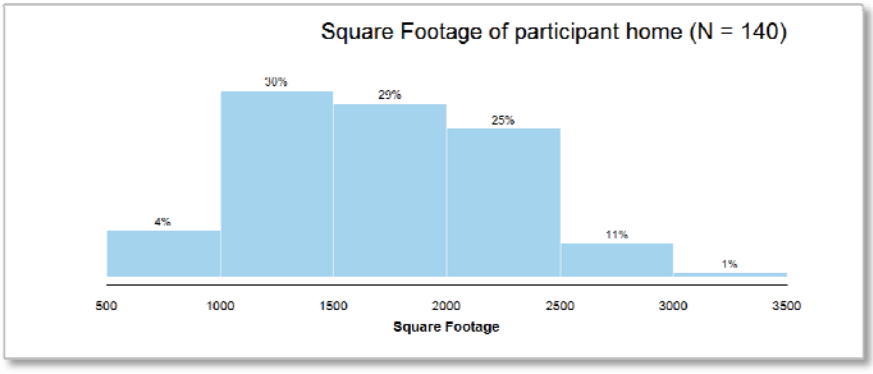
FIGURE 30. DISTRIBUTION OF CEILING R-VALUES



Square footage

The square footage of participant homes was requested in the pre-treatment survey. The 140 responses ranged from 825 to 3076, with a mean of 1753 and median value of 1667 ft^2. Figure 31 shows the distribution of home square footage for these 140 participants.

FIGURE 31. DISTRIBUTION OF SQUARE FOOTAGE OF HOUSES



Occupancy

The number of people in the home was requested in the pre-treatment survey. The 148 responses ranged from 1 to 5, with a mean of 2.3 and median value of 2. Figure 32 shows the distribution of home square footage for these 148 participants.

FIGURE 32. DISTRIBUTION OF NUMBER OF PEOPLE IN THE HOUSEHOLD

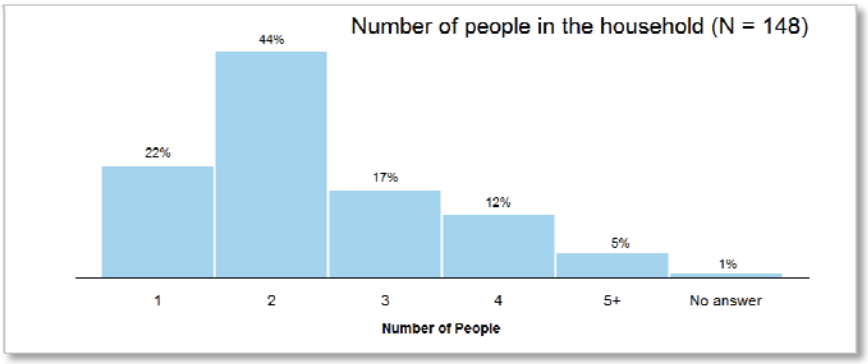


Table 7 provides summary for Q24-Q26 pre-treatment survey responses. Only 116 participants responded to question 24

TABLE 25. OCCUPANCY BY AGE, TIME OF DAY

	Question	Yes	No	Other
Q24	Is anyone in your home less than two years old?	4%	73%	24%
Q25	Is anyone in your home over the age of 65?	26%	72%	1%
Q26	During the typical summer weekday, is there at least one person in your home for at least one hour between 10AM and 4PM?	79%	18%	3%

Appendix D. Observed loads (not modeled)

By Rotation Group

Figure 33 and Figure 34 show that the average load shapes for the three rotation groups on non-event weekdays were similar, but not identical.

FIGURE 33. EVENT DAY ACTUAL LOADS, BY GROUP

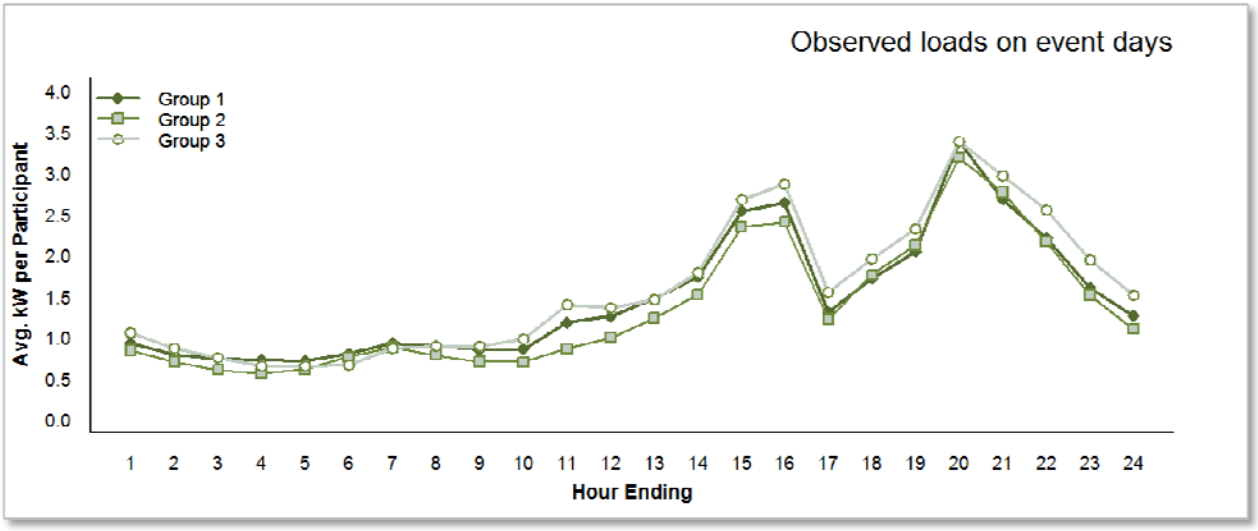
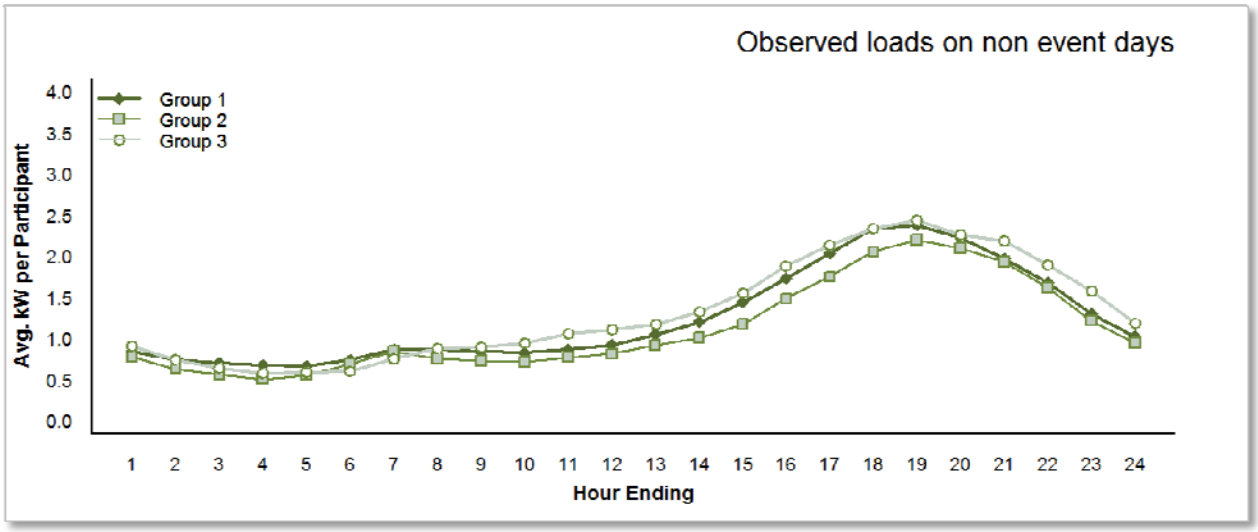


FIGURE 34. NONEVENT DAY ACTUAL LOADS, BY GROUP



Individual Event Day Loads

The following figures (Figure 35 through Figure 42) are plots of the observed hourly load values for each individual event day (8/9/12 through 9/14/12). For comparison, each plot also includes a modeled baseline, adjusted for the temperature profile of that particular day.

FIGURE 35. OBSERVED LOADS ON 8/9/12

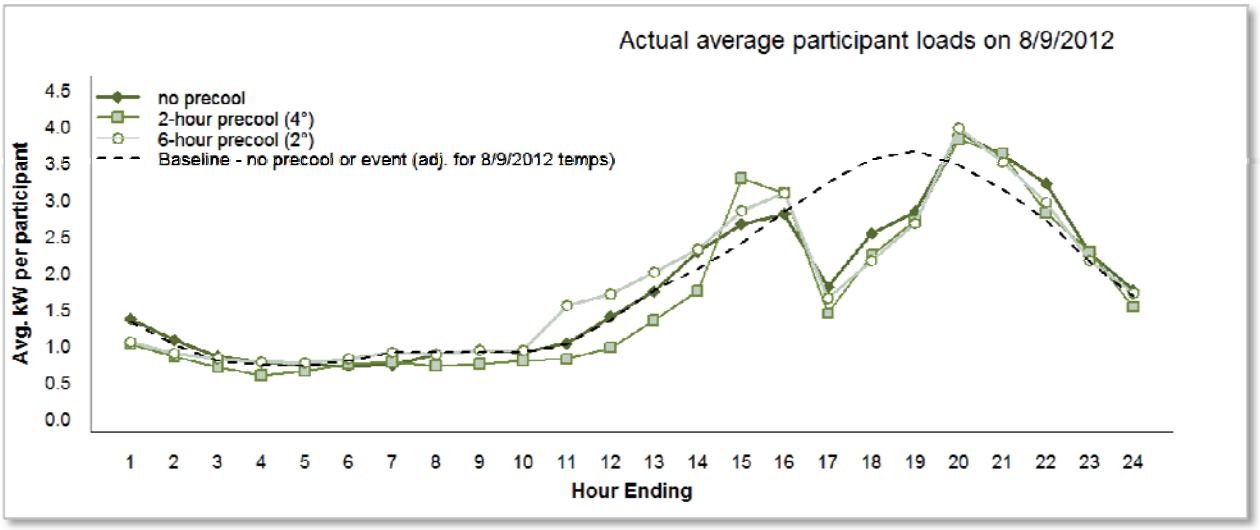


FIGURE 36. OBSERVED LOADS ON 8/13/12

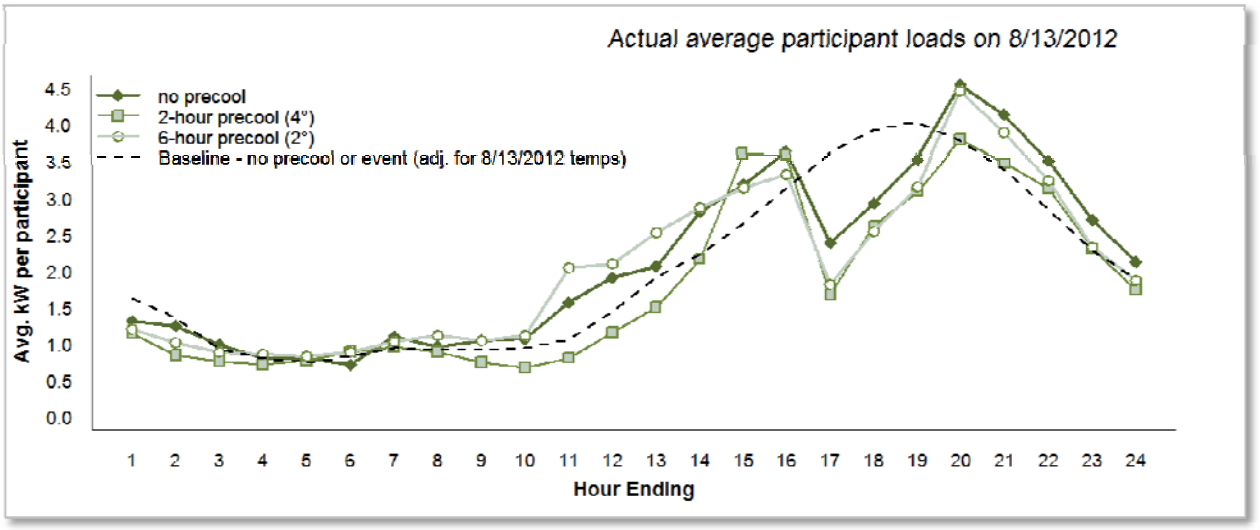


FIGURE 37. OBSERVED LOADS ON 8/15/12

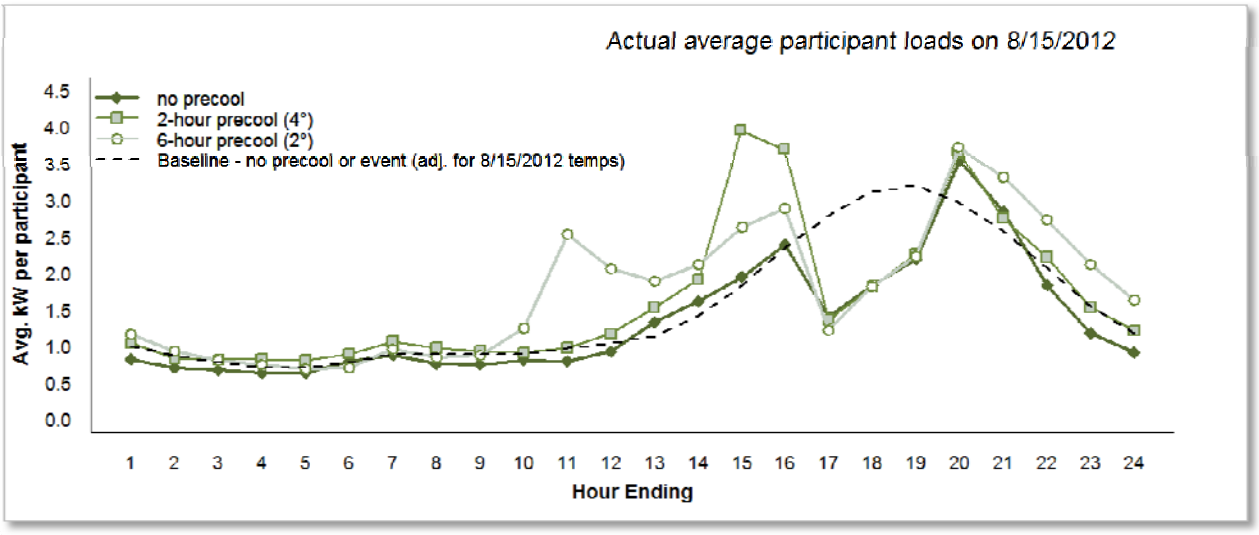


FIGURE 38. OBSERVED LOADS ON 8/17/12

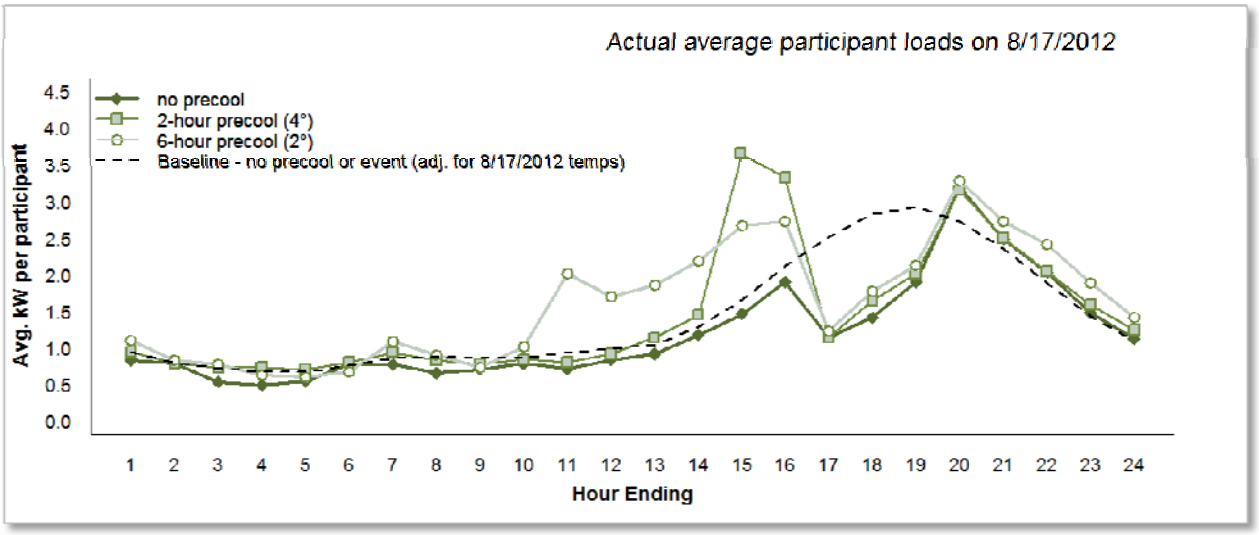


FIGURE 39. OBSERVED LOADS ON 8/23/12

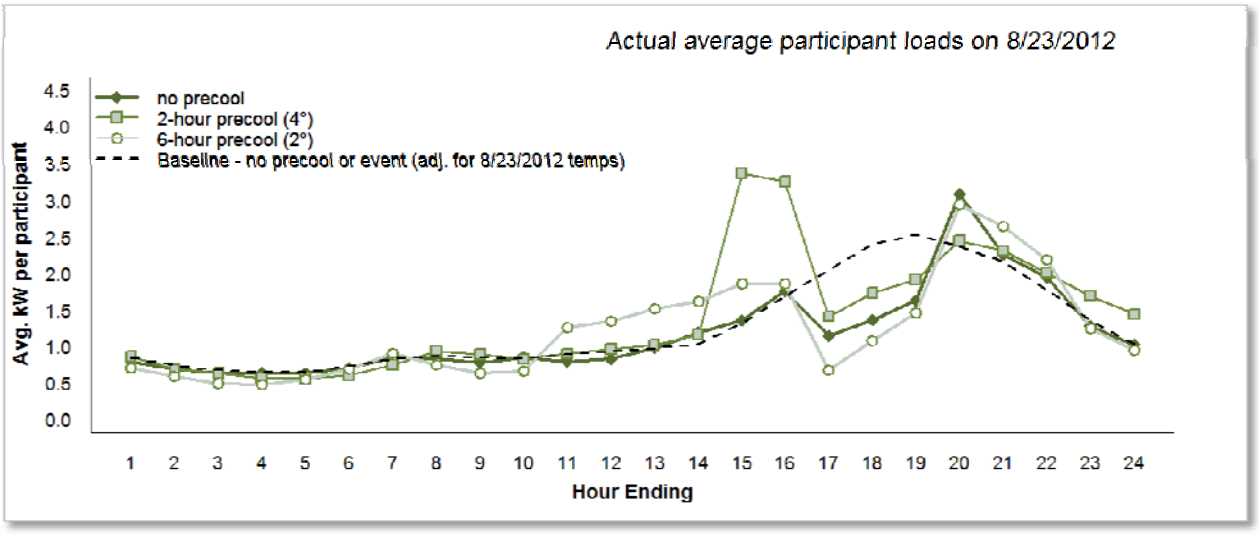


FIGURE 40. OBSERVED LOADS ON 9/4/12

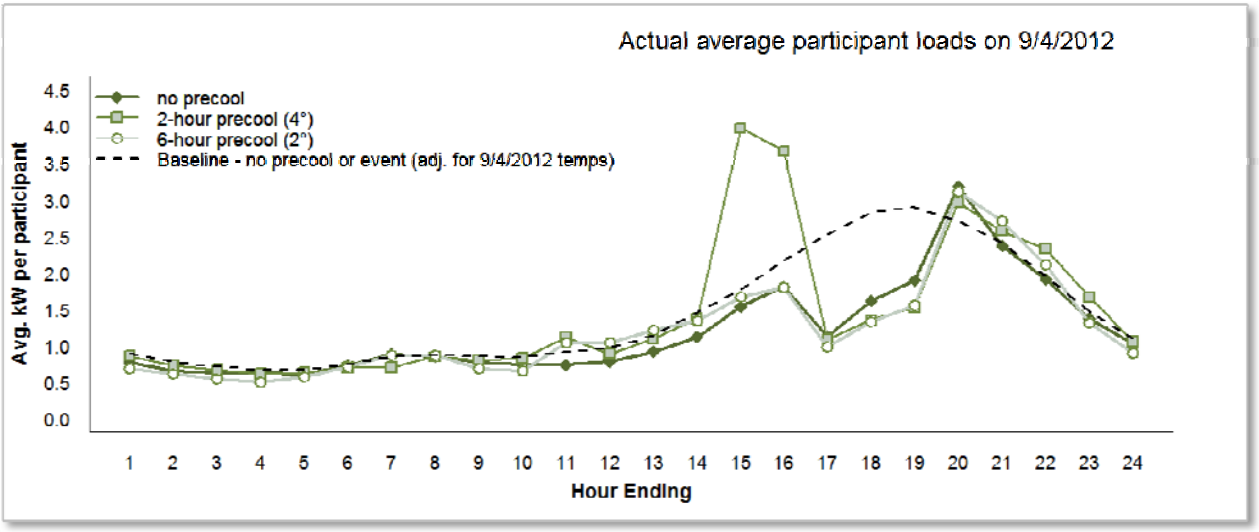


FIGURE 41. OBSERVED LOADS ON 9/12/12

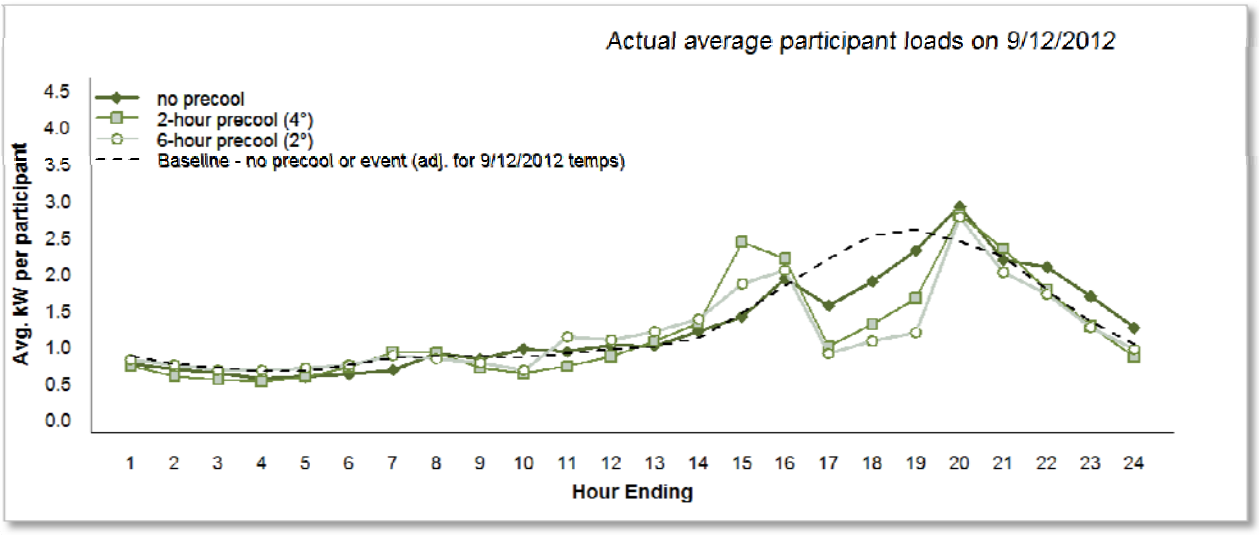
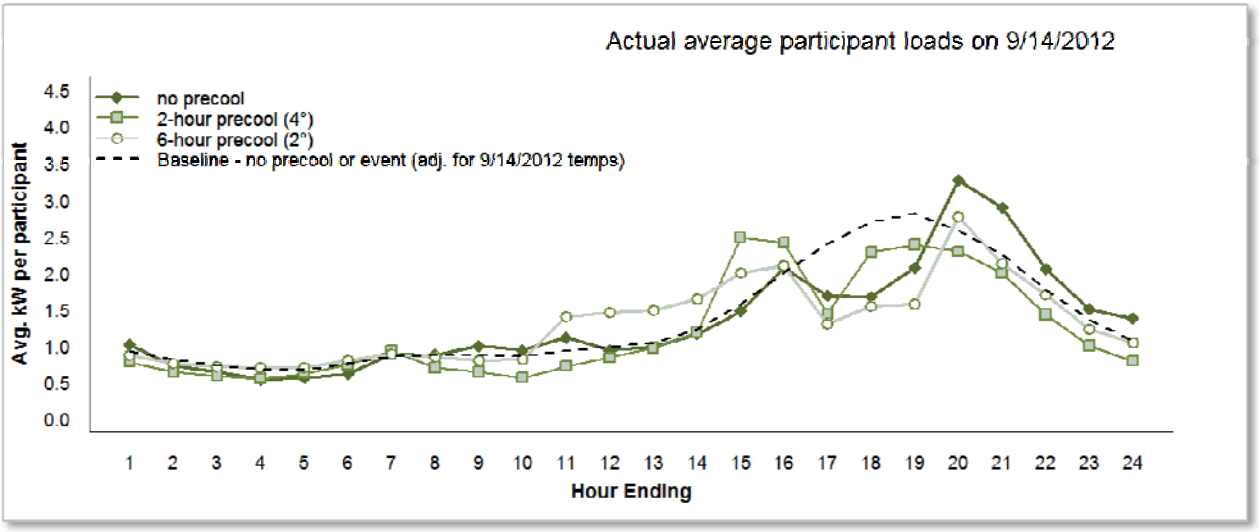


FIGURE 42. OBSERVED LOADS ON 9/14/12



Appendix E. Load Impact Regression Analysis Detail

Based on AIC and BIC criteria and a log likelihood ratio test, it was determined that inclusion of random effects for both customers and days produced a better model for the data than did a model with random effect for customers only. Table 26 provides detailed information about the comparison of the two models. Note the p-value of < 0.0001, which is an indication of significant improvement in the model when both random effects are included. Table 27 contains results for type III test for fixed effects, and Table 28 provides details for average daily and peak impacts on event days.

TABLE 26. MODEL COMPARISON

Model	Random effects	DF	AIC	BIC	logLik	Test	L.Ratio	p-value
1	Customer	387	581541	585523	-290384			
2	Customer, Days	388	568187	572180	-283706	1 vs 2	13356	<0.0001

TABLE 27. TYPE III TEST OF FIXED EFFECTS

Variable	Numerator DF	Denominator DF	F-value	p-value
CDH	1	208586	7638.19	<0.0001
AvgTemp24	1	8957	23.74	<0.0001
Rvalue	1	114	0.00	0.99
hour	24	208586	8.72	<0.0001
treat	3	8957	0.32	0.81
AvgTemp24:Rvalue	1	8957	0.61	0.44
AvgTemp24:hour	23	208586	12.13	<0.0001
Rvalue:hour	23	208586	1.50	0.06
AvgTemp24:treat	3	8957	0.37	0.77
Rvalue:treat	3	8957	0.08	0.97
hour:treat	69	208586	0.97	0.55
AvgTemp24:Rvalue:hour	23	208586	1.73	0.02
AvgTemp24:Rvalue:treat	3	8957	0.09	0.96
AvgTemp24:hour:treat	69	208586	0.98	0.52
Rvalue:hour:treat	69	208586	1.34	0.03
AvgTemp24:Rvalue:hour:treat	69	208586	1.34	0.03

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TABLE 28. DAILY AND PEAK IMPACTS, BY TREATMENT

Period	Treatment	Impact	SE	Lower	Upper	testStat	df	Pvalue
Daily	P0	-0.073	0.023	-0.12	-0.028	-3.18	217652	0.0092
	P2	0.052	0.022	-0.009	0.095	2.37	217652	0.1046
	P6	0.016	0.019	0.002	0.054	0.83	217652	0.4091
Peak	P0	-1.03	0.038	-1.11	-0.96	-27.36	217652	<0.0001
	P2	-1.08	0.036	-1.16	-1.01	-29.99	217652	<0.0001
	P6	-1.26	0.032	-1.32	-1.20	-39.25	217652	<0.0001

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Appendix F. 1-in-2, 1-in-5, and 1-in-10 peak days

FIGURE 43. P0 LOADS FOR 1-IN-2, 1-IN-5, AND 1-IN-10 PEAK DAYS

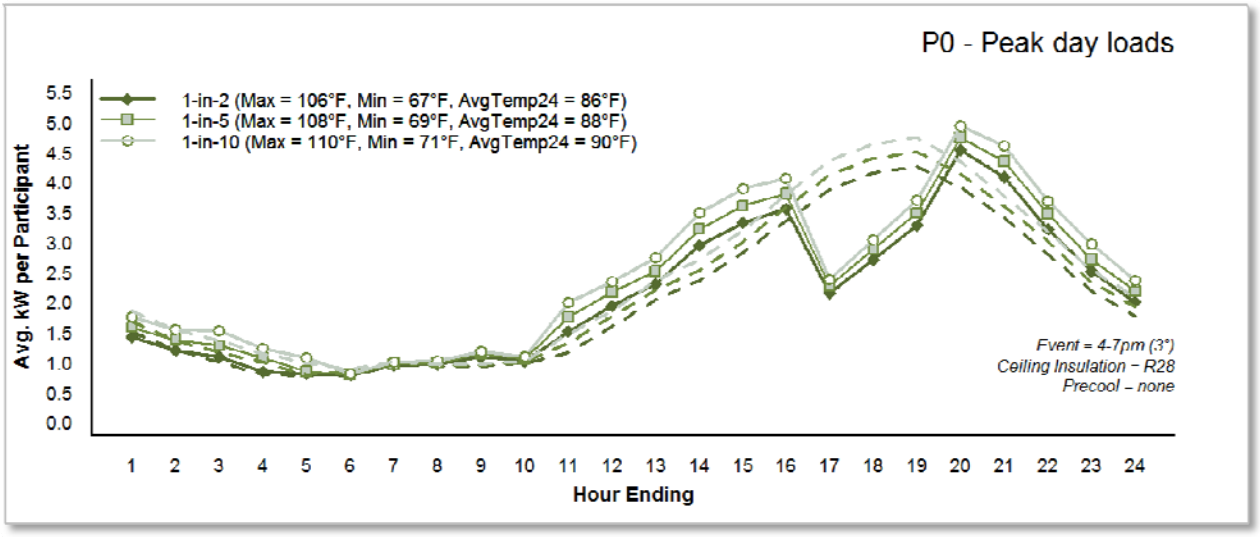

TABLE 29. P0 IMPACTS ON 1-IN-2, 1-IN-5, AND 1-IN-10 PEAK DAYS

Peak Day Type	AvgTemp24 (°F)	Off-Peak (hours 1-14)	Pre-Peak (hours 15-16)	Peak (hours 17-19)	Post-Peak (hours 20-24)	Total (hours 1-24)
1-in-2	86	0.12	0.35*	-1.38*	0.46*	0.02
1-in-5	88	0.16	0.42*	-1.46*	0.49*	0.04
1-in-10	90	0.19	0.48*	-1.54*	0.53*	0.07

* Statistically significant (α = 0.05)

FIGURE 44. P2 LOADS FOR 1-IN-2, 1-IN-5, AND 1-IN-10 PEAK DAYS

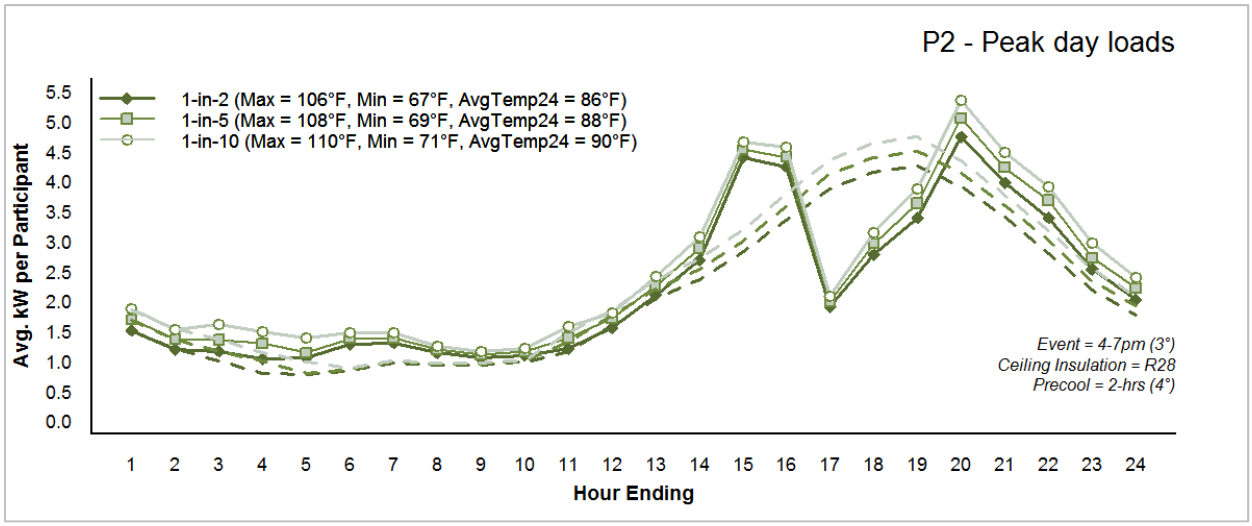

TABLE 30. P2 IMPACTS ON 1-IN-2, 1-IN-5, AND 1-IN-10 PEAK DAYS

Peak Day Type	AvgTemp24 (°F)	Off-Peak (hours 1-14)	Pre-Peak (hours 15-16)	Peak (hours 17-19)	Post-Peak (hours 20-24)	Total (hours 1-24)
1-in-2	86	0.16	1.23*	-1.40*	0.52*	0.13
1-in-5	88	0.19	1.17*	-1.48*	0.58*	0.15
1-in-10	90	0.23	1.12*	-1.55*	0.64*	0.16

* Statistically significant (α = 0.05)

FIGURE 45. P6 LOADS ON 1-IN-2, 1-IN-5, AND 1-IN-10 PEAK DAYS

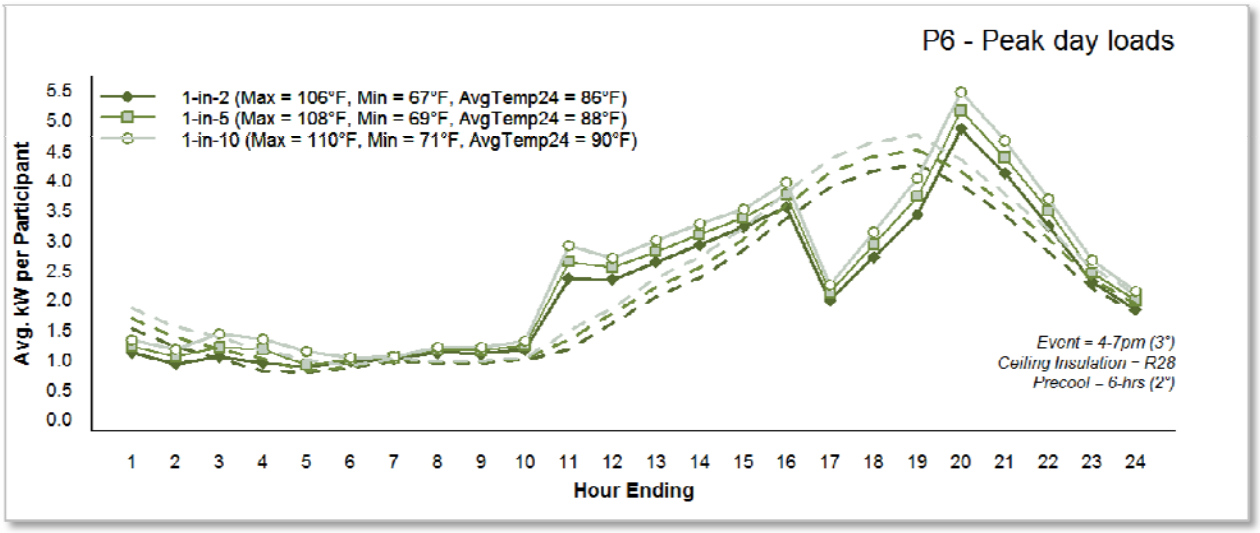

TABLE 31. P6 IMPACTS ON 1-IN-2, 1-IN-5, AND 1-IN-10 PEAK DAYS

Peak Day Type	AvgTemp24 (°F)	Off-Peak (hours 1-14)	Pre-Peak (hours 15-16)	Peak (hours 17-19)	Post-Peak (hours 20-24)	Total (hours 1-24)
1-in-2	86	0.23*	0.29*	-1.39*	0.45*	0.08
1-in-5	88	0.25*	0.26*	-1.42*	0.49*	0.09
1-in-10	90	0.27*	0.24	-1.45*	0.53*	0.11

* Statistically significant (α = 0.05)

Appendix G. Survey responses

Table 32. Survey Response Rates, by Survey

	Invites sent	Completed surveys	Response rate (%)
Pre	152	129	85%
Post	152	119	78%
Wave 1	152	135	89%
Wave 2	152	117	77%
Wave 3	152	118	78%
Wave 4	152	96	63%

Table 33. In Your Own Words, What Would You Say Was the Main Reason You Signed Up to Participate in the PowerStat® Pilot Program?

	Pre 1	Percent
1	Save, conserve energy	36%
2	Save money	22%
3	Free upgraded thermostat	21%
4	Opportunity to learn new	8%
5	Help SMUD	5%
6	NA	4%
7	Control thermostat remotely	2%
8	Help protect environment	1%
9	Other	1%

Table 34. By Participating in this Program, Do You Expect to _____?

	Pre2A-2F	Yes, Definitely	Yes, Probably	No, Probably Not	No, Definitely Not	Not Sure	Prefer not to Answer	NA
1	Save money	43%	39%	12%	0.0%	5.4%	0%	0%
2	Help protect the environment	32%	43%	12%	0.8%	12%	0%	0%
3	Learn how to better conserve electricity	48%	45%	3.9%	0.0%	3.1%	0%	0%
4	Actually use less electricity	41%	43%	7.0%	0.0%	8.5%	0%	0%
5	Have more control over your electricity bill	45%	44%	3.9%	0.8%	6.2%	0%	0%
6	Keep your home at a comfortable temperature	43%	49%	3.9%	0.0%	4.7%	0%	0%

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Table 35. In Your Opinion, How Much Has Participating in the PowerStat® Pilot Program _____?

	Post4A-4F	A lot	Some	A little	None	Not Sure	Prefer not to Answer	NA
1	Helped you save money on your electric bill	10%	24%	18%	22%	27%	0%	0%
2	Helped you protect the environment	13%	30%	14%	13%	29%	0%	0%
3	Improved your knowledge about ways you can reduce your household's electricity use	24%	29%	24%	16%	7.6%	0%	0%
4	Reduced the amount of electricity your household uses	11%	30%	19%	21%	19%	0%	0%
5	Given you more control over your electricity bill	23%	27%	16%	16%	18%	0%	0%
6	Motivated you to change your electricity use habits	22%	29%	21%	24%	4.2%	0%	0%

Table 36. In General, How Would You Rate Your Overall Experience Participating in the PowerStat® Pilot Program?

	Int14 Post1	Very satisfied	Somewhat satisfied	Somewhat dissatisfied	Very dissatisfied	Not sure	Prefer not to answer	NA
1	P0	64%	31%	3.6%	0%	2.1%	0%	0%
2	P2	58%	32%	3.6%	0%	6.4%	0%	0%
3	P6	59%	34%	3.8%	1.1%	2.7%	0%	0%
4	Post-Treat	69%	25%	3.4%	0.8%	1.7%	0%	0%

Table 37. If a Friend Asked You about the PowerStat® Pilot Program, Would You Recommend that They Participate?

Post6	Yes	Not sure	No	Prefer not to answer	NA
1	85%	12%	3.4%	0%	0%

Table 38. Thinking Ahead to Next Summer (2013), Would You Sign Up Again to Allow SMUD to Occasionally Adjust Your Thermostat Settings to Reduce Your Household's Peak-Period Electricity Use?

Post7	Definitely yes	Not sure	Probably yes	Probably no	Definitely no	NA
1	31%	13%	39%	16%	0.8%	0%

TABLE 39. PLEASE INDICATE THE EXTENT TO WHICH YOU AGREE OR DISAGREE WITH THE FOLLOWING STATEMENTS ABOUT THE INSTALLATION PROCESS.

	Pre4A-4I	Strongly Agree	Somewhat Agree	Somewhat Disagree	Strongly Disagree	Not sure	Doesn't Apply	NA
1	I was able to select an installation appointment time that worked best for my schedule	74%	17%	1.6%	0.8%	0%	0.8%	6.2%
2	The technician arrived on-time for the appointment	84%	8.5%	0%	0%	0%	0.8%	6.2%
3	The technician explained the installation process prior to starting the work	85%	7.0%	0%	0%	1.6%	0%	6.2%
4	The length of time it took to install the device was reasonable	90%	3.9%	0%	0%	0%	0%	6.2%
5	The work site was left clean after the installation was complete	93%	0.8%	0%	0%	0%	0%	6.2%
6	There was no damage to my property during the installation process	92%	1%	0%	0%	0%	1%	6%
7	The technician explained to me the basics of how to use the thermostat	90%	4%	0%	0%	0%	0%	6%
8	The technician explained how to log-on to the PowerStat® website	65%	18%	4%	1%	6%	0%	6%
9	I was provided a clear explanation of what I was expected to do during the program	60%	28%	4%	0%	1%	1%	6%

TABLE 40. OVERALL, WERE YOU SATISFIED OR DISSATISFIED WITH THE INSTALLATION PROCESS FOR YOUR NEW THERMOSTAT?

Pre5	Very satisfied	Somewhat satisfied	Somewhat dissatisfied	Very dissatisfied	Not sure	Prefer not to answer	NA
1	89%	4.7%	0%	0%	0%	0%	6.2%

TABLE 41. OVERALL, HOW WOULD YOU RATE YOUR SATISFACTION WITH THE NEW THERMOSTAT?

		Very satisfied	Somewhat satisfied	Somewhat dissatisfied	Very dissatisfied	Not sure	Prefer not to answer	NA
1	Pre7	74%	22%	0.8%	0%	3.9%	0%	0%
2	Post8	78%	19%	2.5%	0%	0.8%	0%	0%

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TABLE 42. PLEASE RATE THE NEW THERMOSTAT ON THE FOLLOWING ATTRIBUTES.

	Pre9A-9H	Excellent	Good	Fair	Poor	Very Poor	Not sure/ Doesn't Apply	NA
1	Easy of use	52%	39%	3.9%	0.8%	0%	5.4%	0%
2	Clarity of thermostat operation manual	39%	43%	6.2%	0%	0%	12.4%	0%
3	Readability of display	72%	23%	3.1%	1.6%	0.8%	0%	0%
4	Availability of technical support	15%	25%	1.6%	0%	0%	59%	0%
5	Appearance	71%	26%	1.6%	0%	0%	0.8%	0%
6	Keeping my home at a comfortable temperature	58%	35%	2.3%	0%	0%	4.7%	0%
7	Ability to program the thermostat using the PowerStat® website	20%	19%	1.6%	3.1%	0%	56.6%	0%
8	Overall Performance	53%	40%	2.3%	0%	0%	4.7%	0%
	Post10A-10H							
1	Easy of use	56%	39%	5.0%	0%	0%	0%	0%
2	Clarity of thermostat operation manual	38%	46%	7.6%	0%	0%	8.4%	0%
3	Readability of display	63%	32%	3.4%	0%	0.8%	0.8%	0%
4	Availability of technical support	15%	23%	2.5%	0%	0%	60%	0%
5	Appearance	64%	34%	1.7%	0%	0%	0%	0%
6	Keeping my home at a comfortable temperature	45%	50%	4.2%	0%	0%	0.8%	0%
7	Ability to program the thermostat using the PowerStat® website	18%	27%	10%	3%	0%	42%	0%
8	Overall Performance	53%	44%	3%	0%	0%	0%	0%

TABLE 43. SINCE ENROLLING IN THE POWERSTAT® PROGRAM AND RECEIVING YOUR NEW THERMOSTAT, HOW EASY OR DIFFICULT HAS IT BEEN TO KEEP YOUR HOME AT A COMFORTABLE TEMPERATURE?

	Very easy	Somewhat easy	Somewhat difficult	Very difficult	Not sure	Prefer not to answer	NA
Pre10	68%	24%	0%	0%	7.8%	0%	0%
Post12	64%	35%	0.8%	0%	0%	0%	0%

TABLE 44. WHEN COMPARED TO YOUR PRIOR THERMOSTAT, WOULD YOU SAY THAT THE NEW THERMOSTAT YOU RECEIVED THROUGH THE POWERSTAT® PILOT PERFORMS BETTER, WORSE OR ABOUT THE SAME OVERALL?

	Much better	Somewhat better	About the same	Somewhat worse	Much worse	Not sure	Prefer not to answer	NA
Pre15	49%	25%	22%	0.8%	0%	3.1%	0%	0%
Post11	52%	26%	22%	0%	0%	0%	0%	0%

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TABLE 45. PRIOR TO RECEIVING YOUR NEW THERMOSTAT, HOW EASY OR DIFFICULT WAS IT TO KEEP YOUR HOME AT A COMFORTABLE TEMPERATURE WHEN THE TEMPERATURE OUTSIDE WAS 100 DEGREES OR HOTTER?

	Very easy	Some-what easy	Some-what difficult	Very difficult	Not sure	Prefer not to answer	NA
Pre16	26%	47%	21%	3.1%	3.1%	0%	0%

TABLE 46. PLEASE INDICATE THE EXTENT TO WHICH YOU AGREE OR DISAGREE WITH THE FOLLOWING STATEMENTS ABOUT YOUR EXPERIENCE PARTICIPATING IN THE POWERSTAT® PILOT PROGRAM.

	Post21	Strongly Agree	Some-what Agree	Some-what Disagree	Strongly Disagree	Not sure	Doesn't Apply	NA
1	SMUD clearly explained the goals of the program	60%	34%	5.0%	0%	0.8%	0.8%	0%
2	SMUD clearly explained what I was expected to do during the program	70%	25%	4.2%	0%	0%	0.8%	0%
3	I was satisfied with how SMUD answered my questions	54%	24%	1.7%	0%	2.5%	17%	1.7%
4	The information SMUD made available was informative and helpful	64%	30%	0.8%	0%	2.5%	1.7%	0.8%

TABLE 47. GENERALLY SPEAKING, ARE YOU SATISFIED OR DISSATISFIED WITH THE JOB SMUD IS DOING TO PROVIDE ELECTRICITY SERVICES TO YOUR HOUSEHOLD?

		Very satisfied	Some-what satisfied	Some-what dissatisfied	Very dissatisfied	Not sure	Prefer not to answer	NA
1	Pre19	78%	21%	0.8%	0%	0.8%	0%	0%
2	Post26	71%	28%	0.8%	0%	0%	0%	0%

TABLE 48. WOULD YOU SAY THAT YOUR PARTICIPATION IN THE POWERSTAT® PILOT PROGRAM HAS POSITIVELY IMPACTED YOUR OPINION OF SMUD, NEGATIVELY IMPACTED YOUR OPINION OF SMUD, OR HAS IT NOT CHANGED YOUR OPINION EITHER WAY?

		Positively impacted opinion about SMUD	Negatively impacted opinion about SMUD	No impact	Not sure	Prefer not to answer	NA
1	Pre20	74%	0%	18%	7.8%	0.8%	0%
2	Post26	78%	1.7%	18%	0.8%	0.8%	0%

TABLE 49. HAVE YOU VISITED SMUDS POWERSTAT® WEBSITE: WWW.SMUD.ORG/POWERSTAT?

		Yes	No	Prefer not to answer	NA
1	Pre11	29%	71%	0%	0%
2	Post13	52%	48%	0%	0%

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Table 50. How Frequently Did You Visit the SMUD's PowerStat® Website Since You Enrolled in the Pilot Program?

	At least two times per week	Once per week	Two to three times per month	Once per month	Less often than once per month	Not sure	Prefer not to answer	NA
Post14	0%	8.1%	27%	23%	32%	10%	0%	0%

Table 51. Have You Used the PowerStat® Website to Do the Following?

	Pre12	Yes	No	Prefer not to answer	NA
1	Learn more about the PowerStat® program	78%	22%	0%	0%
2	Program your thermostat	62%	38%	0%	0%
3	Review the thermostat operation manual	19%	81%	0%	0%
4	Review the frequently asked questions (FAQ's)	49%	51%	0%	0%
	Post15				
1	Learn more about the PowerStat® program	69%	31%	0%	0%
2	Program your thermostat	65%	36%	0%	0%
3	Review the thermostat operation manual	24%	76%	0%	0%
4	Review the frequently asked questions (FAQ's)	58%	42%	0%	0%

Table 52. How Would You Rate the Ability to Schedule the Wake, Leave, Return and Sleep Temperature Settings for Your Thermostat on the PowerStat® Website?

	Excellent	Good	Fair	Poor	Very Poor	Not sure	Prefer not to answer	NA
Post16	31%	11%	11%	0%	1.6%	6.5%	3.2%	35%

Table 53. How Would You Rate the Ability to Use the PowerStat® Website to Make Temporary Adjustments to the Current Temperature in Your Home?

	Excellent	Good	Fair	Poor	Very Poor	Not sure	Prefer not to answer	NA
Post17	23%	26%	6.5%	0%	3.2%	6.5%	0%	35%

Table 54. When You Have Visited the PowerStat® Website, Were You Most Often Doing So From Home, While at Work, or From a Different Location?

		Home	Work	Different Location	Prefer not to answer	NA
1	Pre13	81%	14%	5.4%	0%	0%
2	Post18	73%	16%	8.1%	3.2%	0%

Table 55. How Would You Rate the Overall Quality of the PowerStat® Website?

		Excellent	Good	Fair	Poor	Very Poor	Not sure	Prefer not to answer	NA
1	Pre14	27%	65%	5.4%	0%	0%	2.7%	0%	0%
2	Post19	24%	60%	13%	0%	0%	3.2%	0%	0%

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TABLE 56. DID YOU CONTACT SMUD AND/OR THE INSTALLATION COMPANY (GOODCENTS) DURING THE PAST THREE MONTHS ABOUT ANY ISSUE(S) RELATED TO THE POWERSTAT® PILOT PROGRAM?

	Yes, called SMUD	Yes, called GoodCents	Yes, called SMUD and GoodCents	No	Prefer not to answer	NA
Post22	9.2%	4.2%	5.0%	80%	1.7%	0%

TABLE 57. WAS SMUD/GOODCENTS ABLE TO HELP RESOLVE THE ISSUE(S) TO YOUR SATISFACTION?

	Post24-25	Yes	No	Yes for some issues, no for others	Prefer not to answer	NA
1	SMUD	81%	13%	6.3%	0%	0%
2	GoodCents	73%	18%	9.1%	0%	0%

TABLE 58. DURING THE SUMMER, WHAT TEMPERATURE IS YOUR THERMOSTAT NORMALLY SET AT BETWEEN NOON AND 4PM/ 4PM AND 7PM?

	Pre17-18	Average Temperature
1	noon - 4PM	78.6
2	4PM-7PM	77.4

Appendix H. Invitation Letter

Dear [Customer Name]

You are invited to receive a FREE programmable thermostat and help test new ways to keep your home cool this summer!

PowerStat®, a SMUD Energy Insights Pilot, is being offered to a randomly selected group of 180 customers for a limited time, on a first come, first served basis. By participating, you can help us learn if pre-cooling your home during the warmest part of summer can reduce the amount of electricity you use while still keeping your family comfortable. And you may even save money on your electric bill, too!

Here's how it works:

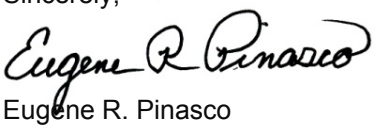
- In July, we'll install a FREE state-of-the-art thermostat (a $300 value) in your home. The thermostat is yours to keep when the pilot ends, and it may help you save energy and money for years to come.
- From August 1 through September 31, 2012, your new thermostat will be programmed to pre-cool your house up to ten (10) days this summer.
- Then, we'll ask you to fill out a simple survey about your experience.

Enroll today and you can take control of your electricity use this summer! Please complete and sign the Participation Agreement and return it in the enclosed pre-paid envelope by June 18, 2012.*

Once we receive your signed agreement, we'll contact you to schedule an appointment to install your new PowerStat® thermostat. A SMUD contractor will install the new thermostat in about one (1) hour.

If you have any questions about this pilot, please visit www.smud.org/powerstat or call me at 916-732-6720. We look forward to hearing from you!

Sincerely,



Eugene R. Pinasco
Product Services Coordinator
(916) 732-6720
gene.pinasco@smud.org

SMUD's Energy Insights Pilots look at a number of new technologies that will provide you with the choices and control you want to lower your electricity usage while staying comfortable.

* To see if you're eligible, please review the "Eligibility Requirements" in the enclosed Participation Agreement.

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Appendix I. Residential Rates

Period	Schedule	Tier	Standard Summer Rate *($/kWh)*	SmartSacramento® TOU Rate *($/kWh)*	SmartSacramento® TOU-CPP Rate *($/kWh)*	% of Time
Event	4:00 - 7:00 p.m.	>700 kWh	$ 0.1859	$ 0.2700	$ 0.7500	1%
		<700 kWh	$ 0.1045			
On-peak	4:00 - 7:00 p.m. Non-holiday weekdays	>700 kWh	$ 0.1859		$ 0.2700	8%
		<700 kWh	$ 0.1045			
Off-peak	All other hours	>700 kWh	$ 0.1859	$ 0.1660	$ 0.1411	91%
		<700 kWh	$ 0.1045	$ 0.0846	$ 0.0721	

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Appendix J. PowerStat® Website FAQ

Frequently Asked Questions

Background | Participation | Pre-cooling | Thermostat | Peak & Off Peak

Background

Why is SMUD doing this?
The PowerStat pilot is part of our goal to explore new technologies that have the potential to benefit our community and help you save energy.

How long will this pilot last?
The pilot is available to approximately 180 randomly selected residential customers, from August 1 through September 30, 2012.

Why should I participate?
By reducing your electricity use during peak hours (weekdays from 4:00 p.m. to 7:00 p.m.), you will help lower our impact on the environment by reducing the need for electricity from more expensive and less environmentally-friendly sources.

How will the pilot work?
You will receive a programmable communicating thermostat that will help us test various ways to pre-cool your home during August and September this year. Then, we will ask you how comfortable you were, and if you were satisfied with the overall program (the web interface to set your thermostat and how it communicated with the thermostat). What we learn from this pilot will help us create programs for all our customers.

Participation

What are the eligibility requirements to participate in the PowerStat pilot?

- You own a single-family home.
- Your home has only one thermostat, and your heating, ventilation, and air conditioning (HVAC) unit must be operating properly.
- You have internet access to go online to change your thermostat settings, set schedules, opt-out of PowerStat events, and to complete our periodic surveys.
- You do no operate a childcare or convalescent care business in your home.
- You do not plan on moving from your home before the end of this year, 2012.

How and why was I chosen for this program?
Customers were randomly selected for the PowerStat pilot.

Can I stay on the plan if I move?
No. This pilot is only available to randomly selected homes.

Are only homeowners eligible for this pilot?
Yes, this pilot is available to homeowners in single family homes.

I'm on the Energy Assistance Program Rate (EAPR). Am I eligible to participate in this pilot?
Yes, EAPR customers are eligible to participate.

If I have questions, who can I call?
You can call Gene Pinasco, Product Services Coordinator at 916-732-6720 or email gene.pinasco@smud.org

If I am unhappy with the pilot or the new thermostat, can I stop being part of the pilot?
Yes. If you are not satisfied for any reason please call us at 916-732-6720 to be removed from the PowerStat pilot. We can arrange for the installation contractor to replace the PowerStat thermostat with your original, at no cost to you, up until December 31, 2012.

Why should I keep my old thermostat?
For whatever reason, if you choose to leave the pilot and are no longer interested in keeping the PowerStat thermostat, we will reinstall your old thermostat. Keep it in a safe place, otherwise you will need to purchase a new thermostat.

PowerStat® Log-In

Opt out of a PowerStat® event or manage your thermostat settings and schedules.

User ID:

Password:

Log In

Forgot your password?

The PowerStat Pilot site is not currently compatible with Internet Explorer version 9. We recommend using an alternate browser. If you have any questions, please call GoodCents at (866) 380-6052.

Operating manual

Download the UtilityPro Series operating manual

PowerStat pilot forms

Download copies of the participation forms:

- Pilot application form
- Pilot agreement

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Pre-cooling

What is pre-cooling?
Pre-cooling involves setting a lower temperature in your home leading up to the heat of the day, then increasing the temperature setting on your thermostat by a few degrees during the peak hours (4:00 to 7:00 p.m.).

Why pre-cool?
When you pre-cool your home early in the day your HVAC doesn't have to work as hard to keep your home cool during the heat of the day. You will use less electricity, and your home will stay comfortable.

What is a PowerStat event?
A PowerStat event is when we send a signal to your thermostat to make a change to your temperature setting to pre-cool your home and then increase the temperature by a couple of degrees during the peak hours of the day (4:00 to 7:00 p.m.). Your thermostat will return to your settings after the event.

Will you notify me when an event happens?
We will send you an email the day before each PowerStat event. If necessary, you will be able to opt-out of the event up to two (2) hours before it begins. We encourage you not to opt-out unless it is necessary, so we can learn about your comfort level.

When and how often will a PowerStat event happen?
We will test several ways of cooling your home on six (6) to ten (10) days from August 1 through September 31, 2012. The PowerStat event will only take place on weekdays (except Labor Day), between the hours of 10:00 a.m. and 7:00 p.m. The pre-cooling will begin either at 10:00 a.m. or 2:00 p.m.

How will a PowerStat event affect the temperature in my home?
The temperature change in your home during a PowerStat event will depend on the outdoor temperature, how well your home is insulated, how long your home is being pre-cooled, the PowerStat event strategy activated, as well as many other variables.

The PowerStat event changes to your thermostat will be no more than four (4) degrees lower for the pre-cooling or no more than three (3) degrees higher for the peak hour period (4:00 to 7:00 p.m.) than the temperature you chose for your settings.

What are the PowerStat event strategies SMUD is testing?
We will be testing three event strategies. You will only experience one at a time, on any event day. There will be from six (6) to ten (10) events days between August 1 to September 31, 2012.

Control PowerStat Event Strategy Options*		
#	Pre-cooling**	Peak Hour Offset***
1	Decrease your thermostat setting two (2) degrees from 10:00 a.m. to 4:00 p.m.	Increase your thermostat setting three (3) degrees from 4:00 p.m. to 7:00 p.m.
2	Decrease your thermostat setting four (4) degrees from 2:00 p.m. to 4:00 p.m.	Increase your thermostat setting three (3) degrees from 4:00 p.m. to 7:00 p.m.
3	No thermostat change	Increase your thermostat setting three (3) degrees from 4:00 p.m. to 7:00 p.m.

*Only one PowerStat Event strategy option will be experienced by the customer on an event day
**Temperature setting decrease from customer temperature preset level
***Temperature setting increase from customer temperature preset level

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Will SMUD change settings on the thermostat without my consent?
When your new thermostat is being installed, the technician will work with you to program your preferred temperatures and schedules. We will not alter any thermostat settings without your approval after the initial installation.

What happens if I go on vacation?
You can schedule a temporary setting while you are away. On the thermostat, just select your desired temperature and press the HOLD key. The thermostat will stay at this temperature until you cancel it by pressing the CANCEL key. Your thermostat will then return to your original settings.

This will not change the schedules you already programmed into your PowerStat.

Thermostat

What is the difference between the new PowerStat and other thermostats?
The new PowerStat offers features such as a built-in radio receiver. This will allow SMUD to send a signal to your thermostat to reduce electricity demand during peak hours of 4:00 to 7:00 p.m. The thermostat is also web-enabled, so you can program the thermostat settings and schedules online through a secure login process.

Are all air conditioners and heat pumps compatible?
Most central air conditioners and heat pump systems are compatible with the PowerStat thermostat. The SMUD contractor will determine if yours is compatible during installation.

I no longer have Internet access in my home. Can I still control my thermostat remotely?
Yes. You can login to the website with your unique user id and password from any computer that has Internet access, such as at work, the library, or a friend's house.

If I initiate an override *before* a PowerStat event, will I have control of my thermostat during the event?
Yes. You can adjust temperature settings via the web or by physically touching the thermostat's screen.

If I initiate an override *during* a PowerStat event, will I have control of my thermostat during the event?
Yes. After overriding the event via the Web, you can adjust temperature settings via the web or by physically touching the thermostat's screen.

If I initiate an override during an event, how long will it take for my preprogrammed settings to take effect?
The preprogrammed settings or newly entered temperature should be received by the thermostat within a few minutes.

If I change my temperature settings or schedule from the website, how will I know the thermostat received it?
A message will appear on the LCD screen of the thermostat confirming your changes.

I made a manual temperature change on the interface of the thermostat. Why do I not see the new temperature on the website?
The technology we are using is called "one-way," meaning that changes made from the home will not be reflected on the website. Only changes done on the website will show on the thermostat.

What will happen if I try and change the temperature setting on the LCD screen of the thermostat during a PowerStat event?
You can only adjust the temperature up, in the "energy saving" direction during a PowerStat event.

How will I know a PowerStat event is in-progress?
The thermostat LCD screen will display various messages depending on the time of the event and schedule of each thermostat. Messages that may appear include: "PRE-COOL," "SAVINGS," "RAMP," "RECOVERY," and/or a blinking "SAVING."

Can I change the thermostat during a PowerStat event?
Yes, but any changes you make to your settings during the PowerStat event will not immediately take effect until after the end of the event.

There is an exception. If you decide to turn off your A/C or raise the temperature during a PowerStat event, resulting in less energy use, the change will be accepted by the thermostat.

Can SMUD see what is the actual temperature of my home?
No. Only you will know your home's temperature from the display on the thermostat. SMUD cannot access the thermostat to see your temperature setting. We can only send a signal to your thermostat for the pre-cooling event, to change the temperature by a few degrees.

What are the recommended settings for cooling my home during the summer?
Program your thermostat to these settings for energy savings.

Monday through Friday		
Wake	6 a.m.	78 Degrees
Leave	8 a.m.	85 Degrees
Return	6 p.m.	78 Degrees
Sleep	10 p.m.	78 Degrees

Saturday and Sunday		
Wake	6 a.m.	78 Degrees
Sleep	10 p.m.	78 Degrees

If I temporarily lose power to my home, will the thermostat clock need resetting?
No. There are batteries in the thermostat that maintain the clock and program. Replace these batteries once a year.

If I lose power to the thermostat, will my air conditioning system work?
No. If there is no power, the HVAC system will not operate. Once power returns, the thermostat will return the HVAC system to the pre-outage settings.

The thermostat display is flashing between the temperature and a message to call an 800 number. What does this mean?
A problem has occurred with the connections of the programmable thermostat and may be causing a problem with the settings. This may prevent you from changing the settings online. Please call GoodCents at the number on the display.

I am at work and someone at my home needs to have the air conditioner on and I don't want to participate in a PowerStat event. What do I need to do?
You can opt-out of that day's event and initiate a temporary temperature setting from the "manual schedule" screen via the web site. If you need help, please call GoodCents at 866-380-6052.

Peak & Off Peak

When are peak hours?
Peak hours are the hours when electricity use among all SMUD customers is typically highest – 4:00 p.m. to 7:00 p.m., Monday through Friday.

When are off-peak hours?
Off-peak hours are Monday through Friday before 4:00 p.m. and after 7:00 p.m., all day on Saturday and Sunday, July 4th and Labor Day.

Why are peak hours from 4:00 p.m. to 7:00 p.m.?
Because that's when electricity use among all SMUD customers throughout our community is highest. People are coming home from work and turning on air conditioners, TVs, computers, using their ovens, etc.

Why is peak a problem?
During the summer months, and especially during late afternoon and early evening weekday hours, electricity use soars. To meet this increased need, we

often have to buy electricity from very expensive and less environmentally-friendly sources. By reducing electricity use during peak periods, we can avoid purchasing less-desirable forms of energy.

Why can't SMUD just buy more energy during peak periods?
We can buy more electricity but it's often from more expensive and less environmentally friendly sources.

What is less desirable energy?
Less desirable energy is energy that costs more or is not environmentally friendly, releasing carbon missions when it is produced.

Work Order Number: 237

New Installation		Appl Controlled AC	Appl Controlled HP	Fan FLA	Compressor RLA	AC Tons	Voltage 240	Voltage 208	Voltage Other	SEER	Appl Loc Yard	Appl Loc Roof	Power to Switch	Switch Location
Attach Bar Code or enter Serial Number Below	F1	☐	☐	____	____	____	☐	☐	____	____	☐	☐	☐ Yes ☐ No	☐ Outdoor Unit ☐ Outdoor Wall ☐ Inside Bldg
	Manufacturer:		Model:											

Type of Building: ☐ Single Family ☐ Dup/Tri/Quadraplex ☐ Apt ☐ Condo ☐ Modular/Mobile Home ☐ Commercial

Size: ☐ < 1000 Sq Ft ☐ 1000 - 1999 ☐ 2000 - 4999 ☐ 5000 - 9999 ☐ > 10,000 sq ft

Age of Building: ☐ < 3 yrs ☐ 3 - 10 ☐ 10-20 ☐ > 20

# of Switches: ____ **# of Thermostats:** ____ **# of AC/HP:** ____ **# Switches Removed:** ____

☐ **Complete**
- ☐ Install
- ☐ Add Device
- ☐ Replace Device
- ☐ Service
- ☐ Maintenance/QA

☐ **Walkaway/Hold**
- ☐ Equipment Condition
- ☐ Customer Request
- ☐ Reschedule for spring
- ☐ Other hold

☐ **Canceled**
- ☐ Could not access equipment
- ☐ Customer cancelled by phone before visit
- ☐ Customer cancelled onsite
- ☐ Customer ineligible
- ☐ Equipment incompatibility
- ☐ Equipment not functioning or poor cond.
- ☐ Insufficient radio signal strength
- ☐ Hazardous electrical condition
- ☐ Enroll in competing program
- ☐ Other cancel

☐ **Reschedule**
- ☐ Could not find
- ☐ No adults
- ☐ Equipment Access
- ☐ Tech Missed Appt
- ☐ Customer No Show
- ☐ Customer Request
- ☐ Weather
- ☐ Did not get to
- ☐ Other

☐ **Removed all devices**
- ☐ Comfort
- ☐ Does not want to participate
- ☐ HVAC Recommendation
- ☐ Problem with operation
- ☐ Enroll in competing program
- ☐ Other

☐ **Customer Removed Devices**

Pre/Post Inspection

	Pre	Post
Fan On	☐	☐
Fan Auto	☐	☐
Heat	☐	☐
Stage 2	☐	☐
Emgy Heat	☐	☐
Cool	☐	☐

Arrival Time: ___:___ **Departure Time:** ___:___ **Work Time:** ___:___ **After Hours:** ☐ **Do Not Bill:** ☐ **Customer Present:** ☐

Start Mileage: _____

End Milage: _____

Notes:

 # Wall Plates: ____

 # Wire Kits: ____

1. Owner has approved of and verified installation of a programmable thermostat
2. Installation technician has explained settings, programming, and battery replacement of the thermostat.
3. Operating instructions were provided and left with customer.
4. Customer is responsible for future resetting and battery replacement of thermostat.
5. Pre-existing thermostat has been left in the owners's care. Customer is responsible for providing thermostat in the case of a removal

Date Completed: _____

Technician Name: _____ **Tech ID:** _____

Customer Signature (if required): _____

E-Mail Address _____

Ambient Temp: R Value:

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Appendix L. True North Report

2012 Residential Direct Load Control Pilot
Customer Experience Survey Report

prepared for the
Sacramento Municipal Utility District

April 29, 2013

TrueNorth Research
741 Garden View Court, Suite 208
Encinitas CA 92024
760.632.9900 www.tn-research.com

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Introduction

The Sacramento Municipal Utility District (SMUD) provides reliable electricity service at competitive rates to all of Sacramento County and a small portion of Placer County. As the sixth largest publicly owned utility in the country, SMUD is known for its innovative energy programs, high customer satisfaction, and commitment to being a leader in promoting community benefits. To this end, SMUD regularly conducts primary market research studies to profile customer needs, develop and refine programs that meet these needs, as well as measure customer awareness, opinions, behaviors and satisfaction as they pertain to SMUD and the services it offers.

Background

The present study is one of numerous pilot studies underway as part of SMUD's SmartSacramento® initiative, a comprehensive customer-centered smart grid system that enables and encourages customers to take an active, informed role in their energy use. Initiated in 2009 and continuing through 2014, the SmartSacramento® project includes Advanced Metering Infrastructure (AMI), distribution automation, demand response, customer applications such as web access to energy usage and analyses, dynamic pricing options, enhanced cyber security, and various partner projects.

Specifically, the *2012 Residential Direct Load Control Pilot* project was designed to measure peak period load reduction that can be achieved by SMUD remotely adjusting thermostat settings in select residential properties on excessively hot days. As part of the pilot, SMUD recruited 180 residential customers to participate in the program, install new PowerStat® thermostats in their homes, and test three strategies on days when temperatures were forecasted to be in the mid 90s or higher:

- Pre-cooling a home six hours by two degrees prior to peak period, followed by increasing the temperature by three degrees during peak period.
- Pre-cooling a home two hours by four degrees prior to peak period, followed by increasing the temperature by three degrees during peak period.
- No pre-cooling period, followed by increasing the temperature by three degrees during peak period.

In addition to quantifying the peak period energy use reduction achieved by the program among participating households, SMUD was interested in evaluating the impacts of the program on customers' experiences, their comfort level, and relevant attitudes about the program and SMUD. Whereas SMUD commissioned Herter Energy to conduct the load reduction analysis, True North Research was selected to assist in designing and

implementing a series of surveys to capture customers' opinions and experiences at different stages of the pilot.

Methodology

True North worked with SMUD to design four different surveys to be administered to customers at various stages of the pilot project. Customers received email invitations (and reminder emails when necessary) to participate in the surveys through a secure, password-protected website hosted by True North. Each participant received a unique personal identification number (PIN) which was used to track their participation in the surveys and link their responses across all surveys in the final database. A summary of the four surveys and related interviewing protocols follows:

Pre-Treatment Survey

The Pre-Treatment survey (see *Pre-Treatment Version*) was administered at the onset of the study, following the installation of the PowerStat® thermostat. The survey included questions about customers' reasons for participating in the pilot program and expectations of the program, as well as evaluative questions regarding the new thermostat installation process, initial impressions of the thermostat and related website, and overall opinions about SMUD. A total of 153 customers completed the Pre-Treatment survey between August 1 and August 9, 2012.[2]

Interim Survey

The Interim survey (see Interim *Version*) was administered after each of eight PowerStat® Event Days, which occurred when high temperatures were forecasted to be in excess of 95 degrees. Pilot participants were randomly assigned to one of three groups (Group 1, 2 or 3) and were administered one of three treatment strategies on each event as detailed in Table 1 below. Customers received an email notification from SMUD the day prior to each PowerStat® Event Day, and surveys were conducted within the three days following each event to promote accurate recall. It's important to note that customers were blind to the strategy they were receiving on any given event, which allows for unbiased comparisons of survey responses across the three treatment strategies tested. Over the course of the pilot period, each treatment group received each of the pre-cooling strategies at least once.

[2] In addition to recruiting participants through targeted email invitations and reminder notices, True North also conducted follow-up phone calls to pilot participants in order to maximize the response rate to the Pre-Treatment survey.

To avoid respondent fatigue, the eight events were grouped into four consecutive two-event waves in which the strategy assignments would remain the same. All participants received an invitation to complete an Interim survey on the *first* PowerStat® Event Day of each wave. Only those who ultimately did not complete a survey on the first event were invited to participate in a survey for the *second* event of each wave.

TABLE 1. POWERSTAT® EVENT DAYS & PRE-COOLING STRATEGY ROTATION BY GROUP

	Wave							
	1		2		3		4	
Event Day	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Group 1	6-hr	6-hr	2-hr	2-hr	None	None	6-hr	6-hr
Group 2	2-hr	2-hr	None	None	6-hr	6-hr	2-hr	2-hr
Group 3	None	None	6-hr	6-hr	2-hr	2-hr	None	None

The Interim survey included questions regarding Event Day awareness, behaviors, and temperature comfort level of the respondent and other individuals in the home during pre-peak and peak hours. Participation ranged from 159 completed surveys and an 88% response rate for Wave 1 to 112 completed surveys and a 62% response rate for Wave 4 (see Table 2).

TABLE 2. EVENT DAYS, COMPLETED INTERIM SURVEYS & RESPONSE RATES

	Event Date	Invites sent	Completed surveys	Response rate
Wave 1	August 9	180	146	81%
	August 13	34	13	38%
		Wave 1 Total	**159**	**88%**
Wave 2	August 15	180	113	63%
	August 17	67	23	34%
		Wave 2 Total	**136**	**76%**
Wave 3	August 23	180	117	65%
	September 4	63	16	25%
		Wave 3 Total	**133**	**74%**
Wave 4	September 12	180	99	55%
	September 14	81	13	16%
		Wave 4 Total	**112**	**62%**

Benchmark Survey

The Benchmark survey (see *Benchmark Version*) was administered two weeks after the final PowerStat® Event Day and included questions regarding temperature comfort level of the respondent and other individuals in the home during pre-peak and peak hours on a *non*-event day. The purpose of the Benchmark survey was to establish a natural *benchmark* comfort level for each participant on a hot day, against which one could better assess the comfort-level impacts of the precooling strategies. A total of

130 customers completed a Benchmark survey between September 27 and October 5, 2012.

Post-Treatment Survey

The Post-Treatment survey (see *Post-Treatment Version*) was similar in content to the Pre-Treatment survey and was administered at the completion of the study. Using question wording that was purposely tracked from the Pre-Treatment survey, the Post-Treatment survey measured satisfaction and perceptions of SMUD, the pilot program, the PowerStat® thermostat and related website, and experiences with SMUD and GoodCents customer service. The survey was completed by 138 customers between October 5 and October 11, 2012.

Note on Wave 1 Exclusion

During the first two PowerStat® Event Days of the season (Wave 1), the pre-cooling strategies were not implemented as intended. Rather than adjusting the temperature from the *normal* settings, some households received adjustments from their *away* settings, which resulted in excessively high temperatures during peak hours. Because the strategies were not implemented correctly, customers' experiences and their survey responses during Wave 1 do not represent an accurate test of the strategies as designed. For this reason, the survey results from Wave 1 are not included in the analyses presented in this report.

Note on Treatment Group Category Adjustments

As noted above, pilot participants were randomly assigned to one of three groups (Group 1, 2 or 3) and were administered one of three treatment strategies on each event as detailed in Table 1. Although group assignments were made at the outset of the pilot, it was discovered after the treatment period that due to thermostat signalization issues 32 participants were mis-grouped—that is, they received the treatments in the sequence appropriate for a different group. Due to these same thermostat signaling issues, it was also not possible to discern the correct treatment sequence for an additional 24 participants. For the analyses presented in this report that depend on proper group assignments, the 32 individuals noted above were reassigned to the group appropriate for their treatment sequence, while the 24 whose treatment sequence could not be identified were dropped from the analyses. For analyses that did not depend on treatment sequence, the 24 individuals were retained as their opinions were still relevant.

Organization of Report

This report is designed to meet the needs of readers who prefer a summary of the findings as well as those who are interested in the details of the results. For those who seek an overview of the findings, the sections titled *Just the Facts* and *Conclusions* are for you. They provide a summary of the most important factual findings of the survey in bullet-point format and a discussion of their implications. For the interested reader, this section is followed by a detailed question-by-question discussion of the results from the surveys by topic area across each of the four surveys, which includes figures summarizing all of the primary topics tested (see *Table of Contents*). And, for the truly ambitious reader, the four questionnaires designed and administered for the study are contained at the back of this report.

Acknowledgements

True North thanks Anya Suneson, Craig Sherman, Michael Daniels, Gene Pinasco and Sandra Kopp at SMUD, as well as Karen Herter of Herter Energy, for contributing their valuable input during the design stage of this study. Their collective experience and insights improved the overall quality of the research presented here.

Disclaimer

The statements and conclusions in this report are those of the authors (Dr. Timothy McLarney and Richard Sarles) at True North Research, Inc. and not necessarily those of SMUD. Any errors and omissions are the responsibility of the authors.

About True North

True North is a full-service survey research firm that is dedicated to providing public agencies with a clear understanding of the opinions, perceptions, priorities and concerns of their constituents and customers. Through designing and implementing scientific surveys, focus groups and one-on-one interviews, as well as expert interpretation of the findings, True North helps its clients to move with confidence when making strategic decisions in a variety of areas—such as planning, program development and evaluation, performance management, organizational development, establishing fiscal priorities, and developing effective public outreach campaigns. During their careers, Dr. McLarney (President) and Mr. Sarles (Principal Researcher) have designed and conducted over 800 survey research studies for public agencies—including more than 300 studies for California municipalities and special districts.

SMUD™

Just the Facts

The following is an outline of the main factual findings from the study. For the reader's convenience, we have organized the findings according to the section titles used in the body of this report. Thus, to learn more about a particular finding, simply turn to the appropriate report section.

Program Participation & Satisfaction

- The most commonly mentioned reason for participating in the PowerStat® pilot program was the desire to use less/conserve energy, mentioned by 41% of respondents, followed by saving money (38%) and receiving a free state-of-the-art thermostat (33%).
- At the onset of the pilot, nine-in-ten customers who provided an opinion said they expected to learn how to better conserve electricity (95%), use less energy (92%), and have more control over their electricity bill (91%) by participating in the pilot.
- At the completion of the pilot, 84% of customers who provided an opinion said the program had improved their knowledge about ways to reduce their household's electricity use, 76% said they had reduced the amount of electricity their household uses, and 82% stated the program gave them more control over their electricity bill.
- Customers were asked to rate their overall experience with the PowerStat® pilot program after each Event Day and at the end of the study. Overall, 94% of customers surveyed at the completion of the PowerStat® pilot program indicated they either very (68%) or somewhat (25%) satisfied with their experience. Satisfaction levels were slightly lower on individual Event Days, although more than 90% were very or somewhat satisfied, regardless of the precooling strategy they were assigned to on that particular day.
- Only 19% of respondents had suggestions for how to improve the pilot program upon its completion. Common themes included a desire for more information about the precooling strategies, advanced notification of Event Days, improved efficiency of opting out and overriding thermostat settings, as well as concerns about the effectiveness of the precooling strategies to provide a comfortable peak-period temperature and ultimately reduce energy use and cost.
- When customers were asked if they would recommend that a friend participate in the PowerStat® pilot program, 86% of respondents answered in the affirmative, 12% were unsure, and only 3% said no.
- Approximately three-quarters (74%) of customers said they definitely (33%) or probably (41%) would sign up again next summer to allow SMUD to occasionally adjust their thermostat settings to reduce peak-period electricity use.

Installation Process

- All customers (100%) surveyed agreed that the installation technician explained the basics of how to use the thermostat, the work site was left clean after the installation was complete, and the length of time it took to install the device was reasonable.
- Nearly all respondents agreed that the technician arrived on time for the appointment (99%), that there was no damage to their property during the installation process (99%), and that the technician explained the installation process prior to starting the work.
- Consistent with the high levels of agreement found with specific statements about the installation process, all customers (100%) surveyed indicated they were either very (95%) or somewhat (5%) satisfied with the installation of their new PowerStat® thermostat.

Thermostat Use & Ratings

- Ninety-five percent (95%) of customers surveyed at the onset of the study were either very (75%) or somewhat (21%) satisfied with the PowerStat® thermostat. When asked again later in the program, overall satisfaction was similarly high (97%), with 79% of customers indicating they were very satisfied and 18% saying they were somewhat satisfied.
- The highest rated attributes of the PowerStat® thermostat included its appearance (99% excellent or good for both Pre-Treatment and Post-Treatment surveys), overall performance (98% Pre-Treatment and 97% Post-Treatment), and the ability to keep the home at a comfortable temperature (98% and 96%). Customers assigned somewhat lower ratings to the ability to program the thermostat using the PowerStat® website, with 87% of Pre-Treatment respondents citing it as excellent or good compared with 80% of Post-Treatment respondents.
- When asked to rate the ease or difficulty of keeping one's home at a comfortable temperature since installation of the PowerStat® thermostat, 69% of respondents in the Pre-Treatment Survey said it was very easy, 23% said it was somewhat easy, and the remaining 8% were unsure. Responses were even more favorable at the Post-Treatment Survey, with 67% stating that it was very easy, and 32% saying it was somewhat easy.
- Shortly after installation of the PowerStat® thermostat, approximately three-quarters (76%) of respondents felt the PowerStat® thermostat was much (54%) or somewhat (22%) better than their prior thermostat, and another 21% said it was about the same. The findings were similarly favorable near the end of the study, with 53% of respondents saying the PowerStat® thermostat was much better than their prior thermostat, 28% saying it was somewhat better, and 20% saying it was about the same.

PowerStat® Website

- Just over half (51%) of customers surveyed visited the PowerStat® website at some point during the program.
- Forty-one percent (41%) of all customers used the website to learn more about the PowerStat® program, 34% reviewed the frequently asked questions (FAQs) on the website, 30% used the website to program their thermostat, and 15% read the operation manual online.
- Two-thirds (67%) of customers who had used the PowerStat® website to program their thermostat rated the ability to schedule wake, leave, return, and sleep temperature settings on the website as excellent (47%) or good (20%), 16% felt it was fair, 2% said it was poor or very poor, and the remaining 16% were not sure.
- Almost three-quarters (73%) of customers who had used the PowerStat® website to program their thermostat rated the ability to make temporary adjustments to their household temperature via the website as excellent (38%) or good (36%), 11% said it was fair, and 7% rated it as poor or very poor. The remaining 9% were unsure.
- Ninety-three percent (93%) of respondents in the Pre-Treatment Survey rated the overall quality of the PowerStat® website as excellent (33%) or good (61%), and 5% said it was fair. Ratings of the website were somewhat lower later in the study with 82% of respondents in the Post-Treatment Survey citing it as excellent (27%) or good (55%), and 13% saying it was fair.
- Approximately one-quarter (27%) of respondents who had visited the PowerStat® website provided a suggestion for improvement. Suggestions varied, but one of the most common suggestions was a request for mobile applications for phones and tablets.

Customer Service

- At least 95% of customers who provided an opinion agreed with the statements: The information SMUD made available was informative and helpful (98%), I was satisfied with how SMUD answered my questions (96%), SMUD clearly explained what I was expected to do during the program (96%), and SMUD clearly explained the goals of the program (95%).
- Twelve percent (12%) of customers indicated that they had contacted SMUD about an issue related to the PowerStat® pilot program, and another 12% said they had contacted GoodCents.
- Among customers who contacted SMUD, 81% said their issues were resolved to their satisfaction and another 6% said their issues were partially resolved.

- Among customers who contacted GoodCents, 75% indicated that their issues were resolved to their satisfaction and an additional 6% said they were partially resolved.
- Customers who had contacted SMUD or GoodCents were asked to describe the issue or issues that prompted their contact. Common issues included difficulties accessing the PowerStat® website, questions about and concerns with thermostat programming and temperature settings on Event Days, clarification about the program, and assistance in participating in the online surveys.

Comfort Level on Event Days

- During the pilot, approximately 5% of customers opted out of the PowerStat® Event Day treatments per event.
- Sixty-two percent (62%) of participants surveyed indicated that they were at home for at least 30 minutes between the hours of 2PM and 4PM on the Event Day. As expected, a larger percentage (83%) were at home for at least 30 minutes during peak hours (4PM to 7PM).
- Comfort levels were greatest during the benchmark episode in which no precooling treatments were applied. During the benchmark survey, the percentage who reported that their house was at a comfortable temperature during pre-peak and peak hours was 90% and 86%, respectively.
- Among the three precooling treatments tested, the 6 hour and 2 hour precool strategies produced similar comfort levels in both the pre-peak and peak periods. For the 6 hour pre-cool strategy, 79% indicated that they were comfortable during the pre-peak period, with 67% indicating that they were comfortable during peak hours. The corresponding results for the 2 hour precool strategy were 76% and 69%, respectively.
- When compared to the other strategies tested, the no-precooling strategy was the least competitive. Comfort levels during the pre-peak period were noticeably lower than the two precooling strategies tested (67%), although the largest differences in comfort could be found during peak hours. Without precooling, the temperatures experienced during the peak period were too hot for many participants, with just 43% indicating they were comfortable and 54% indicating that their home was too hot.
- When asked whether others in their household commented on the temperature during peak hours, the results were generally consistent with the personal comfort levels reported by respondents. During peak hours, the percentage of others in the home who made comments about the home being either too hot or too cold was smallest on the benchmark day (12%), followed by the 6 hour precool strategy (27%), 2 hour precool strategy (31%), and the no precool strategy (37%).

Attitudes about SMUD

- At the onset of the study, nearly all (99%) of customers indicated they were satisfied with SMUD's efforts to provide electricity services, with more than three-quarters (78%) stating that they were very satisfied. Overall satisfaction was virtually identical at the completion of the study, with 99% indicating they were very (72%) or somewhat (28%) satisfied.
- Three-quarters (75%) of customers surveyed shortly after installation of the PowerStat® thermostat indicated that their participation in the program to that point had positively impacted their opinion of SMUD, 17% said it had no impact, and the remaining 8% were unsure. The findings were nearly identical at the completion of the study, with 75% stating that their participation had positively impacted their opinion of SMUD, 22% said it had no impact, and only 1% felt it had a negative impact.

Conclusions

As noted in the *Introduction*, this study was designed to provide SMUD with a reliable understanding of customers' experiences with the *2012 Residential Direct Load Control Pilot* project (a.k.a., PowerStat® program pilot), with a special emphasis on measuring the impacts of the program on customers' comfort levels in home when exposed to precooling strategies. Whereas subsequent sections of this report are devoted to conveying the detailed results of the surveys, in this section we attempt to 'see the forest through the trees' and note how the collective results of the surveys answer some of the key questions that motivated the research.

The following conclusions are based on True North's interpretations of the results, as well as the firm's experience conducting similar evaluation studies for public agencies throughout the State.

What were participants' general experiences with the PowerStat® pilot program?

Overall, customers were generally pleased with their experiences participating in the PowerStat® pilot. Despite the initial signaling problems which resulted in excessively hot or cold conditions for select customers during Wave 1, throughout the remainder of the pilot at least nine out of ten participants indicated that they were satisfied with their overall experiences participating in the program on Event Days and at the conclusion of the study.

That customers were generally pleased with the PowerStat® pilot was evidenced in other areas as well. Even though participants had already received their free thermostat and thus had less incentive to enroll in the program again, approximately three-quarters stated that they would definitely (33%) or probably (41%) sign-up again to allow SMUD to occasionally adjust their thermostat settings in summer of 2013 to reduce their households' peak-period electricity use. More than four out of five customers (86%) also indicated that—if asked by a friend about the PowerStat® pilot program—they would recommend that they participate.

How did participants rate the PowerStat® thermostat and website?

The success of the pilot is based, in part, on customers' opinions of the technology employed. Nearly all participants (95%+) indicated that they were satisfied with the PowerStat® thermostat overall, and more than three-quarters indicated that the PowerStat® thermostat performed better than their prior thermostat. At both the outset and the conclusion of the pilot, participants gave very high marks to the PowerStat® thermostat on every performance dimension tested, including ease of use, appearance,

keeping the home at a comfortable temperature, readability of display, and overall performance.

Paired with the thermostat is the PowerStat® website, which allows users to schedule wake, leave, return, and sleep temperature settings, make temporary temperature adjustments, learn more about the PowerStat® pilot, and access manuals for their new thermostat. Over the course of the pilot, just over half (51%) of participants visited the PowerStat® website. Whereas opinions of the PowerStat® thermostat were overwhelmingly positive, however, participants' ratings of the website were more mixed. At the conclusion of the study, 82% of visitors rated the site as excellent or good overall, 73% provided similar ratings for the ability to make temporary adjustments to the current temperature in their home via the website, and 67% rated as excellent or good the ability to schedule wake, leave, return and sleep temperature settings using the site. A review of the verbatim suggestions for how to improve the website suggest that the interface isn't intuitive, certain temperature-control functions don't work consistently, and many users would prefer to have a mobile application for a tablet or smart phone.

How did customers rate GoodCents' performance?

SMUD contracted with GoodCents to manage the installation of the PowerStat® thermostats in participants' homes. Based on the responses to the Pre-Treatment Survey, GoodCents performed admirably during the installation period. All customers surveyed (100%) agreed that the technician explained the basics of how to use the thermostat, the work site was left clean after the installation was complete, and the length of time it took to install the device was reasonable. Nearly all respondents also agreed that the technician arrived on time for the appointment (99%), that there was no damage to their property during the installation process (99%), and that the technician explained the installation process prior to starting the work. At least nine out of ten respondents also agreed that they were able to select an installation time that worked for their schedule (97%), received a clear explanation of what they were expected to do during the program (94%), and that the technician explained how to log on to the PowerStat® website (90%).

Approximately 12% of participants indicated that they contacted GoodCents regarding one or more issues related to the PowerStat® pilot for customer service. Of these individuals, 75% indicated that their issue was fully resolved to their satisfaction, and an additional 6% indicated that it was partially resolved. Among all program participants, just 2% indicated they contacted GoodCents regarding an issue that ultimately was *not* resolved to their satisfaction.

How did participation in the pilot impact opinions about SMUD?

With respect to specific customer service issues, SMUD received high marks from PowerStat® pilot participants. Nearly all participants agreed that the information SMUD made available about the program was informative and helpful (98%), they were satisfied with how SMUD answered their questions (96%), SMUD clearly explained what they were expected to do during the program (96%), and SMUD clearly explained the goals of the program (95%).

During the course of the pilot, 12% of participants reported that they contacted SMUD regarding one or more issues related to the PowerStat® pilot for customer service. Among customers who contacted SMUD, 81% said their issues were resolved to their satisfaction and another 6% said their issues were partially resolved.

More broadly, the findings of the surveys suggest that simply making the pilot program and free thermostat available to participants had a positive impact on most participants attitudes about SMUD, and their participation in the pilot after enrollment did not significantly alter their very favorable opinions of SMUD. Indeed, 99% of customers surveyed after installation but prior to an Event Day indicated that they were satisfied with the job SMUD is doing to provide electricity services to their household, and 75% stated that their participation in the pilot to that point had positively impacted their opinions of SMUD. These figures remained unchanged at the conclusion of the pilot.

Which precooling strategies performed the best in keeping customers comfortable?

The PowerStat® pilot program and the associated precooling strategies are being evaluated on two fronts—peak period load reduction and the impact of the program on the customer experience. Although the load reduction achievements of the program and respective precooling strategies are the subject of a separate analysis being conducted by Herter Energy, from the *customer experience* perspective it appears that the 6 hour precool treatment was the most successful at maintaining their home at a comfortable temperature.

Among the precooling strategies tested, the 6 hour precool strategy had the highest percentage who reported their home being as comfortable (or more so) when compared to their home's benchmark comfort level during both non-peak (86%) and peak (83%) periods. Although these percentages are lower than the benchmark comfort levels reported by customers on a hot day when they could set the thermostat at any temperature they pleased (90% and 86% respectively), the differences were not statistically significant for this strategy. In other words, the 6 hour precool strategy resulted in comfort levels in the home during both non-peak and peak hours that were statistically similar to those experienced on a *normal* hot day.

The 2 hour precooling strategy was the second-best alternative based on participants' feedback, with 79% indicating it kept their home as comfortable as usual (or more so) during both pre-peak and peak periods. Tests revealed a statistically significant difference during peak hours between the benchmark comfort level and the comfort levels reported for the 2 hour precool strategy (.049 significance, binomial distribution), thus indicating that the 2 hour precooling strategy produced comfort levels in participants' homes that were significantly different (less comfortable) than normal.

When compared to the other strategies tested, the no precool strategy was the least competitive. Although comfort levels during the pre-peak period were comparable to the 2 hour precool strategy (78%), *without* precooling the temperatures experienced during the peak period were too hot for many participants. Overall, just 59% of customers who received the no precool strategy indicated that their household was at least as comfortable as normal during peak hours. When compared to benchmark peak period comfort levels, the difference (reduction) in comfort under the no precool strategy was large and statistically significant (<.0001 significance, binominal distribution).

For a discussion of the tests of statistical significance conducted with respect to the three treatment strategies, see *Statistical Significance Tests*.

Program Participation & Satisfaction

SMUD recruited 180 randomly residential customers to participate in the PowerStat® pilot program. During recruitment, customers were informed about the basic objectives and protocol of the pilot and thus chose to participate with some knowledge and expectations of the program. In this first section of the report, we present the results of questions that pertained to their expectations when enrolling in the pilot and whether the program met these expectations, as well as their suggestions for how the pilot program could be improved.

Motivation for Participating

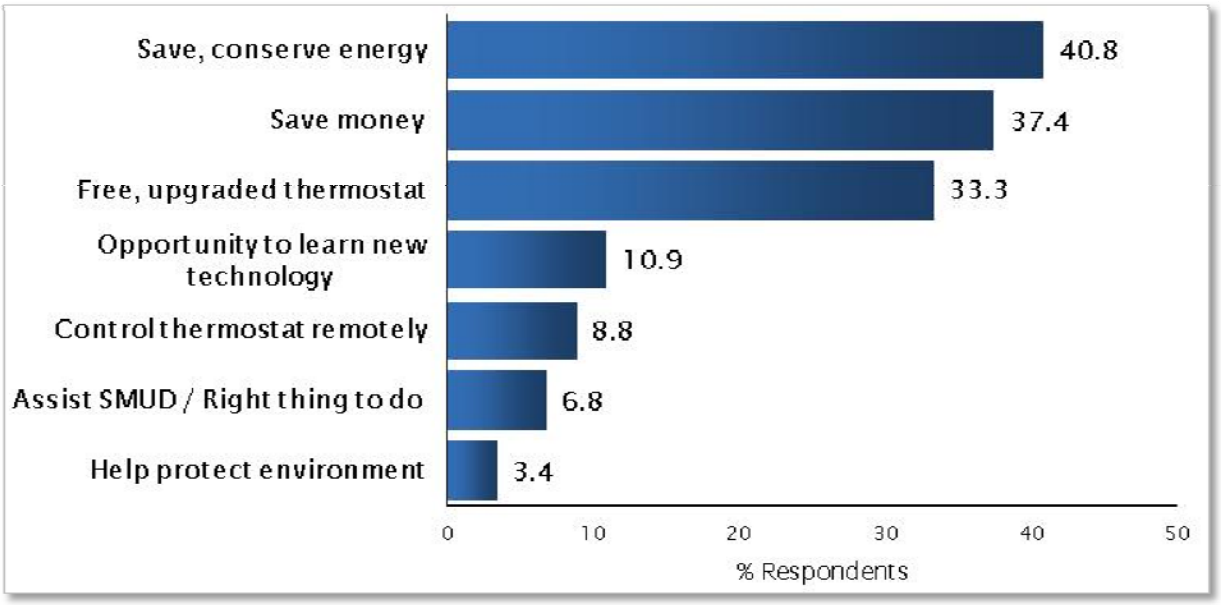
Question 1 of the Pre-Treatment Survey (administered at the onset of the study after installation of the PowerStat® thermostat) asked customers in an open-ended manner to indicate their main reason for participating in the program. Verbatim responses were recorded and later grouped into the categories shown below in Figure 1. Multiple responses were allowed, so the percentage results shown in the figure represent the percentage of participants who cited each reason.

The most commonly mentioned reason for participating in the PowerStat® pilot program was the desire to use less/conserve energy, mentioned by 41% of respondents, followed by save money (38%) and receive a free state-of-the-art thermostat (33%). Others looked forward to the opportunity to learn and utilize new technology (11%) and similarly, the ability to have their thermostat controlled remotely via the Internet (9%).

Question 1 Pre-Treatment

In your own words, what would you say was the main reason you signed up to participate in the PowerStat® pilot program?

FIGURE 1. MAIN REASONS FOR PARTICIPATING IN POWERSTAT® PROGRAM



Expectations & Outcomes

The next question of the Pre-Treatment survey asked more specifically about customers' expectations of the program. Respondents were asked whether by participating in the pilot they expected to achieve each of the seven outcomes listed along the bottom of Figure 2. A similar list was presented again to customers at the completion of the study during the Post-Treatment survey, where they were then asked to what degree participating in the pilot program *achieved* each outcome (a lot, some, a little, or none). The results to both of these questions are summarized in Figure 2.

In general, expectations of the program exceeded the outcomes for every dimension tested, although not by a large amount. At the onset of the program, for example, nine-in-ten customers who provided an opinion said they expected to learn how to better conserve electricity (95%), use less energy (92%), and have more control over their electricity bill (91%). At the completion of the program, 84% of customers who provided an opinion said the program had improved their knowledge about ways to reduce their household's electricity use, 76% said they had reduced the amount of electricity their household uses, and 82% said the program gave them more control over their electricity bill. It's also worth noting that 76% of respondents reported at the conclusion of the pilot

that their experiences during the pilot motivated them to change their electricity-use habits, and 71% found that they saved money by participating in the pilot.

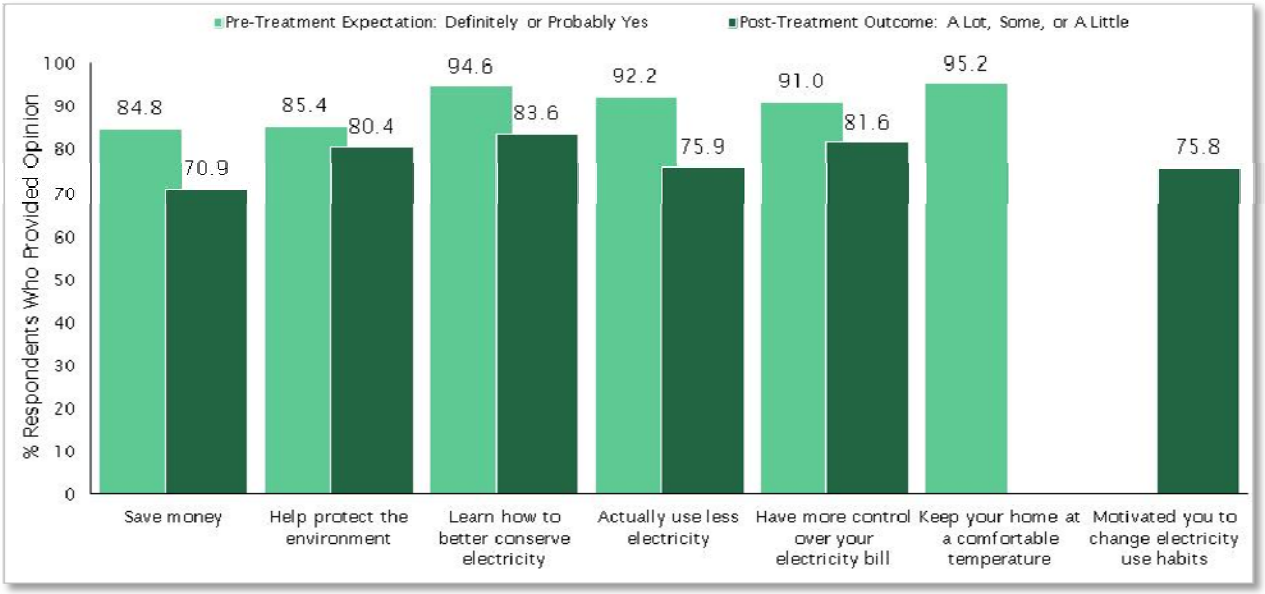
Question 2 Pre-Treatment

By participating in this program, do you expect to _____?

Question 4 Post-Treatment

In your opinion, how much has participating in the PowerStat® pilot program _____?

FIGURE 2. EXPECTATIONS & OUTCOMES OF POWERSTAT® PROGRAM[3]



Overall Satisfaction with Pilot

Customers were asked to rate their overall experience with the PowerStat® pilot program after each Event Day (Interim Surveys) and at the end of the study (Post-Treatment Survey). Figure 3 summarizes the findings of these questions, displaying overall satisfaction with the program by the customer's treatment group on a particular Event Day, as well as satisfaction upon completion of the study. Overall, 94% of customers surveyed indicated they were either very (68%) or somewhat (25%) satisfied with their experience participating in the PowerStat® pilot program at its completion. Satisfaction levels were slightly lower on Event Days, although they did not

[3]Missing bars indicate that they question wasn't asked in that particular survey.

vary significantly across the three precooling strategies. All three precooling strategies achieved overall satisfaction ratings of at least 90%.

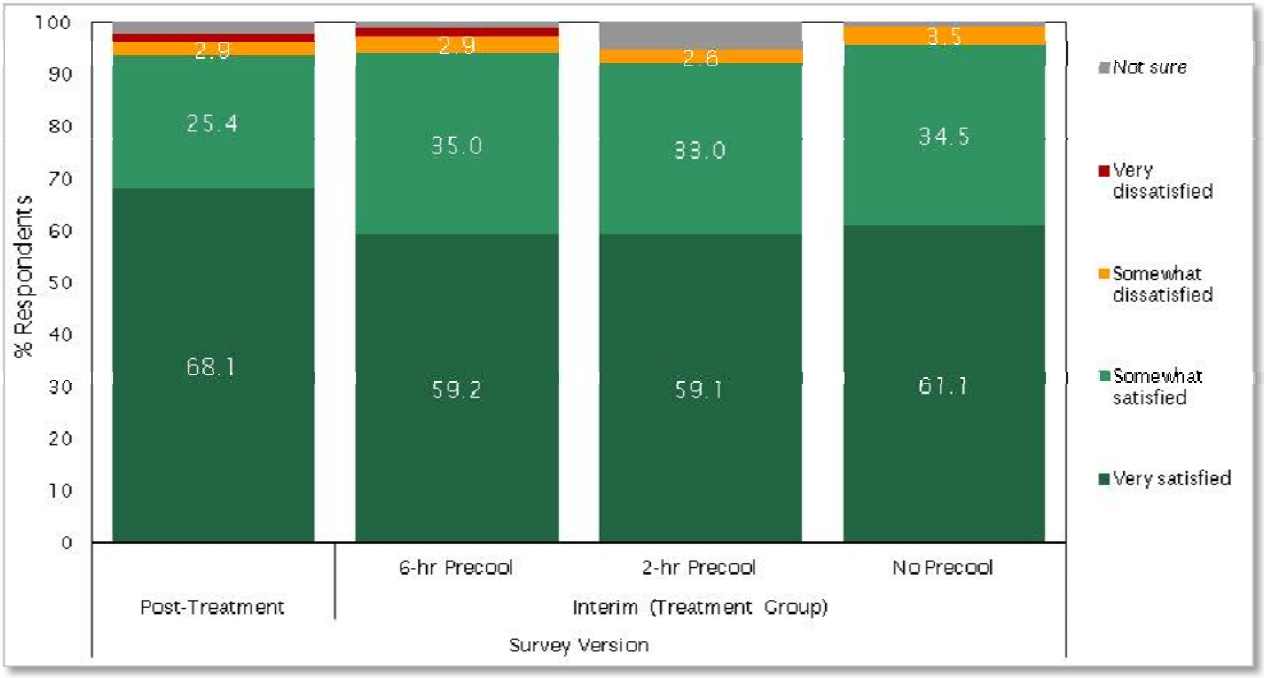
Question 1 Post-Treatment

In general, how would you rate your overall experience participating in the PowerStat® pilot program?

Question 14 Interim

In general, how would you rate your overall experience participating in the PowerStat® program to this point?

FIGURE 3. OVERALL SATISFACTION WITH POWERSTAT® PROGRAM



How can the Pilot be Improved?

At the completion of the study, customers were asked to describe any changes they thought would most improve the PowerStat® pilot program. Only 19% of respondents had suggestions for improving the program. Suggestions varied, but common themes included a desire for more information about the precooling strategies, advanced notification of Event Days, improved efficiency of opting out and overriding thermostat settings, as well as concerns about the effectiveness of the precooling strategies to

provide a comfortable peak period temperature and ultimately reduce energy use and cost. A selection of the verbatim responses is presented on the next page.

Question 3 Post-Treatment

Please briefly describe the one or two changes you think would most improve the PowerStat® pilot program in the text box below.

- Encountered problems with the thermostat, which was not receiving signals properly. If the communication problems with the thermostat receiving signals could be resolved then this would help.
- Examine the benefits or drawbacks of the pre-cooling plan in a home that is not particularly energy efficient.
- The programmed lowering and raising of the temperature never worked correctly, and it seemed the operators I spoke to did not know how it could be fixed. It's a great idea, but the programming obviously needs improvement.
- More information as I never really understood what was being gained or accomplished with the program. Unless it was simply to remotely control temp change in the house and then measure consumption after change. I never got a reply when I asked how causing the unit to run for 4 hours during peak times actually saved electricity.
- Better notification of power saving days...maybe 2 or 3 days ahead?
- The program should lower my energy bill. It went up during the 2 months I was involved. The program should offer a discount.
- We set our temperature at 78 each day which is higher than most consumers. During one of the test days, the thermostat was automatically raised 3 degrees and locked at 81 degrees. If you can see what temperature I have set it at and it is already high, please do not raise it automatically. I endured my home at 81 degrees for your program, but it really isn't a good idea to let the house get that hot. We lived in AZ for a number of years and learned that once the home got to 80+ degrees, it actually took much longer to cool it down to 78 degrees which meant we used more AC/electricity. Please give more advance notification of an upcoming test day. If we have visitors coming or have an illness in the family, we would have more time to “opt out” of the testing that day if it is going to be a hotter than usual day.
- Since I was never home during the first part of the event, I was never able to see what temperatures the thermostat was adjusted to. I would like to be able to keep the same adjustments that were made without my intervention.
- Don't run the air as much. Several days it was too cold and I would have turned the air off during those times. I would have saved more money on my own.

- Provide easier ways to opt out of PowerStat® events. I had a couple times that the opt out did not work as expected.
- Have a more reasonable goal temperature, it seemed like it was often too cold on some of the days.
- Let the homeowner set the thermostat manually as they're the ones who knows when to turn it on or off or set it at a temperature most convenient for them.
- Instead of coming home to a hot 81 degree house, try 79 or 80 if possible.

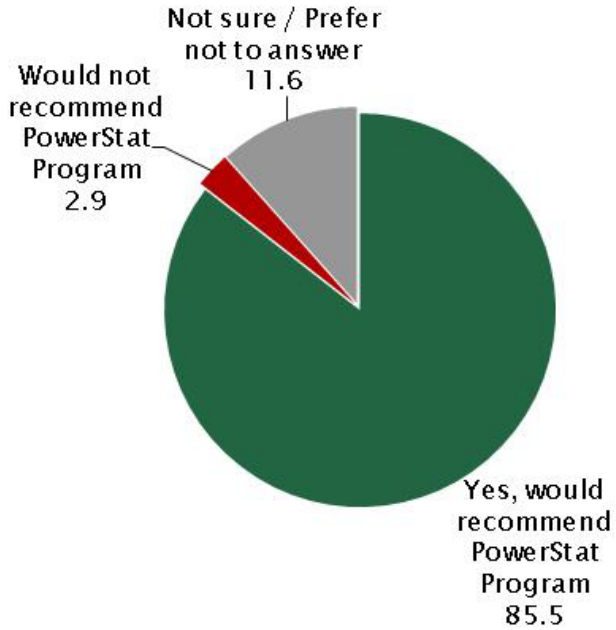
Would you Recommend the Program to a Friend?

Question 6 of the Post-Treatment survey can be viewed in many ways a litmus test for the success of the program from the customer's perspective. When customers were asked if they would recommend that a friend participate in the PowerStat® pilot program, 86% of respondents answered in the affirmative, 12% were unsure, and only 3% said no (see Figure 4).

Question 6 Post-Treatment

If a friend asked you about the PowerStat® pilot program, would you recommend that they participate?

FIGURE 4. WOULD RECOMMEND POWERSTAT® PROGRAM



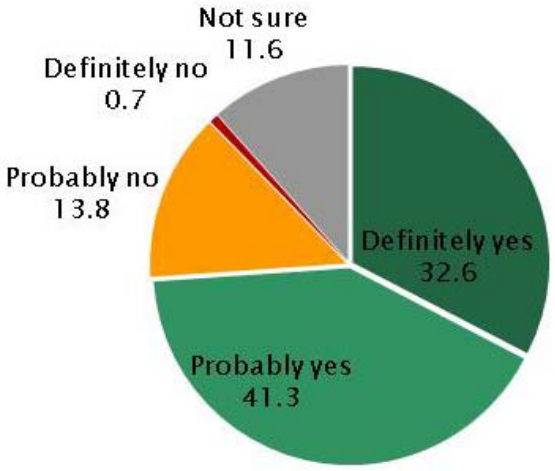
Would they Participate Again?

Another good measure of customers' overall assessment of the PowerStat® pilot program, Question 7 of the Post-Treatment survey asked respondents if they would be interested in signing-up again for a similar program in the summer of 2013. Even though participants had already received their free thermostat and thus had less incentive to enroll in the program again when compared to this initial period, approximately three-quarters (74%) of customers said they definitely (33%) or probably (41%) would sign up to allow SMUD to occasionally adjust their thermostat settings to reduce peak-period electricity use next summer (Figure 5).

Question 7 Post-Treatment

Thinking ahead to next summer (2013), would you sign up again to allow SMUD to occasionally adjust your thermostat settings to reduce your household's peak-period electricity use?

FIGURE 5. WOULD SIGN UP AGAIN FOR SIMILAR PROGRAM



Installation Process

Once a customer had agreed to take part in the PowerStat® pilot program, the first substantial step in participation involved the installation of the new PowerStat® thermostat in the customer's home. The customer's experience and satisfaction with the installation process was examined in the Pre-Treatment Survey.

Ratings for Installation Process

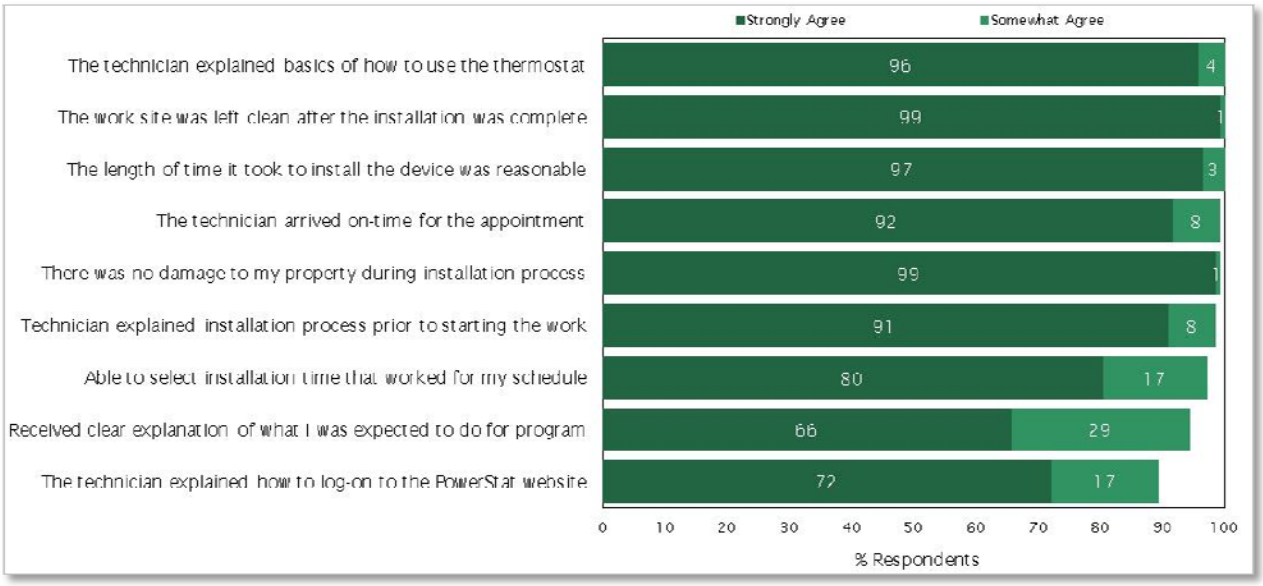
Question 4 presented respondents with a list of nine statements regarding the installation process and asked if they agreed or disagreed with each. Figure 6 presents truncated versions of the statements and the percentage of respondents who strongly or somewhat agreed with each.

All customers surveyed (100%) agreed that the technician explained the basics of how to use the thermostat, the work site was left clean after the installation was complete, and the length of time it took to install the device was reasonable. Nearly all respondents also agreed that the technician arrived on time for the appointment (99%), that there was no damage to their property during the installation process (99%), and that the technician explained the installation process prior to starting the work. Although slightly lower, at least nine out of ten respondents also agreed that they were able to select an installation time that worked for their schedule (97%), received a clear explanation of what they were expected to do during the program (94%), and that the technician explained how to log on to the PowerStat® website (90%).

Question 4 Pre-Treatment

Please indicate the extent to which you agree or disagree with the following statements about the installation process.

FIGURE 6. AGREEMENT WITH STATEMENTS ABOUT INSTALLATION PROCESS



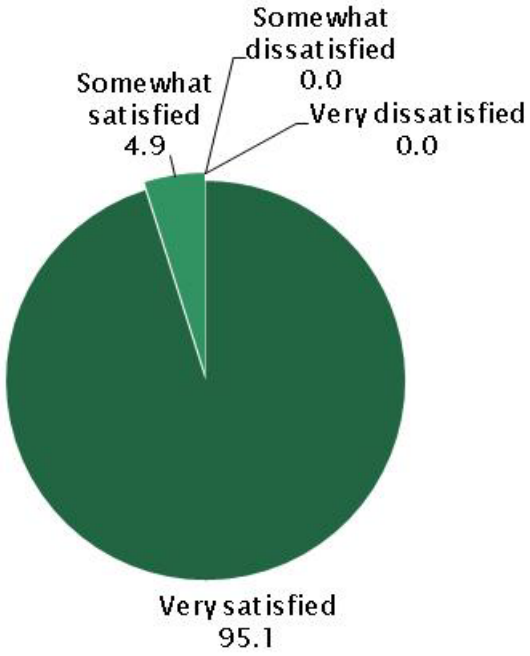
Overall Satisfaction with Installation

After rating various specific aspects of the installation processing in Question 4, customers were asked about their *overall* satisfaction with the installation process for their new thermostat. Consistent with the high levels of agreement found with specific statements about the installation process, all customers (100%) surveyed indicated they were either very (95%) or somewhat (5%) satisfied with the installation of their new thermostat (see Figure 7).

Question 5 Pre-Treatment

Overall, were you satisfied or dissatisfied with the installation process for your new thermostat?

FIGURE 7. SATISFACTION WITH INSTALLATION PROCESS



Thermostat Use & Ratings

One of the incentives for customers who agreed to participate in the PowerStat® pilot program was the receipt and installation of a new PowerStat® thermostat that would remain in the home after completion of the program. The PowerStat® thermostat offers a variety of features such as a built-in radio receiver allowing communication between SMUD and the thermostat, as well as web-enabled technology which allows the user to program thermostat settings and schedules online through a secure login process. The Pre-Treatment and Post-Treatment surveys included a series of questions to assess customers' experiences and satisfaction with their new thermostat.

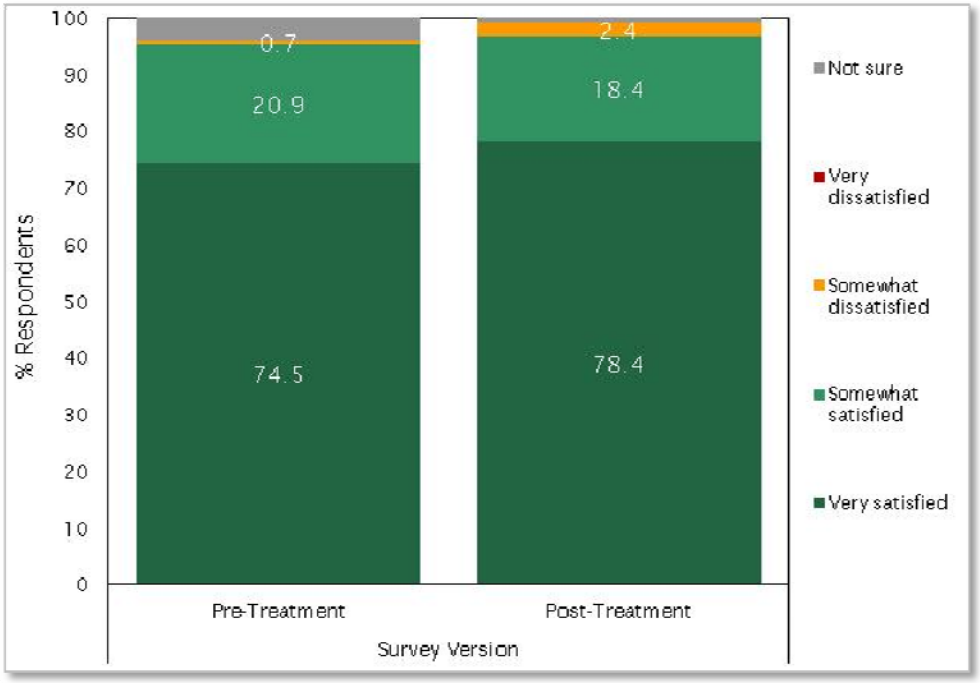
Overall Satisfaction with Thermostat

When asked to rate their overall satisfaction with the new thermostat, 95% of customers surveyed at the onset of the study (Pre-Treatment) were either very (75%) or somewhat (21%) satisfied. When asked again later in the program, overall satisfaction was similarly high (97%), with 79% of customers indicating they were very satisfied and 18% saying they were somewhat satisfied (Figure 8).

Question 7/8 Pre-Treatment/Post-Treatment

Overall, how would you rate your satisfaction with the new thermostat?

FIGURE 8. SATISFACTION WITH NEW THERMOSTAT

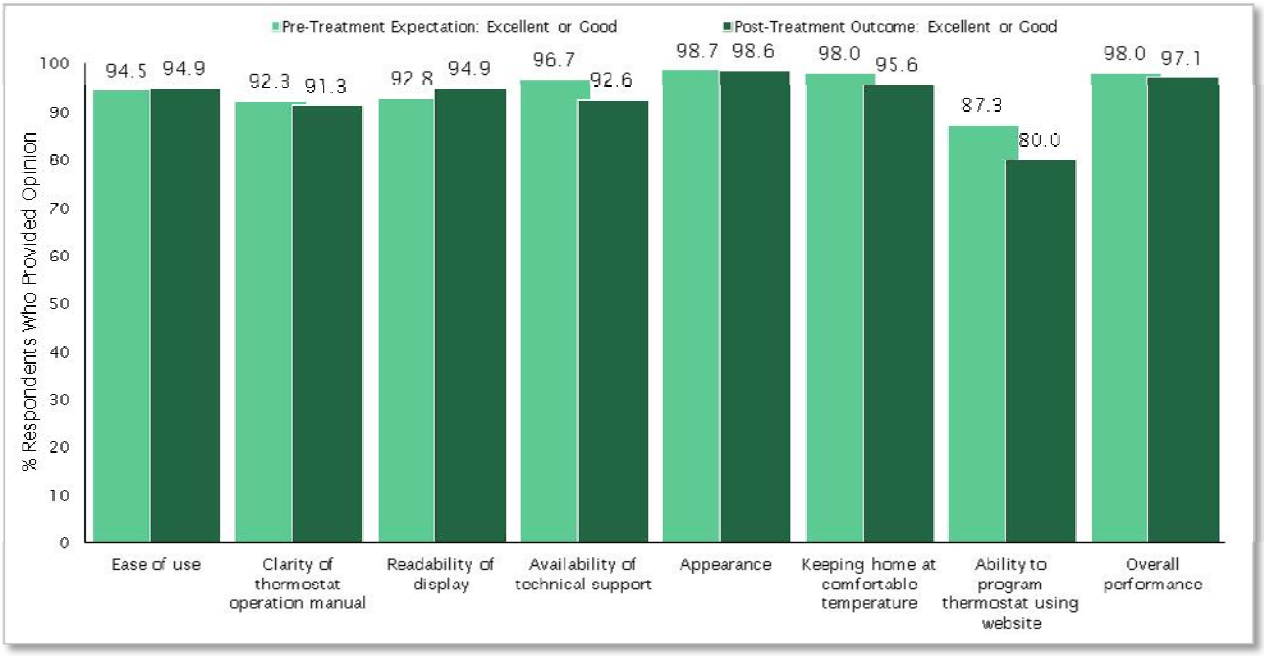


In both the Pre-Treatment and Post-Treatment surveys, customers were asked to rate eight attributes of the PowerStat® using a scale of excellent, good, fair, poor, or very poor. Figure 9 on the next page displays the percentage of respondents that rated an attribute as excellent or good among those who provided an opinion. Ratings were generally very positive and comparable between the Pre-Treatment (light green bars) and Post-Treatment (dark green bars) surveys. The highest rated attributes of the PowerStat® thermostat included its appearance (99% excellent or good for both Pre-Treatment and Post-Treatment), overall performance (98% Pre-Treatment and 97% Post-Treatment), and its ability to keep the home at a comfortable temperature (98% and 96%). Customers assigned somewhat lower ratings to the ability to program the thermostat using the PowerStat® website, with 87% of Pre-Treatment respondents citing it as excellent or good compared with 80% of Post-Treatment respondents.

Question 9/10 Pre-Treatment Post-Treatment

Please rate the new thermostat on the following attributes.

FIGURE 9. RATING ATTRIBUTES OF THE THERMOSTAT



Additional Performance Measures

The final two questions in this series asked respondents to rate the ease or difficulty they experienced in keeping their home at a comfortable temperature since the installation of the PowerStat® thermostat, as well as how their new thermostat performs in comparison to their prior thermostat.

Overall, two-thirds (69%) of respondents in the Pre-Treatment Survey indicated that it was *very* easy to maintain their home at a comfortable temperature with the PowerStat® thermostat, and an additional 23% stated it was *somewhat* easy. The remaining 8% of participants were unsure. Responses were even more favorable at the Post-Treatment Survey, with 67% stating that it was very easy, and 32% saying it was somewhat easy to keep their home at a comfortable temperature using the PowerStat® thermostat (see Figure 10).

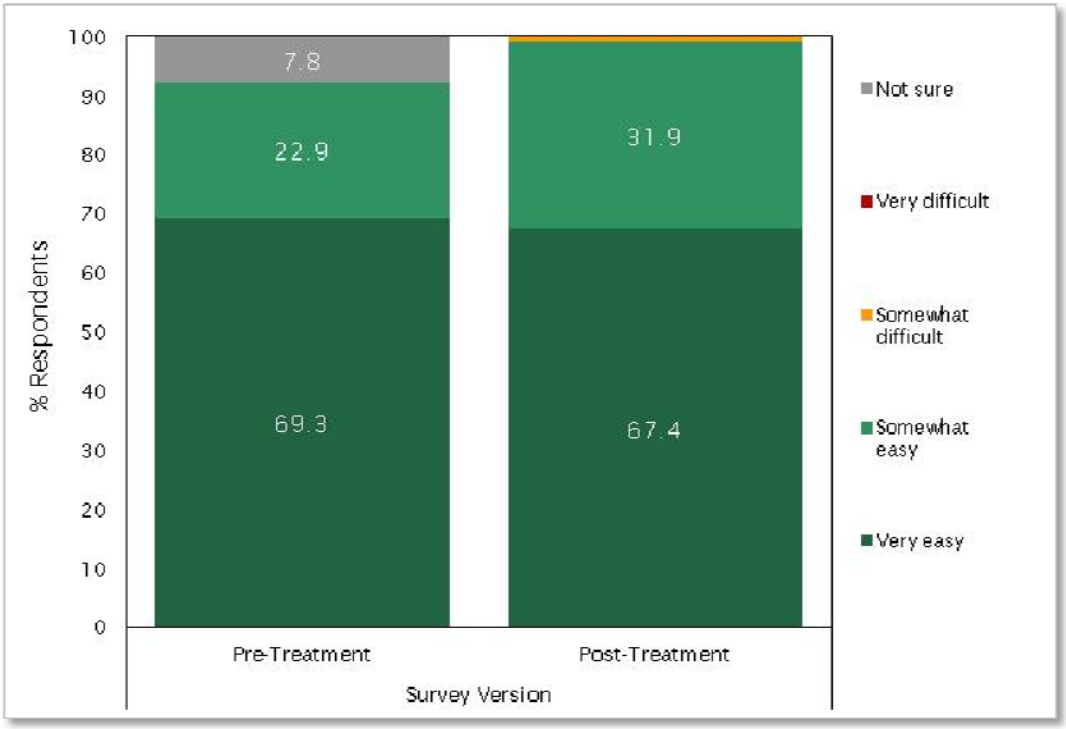
With respect to how the PowerStat® thermostat performs relative to their prior thermostat (see Figure 11), most pilot participants were favorably impressed by the PowerStat® thermostat. During the Pre-Treatment Survey, approximately three-quarters (76%) of respondents felt the PowerStat® thermostat was much (54%) or

somewhat (22%) better than their prior thermostat, and another 21% said it was about the same. The findings were similarly favorable in the Post-Treatment Survey, with 53% of respondents stating that the PowerStat® thermostat was much better than their prior thermostat, 28% saying it was somewhat better, and 20% indicating it was about the same. At the conclusion of the study, *not one* participant indicated that the PowerStat® thermostat underperformed their prior thermostat.

Question 10/12 Pre-Treatment/Post-Treatment

Since enrolling in the PowerStat® program and receiving your new thermostat, how easy or difficult has it been to keep your home at a comfortable temperature?

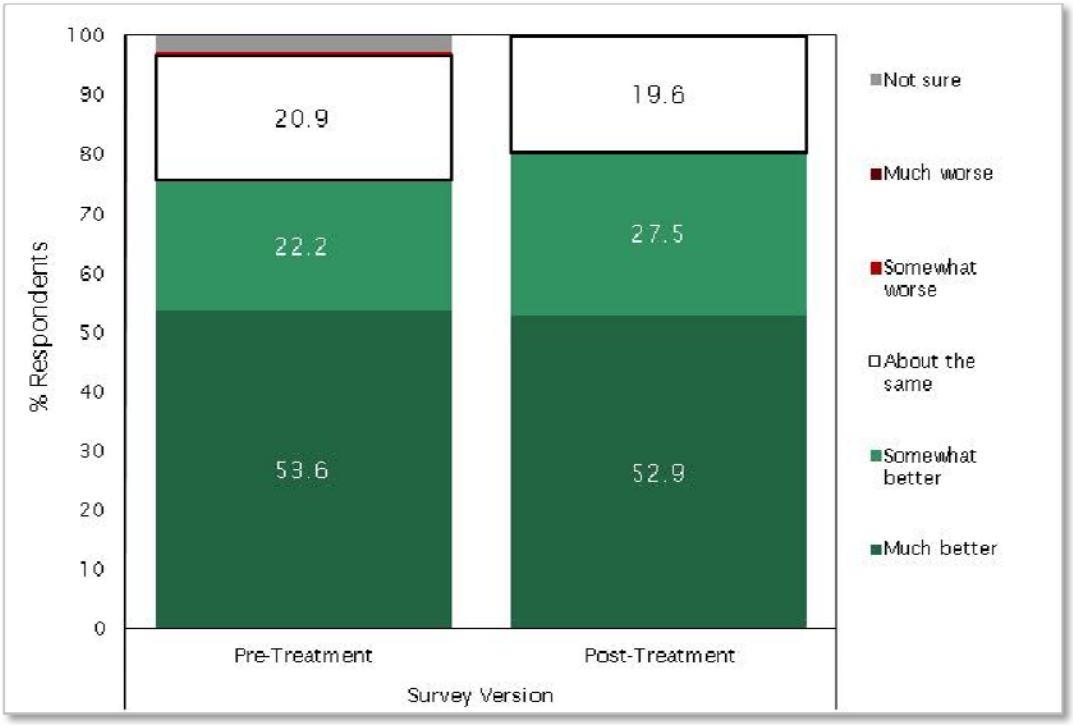
FIGURE 10. EASE OF KEEPING HOME AT COMFORTABLE TEMPERATURE



Question 15/11 Pre-Treatment/Post-Treatment

When compared to your prior thermostat, would you say that the new thermostat you received through the PowerStat® Pilot program performs better, worse or about the same overall?

FIGURE 11. NEW THERMOSTAT COMPARED WITH PRIOR THERMOSTAT



PowerStat® Website

The PowerStat® thermostat is a web-enabled device, which allows users to schedule wake, leave, return, and sleep temperature settings, as well as make temporary temperature adjustments online via the SMUD website through a secure login process. The Pre-Treatment and Post-Treatment surveys included several questions to assess customers' use of—experiences with—the PowerStat® website.

Visited PowerStat® website

Respondents in the Pre-Treatment and Post-Treatment surveys were asked if they had visited SMUD's PowerStat® website at www.SMUD.org/PowerStat. Figure 12 below combines the findings of both surveys to identify the percentage of customers who had visited the website at least once by the conclusion of the study. Overall, just over half (51%) of customers surveyed visited the PowerStat® website at some point during the program.

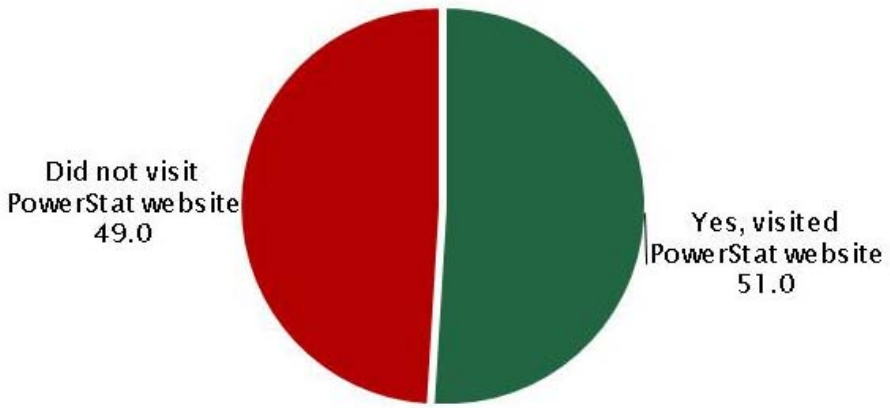
Question 11 Pre-Treatment

Have you visited SMUD's PowerStat® website: www.SMUD.org/PowerStat®?

Question 13 Post-Treatment

During the past three months, have you visited SMUD's PowerStat® website: www.SMUD.org/PowerStat?

FIGURE 12. VISITED POWERSTAT® WEBSITE



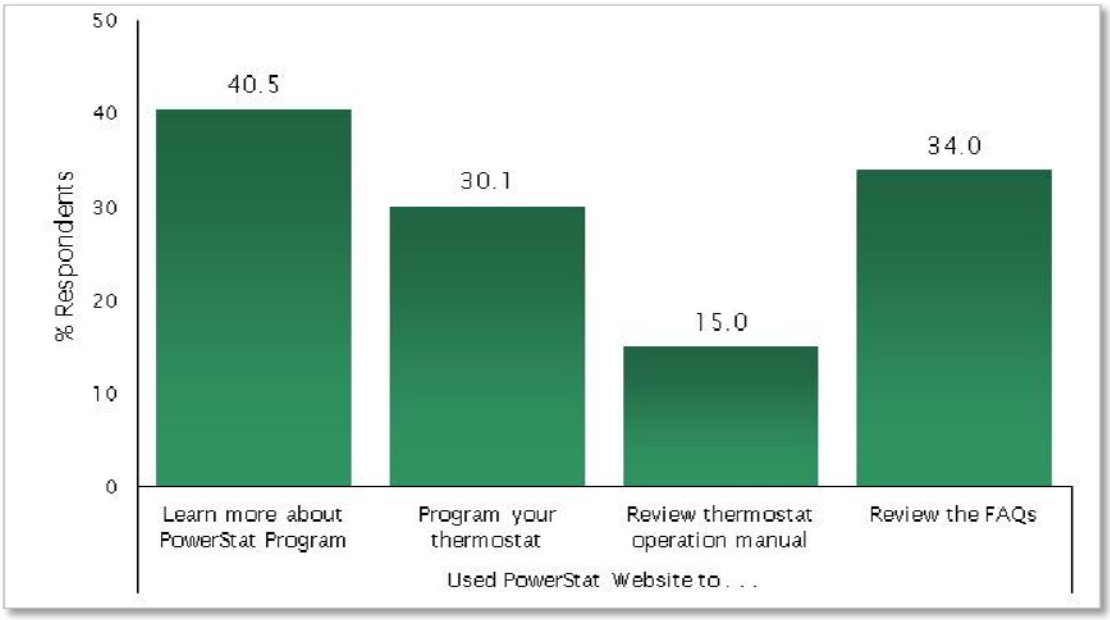
Activities Performed at PowerStat® website

Customers who had visited the PowerStat® website were subsequently asked to indicate the types of activities that they performed while on the site. Figure 13 on the next page displays the percentage of *all* participants surveyed who utilized the website to perform each activity. Overall, 41% of customers used the website to learn more about the PowerStat® program, 34% reviewed the frequently asked questions (FAQs) on the website, 30% used the website to program their thermostat, and 15% read the thermostat operation manual online.

Question 12/15 Pre-Treatment/Post-Treatment

Have you used the PowerStat® website to do the following?

FIGURE 13. POWERSTAT® WEBSITE ACTIVITIES

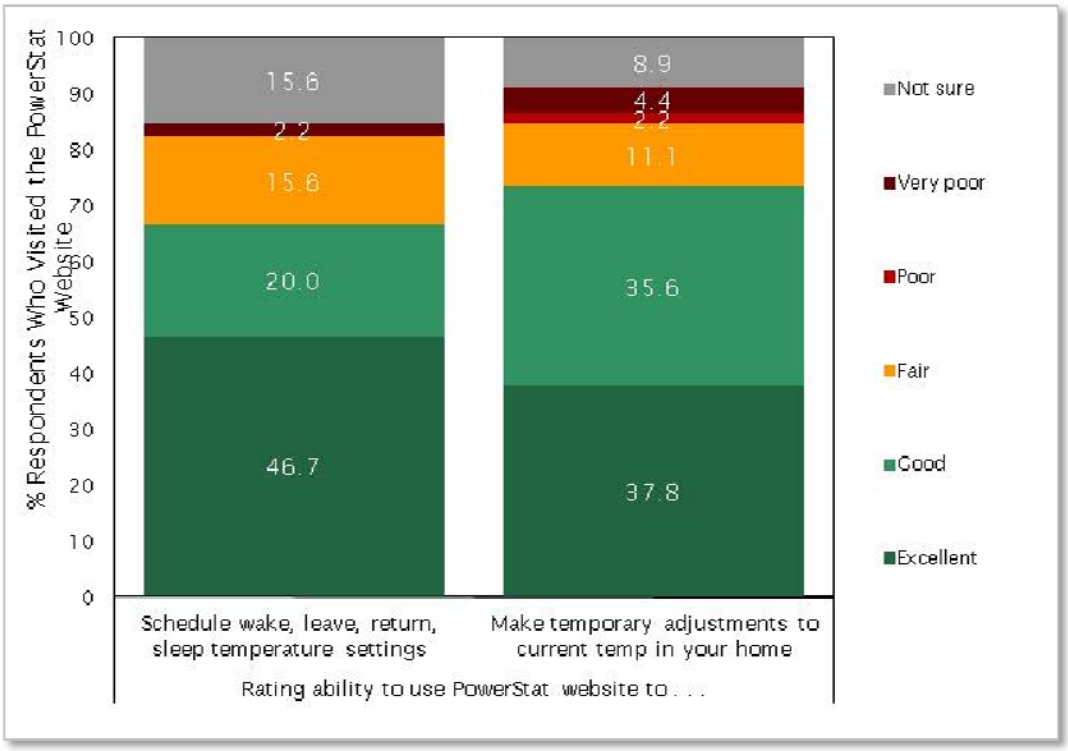


Ratings of PowerStat® website

Customers who used the PowerStat® website to program their thermostat received two more detailed follow-up questions in the Post-Treatment Survey about that activity. Specifically, respondents were asked to rate the ability to program schedule settings and make temporary temperature changes via the PowerStat® website using a scale of excellent, good, fair, poor, or very poor. As presented in Figure 14, two-thirds (67%) of customers rated the ability to schedule wake, leave, return, and sleep temperature settings on the PowerStat® website as excellent (47%) or good (20%), 16% felt it was

fair, 2% said it was poor or very poor, and the remaining 16% were not sure. Almost three quarters (73%) of customers rated the ability to make temporary adjustments to their household temperature via the website as excellent (38%) or good (36%), 11% said it was fair, and 7% rated it as poor or very poor. The remaining 9% of customers were unsure.

FIGURE 14. RATING ASPECTS OF POWERSTAT® WEBSITE



Question 16 Post-Treatment

How would you rate the ability to schedule the wake, leave, return and sleep temperature settings for your thermostat on the PowerStat® website?

Question 17 Post-Treatment

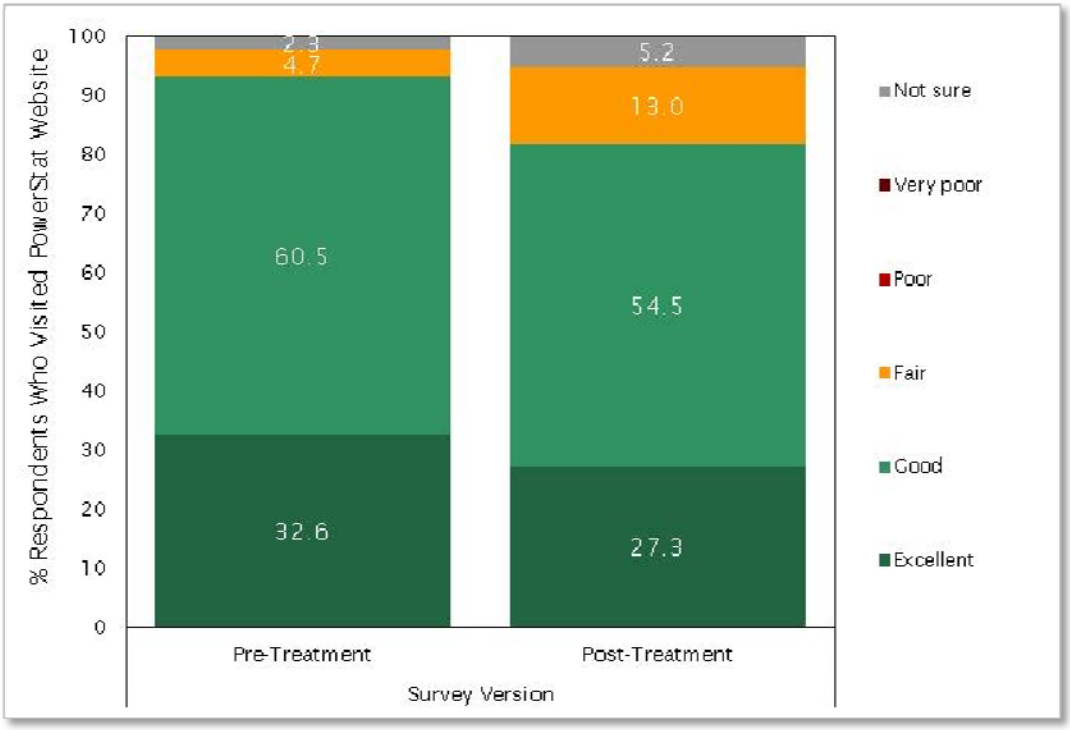
How would you rate the ability to use the PowerStat® website to make temporary adjustments to the current temperature in your home?

When asked to rate the overall quality of the PowerStat® website, 93% of respondents in the Pre-Treatment Survey said it was excellent (33%) or good (61%), and 5% said it was fair. Ratings of the website's overall quality were somewhat lower later in the study with 82% of respondents in the Post-Treatment Survey rating it as excellent (27%) or good (55%), and 13% saying it was fair.

Question 14/19 Pre-Treatment/Post-Treatment

How would you rate the overall quality of the PowerStat® website?

FIGURE 15. OVERALL RATING OF POWERSTAT® WEBSITE



How can the PowerStat® Website be Improved?

The final question in this series asked all customers who had visited the PowerStat® website to provide suggestions for improving the website. Approximately one-quarter (27%) of respondents who had visited the website during the pilot offered an improvement in response to Question 20. Although suggestions varied widely, one of the most common suggestions was the request for mobile applications for phones and tablets. A selection of the verbatim responses is presented below.

Question 20 Post-Treatment

Please briefly describe any specific ways that you think the PowerStat® website can be improved.

- Mobile-enabled website would be helpful. Reverting to built-in t-stat program doesn't always seem to work.

- It has been a great experience overall. I would prefer bigger characters and brighter lights. It is located in the hallway and I need to stand really close to read it.
- I had trouble switching from heat to air conditioning. I did it manually but thought it was automatic, based on the temp of the house and the thermostat settings.
- I had problems when I forgot my password. I am still unable to reset my password.
- Be able to make changes to existing programming even if it wasn't established at the web site.
- Make an app in mobile phone or tablet.
- I would rather have an app for my Smartphone (Windows Phone 7.5) that presents me with all the options instantly, rather than browse to a website and wait for it to download to my phone. It would make it faster and easier for me to interact with my thermostat, and reduce the load on my metered/measured data plan. These same reasons would also provide excellent selling points to other customers.
- It's not the most user friendly site. Try using it as a user and you will see it is not straight forward.
- Could not get it to program while away, that would have been nice.
- Could be used to inform the PowerStat® user in a more precise way the temperature contour that will be remotely controlled by SMUD.
- Providing instructions to remotely access the thermostat.
- Don't quite understand graphs.
- Make available a mobile application.
- Simpler, more intuitive interface, and easier way to make minor adjustments on the fly. Also, mobile friendly.

Customer Service

Satisfaction with the PowerStat® pilot program and perceptions of SMUD could be influenced by a variety of factors throughout the pilot, including the installation process, the quality and functionality of the PowerStat® thermostat and website, temperature comfort level on Event Days, and of course the customer's energy bill. At the completion of the study, Post-Treatment Survey respondents were asked about another important aspect of their experience during the pilot program: customer service.

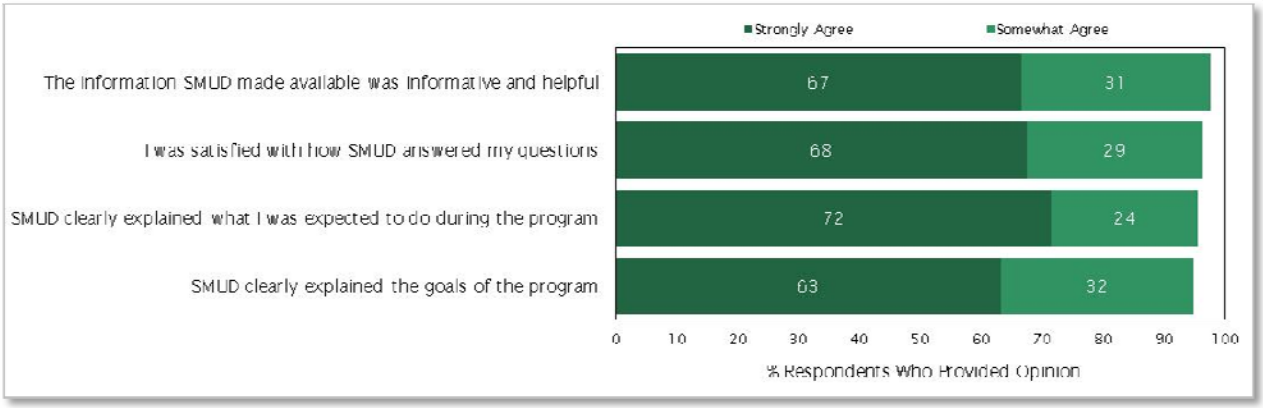
SMUD Customer Service

The Post-Treatment Survey presented respondents with four statements about SMUD's communication and general customer service during the pilot and asked if they agreed or disagreed with each. Figure 16 displays the performance statements tested, as well as the percentage of customers that strongly or somewhat agreed with each statement. As shown in the figure, SMUD received high marks across the board with respect to the customer service it provided during the pilot. At least 95% of customers who provided an opinion agreed with the statements: The information SMUD made available was informative and helpful (98%), I was satisfied with how SMUD answered my questions (96%), SMUD clearly explained what I was expected to do during the program (96%), and SMUD clearly explained the goals of the program (95%).

Question 21 Post-Treatment

Please indicate the extent to which you agree or disagree with the following statements about your experience participating in the PowerStat® pilot program.

FIGURE 16. AGREEMENT WITH STATEMENTS ABOUT CUSTOMER SERVICE



Customer Service Contact & Resolution

The Post-Treatment Survey also included a short series of questions to assess the extent to which customers contacted SMUD and/or Good Cents regarding issues related to the PowerStat® program, and whether or not those issues were ultimately resolved to their satisfaction. Figure 17 on the next page summarizes the findings of these questions. Overall, 12% of customers indicated that they contacted SMUD, and another 12% stated that they contacted GoodCents during the pilot. Among customers who contacted SMUD, 81% said their issues were resolved to their satisfaction and another 6% said their issues were partially resolved. Among customers who contacted GoodCents, 75% indicated that their issues were resolved to their satisfaction and an additional 6% said they were partially resolved. Multiplying the percentages reveals that approximately 2% of pilot participants had reason to contact GoodCents regarding an issue that ultimately was not resolved. The corresponding figure for customers who contacted SMUD was less than 1.5%.

Question 22 Post-Treatment

Did you contact SMUD and/or the installation company (GoodCents) during the past three months about any issue(s) related to the PowerStat® pilot program?

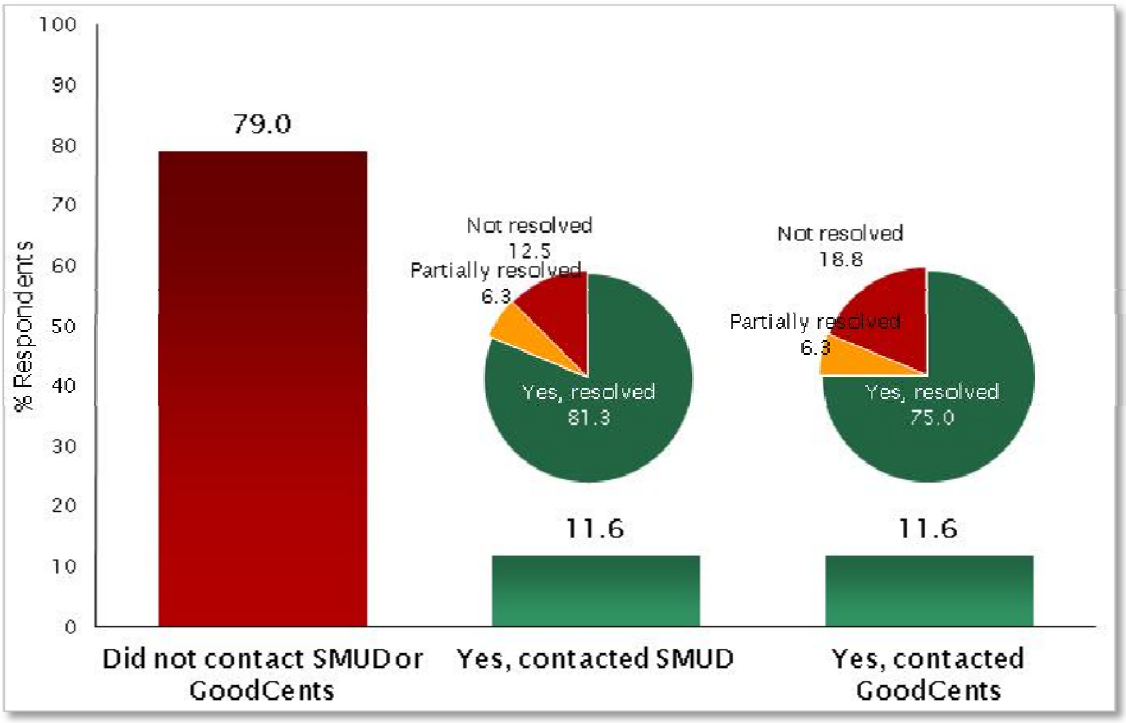
Question 24 Post-Treatment

Was SMUD able to help resolve the issue(s) to your satisfaction?

Question 25 Post-Treatment

Was the installation company (GoodCents) able to help resolve the issue(s) to your satisfaction?

FIGURE 17. CONTACT WITH CUSTOMER SERVICE & RESOLUTION



The 21% of customers who contacted SMUD and/or GoodCents were asked to describe the issue or issues that prompted their contact. Common issues included difficulties accessing the PowerStat® website, questions about/concerns with thermostat programming and temperature settings on Event Days, clarification about the program, and assistance in participating in the online surveys. A selection of the verbatim responses is presented below.

Question 23 Post-Treatment

Please briefly describe the issue(s) that prompted your call to SMUD and/or the installation company (GoodCents) in the text box below.

- Automatically switching between heat and air conditioning, instead of doing it manually.
- Problems getting into the website.
- To replace the thermostat at SMUD direction.

- First time in use, it was off for too long. It was better after I was told how to use it...but we still don't like it to get hotter than 80.
- Initial question about setting the thermostat.
- The programming on PowerStat® days did not work correctly. The 2-4 p.m. cooling did not happen, and from 4-7 p.m. instead of raising the thermostat temperature, the program dropped it to 67 degrees.
- I contacted SMUD because I was not receiving surveys.
- My thermostat was not displaying the actual house temperature, GoodCents tech made a visit and corrected the problem.
- To replace my lost manual.
- Sent e-mail regarding the last survey. Non-issue. Received prompt response. Great service.
- Only at the beginning of the program to learn more about the program.
- Due to home construction postponed one day which did not registered on email. I had to use the phone.
- Realized too late that I was going to be on the power save day and asked that I not be included that particular day, they agreed and all went well.
- My electrical bill went up significantly while in the program and I expected it to go down.
- House got too hot during the day and needed to end the PowerStat® event.
- We were having problems using our password.
- Couldn't find the hold button and then released it was a power stat day so I could not change the temperature.
- I called because I had opted out and it did not work. I also had issues soon after the installation of the thermostat which I thought might be caused by the installation but it was not.
- Thought we had missed a survey.
- I was confused about how to access the website.
- I set the temperature for 74 degrees during all periods day and night. Even though I was told to set the temp for my usual comfort level and that my temp setting would be reduced 3 to 4 degrees during the cool down period by SMUD, the adjustment was not being made on event days. I suspected this occurred because the expectation was that I would set the temp at 78 degrees. Once I reported the problem, the next event worked as represented.

Comfort Level on Event Days

One of the primary goals of this study was to profile customers' experiences on PowerStat® Event Days when SMUD would remotely administer several different precooling strategies to reduce electricity use during peak hours. Put simply, how did the precooling treatments affect customers' comfort levels? Did a particular treatment outperform the others in keeping customers' homes at a comfortable temperature? And how did comfort levels on PowerStat® Event Days compare to the benchmark or natural comfort levels expressed by participants on a normal hot day? Answers to these and related questions are presented in this section.[4]

Opt-Out Feature

The opening question in this series was a screener question designed to identify whether a participant chose to opt out of the treatment on a particular PowerStat® Event Day by overriding the signal using the PowerStat® website. Only customers who received a precooling treatment were asked the subsequent questions in this series regarding their experiences. Across the season, approximately 5% of customers opted out of the PowerStat® Event Day treatments (Figure 18).

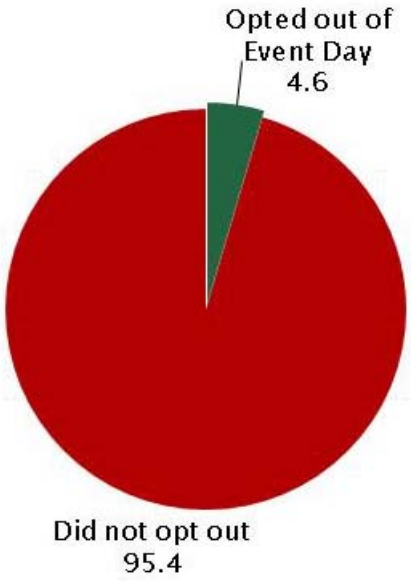
[4] As indicated in the *Introduction* of this report, the precooling strategies were not implemented correctly during the Wave 1 events. Households often experienced far hotter or far cooler temperatures than intended. For this reason, the corresponding survey data from these events is not included in the analyses of this section as it does not accurately capture customers' experiences with the strategies as they were designed.

SMUD™

Question 2 Interim

Did you or someone else in your home choose the opt-out feature on the website to override the signal and return your thermostat to your normal settings on the PowerStat® Event Day?

FIGURE 18. OPTED OUT OF EVENT DAY



Were you at Home to Experience the Event?

In addition to screening respondents based on whether they opted out of the treatment on a given Event Day, the survey also screened respondents to identify whether they were *personally* at home to experience the treatments between the hours of 2PM and 4PM, and 4PM and 7PM, respectively. Only respondents who were at home during these times were asked questions regarding their comfort level during the specified hours.

As shown in Figure 19, 62% of participants surveyed indicated that they were at home for at least 30 minutes between the hours of 2PM and 4PM on the Event Day. As expected, a larger percentage (83%) were at home for at least 30 minutes during peak hours (4PM to 7PM).

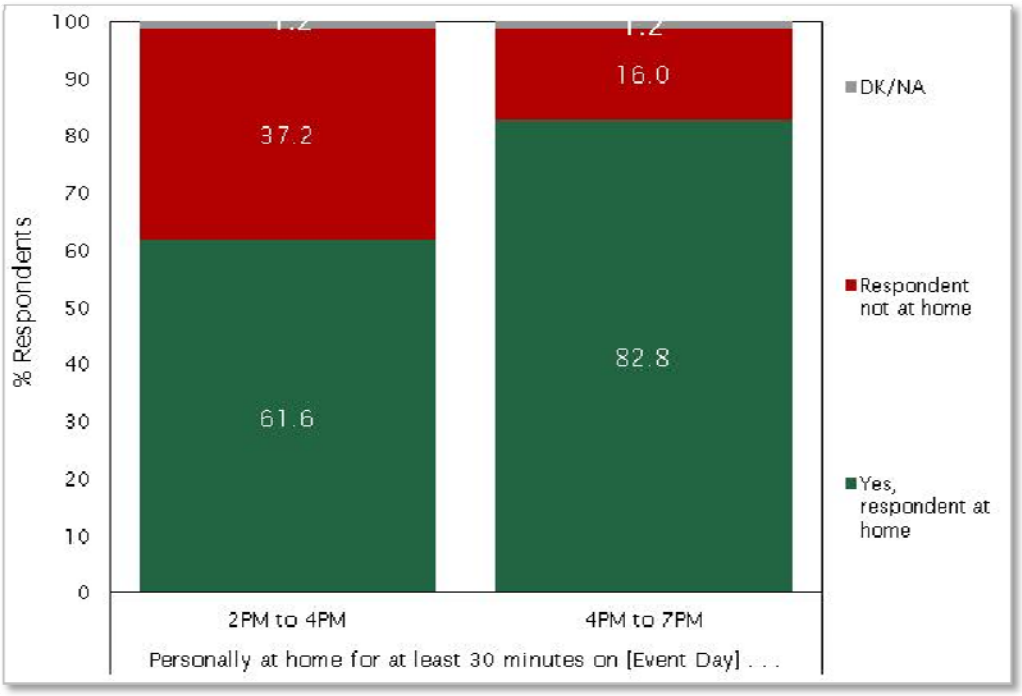
Question 4 Interim

Were you personally at home for at least 30 minutes on [Event Day] between 2PM and 4PM?

Question 6 Interim

Were you personally at home for at least 30 minutes on [Event Day] between 4PM and 7PM?

FIGURE 19. RESPONDENT AT HOME ON EVENT DAY



Respondent Comfort Level Ratings

Respondents who indicated that they were at home during the pre-peak and/or peak hours on a PowerStat® Event Day and chose not to opt out of the treatment were asked to rate the temperature in their home on a five point scale of much too hot, somewhat too hot, about right/comfortable, somewhat too cold, or much too cold for the pre-peak and peak hour periods, respectively. The Benchmark survey captured the same information on a hot summer day when treatments were *not* applied to establish a *benchmark* measure of comfort in a respondent's home. Figure 20 on the next page presents the comfort level findings by pre-peak (2PM to 4PM) and peak (4PM to 7PM) hours, as well as by treatment (benchmark, 6 hour precool, 2 hour precool, no-precool).

As one might expect, comfort levels were greatest during the benchmark episode in which no precooling treatments were applied. During the benchmark survey, the percentage who reported that their house was at a comfortable temperature during pre-peak and peak hours was 90% and 86%, respectively.

Among the three precooling treatments tested, the 6 hour and 2 hour precool strategies produced similar comfort levels in both the pre-peak and peak periods. For the 6 hour pre-cool strategy, 79% indicated that they were comfortable during the pre-peak period, with 67% indicating that they were comfortable during peak hours. The corresponding results for the 2 hour precool strategy were 76% and 69%, respectively. When compared to the other strategies tested, the no-precooling strategy was the least competitive. Comfort levels during the pre-peak period were noticeably lower than the two precooling strategies tested (67%), although the largest differences in comfort could be found during peak hours. Without precooling, the temperatures experienced during the peak period were too hot for many participants, with just 43% indicating they were comfortable and 54% indicating that their home was too hot.

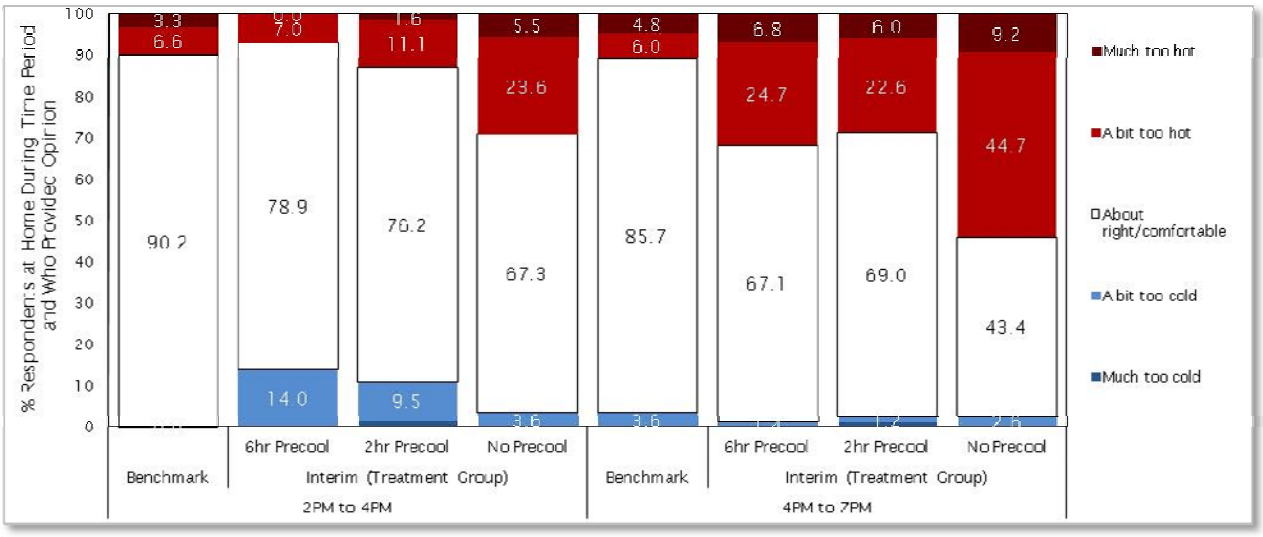
Question 2/4 Benchmark/Interim

How would you rate the temperature in your home on [Benchmark Day/Event Day] between 2PM and 4PM?

Question 4/6 Benchmark/Interim

How would you rate the temperature in your home on [Benchmark Day/Event Day] between 4PM and 7PM?

FIGURE 20. RESPONDENT COMFORT LEVEL ON BENCHMARK & EVENT DAYS



The primary motivation for conducting the Benchmark survey was to measure the natural comfort level in a respondents' home during a normal, hot day. Knowing that a respondent's home is normally a bit hot, for example, provides a better basis for judging the impacts of the precooling strategies on their comfort level than simply *assuming* that they would have otherwise been comfortable.

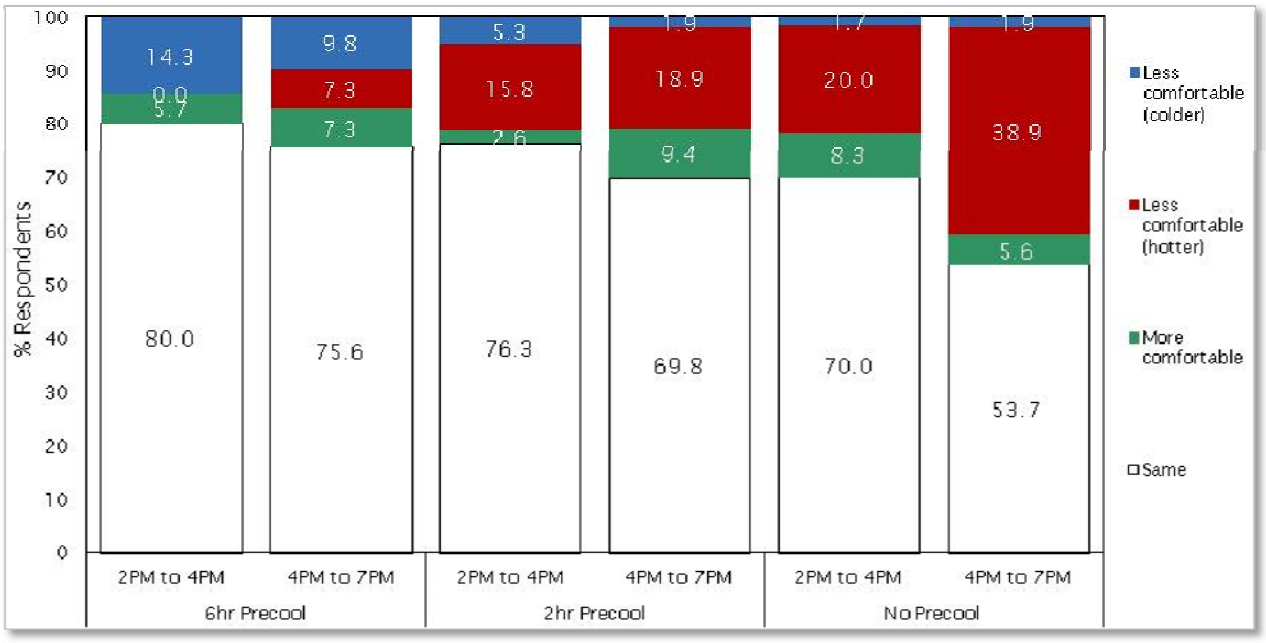
Using each respondents' benchmark comfort level as the baseline, Figure 21 on the next page shows the impacts of the three treatment strategies on the respondents' comfort levels during pre-peak and peak hours, respectively. Note that there is some variation in the results between Figure 20 and Figure 21 that is due to 'missing data' as the analysis in Figure 21 requires data from *both* the benchmark survey and a particular precooling strategy, which means that respondents who did not participate in the benchmark survey are not included in Figure 21.

Overall, the 6 hour precool strategy registered the most favorable response from participants during pre-peak hours, with 80% indicating that the comfort level in their home was the same as normal, and 6% indicating that it was more comfortable than usual. During peak hours, the 6 hour precool strategy also outperformed the others, with 83% indicating that their household was as (76%) or more comfortable (7%) than usual.

The 2 hour precooling strategy was the second-best alternative based on participants' feedback, with 79% indicating it kept their home as (76%) or more comfortable (3%) than usual during pre-peak hours. There was little change during peak hours for this strategy, with 79% again stating that their home was as comfortable as normal (70%) or more so (9%).

The no precool strategy performed similarly to the 2 hour precool strategy during pre-peak hours, with 78% reporting that their home was as comfortable (70%) or more comfortable (8%) than usual. However, during peak hours, less than 60% of participants indicated that their home was as (54%) or more comfortable (6%) than usual when exposed to the no precooling treatment—which is much lower than found with the two precooling strategies.

FIGURE 21. COMFORT LEVEL ON EVENT DAYS COMPARED WITH BENCHMARK

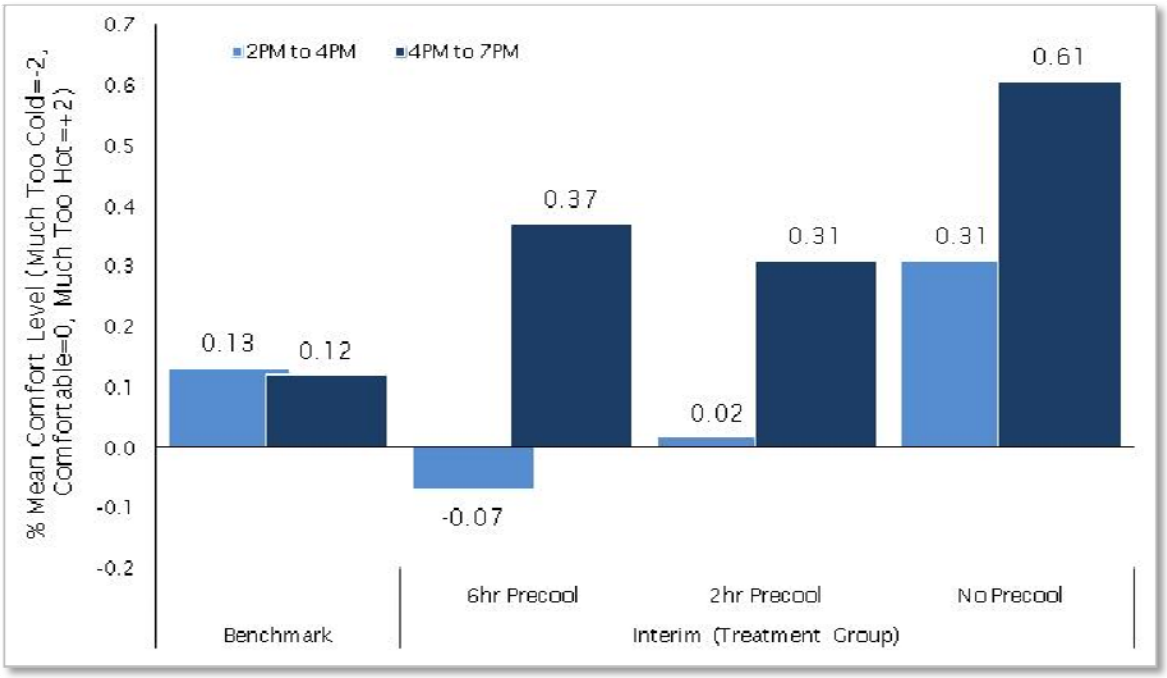


Why Average Comfort Levels are Misleading

Figure 20 displays the percentage results for each response option—much too hot, a bit too hot, about right/comfortable, a bit too cold, and much too cold. Applying an interval scale to these options that ranges from +2 for much too hot to -2 for much too cold, Figure 22 on the next page presents a simplified representation of the findings by displaying the *average* comfort level in each scenario.

The results are somewhat different than those shown in Figure 20, and they underscore the potential hazards of using means or averages to evaluate the various treatment strategies with respect to comfort in the home. The mean comfort levels for 6 hour and 2 hour precooling strategies during pre-peak, for example, are closer to 0 (about right/comfortable) than the benchmark value. Although at first glance it appears that the strategies outperform the benchmark during the pre-peak period, the reality is that this result is achieved by those who felt their house was too cold (- value) offsetting or canceling-out those who felt it was too hot (+ value). We present the Figure 22 graphic to illustrate the point that—in the present case—using mean comfort values to evaluate the precooling strategies is not recommended as it generates misleading results.

FIGURE 22. MEAN COMFORT LEVEL ON BENCHMARK & EVENT DAYS



Statistical Significance Tests

The pilot followed a within-subjects design in which the same individuals were administered different treatments (6 hour pre-cool, 2 hour pre-cool, no pre-cool) on different event days. One of the advantages of a within-subjects design is it eliminates the between-group variance that would occur if each group received a single treatment and comparisons of treatment impacts were made across groups. In short, we have more statistical power to identify significant impacts given the small number of participants in our study using a within-subjects design when compared to a between-subjects design.

With a between-subjects design, the usual significant tests for differences between groups do not apply. As explained above, we also have the added issue of not being able to use mean scores since we have a scale where one can be uncomfortable on either end of the scale (+ or -; hot or cold). Translation: we can't use a repeated measures ANOVA to test for significance.

The appropriate test in this case is a within-subjects chi-square test (McNemar Test) where each treatment strategy is compared against the benchmark levels of comfort in the respondents' households.

These tests revealed a statistically significant difference during peak hours between the benchmark comfort level and the comfort levels reported for the *no precool* strategy. As noted above, a much higher percentage of respondents reported being uncomfortable with the no precool strategy when compared to the other strategies tested—and this difference is statistically significant (<.0001 significance, binominal distribution) despite there being only 58 respondents that had comparable measures.

The tests also revealed a statistically significant difference during peak hours between the benchmark comfort level and the comfort levels reported for the 2 hour precool strategy (.049 significance, binomial distribution), thus indicating that the 2 hour precooling strategy produced comfort levels in participants' homes that were significantly different (less comfortable) than normal.[5]

Meanwhile, the comfort levels registered for the 6 hour precool strategy during peak hours were not significantly different than the levels recorded on the benchmark day.[6] This result reaffirms the previously mentioned finding that the 6 hour precool strategy performed best at keeping the temperature in participants' households at a comfort level similar to that they normally experience on a hot day.

What About Temperature Variation?

Although all PowerStat® Event Days were called on days in which the temperature was expected to be at or above 95 degrees, there was some variation in the temperature from event to event. Across the events that were included in the comfort-level analyses, the high temperature in the Sacramento region ranged from 91 to 96 degrees.

Anticipating this type of temperature variation from event to event, the study was administered in a manner to effectively neutralize temperature as a potential confounding variable when examining the comfort levels associated with each precooling treatment in a simple, bivariate analysis. By using three different treatment groups and administering all three strategies on any given event (one to each group), temperature variation across events is not systematically associated (by chance) with a particular precooling strategy.

Given that thermostats are designed to adjust temperature settings in the home to a preferred setting regardless of outside temperatures, it stands to reason that outside temperature variations would not exert a significant impact on comfort levels inside the

[5]There were 63 participants available for this analysis.

[6]The significance level was 0.118 using 55 participants.

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home. To confirm that outside temperature variations did not exert an independent influence on the comfort levels expressed by respondents on PowerStat® Event Days, True North also conducted a regression analysis on comfort in which temperature was included in the model as an explanatory variable along with each of the treatment strategies. The coefficient for temperature was not substantively or statistically significant.

Comfort Level Ratings of Others in the Home

Although most of the questions related to comfort in the home were focused on the respondent, the survey also asked whether there were others in the home during the peak hours and—if yes—if they made comments about it being too hot or too cold.

Figure 23 on the next page presents the results for the Benchmark survey as well as for each of the precooling strategies tested in the pilot with respect to the comfort levels expressed by others in the home. The results are generally consistent with the personal comfort levels reported by respondents. During peak hours, the *smallest* percentage of others in the home made comments about the home being either too hot or too cold on the benchmark day (12%), followed by the 6 hour precool strategy (27%), 2 hour precool strategy (31%), and the no precool strategy (37%).

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Question 5/9 Benchmark/Interim

Was anyone else in your home on [Benchmark Day/Event Day] between the hours of 4PM and 7PM?

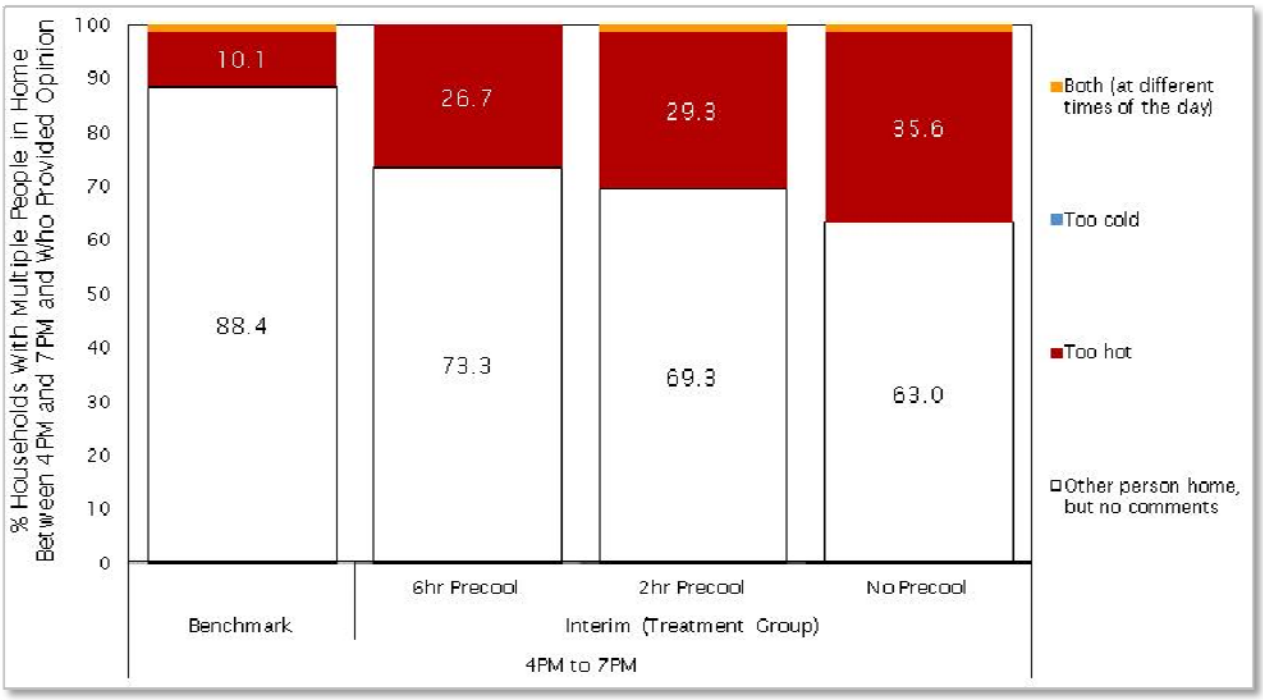
Question 6/10 Benchmark/Interim

Did they make any comments about being too hot or too cold while in your home between 4PM and 7PM that day?

Question 7/11 Benchmark/Interim

Did they say it was too hot or too cold?

FIGURE 23. OTHER PERSON IN HOUSEHOLD COMFORT LEVEL ON BENCHMARK & EVENT DAYS



Attitudes about SMUD

The PowerStat® Pilot program is just one example of the types of innovative programs and services that SMUD offers its customers to help them better manage their energy use, save money, and improve the environment. Awareness of and participation in such programs often contributes to higher levels of customer satisfaction and more positive views of SMUD as a leader in the utility industry, an energy partner, and an active member of the local community[7]. Although the focus of the PowerStat® surveys was on profiling customers' experiences and comfort levels throughout the PowerStat® pilot, one related area of interest was to understand how participation in the pilot may have affected customers' attitudes about SMUD.

Overall Satisfaction with SMUD

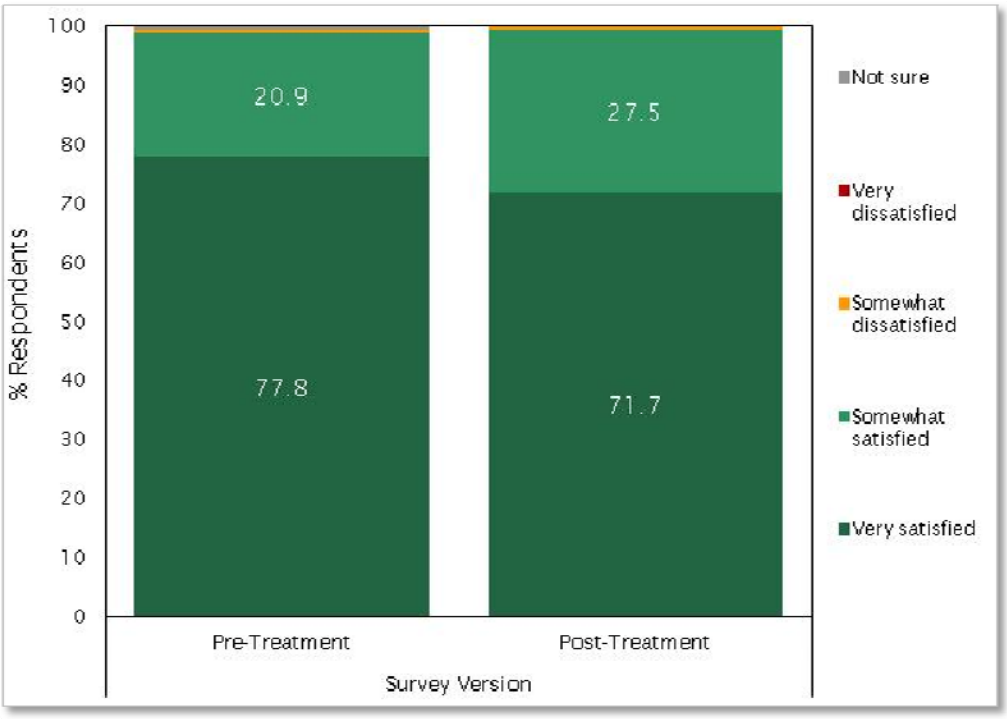
The Pre-Treatment and Post-Treatment surveys asked customers to indicate if, overall, they were satisfied or dissatisfied with the job that SMUD is doing to provide electricity services to their household. Because this question does not reference a specific aspect of service and requested that the respondent consider SMUD's performance in general, the findings of this question may be regarded as an overall performance rating for the agency. Comparing the overall satisfaction ratings with SMUD between the Pre-Treatment and Post-Treatment surveys is an *indirect* way of gauging the impact of pilot participation on respondents' opinions of SMUD's performance in providing electricity services.

[7]Source: SMUD Perception Tracker Study, 2012.

Question 19/26 Pre-Treatment/Post-Treatment

Generally speaking, are you satisfied or dissatisfied with the job SMUD is doing to provide electricity services to your household?

FIGURE 24. OVERALL SATISFACTION WITH SMUD



As shown in Figure 24, at the onset of the study nearly all (99%) of customers indicated they were satisfied with SMUD's efforts to provide electricity services, with more than three-quarters (78%) stating that they were *very* satisfied. Overall satisfaction was virtually identical at the completion of the study, with 99% indicating they were very (72%) or somewhat (28%) satisfied. The differences between the satisfaction ratings pre and post-pilot were not statistically significant.

Impact of Participation on Attitudes about SMUD

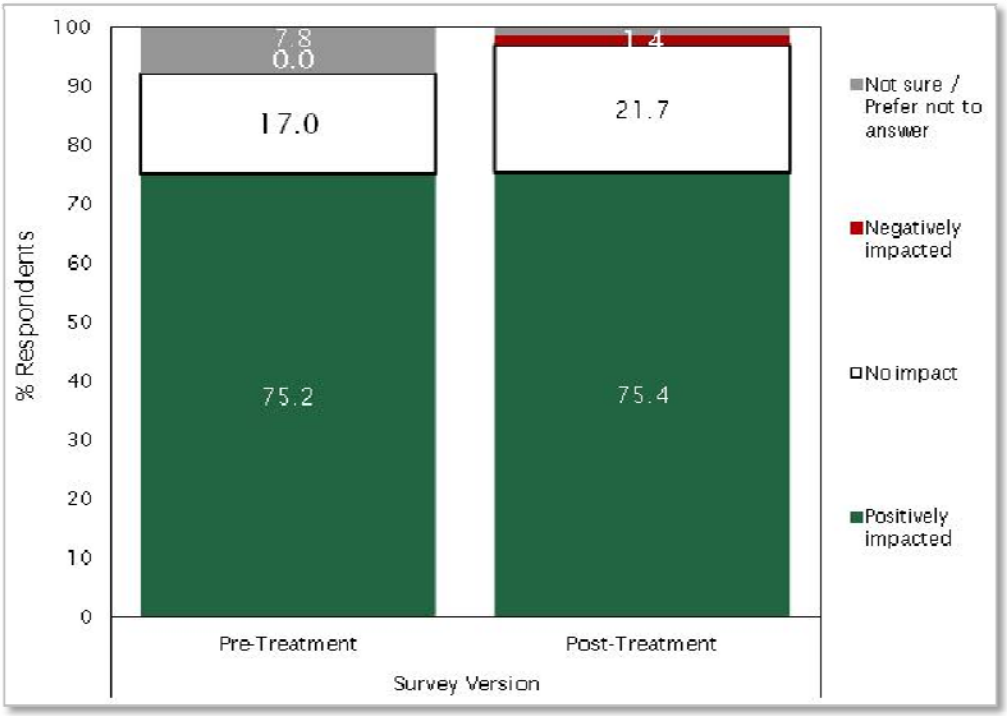
In contrast to the indirect method described above, the surveys also directly asked respondents whether their participation in the PowerStat® Pilot program had impacted their opinion of SMUD in any way. As displayed in Figure 25, three-quarters (75%) of customers surveyed just after installation of their PowerStat® (Pre-Treatment Survey) indicated that their participation in the program to that point had positively impacted their opinion of SMUD, 17% said it had no impact, and the remaining 8% were unsure. Near the completion of the program (Post-Treatment Survey), the findings were nearly

identical, with 75% stating that their participation had positively impacted their opinion of SMUD, 22% said it had no impact, and only 1% felt it had a negative impact. Collectively, the findings of these questions suggest that simply making the pilot program and free thermostat available to these customers had a positive impact for most (75%), and their participation in the pilot after enrollment did not significantly alter their very favorable opinions of SMUD.

Question 20/27 Pre-Treatment/Post-Treatment

Would you say that your participation in the PowerStat® Pilot program has positively impacted your opinion of SMUD, negatively impacted your opinion of SMUD, or has it not changed your opinion either way?

FIGURE 25. EFFECT OF POWERSTAT® PROGRAM PARTICIPATION ON OPINION OF SMUD



Questionnaires

Section 3: Installation Process									
Q3	Were you personally at home when the technician installed your new thermostat?								
	1	Yes				*Ask Q4*			
	2	No				*Skip to Q7*			
	99	Prefer not to answer				*Skip to Q7*			
Q4	Please indicate the extent to which you agree or disagree with the following statements about the installation process.								
	Read in Order		Strongly Agree	Somewhat Agree	Somewhat Disagree	Strongly Disagree	Not Sure	Doesn t Apply	
A	I was able to select an installation appointment time that worked best for my schedule		1	2	3	4	98	99	
B	The technician arrived on-time for the appointment		1	2	3	4	98	99	
C	The technician explained the installation process prior to starting the work		1	2	3	4	98	99	
D	The length of time it took to install the device was reasonable		1	2	3	4	98	99	
E	The work site was left clean after the installation was complete		1	2	3	4	98	99	
F	There was no damage to my property during the installation process		1	2	3	4	98	99	
G	The technician explained to me the basics of how to use the thermostat		1	2	3	4	98	99	
H	The technician explained how to log-on to the Powerstat website		1	2	3	4	98	99	
I	I was provided a clear explanation of what I was expected to do during the program		1	2	3	4	98	99	
Q5	Overall, were you satisfied or dissatisfied with the installation process for your new thermostat?								
	1	Very satisfied				*Skip to Q7*			
	2	Somewhat satisfied				*Skip to Q7*			
	3	Somewhat dissatisfied				*Ask Q6*			
	4	Very dissatisfied				*Ask Q6*			
	98	Not sure				*Skip to Q7*			
	99	Prefer not to answer				*Skip to Q7*			
Q6	Please briefly describe why you were dissatisfied with the installation process. *Insert response in text box below.*								
Verbatim field									

	99	Prefer not to answer	

Section 4: Use & Product Ratings				
The next few questions focus on the thermostat and your experiences when using it.				
Q7	Overall, how would you rate your satisfaction with the new thermostat?			
	1	Very satisfied		*Skip to Q9*
	2	Somewhat satisfied		*Skip to Q9*
	3	Somewhat dissatisfied		*Ask Q8*
	4	Very dissatisfied		*Ask Q8*
	98	Not sure		*Skip to Q9*
	99	Prefer not to answer		*Skip to Q9*
Q8	Please briefly describe why you are dissatisfied with the thermostat. *Insert response in text box below.*			
Verbatim field				
	99	Prefer not to answer		

Q9	Please rate the new thermostat on the following attributes.						
	Randomize. But always have H appear last.	Excellent	Good	Fair	Poor	Very Poor	Not Sure/Doesn t Apply
A	Ease of use	1	2	3	4	5	98
B	Clarity of thermostat operation manual	1	2	3	4	5	98
C	Readability of display	1	2	3	4	5	98
D	Availability of technical support	1	2	3	4	5	98
E	Appearance	1	2	3	4	5	98
F	Keeping my home at a comfortable temperature	1	2	3	4	5	98
G	Ability to program the thermostat using the Powerstat website	1	2	3	4	5	98
H	Overall performance	1	2	3	4	5	98

Q10	Since enrolling in the Powerstat program and receiving your new thermostat, how easy or difficult has it been to keep your home at a comfortable temperature?	
	1	Very easy
	2	Somewhat easy
	3	Somewhat difficult

	4	Very difficult	
	98	Not sure	
	99	Prefer not to answer	

Section 5: Website				
Q11	Have you visited SMUD s Powerstat website: www.SMUD.org/powerstat?			
	1	Yes		*Ask Q12*
	2	No		*Skip to Q15*
	99	Prefer not to answer		*Skip to Q15*
Q12	Have you used the Powerstat website to do the following?			
	Randomize	Yes	No	Prefer not to answer
A	Learn more about the Powerstat program	1	2	99
B	Program your thermostat	1	2	99
C	Review the thermostat operation manual	1	2	99
D	Review the frequently asked questions (FAQ s)	1	2	99
Q13	When you have visited the Powerstat website, were you most often doing so from home, while at work, or from a different location?			
	1	Home		
	2	Work		
	3	A different location		
	99	Prefer not to answer		
Q14	How would you rate the overall quality of the Powerstat website?			
	1	Excellent		
	2	Good		
	3	Fair		
	4	Poor		
	5	Very poor		
	98	Not sure		
	99	Prefer not to answer		

Section 6: Thermostat Comparison			
Q15	When compared to your prior thermostat, would you say that the new thermostat you received through the PowerStat Pilot program performs better, worse or about the same overall?		
	1	Much better	
	2	Somewhat better	
	3	About the same	
	4	Somewhat worse	
	5	Much worse	
	98	Not sure	
	99	Prefer not to answer	
Q16	Prior to receiving your new thermostat, how easy or difficult was it to keep your home at a comfortable temperature when the temperature *outside* was 100 degrees or hotter?		
	1	Very easy	
	2	Somewhat easy	
	3	Somewhat difficult	
	4	Very difficult	
	98	Not sure	
	99	Prefer not to answer	
Q17	During the summer, what temperature is your thermostat normally set at between noon and 4PM?		
Record Temp			
	99	Not sure	
Q18	During the summer, what temperature is your thermostat normally set at between 4PM and 7PM?		
Record Temp			
	99	Not sure	

Section 7: Attitudes about SMUD			
Q19	Generally speaking, are you satisfied or dissatisfied with the job SMUD is doing to provide electricity services to your household?		
	1	Very satisfied	
	2	Somewhat satisfied	
	3	Somewhat dissatisfied	
	4	Very dissatisfied	
	98	Not sure	

	99	Refused	
Q20	Would you say that your participation in the PowerStat Pilot program has positively impacted your opinion of SMUD, negatively impacted your opinion of SMUD, or has it not changed your opinion either way?		
	1	Positively impacted opinion of SMUD	
	2	Negatively impacted opinion of SMUD	
	3	No impact	
	98	Not sure	
	99	Prefer not to answer	

Section 8: Household Information			
Next are a few background questions for statistical purposes.			
Q21	Which of the following best describes your home?		
	1	Detached, single family residence	
	2	Duplex	
	3	Townhome/row house/triplex	
	4	Apartment/condominium	
	5	Mobile home	
	98	Not sure	
	99	Prefer not to answer	
Q22	What is the approximate square footage of your home?		
Record square footage			
	99	Not sure	
Q23	Including yourself, how many people live in your home?		
	1	One	*Skip to Q25*
	2	Two	*Ask Q24*
	3	Three	*Ask Q24*
	4	Four	*Ask Q24*
	5	Five or more	*Ask Q24*
	98	Not sure	*Ask Q24*
	99	Prefer not to answer	*Ask Q24*

Q24	Is anyone in your home less than two years old?		
	1	Yes	
	2	No	
	98	Not sure	
	99	Prefer not to answer	
Q25	Is anyone in your home over the age of 65?		
	1	Yes	
	2	No	
	98	Not sure	
	99	Prefer not to answer	
Q26	During a typical summer weekday, is there at least one person in your home for at least one hour between 10AM and 4PM?		
	1	Yes	
	2	No	
	98	Not sure	
	99	Prefer not to answer	
Thank you for participating in this survey!			

INTERIM VERSION

Q5	How would you rate the temperature in your home on **day**, **date** between **2PM and 4PM**?		
	1	Much too cold	
	2	A bit too cold	
	3	About right/comfortable	
	4	A bit too hot	
	5	Much too hot	
	98	Not sure	
	99	Prefer not to answer	
Q6	Were you personally at home for at least 30 minutes on **day**, **date** between **4PM and 7PM**?		
	1	Yes	*Ask Q7*
	2	No	*Skip to Q8*
	98	Not sure	*Skip to Q8*
	99	Prefer not to answer	*Skip to Q8*
Q7	How would you rate the temperature in your home on **day**, **date** between **4PM and 7PM**?		
	1	Much too cold	
	2	A bit too cold	
	3	About right/comfortable	
	4	A bit too hot	
	5	Much too hot	
	98	Not sure	
	99	Prefer not to answer	
Q8	Was anyone else in your home on **day**, **date** between the hours of **4PM and 7PM**?		
	1	Yes	*Ask Q9*
	2	No	*Skip to Q11*
	99	Prefer not to answer	*Skip to Q11*
Q9	Did they make any comments about being too hot or too cold while in your home between **4PM and 7PM** that day?		
	1	Yes	*Ask Q10*
	2	No	*Skip to Q11*
	98	Not sure	*Skip to Q11*
	99	Prefer not to answer	*Skip to Q11*

Q10	Did they say it was too hot or too cold?		
	1	Too hot	
	2	Too cold	
	3	Both (at different times of the day)	
	99	Prefer not to answer	
Q11	Which of the following best describes the status of your air conditioning unit on **day**, **date?**		
	1	Broken/not in working condition	
	2	In working condition, but turned off	
	3	In working condition and turned on	
	98	Not sure	
	99	Prefer not to answer	

Section 4: Behavior Changes			
Ask Q12 if Q1=1. Otherwise skip to instruction preceding Q13.			
Q12	On **day, date**, did you close the blinds or curtains in your home specifically because it was a PowerStat Event Day?		
	1	Yes	
	2	No	
	99	Prefer not to answer	
Ask Q13 if Q6=2. Otherwise skip to Q14.			
Q13	You mentioned you were not at home between 4PM and 7PM on **day, date**. Were you avoiding being at home because it was a PowerStat Event Day or were you away from your home for a different reason?		
	1	Because it was a PowerStat Event Day	
	2	Different Reason	
	99	Prefer not to answer	

Section 5: Overall Satisfaction			
Q14	In general, how would you rate your overall experience participating in the PowerStat program to this point?		
	1	Very satisfied	*Skip to Q16*
	2	Somewhat satisfied	*Skip to Q16*
	3	Somewhat dissatisfied	*Ask Q15*
	4	Very dissatisfied	*Ask Q15*
	98	Not sure	*Skip to Q16*
	99	Prefer not to answer	*Skip to Q16*
Q15	Please describe the reasons why you are dissatisfied with your experience participating in the PowerStat program so far. *Please insert your comments in text field below.*		
Verbatim field			
	99	Not sure	
Q16	In general, how easy or difficult has it been to keep your home at a comfortable temperature during the past **two weeks** not including PowerStat Event Days.		
	1	Very easy	
	2	Somewhat easy	
	3	Somewhat difficult	
	4	Very difficult	
	98	Not sure	
	99	Prefer not to answer	

Section 6: Thermostat Use			
Q17	Which of the following best describes the way you typically control the temperature in your home?		
	1	I program my thermostat to change temperatures automatically at certain times of the day	
	2	I manually adjust the temperature using the up and down buttons on the thermostat as needed	
	3	I use the thermostat hold feature to keep a certain temperature all the time	
	98	Not sure	
	99	Prefer not to answer	

Thank you for participating in this survey!

BENCHMARK VERSION

TRUE NORTH RESEARCH

SMUD
PowerStat Benchmark Survey
Questionnaire Final Version
November 2012

Section 1: Introduction
Welcome! Thank you for taking this survey about the PowerStat pilot program in which your household is participating. Your individual responses to this and future surveys will be kept strictly CONFIDENTIAL.
Web Instructions: During the survey, please do not use your browser's 'Forward' and 'Back' buttons. To move through the survey, use the 'Back' and 'Next' buttons at the bottom of each page. When you have finished the survey click the 'Done' button to submit your survey. If you need to stop while taking this survey, your answers will be saved so that you may return and resume where you left off. To see the survey most clearly, MAXIMIZE this browser screen.

Section 2: Benchmark Day Comfort			
Q1	Were you personally at home for at least 30 minutes on **day**, **date** between **2PM and 4PM**?		
	1	Yes	*Ask Q2*
	2	No	*Skip to Q3*
	98	Not sure	*Skip to Q3*
	99	Prefer not to answer	*Skip to Q3*
Q2	How would you rate the temperature in your home on **day**, **date** between **2PM and 4PM**?		
	1	Much too cold	
	2	A bit too cold	
	3	About right/comfortable	
	4	A bit too hot	
	5	Much too hot	
	98	Not sure	
	99	Prefer not to answer	
Q3	Were you personally at home for at least 30 minutes on **day**, **date** between **4PM and 7PM**?		
	1	Yes	*Ask Q4*
	2	No	*Skip to Q5*
	98	Not sure	*Skip to Q5*
	99	Prefer not to answer	*Skip to Q5*

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Q4	How would you rate the temperature in your home on **day**, **date** between **4PM and 7PM**?		
	1	Much too cold	
	2	A bit too cold	
	3	About right/comfortable	
	4	A bit too hot	
	5	Much too hot	
	98	Not sure	
	99	Prefer not to answer	
Q5	Was anyone else in your home on **day**, **date** between the hours of **4PM and 7PM**?		
	1	Yes	*Ask Q6*
	2	No	*Skip to Q8*
	99	Prefer not to answer	*Skip to Q8*
Q6	Did they make any comments about being too hot or too cold while in your home between **4PM and 7PM** that day?		
	1	Yes	*Ask Q7*
	2	No	*Skip to Q8*
	98	Not sure	*Skip to Q8*
	99	Prefer not to answer	*Skip to Q8*
Q7	Did they say it was too hot or too cold?		
	1	Too hot	
	2	Too cold	
	3	Both (at different times of the day)	
	99	Prefer not to answer	
Q8	Which of the following best describes the status of your air conditioning unit on **day**, **date?**		
	1	Broken/not in working condition	
	2	In working condition, but turned off	
	3	In working condition and turned on	
	98	Not sure	
	99	Prefer not to answer	

Section 5: Overall Satisfaction			
Q9	In general, how easy or difficult has it been to keep your home at a comfortable temperature during the past **two weeks** not including PowerStat Event Days.		
	1	Very easy	
	2	Somewhat easy	
	3	Somewhat difficult	
	4	Very difficult	
	98	Not sure	
	99	Prefer not to answer	
Thank you for participating in this survey!			

POST-TREATMENT VERSION

TRUE NORTH RESEARCH

SMUD
PowerStat Post-Treatment Survey
Questionnaire Final Version
October 2012

Section 1: Introduction
Welcome! Thank you for taking this survey about the PowerStat® pilot program in which your household is participating. This is the final survey you will be asked to complete as part of the PowerStat® pilot. By sharing your opinions with us, you will help SMUD evaluate the PowerStat® pilot and decide what type of program to offer to customers in the future. Your individual responses to this survey will be kept strictly CONFIDENTIAL.
Web Instructions: During the survey, please do not use your browser's 'Forward' and 'Back' buttons. To move through the survey, use the 'Back' and 'Next' buttons at the bottom of each page. When you have finished the survey click the 'Done' button to submit your survey. If you need to stop while taking this survey, your answers will be saved so that you may return and resume where you left off. To see the survey most clearly, MAXIMIZE this browser screen.

Section 2: Overall Pilot Rating & Impacts			
Q1	In general, how would you rate your overall experience participating in the PowerStat® pilot program?		
	1	Very satisfied	
	2	Somewhat satisfied	
	3	Somewhat dissatisfied	
	4	Very dissatisfied	
	98	Not sure	
	99	Prefer not to answer	
Q2	Do you have any suggestions on how the PowerStat® pilot program can be improved?		
	1	Yes	*Ask Q3*
	2	No	*Skip to Q4*
	99	Prefer not to answer	*Skip to Q4*
Q3	Please briefly describe the one or two changes you think would most improve the PowerStat® pilot program in the text box below.		
Verbatim field			
	99	Not sure	

SMUD™

Q4	In your opinion, how much has participating in the PowerStat® pilot program _____?						
	Randomize	A lot	Some	A little	None	Not Sure	Prefer not to answer
A	Helped you save money on your electric bill	1	2	3	4	98	99
B	Helped you protect the environment	1	2	3	4	98	99
C	Improved your knowledge about ways you can reduce your household s electricity use	1	2	3	4	98	99
D	Reduced the amount of electricity your household uses	1	2	3	4	98	99
E	Given you more control over your electricity bill	1	2	3	4	98	99
F	Motivated you to change your electricity use habits	1	2	3	4	98	99

Ask Q5 if Q4a=(1,2,3). Otherwise skip to Q6.

Q5	In a typical **summer** month, how much have you saved on your electricity bill by participating in the PowerStat® pilot program?	
Dollars.cents		
	98 Not sure	
	99 Prefer not to answer	

Q6	If a friend asked you about the PowerStat® pilot program, would you recommend that they participate?	
	1 Yes	
	2 No	
	98 Not sure	
	99 Prefer not to answer	

Q7	Thinking ahead to ***next*** summer (2013), would you sign up again to allow SMUD to occasionally adjust your thermostat settings to reduce your household s peak-period electricity use?	
	1 Definitely yes	
	2 Probably yes	
	3 Probably no	
	4 Definitely no	
	98 Not sure	
	99 Prefer not to answer	

Section 3: Use & Product Ratings			
The next few questions focus on the thermostat and your experiences when using it.			
Q8	Overall, how would you rate your satisfaction with the new thermostat?		
	1	Very satisfied	*Skip to Q10*
	2	Somewhat satisfied	*Skip to Q10*
	3	Somewhat dissatisfied	*Ask Q9*
	4	Very dissatisfied	*Ask Q9*
	98	Not sure	*Skip to Q10*
	99	Prefer not to answer	*Skip to Q10*
Q9	Please briefly describe why you are dissatisfied with the thermostat. *Insert response in text box below.*		
Verbatim field			
	99	Prefer not to answer	

Q10	Please rate the new thermostat on the following attributes.						
	Randomize. But always have H appear last.	Excellent	Good	Fair	Poor	Very Poor	Not Sure/Doesn t Apply
A	Ease of use	1	2	3	4	5	98
B	Clarity of thermostat operation manual	1	2	3	4	5	98
C	Readability of display	1	2	3	4	5	98
D	Availability of technical support	1	2	3	4	5	98
E	Appearance	1	2	3	4	5	98
F	Keeping my home at a comfortable temperature	1	2	3	4	5	98
G	Ability to program the thermostat using the PowerStat® website	1	2	3	4	5	98
H	Overall performance	1	2	3	4	5	98

Q11	When compared to your prior thermostat, would you say that the new thermostat you received through the PowerStat® Pilot program performs better, worse or about the same overall?		
	1	Much better	
	2	Somewhat better	
	3	About the same	
	4	Somewhat worse	
	5	Much worse	
	98	Not sure	
	99	Prefer not to answer	
Q12	Since enrolling in the PowerStat® pilot program and receiving your new thermostat, how easy or difficult has it been to keep your home at a comfortable temperature?		
	1	Very easy	
	2	Somewhat easy	
	3	Somewhat difficult	
	4	Very difficult	
	98	Not sure	
	99	Prefer not to answer	

Section 4: Website			
Q13	During the past three months, have you visited SMUD s PowerStat® website: www.SMUD.org/powerstat?		
	1	Yes	*Ask Q14*
	2	No	*Skip to Q21*
	99	Prefer not to answer	*Skip to Q21*
Q14	How frequently did you visit the SMUD s PowerStat® website since you enrolled in the pilot program?		
	1	At least two times per week	
	2	Once per week	
	3	Two to three times per month	
	4	Once per month	
	5	Less often than once per month	
	98	Not sure	
	99	Prefer not to answer	

Q15	Have you used the PowerStat® website to do the following?			
	Randomize	Yes	No	Prefer not to answer
A	Learn more about the PowerStat® pilot program	1	2	99
B	Program your thermostat	1	2	99
C	Review the thermostat operation manual	1	2	99
D	Review the frequently asked questions (FAQ s)	1	2	99

Ask Q16 and Q17 if Q15b=1. Otherwise skip to Q18.

Q16	How would you rate the ability to schedule the **wake**, **leave**, **return** and **sleep** temperature settings for your thermostat on the PowerStat® website?	
	1	Excellent
	2	Good
	3	Fair
	4	Poor
	5	Very poor
	98	Not sure
	99	Prefer not to answer

Q17	How would you rate the ability to use the PowerStat® website to make **temporary adjustments** to the current temperature in your home?	
	1	Excellent
	2	Good
	3	Fair
	4	Poor
	5	Very poor
	98	Not sure
	99	Prefer not to answer

Q18	When you have visited the PowerStat® website, were you most often doing so from home, while at work, or from a different location?	
	1	Home
	2	Work
	3	A different location
	99	Prefer not to answer

Q19	How would you rate the overall quality of the PowerStat® website?		
	1	Excellent	
	2	Good	
	3	Fair	
	4	Poor	
	5	Very poor	
	98	Not sure	
	99	Prefer not to answer	
Q20	Please briefly describe any specific ways that you think the PowerStat® website can be improved. *Insert response in text box below.*		
Verbatim field			
	2	No improvements to suggest	
	99	Prefer not to answer	

Section 5: Customer Service

Q21 Please indicate the extent to which you agree or disagree with the following statements about your experience participating in the PowerStat® pilot program.

	Randomize	Strongly Agree	Somewhat Agree	Somewhat Disagree	Strongly Disagree	Not Sure	Doesn't Apply	Prefer not to answer
A	SMUD clearly explained the goals of the program	1	2	3	4	97	98	99
B	SMUD clearly explained what I was expected to do during the program	1	2	3	4	97	98	99
C	I was satisfied with how SMUD answered my questions	1	2	3	4	97	98	99
D	The information SMUD made available was informative and helpful	1	2	3	4	97	98	99

Q22	Did you contact SMUD and/or the installation company (GoodCents) during the past three months about any issue(s) related to the PowerStat® pilot program? *You can check one or both yes options below.*		
	1	Yes, called SMUD	
	2	Yes, called installation company GoodCents	
	3	No	
	99	Prefer not to answer	

Ask Q23 if Q22=(1,2)			
Q23	Please briefly describe the issue(s) that prompted your call to SMUD and/or the installation company (GoodCents) in the text box below.		
Verbatim field			
	99	Prefer not to answer	
Ask Q24 if Q22=1			
Q24	Was SMUD able to help resolve the issue(s) to your satisfaction?		
	1	Yes	
	2	No	
	3	Yes for some issues, no for others	
	99	Prefer not to answer	
Ask Q25 if Q22=2			
Q25	Was the installation company (GoodCents) able to help resolve the issue(s) to your satisfaction?		
	1	Yes	
	2	No	
	3	Yes for some issues, no for others	
	99	Prefer not to answer	

Section 6: Attitudes about SMUD			
Q26	Generally speaking, are you satisfied or dissatisfied with the job SMUD is doing to provide electricity services to your household?		
	1	Very satisfied	
	2	Somewhat satisfied	
	3	Somewhat dissatisfied	
	4	Very dissatisfied	
	98	Not sure	
	99	Refused	

Q27	Would you say that your participation in the PowerStat® Pilot program has positively impacted your opinion of SMUD, negatively impacted your opinion of SMUD, or has it not changed your opinion either way?		
	1	Positively impacted opinion of SMUD	
	2	Negatively impacted opinion of SMUD	
	3	No impact	
	98	Not sure	
	99	Prefer not to answer	
Thank you for participating in this survey!			