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Small Business Demand Response with Communicating Thermostats: SMUD's Summer Solutions Research Pilot

K. Herter, S. Wayland, J. Rasin

Heschong Mahone Group

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Disclaimer

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Abstract

This report documents a field study of 78 small commercial customers in the Sacramento Municipal Utility District service territory who volunteered for an integrated energy-efficiency/ demand-response (EE-DR) program in the summer of 2008. The original objective for the pilot was to provide a better understanding of demand response issues in the small commercial sector. Early findings justified a focus on offering small businesses (1) help with the energy efficiency of their buildings in exchange for occasional load shed, and (2) a portfolio of options to meet the needs of a diverse customer sector. To meet these expressed needs, the research pilot provided on-site energy efficiency advice and offered participants several program options, including the choice of either a dynamic rate or monthly payment for air-conditioning setpoint control.

An analysis of hourly load data indicates that the offices and retail stores in our sample provided significant demand response, while the restaurants did not. Thermostat data provides further evidence that restaurants *attempted* to precool and reduce AC service during event hours, but were unable to because their air-conditioning units were undersized. On a 100°F reference day, load impacts of all participants during events averaged 14%, while load impacts of office and retail buildings (excluding restaurants) reached 20%. Overall, pilot participants including restaurants had 2007-2008 summer energy savings of 20% and bill savings of 30%. About 80% of participants said that the program met or surpassed their expectations, and three-quarters said they would probably or definitely participate again without the $120 participation incentive.

These results provide evidence that energy efficiency programs, dynamic rates and load control programs can be used concurrently and effectively in the small business sector, and that communicating thermostats are a reliable tool for providing air-conditioning load shed and enhancing the ability of customers on dynamic rates to respond to intermittent price events.

Keywords: small commercial, demand response, dynamic pricing, smart thermostats, communicating thermostats, air-conditioning control (ACC), critical peak pricing (CPP)

Executive Summary

Introduction

The Small Business Summer Solutions pilot was a research effort funded jointly by the Demand Response Research Center and the Sacramento Municipal Utility District (SMUD). The research pilot involved a market assessment and focus groups leading up to a summer pilot designed to test the response and perceptions of very small (<20 kW) commercial customers to an integrated energy efficiency and demand response program. This report describes each of these efforts along with a description of the data analysis and final results.

The first effort consisted of reviewing all commercial customer accounts to provide justification for targeting (1) certain customer types in (2) a bounded area smaller than the entire SMUD service territory. For (1), the market assessment report recommended targeting offices, retail stores and restaurants, focusing on customer types that were numerous (offices), high usage (restaurants), and both (retail). For (2), the report recommended an area of the SMUD service territory comprised of seven contiguous zip codes where the small commercial customers had unusually high electricity bills, based on the assumption that these customers were likely to need the most help with energy efficiency.

After the market assessment recommendations were finalized, two focus groups were conducted with target customer types in the target area. In the focus groups, 13 small commercial customers were provided with information about hypothetical air-conditioning control programs and dynamic rate offerings – and were encouraged to discuss their initial perceptions. Participants who preferred the dynamic rate did so because they perceived it to be more flexible, while those preferring air-conditioning control did so because they felt it was less hassle. Despite our initial focus on demand response, the overwhelming lesson we took away from the focus groups was that small commercial customers desperately wanted SMUD to help them with the efficiency of their buildings. Participants mentioned energy audits multiple times, but found SMUD's $300 commercial energy audit fee too onerous for their very small operations. These findings justified a focus on offering small businesses (1) help with the energy efficiency of their buildings in exchange for occasional load shed, and (2) a portfolio of options to meet the needs of a diverse customer sector.

Based on the findings of the focus groups, we designed a marketing plan for the research pilot that emphasized a quid-pro-quo contract: agree to help SMUD by lowering peak load on event days and SMUD will provide individual help with the efficiency of your building. Customers choosing to participate would then have to choose between being placed a critical peak pricing rate and being paid for temperature setpoint increase of either 2 or 4 degrees. Recruitment letters were mailed out to the target population with return postcards and a program website address where letter recipients could find more information and sign up for the pilot. In all 1887 direct mail letters were sent out, 126 responded, and 78 customers ultimately signed up for the pilot, for an overall recruitment rate of 4.2 percent.

In the spring of 2008, communicating thermostats were installed in participant premises, mini-audits were conducted, participants were educated on the thermostat operation and new rate (where applicable), and initial survey data were collected. Between June 1 and September 30, 2008, 12 demand response events were called on days with forecast daily maximum temperatures between 87.7°F and 106.7°F in the Sacramento area. Participants and their thermostats were notified one day in advance. During events, thermostats of air-conditioning control (ACC) participants were set up by 2 or 4 degrees and could not be changed, while thermostats of critical peak pricing (CPP) customers were set up by the number of degrees programmed by the customer and could be changed at any time.

Purpose

The purpose of this study was to investigate the differential responses and perceptions of the target small business customers to different demand response program options and control strategies. Program options included critical peak pricing and remote air-conditioning control, both with a precooling option.

Objective

The objective for this pilot was to provide a better understanding of demand response issues in the small commercial sector, thus allowing SMUD to design programs that benefit both the District and its small business customers.

Project Outcomes

An analysis of hourly load data indicates that the offices and retail stores in our sample provided significant demand response, while the restaurants did not. Thermostat data provides further evidence that restaurants *attempted* to precool and reduce cooling services during event hours, but were unable to because their air-conditioning units were undersized. In contrast, office and retail buildings on both the CPP and ACC programs precooled on event days beginning about 8 a.m., and used significantly less power during events. On a 100°F reference day, load impacts of all participants during events averaged 14%, while load impacts of office and retail buildings (excluding restaurants) reached 20%.

Overall, pilot participants including restaurants had 2007-2008 summer energy savings of 20% and bill savings of 20% to 30%. About 80% of participants said that the program met or surpassed their expectations, and three-quarters said they would probably or definitely participate again without the $120 participation incentive.

Some of the other important outcomes of this study include:

Recruitment. Offices and retail were about twice as likely to sign up for the pilot as were restaurants. Restaurant owners in focus group indicated that lowering energy usage between 4 and 7 p.m. would be difficult because it overlapped the peak dinner hours. In addition, air-conditioning was considered a non-discretionary load for most restaurants, who constantly battled heat generated from cooking and refrigerator exhaust.

Efficiency. Compared to the summer of 2007, pilot participants saved 20% more energy than a control group (after normalizing for weather).

Demand Response. Offices and retail stores on both the ACC and CPP programs had the greatest demand response of between 0.6 and 0.8 kWh/h, averaging 20% peak load reduction during events. Participating restaurants modified setpoints in response to events, but load reductions were not realized because the AC units, running flat out, could not maintain requested temperatures.

Communicating Thermostats. On average, participants with communicating thermostats dropped nearly four times as much peak load as those without them.

Bill Impacts. All but four of the CPP participants benefited from the CPP rate relative to the standard small business rate. Average CPP bill savings were 5 percent for all three business types. Note that these savings are *in addition* to the energy efficiency savings discussed above.

Precooling. The pilot significantly increased the use of precooling among participants. Despite precooling, total participant usage did not increase on event days.

Overrides. About 3 percent of ACC participants overrode the event settings during events, and about 5 percent of CPP participants modified their own default thermostat setpoint during events.

Satisfaction Rate. About 80 percent of participants said that the program met or surpassed their expectations. About three-quarters said they would probably or definitely participate again without the $120 pilot participation incentive.

Communications Technology. The communications technology (Radio Data System or RDS) successfully broadcast system alerts to automatically adjusting thermostat setpoints in near real time.

Conclusions

Despite the small number of participants in the study, customer responsiveness and comprehension with the pilot program was high. We found the Summer Solutions research pilot to be a three-way win, benefiting SMUD, pilot participants, and society in general: SMUD benefited by receiving 20% peak load reductions on event days, participants benefited from 20% to 30% lower bills, and society benefited from the 20% energy-efficiency savings. Given the current pace of communicating thermostat evolution and cost reductions associated with the technology recently noted in the industry, we expect a Summer Solutions type program that includes communicating thermostats to be one of the most popular and possibly most cost-effective demand response options available for small businesses.

Recommendations

We learned many lessons over the course of this study – some expected, some not. Below are a few recommendations for future programs and pilots based on our experience with this study.

- Utilities should not hesitate to target the small commercial sector, in particular small offices and retail shops, for integrated EE-DR programs
- Demand response programs should provide participants with energy efficiency assistance – especially envelope enhancements
- Small commercial demand response program offerings should give customers a choice between a dynamic rate and load/temperature control
- SMUD should seriously consider expanding this voluntary program offering to all of their small commercial customers (following a cost-effectiveness study)

Benefits to California

This study provides California State policy makers with evidence that dynamic rates and load control programs can be used concurrently and effectively in the small business sector. This study also informs California State energy agencies that it is possible to use Radio Data System communications technology to broadcast system alerts to the mass market in support of dynamic rates, demand response programs, and utility service messages. This last capability would exist even in the event of a power outage. Finally, this study provides further evidence that communicating thermostats are a viable demand response technology, capable of automatically increasing setpoints to a either a customer-determined or utility-determined level, thus providing air-conditioning demand response within seconds or just a few (less than five) minutes.

1.0 Introduction

1.1. Background

Demand Response programs have existed in California for several decades. Since California's energy crisis in 2000 and 2001, improving electric demand response through incentive programs and rate adjustments has become a priority at both the state and federal levels. For example, the U.S. Energy Policy Act of 2005 requires utilities and state legislators to consider time-varying rate options, and required the Federal Energy Regulatory Commission to hold hearings investigating demand response programs and advanced metering technologies.

Several different demand response incentive structures exist, though two are of particular interest, having previously been studied and piloted by several utilities. Since the 1980's, utilities have offered Direct Load Control (DLC) programs, most notably air-conditioning control (ACC), which offer payments in exchange for intermittent reductions in customer air conditioning via switches remotely controlled by the utility. Recent plans to install advanced metering infrastructure in many utilities in California have sparked increased interest in encouraging demand response through dynamic pricing like Critical Peak Pricing (CPP), which provides time-varying price incentives for customers to reduce their own electricity use – manually or through the use of enabling technologies that can sense and respond to the variable rate.

A recent study in California showed that small commercial customers with enabling thermostats dropped 13 percent of their peak load in response to Critical Peak Pricing events (CRA 2005). Even so, small commercial customers can be complicated targets for demand response programs and tariffs. Customers tend to be fairly heterogeneous, have limited time and money to devote to energy management, and are skeptical about the possible tradeoffs between money saved and business lost. As a result, the small commercial sector has been relatively unaddressed by energy demand response research, and very few demand response programs are offered to this sector.

1.2. Project Scope and Goals

The goal for this pilot is to provide a better understanding of demand response issues in the small commercial sector, thus allowing SMUD to design programs that benefit both the District and its small business customers.

The pilot program was intentionally offered on a voluntary basis so that results would be representative of a voluntary program. The results are not intended to be statistically representative of the entire small commercial sector.

1.3. Project Overview and Schedule

The first part of the study identified small commercial customers most likely to participate in and respond to demand response programs and events. The results of this investigation targeted offices, retail, and restaurants as good candidates.

The second part of the study consisted of focus groups, which investigated, among other things the extent to which interactions of the various players (business owners, business managers, building owners, and/or building occupants) might affect demand response program participation and response. Also discussed were issues related to demand response capabilities at small businesses. The results of this work were used to refine the design and implementation of the field study.

The field study – known to participants as the Small Business Summer Solutions Research Pilot – was implemented in the Sacramento Municipal Utility District (SMUD) during the summer of 2008. The field study was designed to investigate the differential responses and perceptions of small businesses customers to different demand response program options and control strategies, comparing the three business and two program types in terms of load impacts and satisfaction with the program.

Table 1 outlines the major phases of project activity in 2008 and describes corresponding research tasks.

Table 1. Summer Solutions Research Schedule, 2008

Task	Dates	Research Actions
Recruitment	Feb – Mar	• Mail out recruitment letters • Collect signed Participation Agreements with program choice indicated
Participant Preparation	Mar – May	• Install, program and test thermostats and loggers • Distribute participation incentives, information packets, display placards, and magnets • Spring Survey: collect information on buildings and businesses • SMUD installs meters
Field Study	Jun – Sep	• Ongoing data collection from meters and loggers • Call 12 events • Event Surveys: collect information on experience with most recent event
Data Collection and Analysis	Oct – Dec	• Retrieve logger data from sites • Get billing and meter data from SMUD • Fall Survey: collect information on experiences with pilot • Analysis of quantitative and qualitative data streams, individually and linked

2.0 MARKET RESEARCH

The Sacramento Municipal Utility District (SMUD) was established in 1946 and is currently the nation's sixth largest community-owned electric utility in terms of customers served. SMUD serves over half a million customers in Sacramento County, spanning 900 square miles. Peak demand for the SMUD system, measured on July 24, 2006, was 3.3 gigawatts.

Figure 1 shows the location of the SMUD service territory, forecast climate zone 6, in relation to the state of California.

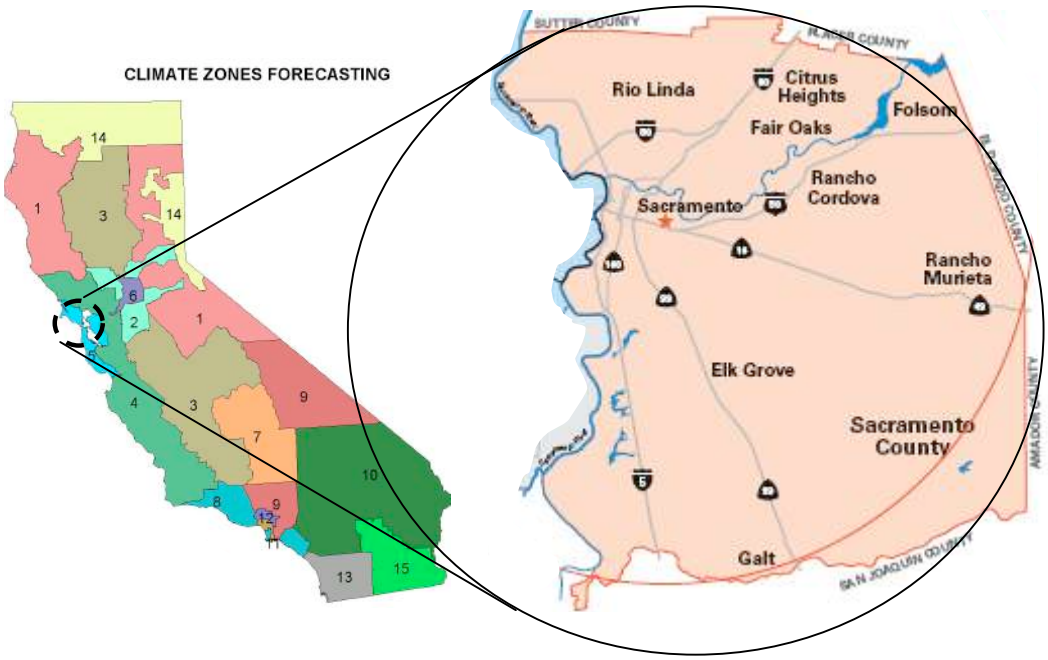

Figure 1. SMUD service territory

SMUD has over 30,000 accounts on the small commercial tariff, known within SMUD as the GSN tariff. To qualify, commercial customers must maintain a monthly maximum peak demand below 20 kW. Customers with peak demands above 20 kW for three or more consecutive months are automatically bumped into the 20-200 kW tariff, known as the GSS tariff.

SMUD's current demand response program portfolio includes the following:

- Peak Corp, Air Conditioning Load Management – More than 100,000 of SMUD's residential customers receive modest incentives (about $10 per year) to allow the District to cycle off their air conditioner under emergency conditions.
- Voluntary Load Curtailment – At SMUD's request, businesses voluntarily drop load during critical hours. There are no financial benefits or penalties and no metering of load drop.

- Special Curtailment Agreements – Through contracts, large commercial customers agree to reduce a specified amount of load when called, in return for specified incentives.

Small commercial customers are highly underrepresented in these demand response programs. In fact, of SMUD's demand response programs, only one - the Voluntary Load Curtailment program - allows small commercial customers to participate. Given the voluntary nature of the Voluntary Load Curtailment program, however, it is safe to say that none of the existing demand response programs at SMUD give small commercial customers the opportunity to earn or save money by dropping load on critical days.

2.1. Target Businesses and Area

The goal of the market assessment was to choose a target subset of the small commercial population that would be likely to respond well to demand response programs, thus improving overall program cost-effectiveness.

2.1.1. Business Types

Table 2 shows summary characteristics, as of July 2007, of SMUD's small commercial customers divided into the eleven building types developed by the California Energy Commission. Based on these values, offices, restaurants, and retail stores were chosen as the target population for this pilot as described in the following sections.

Table 2. Small commercial customer characteristics by building type, July 2007

Building Type	Customers	Avg. Usage (kWh)	Avg. July 2007 Bill
College	78	1,455	$ 166
Food/Liquor	297	3,116	$ 348
Health Care	258	1,889	$ 213
Hotel	45	1,666	$ 191
Miscellaneous	3,911	1,445	$ 165
Office	14,989	945	$ 110
Refr Warehouse	91	2,045	$ 231
Restaurant	763	3,827	$ 426
Retail Store	1,811	1,746	$ 199
School	368	1,434	$ 162
Warehouse	840	1,341	$ 155
Not specified	7,400	953	$ 111
Grand Total	30,851	1,179	$ 136

Office Buildings

Office buildings comprise about half of SMUD's small businesses. On average, the small offices have lower energy use and summer bills than other business types. In aggregate, however, peak energy use is likely to be substantial simply because there are so many small offices. One

concern at this stage was whether offices - which are likely to shut down operations at 5 or 6 p.m. - would contribute savings after hours.

Restaurants

Restaurants have the highest energy use and, correspondingly, the highest electricity bills. These businesses are likely to have large amounts of refrigeration running 24 hours a day, seven days a week and additionally run air conditioning during business hours. On one hand, restaurants could be good candidates for demand response programs because they have such high load and high bills. On the other hand, this high load might not be considered discretionary since system peaks tend to occur precisely when restaurants need to prepare and serve dinner.

Retail

Like offices, retail stores are likely to have very little energy use outside of business hours, but high air conditioning use on summer afternoons and evenings. Unlike offices, however, most retail stores continue business operations past 5 or 6 p.m. Electricity bills for retail businesses are moderate to high, so one might hypothesize that they are more likely than offices to be interested in programs promising lower bills or rewards, particularly in instances when their profit margins are low to moderate. Thus, retail stores were also good candidates for thermostat-based demand response programs.

Other building types

The remaining building types are less desirable for demand response programs for a variety of reasons.

The miscellaneous and uncategorized businesses are likely to be too diverse to reach any general conclusions. This is not to say that the miscellaneous category does not have demand response potential, but that a behavioral study is probably not appropriate. Should a better-defined sub-categorization of the miscellaneous category be created, there are likely to be sub-categories with excellent opportunities for behavioral research.

Small colleges, hotels and warehouses are so few that an in-depth study would not provide much potential for broad use of lessons learned.

Health care and schools, while potentially good candidates for demand response programs, are in aggregate likely to have lower peak energy use than the business types we have chosen for this study.

2.1.1 Geographic Location

Because this study involved several visits to participant premises, the study sample was limited to as small a geographic area as possible. After a careful analysis of customer populations and bills by zip code, seven contiguous zip codes were chosen as the target area as shown in Figure 2.

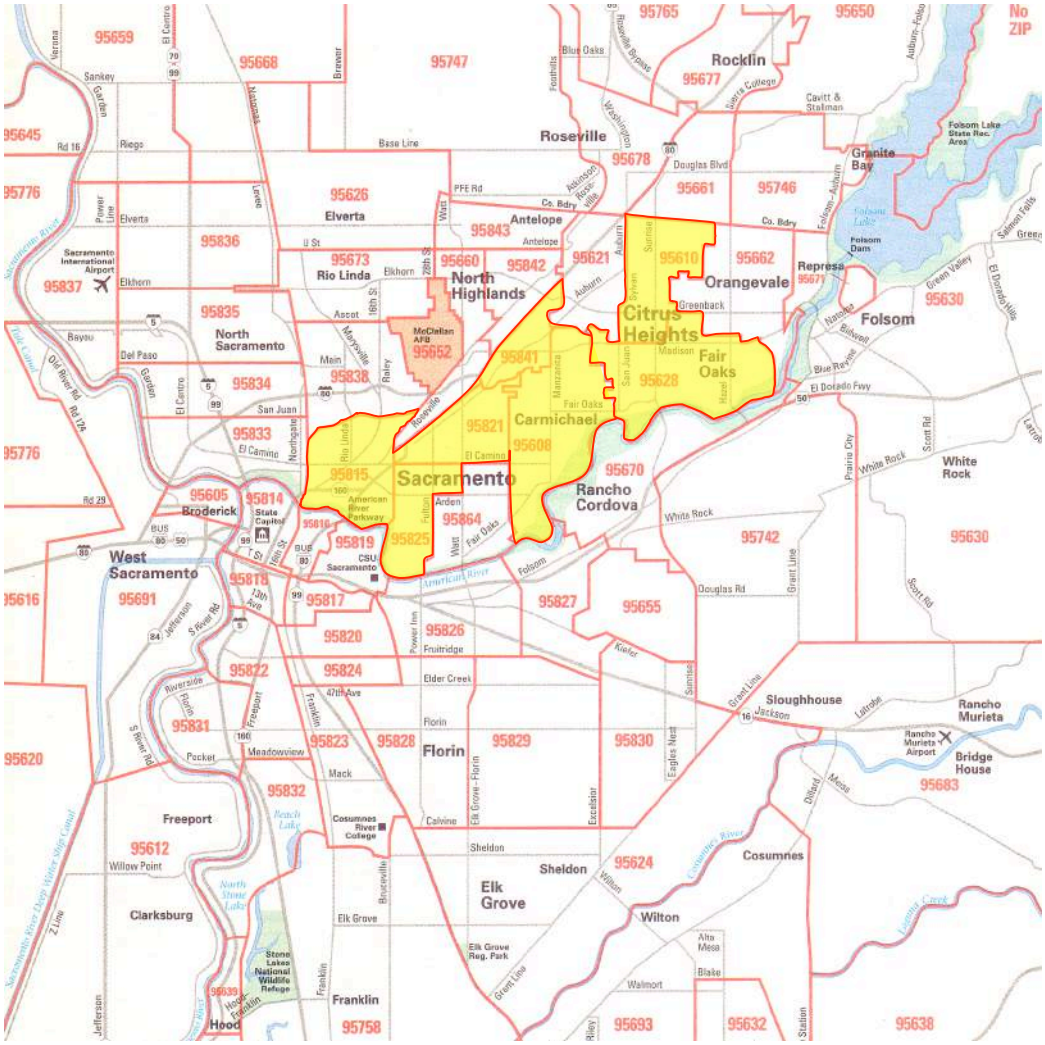

Figure 2. Target zip codes in the SMUD service territory

Table 3 summarizes the total number of small business customers in each target zip code.

Table 3. Number of businesses in the target area, by zip code

Zip Code	Office	Restaurant	Retail Store	Total
95608	1127	57	88	1282
95610	956	61	113	1149
95628	745	45	72	870
95815	238	15	97	354
95821	814	37	101	970
95825	1397	59	145	1613
95841	774	37	136	961
Total	6051	311	752	7199

2.2. Focus Groups

The purpose of focus groups in this study was to collect information from real customers to refine the research design. Two focus groups were held with a total of 13 customers: 5 retail, 4 offices, and 4 restaurants.

Generally, we found that focus group participants were eager to partner with SMUD, both to learn about energy saving measures and to help SMUD with peak load issues. Energy audits were unanimously popular, but costs were perceived to be high and benefits uncertain. One idea was that SMUD should consider offering very simple and discounted on-site audits for small commercial customers, using the contact opportunity to recruit for both energy efficiency and demand response programs.

When presented with a general description of demand response program goals and characteristics, nearly all participants were confident they could provide some load relief during critical events. Program characteristics that increased the likelihood of participation included options for controlled end-uses and event timing, both time of day and length of event.

Participants were presented with the options of air conditioning load control and dynamic pricing under the assumption that both would provide similar discounts. Those preferring the dynamic pricing option considered it more flexible with respect to affected appliances and ability to not respond on certain days. Concerns with the dynamic pricing program revolved around an unwillingness to manually control appliances in real time. Those preferring the air conditioning control program said they thought it would be less hassle, but there were concerns about allowing the utility to control the air conditioning.

In both focus groups, there were also concerns that the utility would collect information about the customer through the communicating thermostat. This discussion implied that, when informing participants about the program, emphasis should be placed on the fact that the thermostat will not send any customer data to SMUD without the customer's permission.

Participants expressed interest in options that provided the flexibility small commercial customers might need to commit to reducing peak load: for example, flexibility in how much, how often, at what time, and for how long customers need to respond.

For the Critical Peak Pricing program, focus group participants stressed the importance of being provided information about what kinds of actions would provide the biggest benefit. This implies that there should be some translation from appliance use to energy use to costs and savings.

3.0 FIELD STUDY IMPLEMENTATION

The target customers were offered participation payments, recognition, energy efficiency recommendations and free thermostats in exchange for their participation in the Small Business Summer Solutions Research Pilot. During the four-month experiment from June through September 2008, we chose twelve days to call demand response events, which occurred during SMUD's peak period from 4 to 7 p.m. All participants had the option to have installed a free communicating thermostat that could be programmed to pre-cool their building in the hours before an event and increase AC temperature setpoints during the event periods.

3.1 Participant Benefits

Benefits of the pilot included:

- *Efficiency information.* The pilot provided participants with several sources of information - via site visits, websites and brochures - on best practices and rebates.
- *A $120 participation payment,* distributed in two $60 installments, one at the beginning and one at the end of the study.
- *A new thermostat installed for free*. Customers received a new Programmable Communicating Thermostat and had it installed for free if they wanted. Benefits of the thermostat include: ability to program up to four set points per day (each day can be scheduled independently) and the option of automatic pre-cooling on event days. The thermostats also provided notification of events on the thermostat screen and AC temperature reset.
- *A display placard* indicating participation in the pilot (Figure 3).
- *The opportunity for lower energy bills* by shifting load out of the peak period into cheaper periods, or by conserving during events and overall.
- *Good will*. Partaking in demand response can give customers the feeling that they are doing their part for the environment and to help reduce strain on the electric grid during peak times, improving electric reliability for everyone.

Figure 3. Display Placard distributed to participants

3.1. Program Options

The Small Business Summer Solutions Research Pilot offered two electric tariff options, allowing participants to choose the one that best suited their business needs. In both cases, 12 demand response events were called between June 1 and September 30, 2008, when the pilot tariffs were in force. The two programs were designed to offer roughly equivalent benefits assuming similar customer load drop during these events.

3.1.1 Critical Peak Pricing (CPP)

The CPP option used a Time of Use rate to reward efficiency or load shifting every day, plus a Critical Peak component to reward load shifting and temporary load reductions during events.

Table 4 summarizes the experimental CPP tariff and compares it to the existing small business rate (GSN).

Table 4. CPP tariff compared to the standard small commercial rate

Price Tier	Time Period	GSN ($/kWh)	CPP ($/kWh)	Hours per Summer	% of Time
Critical peak	12 Event weekdays 4:00 P.M. - 7:00 p.m.	$ 0.113	$ 0.572	36	1%
Super peak	Normal Weekdays 4:00 p.m. - 7:00 p.m.	$ 0.113	$ 0.131	219	8%
On peak	All Weekdays 12:00 p.m. - 4:00 p.m.	$ 0.113	$ 0.099	881	31%

	7:00 p.m. - 10:00 p.m. Weekends & Holidays 12:00 p.m. - 10:00 p.m.				
Off peak	All Other Hours	$ 0.113	$ 0.085	1708	60%

On weekdays, the experimental CPP rate was lower than the GSN in all hours except for the three-hour peak period. On weekends and holidays, the experimental rate was lower than the existing rate for all hours of the day, so businesses that were open on the weekend could take advantage of these low rates.

During the 12 event days, participants were charged 57.2 cents per kilowatt-hour (kWh) during peak hours. During this time, participants were asked to reduce electricity use in any way that made sense for their business. Focus groups participants suggested that restaurants might lower the lighting during this time, while offices or retail might prefer to reduce the air conditioning load slightly.

The optional communicating thermostats allowed participants to automatically pre-cool their buildings before the event hours, and then increase the set point at the onset of the event period. CPP participants were allowed to choose the default temperature offset for events and to change thermostat set points at will during events.

3.1.2 Air-Conditioning Control (ACC): 2 or 4 Degrees

Participants choosing the ACC program stayed on their original flat GSN rate (see

Table 4), but received a $5 or $10 monthly credit on their bill in exchange for a 2- or 4-degree offset, respectively, during demand response events. ACC participants were required to have a thermostat or thermostats installed and programmed to respond to events. Participants were told that they were not allowed to override the event settings – but overrides were technically feasible; i.e., the thermostats would allow the user to change event settings after answering affirmatively to an "Are you sure?" screen. All overrides were recorded for later analysis.

3.1.3 Precooling Option

All participants had the option to program their communicating thermostat to automatically pre-cool their building by four degrees in the four hours preceding events. The pre-cooling strategy could be enabled or eliminated by the user at any time.

3.2. Meters and Enabling Technologies

3.2.1 Communicating Thermostat Hardware

The communicating thermostat hardware enabled precooling and temperature offsets on event days for both programs, and recorded several variables for analysis. The thermostat hardware consisted of four main parts: the thermostat display unit, the control unit, an FM receiver, and a data logger.

Communication to the thermostats was accomplished using Radio Data System or RDS. RDS utilizes a 57 kHz subcarrier of the standard FM broadcast system to carry data at over 1,000 bits per second. The system was originally designed to send data related to musical broadcasts, including time, artist information and station identification. For this study, Sacramento radio station KXJZ (90.9 FM) provided the RDS transmission to the communicating thermostats.

The communicating thermostat was custom made based on the Residential Control Systems TR40, a thermostat currently available in the retail market (Figure 4). The TR40 has a menu-driven display capable of both text and graphics on multiple display screens.

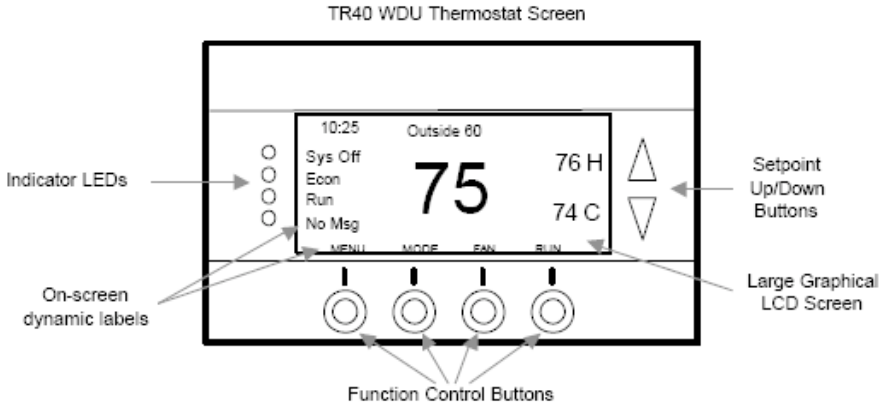

Figure 4. Residential Control System's TR40 Display Unit

The controller for the TR40 is separate from the display, and is connected to the thermostat wire at any point between the HVAC unit and the display. A removable RDS receiver was connected to the controller through the logging unit, which collected information about set points, schedules, compressor status and indoor temperatures.

A total of one hundred Residential Control Systems thermostats were available for this study. All thermostats, receivers, and loggers were tested by Residential Control Systems prior to installation to ensure proper operation. The thermostats received an RDS signal indicating event start and stop time, which was always 4 to 7 p.m., and responded to these event calls according to their tariff design and programmed settings. CPP participants could have one or no thermostat. ACC participants were required to replace all thermostats in the building and were held to a maximum of two.

3.2.2 Meters

SMUD installed interval meters and provided HMG with a list of meter numbers linked to each pilot participant. On installation, SMUD began collecting 15-minute usage data via their MV-90 remote data collection system.

3.3. Recruitment and Participation

The goal of the marketing strategy for the pilot was to recruit a final sample of one hundred participants by the end of February 2008. The market analysis recommended that SMUD focus efforts for the demand response pilot on offices, restaurants, and retail businesses. These business types are not evenly represented in the small business population. To maximize validity within each category, the target sample size was set at 33 businesses of each type.

Table 3 shows the final recruitment and participant numbers, by business type. Since the number of recruitment letters is equal to all of the small business customers in the target area, these numbers represent the actual business type ratios for that area and are similar to district-wide ratios. At 4.2%, the participation rate for this voluntary program offering was unexpectedly high when compared to participation rates for similar time-of-use offerings, which tend to be around 1 or 2 percent. Note that the participation rates for office and retail are direct results of recruitment letters only, while the participation rate for restaurants was more than doubled by face-to-face recruitment efforts initiated when it became clear that restaurant participation goals would not be met.

Table 5. Participation agreements and rate, by business type

Building Type	Recruitment Letters	Participation Agreements	Participation Rate
Office	893	35	3.9%
Retail	729	31	4.3%
Restaurant	265	12*	4.5%
Overall	1887	78	4.2%

* Includes seven participants recruited in person

3.3.1 Recruitment Procedure

Recruitment letters were the primary strategy to inform the potential participants of the opportunity to sign up for the pilot. SMUD mailed out the 1,887 letters describing the project, customer value, and customer responsibility, and directed customers to indicate their interest by responding with a few basic pieces of information via postcard, phone, or online.

- The letter conveyed the following basic messages:
- That the targeted customers are part of a group special for being small business customers with unusually high electricity bills.

- That the District is offering participation in this pilot both to help them reduce their own bills and to test the program for expansion to other customers.
- That the District will provide participants with several benefits, including a free thermostat, personalized energy information, $120 in cash incentives, and the opportunity to save money on their bills.
- That the participants will help reduce the frequency of emergency conditions, and the need for rotating outages when emergency conditions do occur.

Those who agreed to participate were subject to a few questions to verify eligibility and were then sent a participation agreement. The agreement required that the person named on the SMUD account choose a program option and sign the agreement.

A small response from restaurants required follow-up phone calls and site visits to eligible restaurants. While the extra effort did roughly double the number of participating restaurants to 12, the target population of 33 restaurants was not achieved.

Screening

Four screening criteria were used to limit the database of over 30,000 small commercial customers to the final 1,887 potential participants as follows.

Include zip codes 95608, 95610, 95628, 95815, 95821, 95825, 95841.

Include Offices, Restaurants, and Retail.

1. Excluded NAICS codes 531110, 531120, 531190 – codes indicating property management companies.
2. Exclude customers using <20 kWh in December 2007 or <200 kWh in July 2007.

3.3.2 Participant Characteristics and Program Choices

At the beginning of the summer, the Summer Solutions pilot included 78 small businesses: 35 offices, 31 retail stores and 12 restaurants (Table 6). Of these, roughly two-thirds chose the CPP option, while the remaining one-third chose either the 2-degree or 4-degree ACC option. About 80% of CPP participants, for whom communicating thermostats were optional, chose to have one installed. All ACC participants were required to have communicating thermostats installed.

Table 6. Participant program choices (including PCTs) by business type

	2° ACC	4° ACC	CPP	**Total number of participants**	*Participants with one or more communicating thermostats*	*Number of communicating thermostats installed*
Office	1	11	23	**35**	*30*	*31*
Restaurant	3	1	8	**12**	*9*	*11*
Retail	3	8	20	**31**	*27*	*29*

Total	**7**	**20**	**51**	**78**	*66*	*71*

The Critical Peak Pricing rate was chosen most often. This may have been due partly to the fact that a significant number of participants were ineligible for the temperature control option due to various limitations. Some customers had no central air-conditioning; others had more than two zones. For many, the potential for savings was greater on the Critical Peak Pricing rate, particularly business that did not feel they could significantly contribute to air conditioning load drop during the 4 to 7 p.m. window consistently, but were open for business on the weekends.

Table 7 summarizes other important characteristics of the participant population, including building age, size, and ownership; number of employees and closing time. More detailed descriptions of these attributes are provided in the following sections.

Table 7. Participant characteristics: buildings, staff and schedule

Business Type	N	Median Age (years)	Median Size (ft^2)	Building Ownership (%)	Avg. # of Employees	Median closing time
Office	35	8	1563	37	3.1	5:00 p.m.
Restaurant	31	42	2108	0	2.8	9:00 p.m.
Retail	12	39	3291	0	2.3	6:00 p.m.

Building Age, Size and Ownership

Participant buildings ranged, in both size and age. One retail warehouse had been built around 1900 while one of the office buildings was constructed in 2006. In general, office buildings were much newer than either restaurants or retail structures.

The targeting of small businesses helped to dictate the size of eligible participants (Figure 5). Offices that signed up were the smallest of the three business types, averaging less than 1,400 square feet.

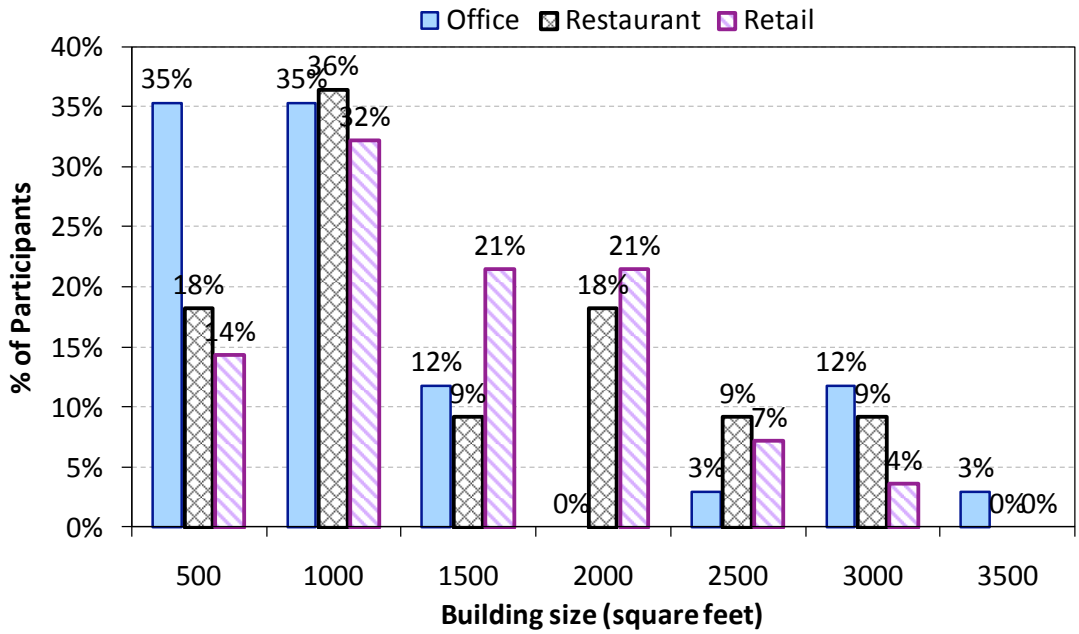

Figure 5. Building size by business type

Of the participants, 13 offices owned their buildings, while the rest rented. Program choices of building owners were not significantly different from the group of participants as a whole: ten chose the CPP rate while the other three chose the 4° ACC.

Point of Contact, Staff and Hours of Operation

The owner was the main point of contact for 68 of the 78 businesses in this study. Of the remaining 10 contacts, 9 were managers and 1 was an administrative assistant.

On average, offices had the most employees, averaging about 3 per site. Restaurants had an average of 2.8 staff with the largest restaurant employing 4 staff at any given time. Retail shops averaged just 2.3 staff, the largest employing 6 at any given time. There was at least one participant of each business type that employed one staff member at a time.

In total 8 participants (1 office, 2 restaurants, and 5 retail shops) were closed on Mondays, and one office was closed on Fridays. Figure 6 shows the scheduled closing times of the participants. Not all businesses had clearly defined opening and closing times, but in those cases, the contact provided an approximation.

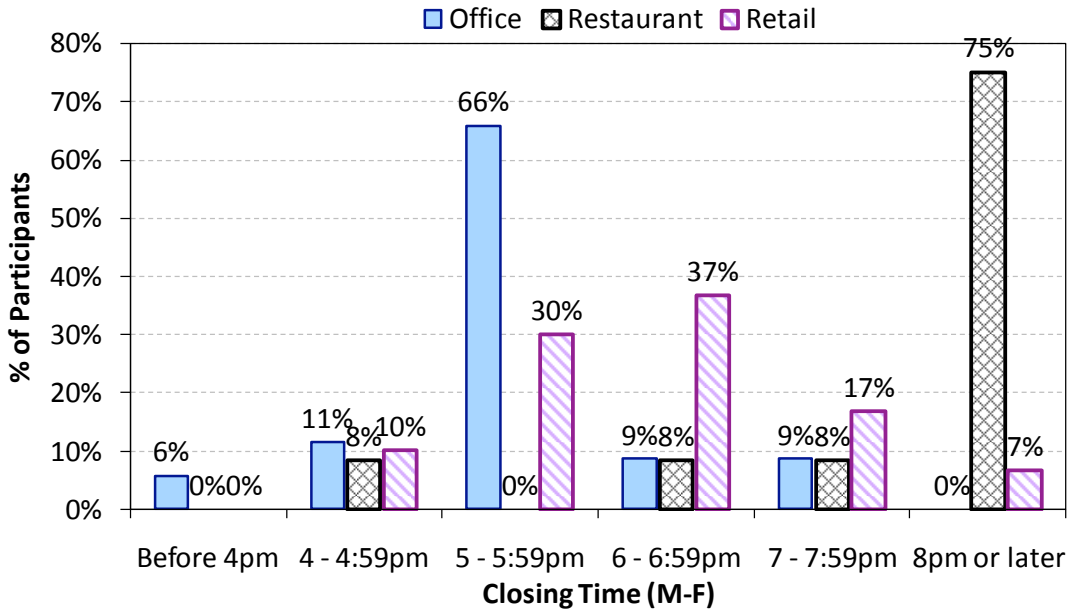

Figure 6. Closing time by business type

Offices most consistently closed at 5 p.m., however they ranged from as early as 1 p.m. to as late as 7 p.m. Restaurants had later closing times, as would be expected, ranging from 4 p.m. to 2 a.m. Retail shops closed anywhere between 4 p.m. and 8 p.m., with 6 p.m. being the most common closing time.

3.4. Participant Preparation and Education

3.4.1 Participant Education

In addition to personal attention provided by the research team, participants were provided several opportunities to review information about the pilot and actions they could take as participants. A website was posted prior to mailing the recruitment letters so that prospective participants could review program details at their leisure. Other program materials were physically handed to participants at the time of the Spring Survey. Emails throughout the summer reminded participants of specific strategies that could be taken during events.

Finally, SMUD bills provided feedback on usage. For CPP participants, usage information was provided by price tier, and bill savings or increases relative to the standard GSN rate were printed. In addition, those who saved money were provided with a congratulatory message, while those with higher bills were directed to the Summer Solutions website for money saving tips.

Website

A website was created and hosted by HMG to provide basic information about the pilot, including a detailed description of the pilot and links to SMUD rebate program information. Participants were first notified of the website in the Recruitment Letter. The website address was also provided in emails sent to participants, was printed at the bottom of the CPP rate magnet (discussed below), and printed on the bills of CPP participants who did not save money that month.

Other Program Materials

Several items were distributed to participants before the experimental tariffs went into effect in June. Each business received a packet, tailored for their particular business type, with information about conserving energy usage.

A single summary page included advice for thermostat settings, solar shading and lighting fixtures, plus the address of a SMUD website listing contractors and rebates.

All participants on the CPP tariff received a magnet that summarized the rates by hour of the day, day of the week, and during events (Figure **7**).

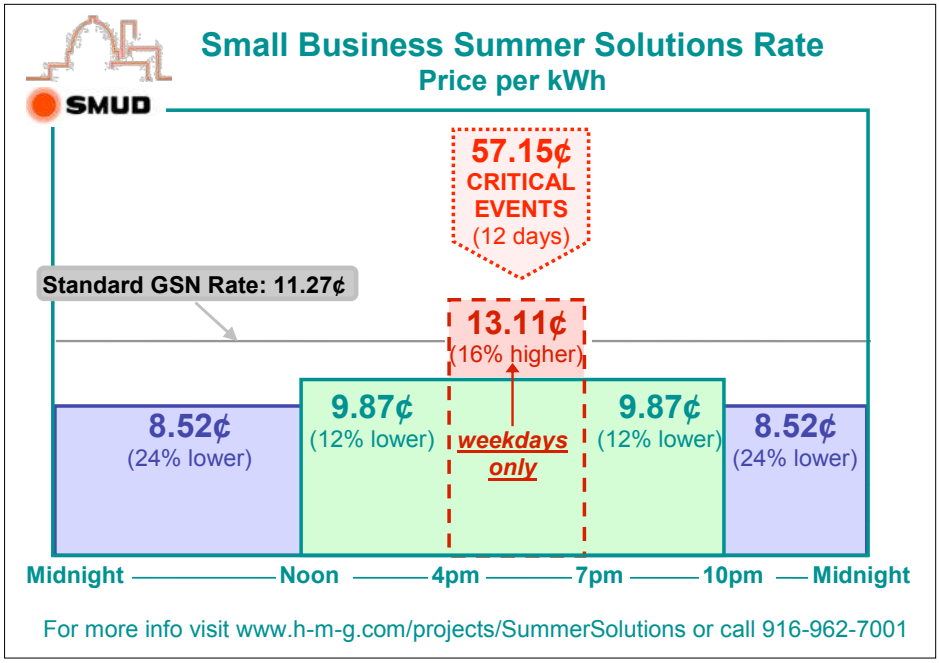

Figure 7. Magnet given to each CPP participant

Event Emails

After each event, or group of consecutive events, the research team sent emails to all 64 participants with email addresses. This email served two purposes: (1) to send a link reminding participants to respond to the online event survey, and (2) to remind participants of actions that could be taken during events.

Bills

Two different bill strategies were instituted for the two different tariff options. For the ACC option, customers received their standard SMUD bill with a new line indicating the $5 or $10 Summer Solutions payment, for 2° and 4° ACC offsets, respectively. For the CPP option, participants were sent the standard GSN bill plus a separate sheet that outlined how the CPP rate reduced or increased the amount they owed.

3.4.2 Thermostat Installation

We began installations of thermostats in March 2008 and completed all installations before June 2008. This allowed participants at least one month to become accustomed to the new thermostat before the first event on June 26, 2008.

A maximum of two thermostats were installed at each participant site. Customers having more than one air conditioning unit or more than two zones were discouraged from participating in the ACC program. A few of these customers (restaurants) were eventually recruited, however, due to response rates being lower than expected. Customers with more than two thermostats were welcome to participate in the CPP rate, but only one thermostat was installed.

A licensed HVAC contractor accompanied by an HMG staff member visited each site to install the thermostat hardware. The replacement thermostat was located in place of the existing one, and the connections to the air conditioning unit were as the original. Before installation, the existing thermostat wiring was photographed. After installation, the new thermostat wiring was also photographed. In this way, we had a record of the installation process at each site.

An initial functional test was carried out prior to replacement to ensure correct and safe operation of the existing installation. When this initial test failed, further work at the site was suspended until corrective measures were complete. In particular instances, the heating element of the HVAC system was not operational. Participants were notified and, in each case, agreed to continue with the installation. Following thermostat installation, a similar test was carried out to ensure full operation.

On completing installation and testing, HMG worked with the customer to program the thermostat as desired, and provided a brief tour of the thermostat programming options. Each participant received an instruction manual for the thermostat and phone numbers to get help or further information.

3.4.3 Spring Survey

The 70-question Spring Survey was administered in person to all participants, generally at the time of installation of the Summer Solutions thermostat. If the participant did not have a thermostat installed, the business was still visited and the survey conducted in person. Responses were recorded directly into an Access database on a portable laptop computer taken to each site. In all, 79 surveys were conducted, although only 78 of these ultimately participated in the pilot. A complete list of the questions on the Spring Survey is provided in Appendix B.

3.5. Summer 2008 Field Study

3.5.1 Event Schedule

There was one test event on June 16, followed by 12 actual events called over the course of the summer (Table 8). No events were called on Mondays, mainly because a one-day advance notification would fall on a Sunday.

Table 8. Schedule of events for the 2008 Summer Solutions Pilot

Event #	Date	Day	Hi Temp
1	6/26/2008	Thu	87.7
2	7/8/2008	Tue	106.7
3	7/9/2008	Wed	106.6
4	7/18/2008	Fri	96.7
5	7/23/2008	Wed	95.3
6	7/24/2008	Thu	96.3
7	8/7/2008	Thu	91.9
8	8/13/2008	Wed	102.4
9	8/15/2008	Fri	102.3
10	8/25/2008	Tue	94.7
11	8/29/2008	Fri	103.8
12	9/5/2008	Fri	100.7

3.5.2 Event Procedure

The goal for this program was to call 12 events, roughly evenly spaced across the temperature range between 90 and 110, based on temperature forecasts from the National Weather Service. The following sections describe the procedures followed for each event.

Pre-Event Days

Once SMUD and HMG agreed to call an event, several actions needed to take place before 4 p.m. on the day before the event.

Emails were sent to all participants with working email addresses, notifying them of the event scheduled for the following day. Separate emails with slightly different messages were sent to the CPP and ACC groups. Both emails indicated that the following day would be an event day for the Small Commercial Summer Solutions Program. Participants were asked to reduce electricity use as much as possible between 4 and 7 p.m. to help with the high peak electrical

demand forecast for the following day. Those with a Summer Solutions thermostat were reminded that it should already be programmed to respond to the event. Those without were asked to consider manually increasing their thermostat setpoints by a couple of degrees during the 4 to 7 p.m. peak. Other actions suggested for the events included turning off or dimming lights, and avoiding the use of other high-power devices where possible.

In addition to the email notification, text messages were sent to all thermostats, announcing the day, date and time of the planned event, while participants without email or thermostats were phoned or sent cell phone text messages.

Event Days

To signal the communicating thermostats, one event per Program Group was created on the custom-made control website. Although the technology allows for events to occur at any time for any duration specified, SMUD requested that all events be scheduled to run from 4 p.m. to 7 p.m.

Prior to sending each event signal, a test thermostat at HMG was set to receive the signal for each group, to ensure via firsthand experience that the event notification system was sent correctly. Thus, event creation proceeded as follows.

- CPP: Group 2
    - Change the HMG test thermostat to Group 2
    - Create Price event: Tier 4 - Critical Peak
- 2° ACC: Group 3
    - Change the HMG test thermostat to Group 3
    - Create Change Temp event: add 2 degrees
- 4° ACC: Group 4
    - Change the HMG test thermostat to Group 4
    - Create Change Temp event: add 4 degrees

Sending the events twice – once in the morning, and then again around noon – helped to ensure that the participants received the signal.

On receiving the signal, the thermostat displays flashed a warning of the upcoming event. At the onset of the event, the display flashed a message that an event was in progress. Warning and event messages contained specific information about the timing and duration of each event, and remained on the screen until acknowledged by the participant through a button press.

Participants also had the opportunity to receive event notification by email or phone call, which was of particular import for participants that opted out of thermostat installation.

Post-Events Days

Follow up emails were sent to all participants with email addresses. The emails thanked participants for their efforts, contained a link to the Event Survey (see below), and directed them to contact the HMG support team if they had any trouble.

3.5.3 Event Surveys

The Event Survey was administered online. After each event or series of events, an email containing a link to the survey and a request for their help in filling it out was sent to all participants with an email address. Participants that lacked email or an Internet connection were phoned personally, and their responses marked for them in the online form. A complete list of the questions on the Event Survey is provided in Appendix B.

Although there were 12 events over the course of the study, there were only 10 Event Surveys because of two sets of events scheduled back-to-back (see Table 8). At these times only one request for an event survey was sent out for the two events.

There were 76 participants that completed the pilot, and each one responded to at least one event survey (Figure 8). At the end of the summer, a total of over 200 event surveys had been submitted.

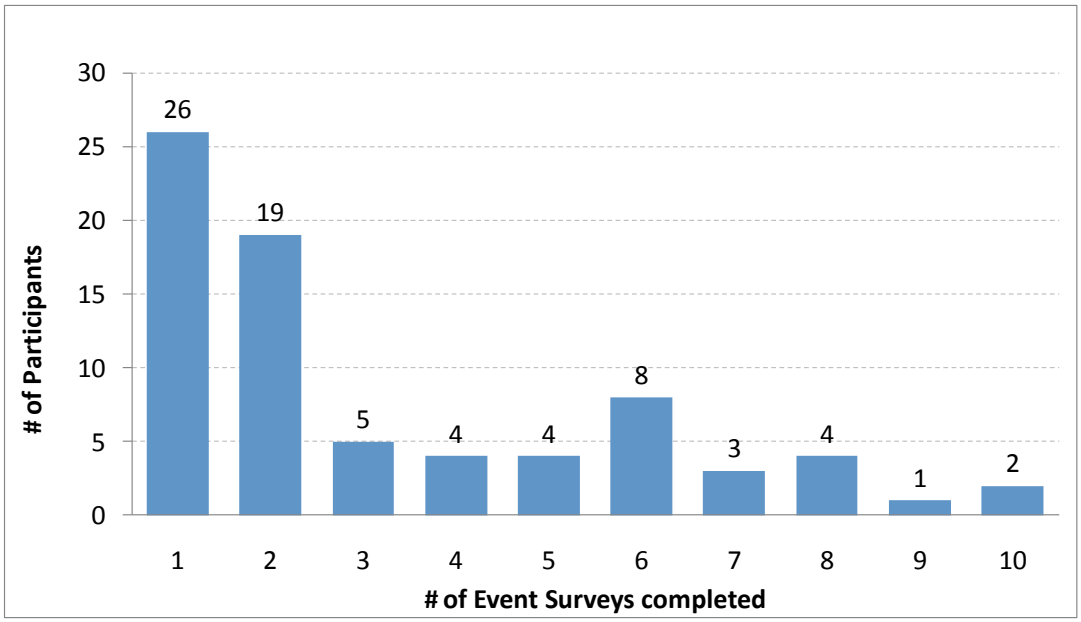

Figure 8. Number of event surveys completed by participants

3.5.4 Fall Survey

At the end of October, participants were emailed or phoned reminding them to complete the Fall Survey, which focused on their perceptions of the summer pilot. Given that the second $60 incentive payment was contingent on completion of the survey, this survey had a very high completion rate: 75 out of the remaining 76 participants completed the Fall Survey. Most participants completed the online version of the survey, while those without access to the Internet were surveyed in person. A complete list of the questions on the Fall Survey is provided in Appendix B.

3.5.5 Decommissioning

This pilot began with 78 participants and 71 thermostats with loggers. At the end of the study, there were 76 participants and 69 thermostats and loggers in the field. Of the 69 loggers in the field, 62 functioned properly throughout the entire summer (Table 9).

Table 9. Installed thermostats and loggers

	In place by June 1, 2008	Active thru Sept 31, 2008	% Change
Participants	78	76	-3.8%
Thermostats	71	69	-2.8%
Loggers	71	62	-12.7%

Participants that did not complete the pilot

Three businesses never completed the pilot. The first, a retail shop, signed up and went through the initial survey, but then sold the business and moved before the tariffs went into effect on June 1. A second participant, owner of another retail shop, passed away sometime in July. The third, a bar/restaurant owner went out of business and moved towards the end of August.

Logger Issues

Two loggers had no data due to installation error (one cord missing, one memory card not fully plugged in). One was not plugged in to the RDS receiver completely. Three data loggers had missing or incomplete data seemingly due to hardware malfunction. An additional three were unplugged and/or plugged back in incorrectly before the 8th event.

Thermostat Malfunctions

Of the thermostats installed for this pilot, only one was removed because it malfunctioned. The faulty thermostat was installed at a retail shop, who complained that the thermostat was unable to keep the business cool in the afternoons, whether or not it was an event that day. After reinstallation of their original thermostat, everything returned to normal. Despite this negative experience, the owner elected to stay on the CPP rate beyond the thermostat removal.

Other Thermostat Issues

In May, before the pilot really got under way, one restaurant requested the removal of the thermostat because it was not keeping them cool in the afternoons. After their old thermostat was reinstalled and the comfort issues were not resolved, a unit inspection revealed that their air-conditioner was old and undersized. At this point, the restaurant requested that the thermostat be reinstalled.

After the conclusion of the pilot, three retail businesses requested the removal of the thermostats. One was a pet store, who said they wanted their original thermostats reinstalled because they were more expensive and advanced; they had no negative things to say about the thermostats we had installed for them. One was a copy shop who was unhappy about the 6-minute minimum off-time for the compressor, because the business had so many heat-generating pieces of equipment (e.g. copiers, printers, and computers). The reason given for the third and final removal was that the staff considered the thermostat too complicated to operate – they preferred a simple on/off switch, which was how their old thermostat worked.

Two businesses also had problems operating their heat after the study concluded. After site visits by an HVAC contractor, these issues were resolved. One retail shop had an unusually old electric furnace, which required the addition of a sequencer for the new thermostat to operate the heat properly. At the other site, the thermostat was wired improperly for heat at the original installation. The contractor rewired it correctly and the problem was resolved.

4.0 DATA ANALYSIS AND RESULTS

Multiple types of information were collected from study participants at several points in the project. Initially, basic characteristics for each participant were gathered during the recruitment stage. More detailed business and building information was collected through the Spring Survey. Once hardware was installed, we began logging electric meter and thermostat data every fifteen minutes. Throughout the summer, we requested that participants complete a short Event Survey, directly after each event, on how they perceived and responded to each event. At the end of the study, detailed participant perceptions of the program were documented in their Fall Survey answers. A summary of these and other datasets and sources utilized for this study is presented in Table 10.

Table 10. Summary of data collected for this project

Source	Data collected	Use(s)
SMUD customer database	• Contact information • Monthly billing data	• Market assessment and segmentation • Recruitment and screening • Monthly load impact analysis
Spring Survey	• Business operations • Building & equipment characteristics	• Refine segmentation & screening
	• Pre-pilot load shifting behavior	• Pre/post behavior analysis
Event Surveys	• Event behavior and comfort	• Customer education & encouragement • Participant problem resolution
Thermostat Logger	• Thermostat set points	• Participant behavior vis-à-vis AC
	• Indoor temperature • Compressor status	• AC unit behavior • Diagnostics
	• Messages from utility	• Event signal receipt confirmation
CPP bills	• Monthly electricity charges on CPP and GSN rates	• Billing analysis for CPP participants
Interval Meter	• 15-minute whole house electricity usage	• Critical Peak Pricing billing (SMUD) • Hourly load impact analysis
CIMIS	• Outdoor ambient temperatures for Fair Oaks, California	• Event scheduling • Hourly load impact analysis
Fall Survey	• Satisfaction	• …with new tariff • …with new thermostat • …with program in general
	• Load shifting behaviors • Event behaviors	• Pre/post behavior analysis

Analysis of both quantitative and qualitative data focused around segmentation of data by building and program type. The following sections describe the data analysis and results.

4.1. Thermostat Logger Data

Throughout the pilot, a logger on each thermostat collected data every fifteen minutes from the thermostat. Each record included a timestamp plus actual setpoints, indoor temperature, compressor status, reception of utility messages and event setting overrides. These data allowed for analysis of signal reception, event override, and setpoint activity with accompanying indoor temperatures and compressor status.

4.1.1 Signal Reception Analysis

Prior to each event day, information about the upcoming event was broadcast via RDS, so participants with thermostats would receive a notification of the event on the thermostat display. On average, 73% of the event signals sent were received and acted upon by the 67 communicating thermostats in the field (Figure 9). This RDS reception rate is expected to increase in the near future as the next version of RDS receivers enters the market.

About half of the signaling problems were resolved by the fourth event, however, loss of logger data, which was not related to RDS reception, increased slightly after the sixth event.

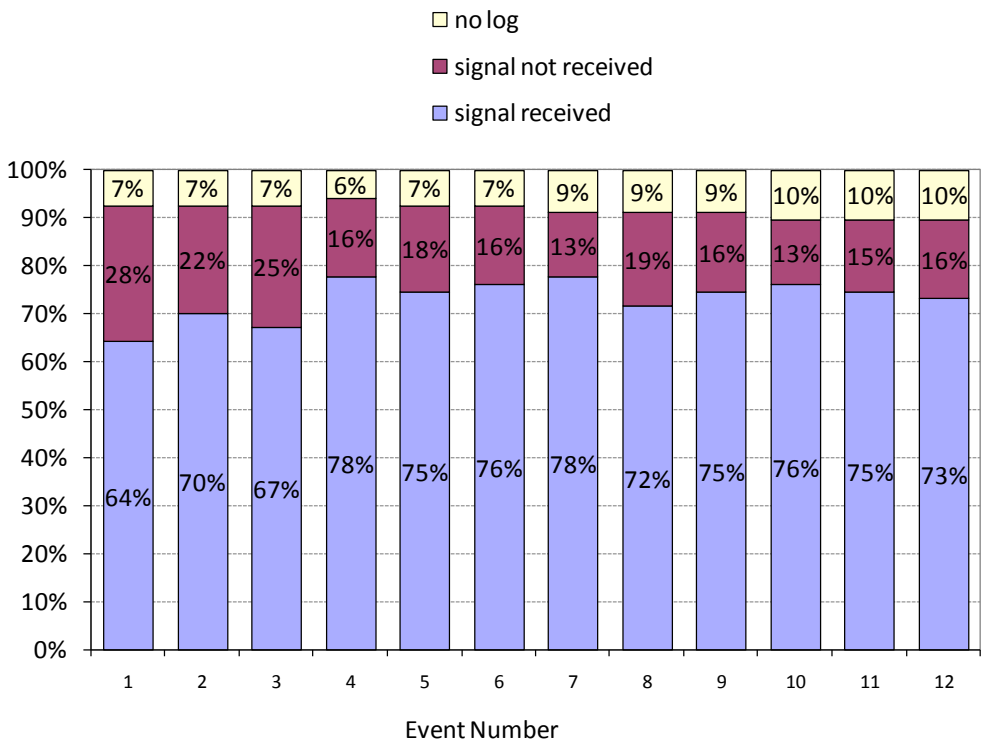

Figure 9. Percentage of event signals received and acted upon, by event number

Figure 10 shows that about one-third of the 67 thermostats received all 12 events, while about three-quarters received at least 8 of the 12 event signals. Eight thermostats (12%) received no event signals at all.

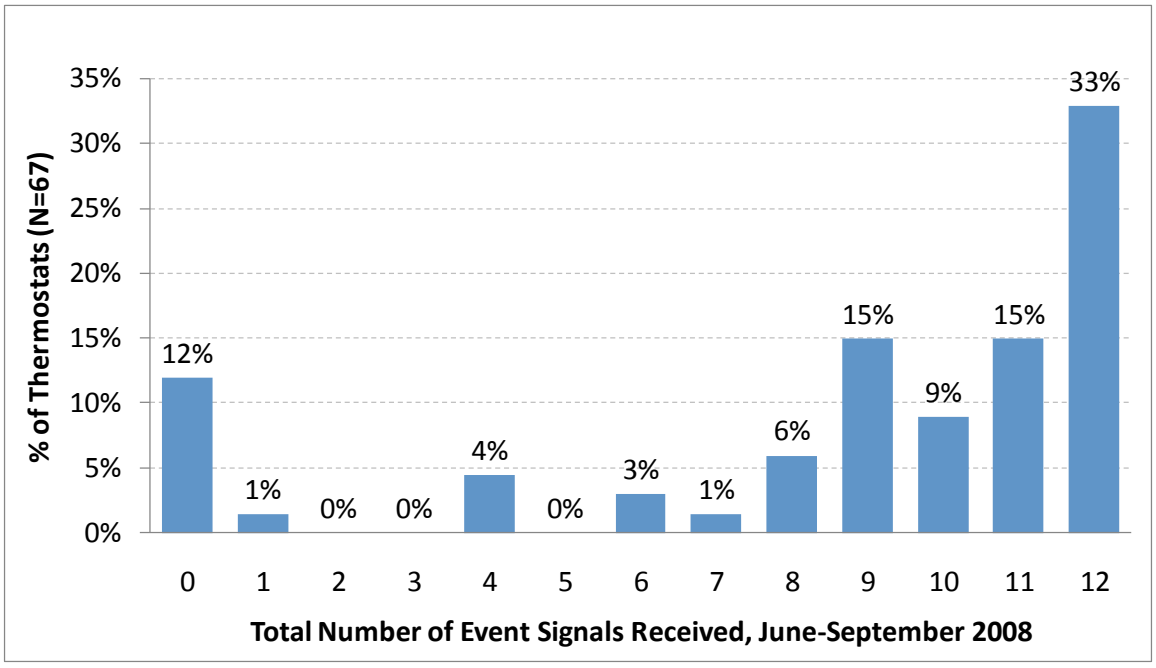

Figure 10. Percentage of thermostats receiving no events signals, all 12 event signals, and everything in between

4.1.2 Override Analysis

Overall, about 5% of events were overridden by participants, meaning that after a thermostat responded to an event signal, one of the occupants of the building decreased the event setpoint by one or more degrees (Table 11).

Table 11. Percent of event signals overridden, by business type and program choice

Business Type	2° ACC	4° ACC	CPP	All
Office	8%	3%	5%	4%
Restaurant	0%	N/A	11%	4%
Retail	6%	2%	9%	7%
All	3%	3%	7%	5%

As expected, fewer overrides occurred in the ACC programs, because these participants were told that overrides were not allowed. Although CPP participants were told they could override

their event settings at any time, only 7% of CPP events swayed participants to modify the event setpoint.

4.1.3 Setpoint and Compressor Analysis

Among other things, thermostat loggers recorded setpoints and compressor status. This section compares average thermostat setpoints along with the corresponding status of participating air-conditioning compressor units on event days and non-event days. For all graphs provided in this section, actual setpoints are plotted, while compressor status is weather-normalized using the regression model shown in Equation 1.

$$Pr(Compressor_i = 1) = logit^{-1}(\alpha + \sum_{j=1}^{23}(\beta_j^{Hour} \cdot Hour_j + \beta_j^{EventHour} \cdot EventHour_j) + \sum_{k=1}^{3} \beta_k^{Month} \cdot Month_k + \sum_{l=1}^{4} \beta_l^{Day} \cdot Day_l + \beta^{CDH} \cdot CDH + \beta^{dayCDH} \cdot DayCDH) \quad (1)$$

Where $Compressor_i$ is a dummy variable equal to 1 if the compressor is running for hour i and 0 otherwise, α is the intercept term, and the β's are the estimated parameters, and:

- Hour is a set of 23 dummy variables for hour of the day for non-event days,
- EventHour is a set of 23 dummy variables for hour of the day for event days,
- Month is a set of three dummy variables for month, and
- Day is a set of four dummy variables for day of the week.

The two other variables are calculated from hourly weather data, where:

- CDH is the number of cooling degree hours (base 75) for hour i
- DayCDH is the total cooling degree hours for the day

Figure 11 shows average setpoints and weather normalized compressor status on event and non-event days for participating offices. Average setpoints on non-event days show a smooth transition from roughly 85° at night to about 75° during work hours. On event days, a clear shift takes place. Event day setpoints are about 4° lower than non-event setpoints between 8 a.m. and 4 p.m., indicating precooling on event days. Average setpoints then increase from 75° to over 80° at 4 p.m., and then again to more than 85° at 5 p.m., when most offices close for the evening.

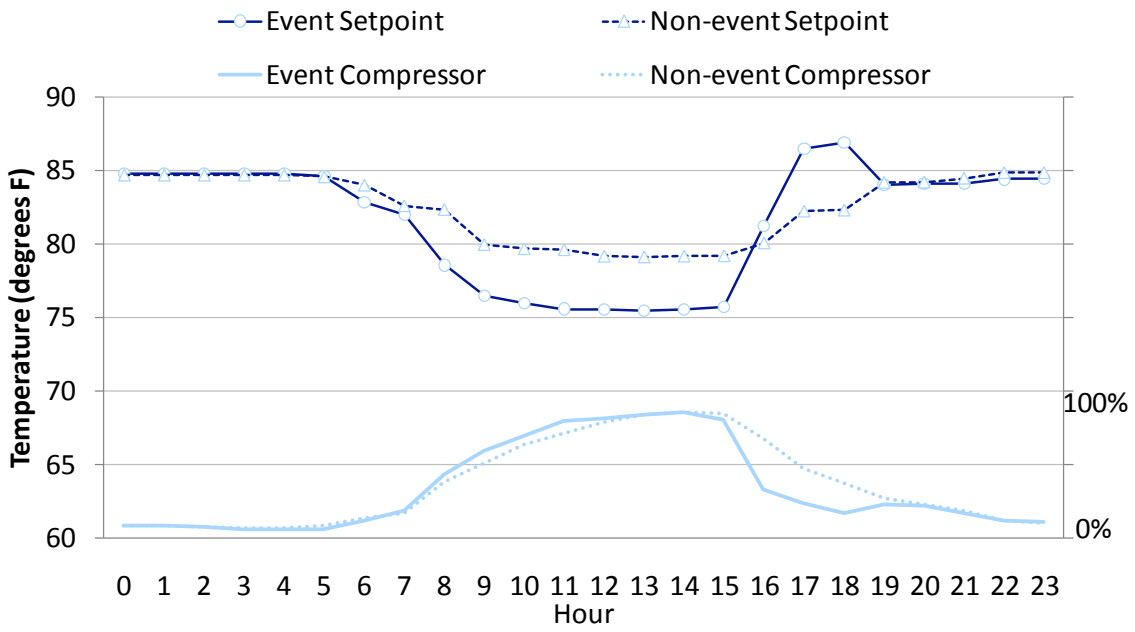

Figure 11. Event and non-event setpoints, with weather-normalized compressor status, offices

Compressor status, also shown in Figure 11, should be compared to the right axis labels, where 100% indicates that all of the compressors in the sample are running, and 0% indicates that none of the compressors are running. Here, the effects of precooling on event days can barely be seen in the morning hours. In contrast, the event hours - indicated by the shading between 4 and 7 p.m. - show a marked decrease in compressor activity.

Logger data for restaurants paint a slightly different picture (Figure 12). Restaurants, like offices, attempt to precool on event days, lowering setpoints by as much as 6° between 10 a.m. and 4 p.m. However, the precooling has no effect on the compressors, which are running continuously under both scenarios. Following this "precooling," loggers show an event offset of 4° at 4 p.m., however, again the compressors are unaffected. This provides evidence that (1) the restaurants in our participant population have undersized AC units, and (2) building spaces with undersized AC units are unlikely to provide load drop during demand response events.

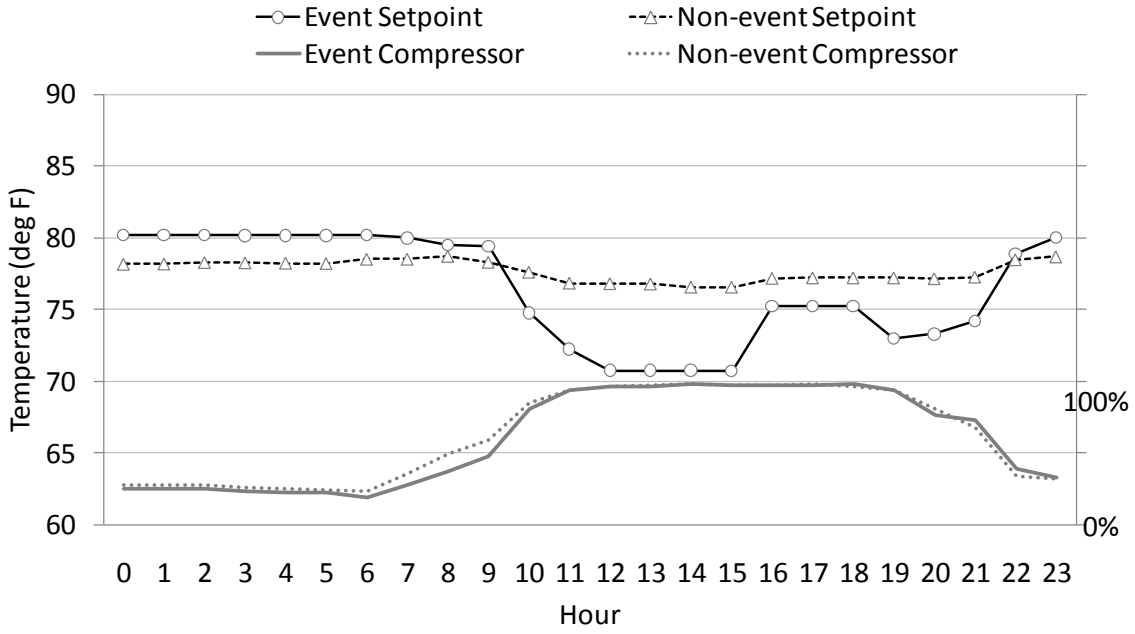

Figure 12. Event and non-event setpoints, with weather-normalized compressor status, restaurants

The plot of logger data for retail (Figure 13) looks very similar to that of offices (Figure 11). Precooling to 75° begins at about 8 a.m. on event days, and continues to 4 p.m., when setpoints increase by about 5° on average to 80°, and then to 85° at 6 p.m. The resulting compressor status is also similar. Again, the effects of precooling on event days can barely be seen in the morning hours, while the effects of the event offset are clearly visible between 4 and 7 p.m.

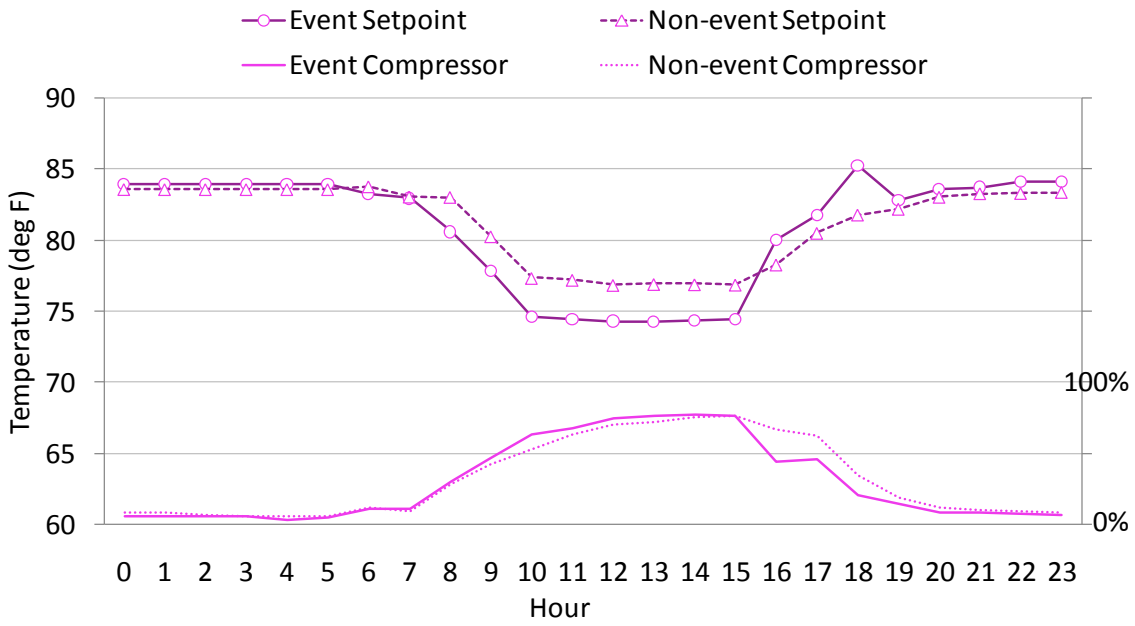

Figure 13. Event and non-event setpoints, with weather-normalized compressor status, retail

4.2. Hourly Load Impacts on Event Days

The interval meters installed on participant buildings recorded load every fifteen minutes for the purpose of participant load impact estimation and CPP billing. For simplicity, this data was aggregated by hour prior to analysis.

4.2.1 Hourly Load Impact Regression Model

The model used to analyze the hourly load data is a linear autoregressive model, which estimates the hourly load (in kWh per hour) for an average customer, fit using the maximum likelihood method with a lag of 1. The model controls for several important factors: hour of the day, day of the week, month, cooling degree hours for the hour in question, and total cooling degree hours for the day (Equation 1). Because the model uses the load shape of each customer on non-event days as the baseline load, a control group is not necessary for estimation of kW load impacts.

$$\begin{aligned} Q_i &= \alpha + \beta^{lag_1} \cdot Q_{lag_1} + \sum_{j=1}^{23} (\beta_j^{Hour} \cdot Hour_j + \beta_j^{EventHour} \cdot EventHour_j) + \\ &\sum_{k=1}^{3} \beta_k^{Month} \cdot Month_k + \sum_{l=1}^{4} \beta_l^{Day} \cdot Day_l + \\ &\beta^{CDH} \cdot CDH + \beta^{DayCDH} \cdot DayCDH + \epsilon_i \end{aligned} \quad (2)$$

In Equation 2, Q_i is the kWh/hr for hour i for an average customer, α is the intercept term, and the β's are the estimated parameters. Also:

- Q_{lag1} is the kWh/hr load for the previous hour,
- *Hour* is a set of 23 dummy variables for hour of the day for non-event days,
- *EventHour* is a set of 23 dummy variables for hour of the day for event days,
- *Month* is a set of three dummy variables for month, and
- *Day* is a set of four dummy variables for day of the week.

The two other variables, are calculated from weather data, where:

- *CDH* is the number of cooling degree hours (base 75) for hour i, and
- *DayCDH* is the total cooling degree hours for the day.

A total of fifteen models were fit to the data. First to examine the average loads for each business type, we made three models, pooling data for each business type (office, restaurant, retail). Then to look at the average loads by program, we pooled data by program (2° ACC, 4° ACC and CPP). Finally, we made nine models to find the average response for each program

within each business type. Load and impact results are presented here for a 100° day with the temperature profile shown in Figure 14.

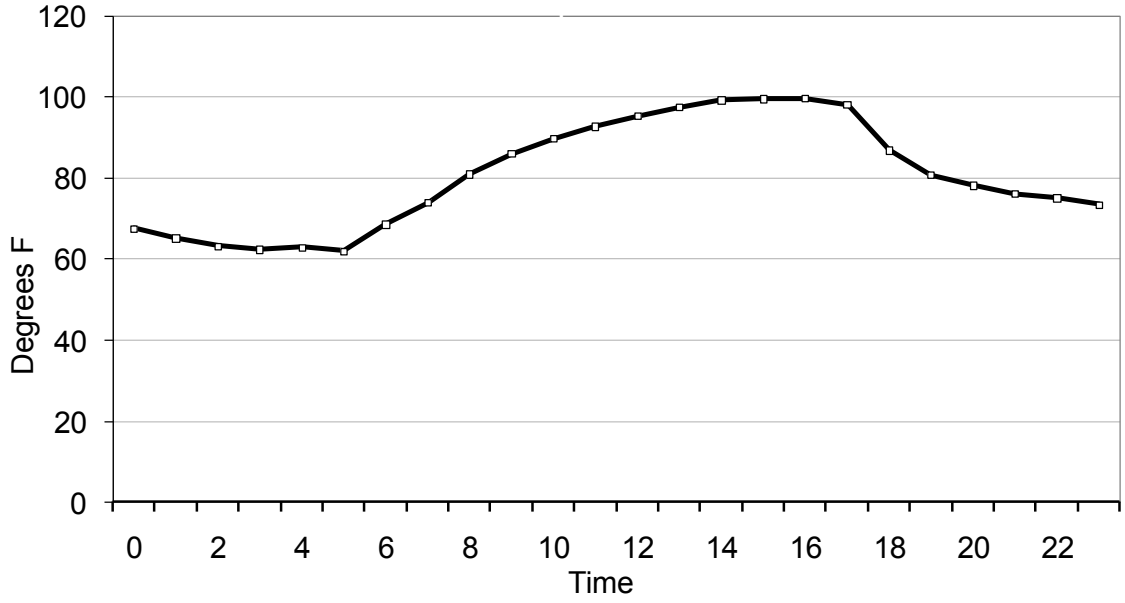

Figure 14. Temperature profile used to create load and impact results

The following sections provide the results of this model.

4.2.2 Overall results

Modeled savings estimates, averaged over event periods, are shown in Table 12, by business type and program choice. These results show the greatest savings (0.76-0.81 kWh) from retail on the CPP rate and for offices and retail on a 4-degree ACC program. Good results (0.35-0.57 kWh/h) were also obtained for offices and retail on the 2-degree ACC program, offices on the CPP program, and restaurants on the CPP program.

Table 12. Average load drop during event periods

	2° ACC		4° ACC		CPP	
	(kWh/h)	*(% of baseline)*	*(kWh/h)*	*(% of baseline)*	*(kWh/h)*	*(% of baseline)*
Office	-0.48*	-42%*	-0.80	-38%	-0.57	-24%
Restaurant	-0.18	-1%	-0.10*	-1%*	-0.35	-3%
Retail	-0.45	-8%	-0.76	-22%	-0.81	-14%

* Only one participant in the sample

Figure 15 shows, for each participant, the magnitude of their peak load change during event hours (y-axis) graphed against the magnitude of change in their daily usage on event days (x-axis). The size of the bubble indicates the number of events for which each participant received and responded to the event notification. The color of the bubbles indicates whether the participant had installed a communicating thermostat.

The white bubbles are all the same size because these customers did not have a thermostat, and therefore received a phone call or email notifying them of each event. The smallest bubbles indicate that no event notifications were received by the thermostat – however, most of these participants were also notified by email, and so could have responded manually. The largest received all twelve event notifications.

During event hours, 66 meters recorded a reduction in load (kW), while 14 recorded an increase in load, for an overall average load drop of 0.52 kW during events. On event days, 51 meters recorded a reduction in usage (kWh), while 29 recorded an increase in usage, for an overall average of 0.74 kWh load drop on event days. Note that the total number of meters (80) is higher than the final number of participants because there were a few businesses with two accounts that were individually metered.

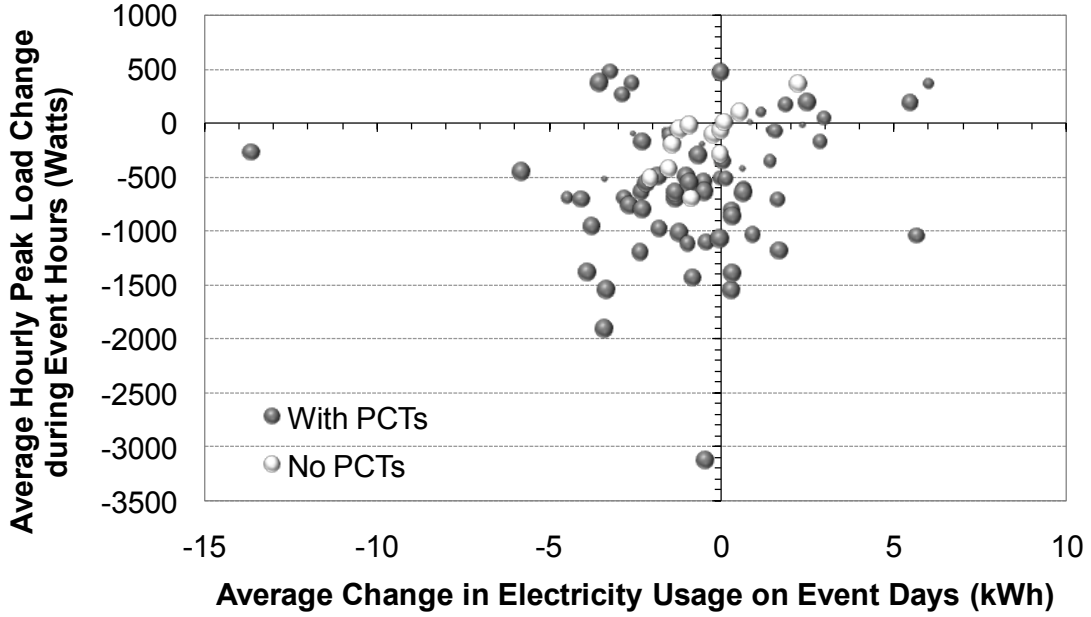

Figure 15. Total Load Change on event days, percent vs. watts

Also noteworthy is that the non-PCT participants are more densely clustered around the origin than are the PCT participants, indicating that load and usage changes were more extreme for those customers with communicating thermostats. On average, participants with PCTs dropped 0.58 kW during events, while those without PCTs dropped 0.16 kW during events. Likewise, participants with PCTs used 0.8 kWh less on event days than on non-event days, while those without PCTs used 0.4 kWh less on event days.

In summary, this analysis shows that, on average, participants were able to drop load during event hours without increasing overall usage on event days, and that use of enabling technology (PCT) results in greater load and energy savings.

4.2.3 By Business Type and Program

The following three sections provide the results of the hourly load data analysis for offices, restaurants and retail shops. Within each section, the data analysis is provided for each of the three program types: 2- degree ACC, 4-degree ACC and CPP.

Offices

Figure 16 shows the hourly load shapes for the one office that signed up for the 2-degree ACC program. For this one participant, the graph shows a statistically significant load increase at 8 a.m. on event days, and a statistically significant load drop in the first hour of the event between 4 and 5 p.m. A significant rebound effect can also be seen at 7 p.m. following the event.

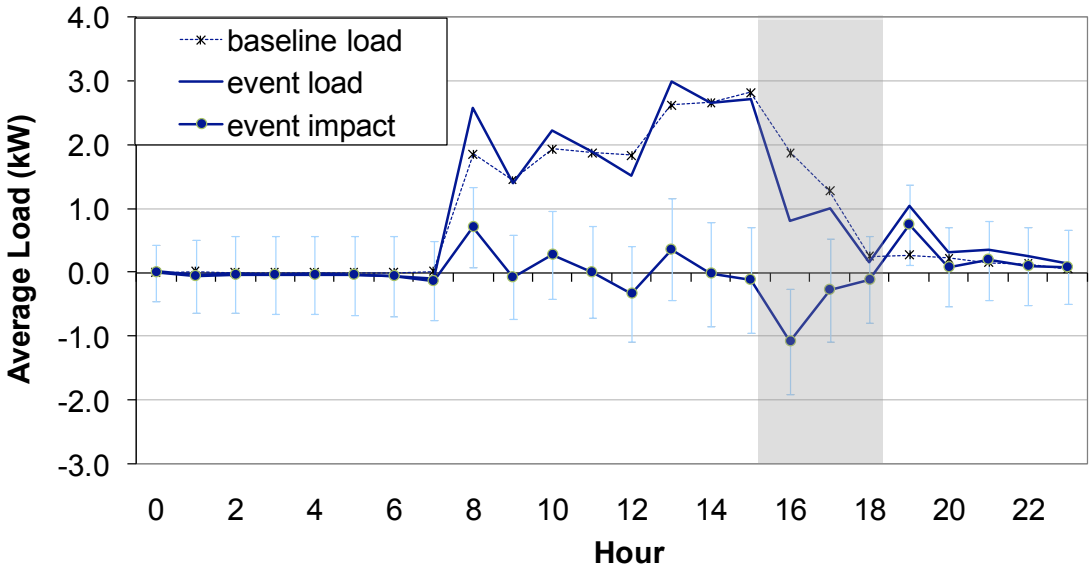

Figure 16. Average loads on event and non-event days, 2-degree office (N=1)

Figure 17 shows the hourly load shapes for the 11 offices that signed up for the 4-degree ACC program, and Figure 18 shows the hourly load shapes for the 23 offices that signed up for the CPP rate. In both graphs, there is no significant load increase preceding events, and a statistically significant load drop in all three hours of the event between 4 and 7 p.m. No significant rebound effect can be seen following events.

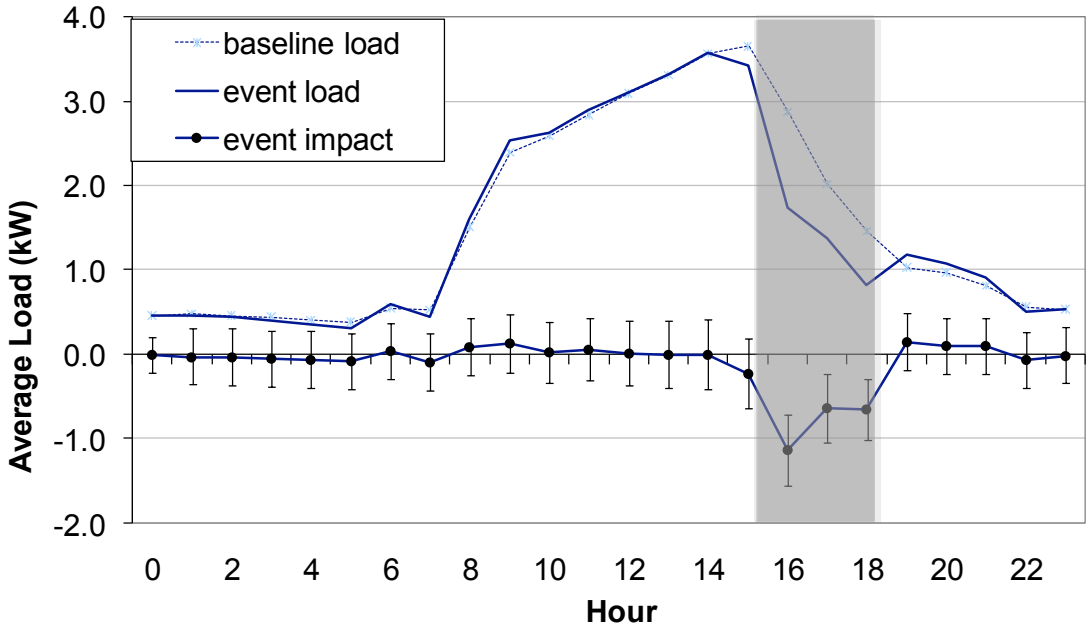

Figure 17. Average loads on event and non-event days, 4-degree office (N=11)

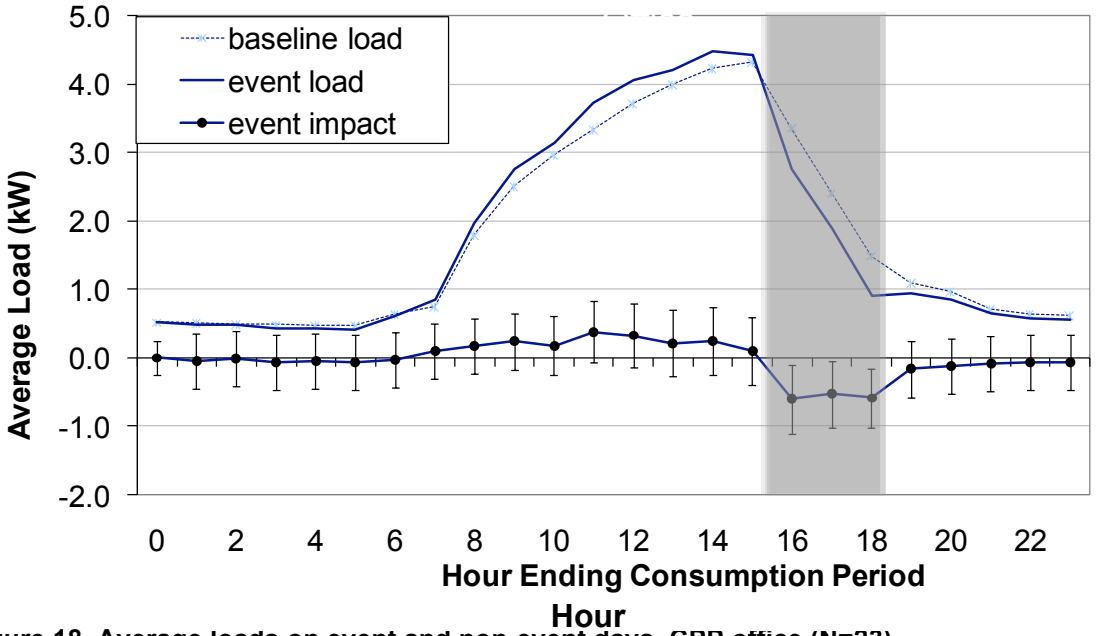

Figure 18. Average loads on event and non-event days, CPP office (N=23)

Restaurants

Figure 19 shows the hourly load shapes for the three restaurants that signed up for the 2-degree ACC program. For these participants, the graph shows a statistically significant load drop between 8 and 10 a.m. on event days, no significant load drop during events, and a significant rebound effect between 9 and 10 p.m. following events.

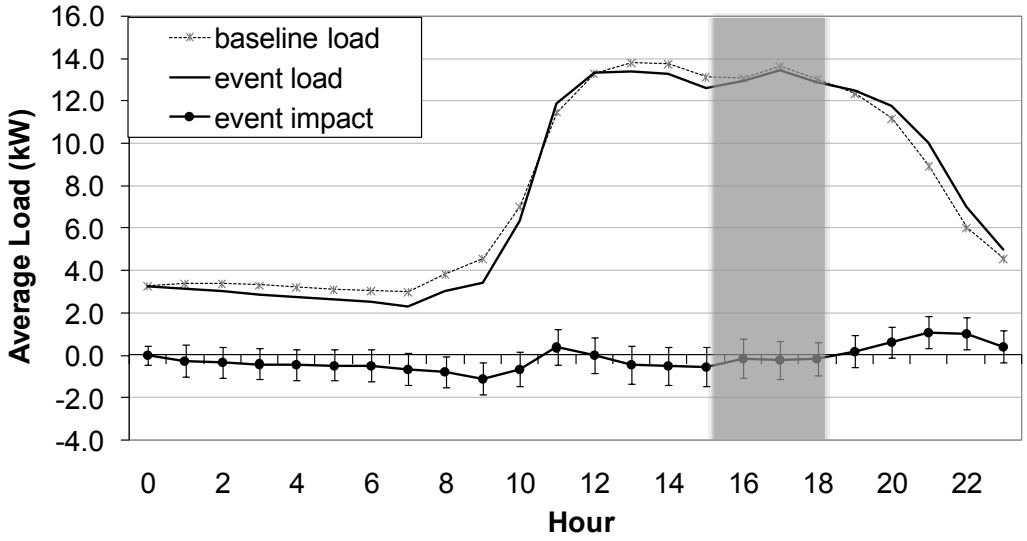

Figure 19. Average loads on event and non-event days, 2-degree restaurants (N=3)

Figure 20 shows the hourly load shapes for the one restaurant that signed up for the 4-degree ACC program, and Figure 21 shows the hourly load shapes for the 8 restaurants that signed up for the CPP rate. In both graphs, there is no significant load change in any hour of the event days.

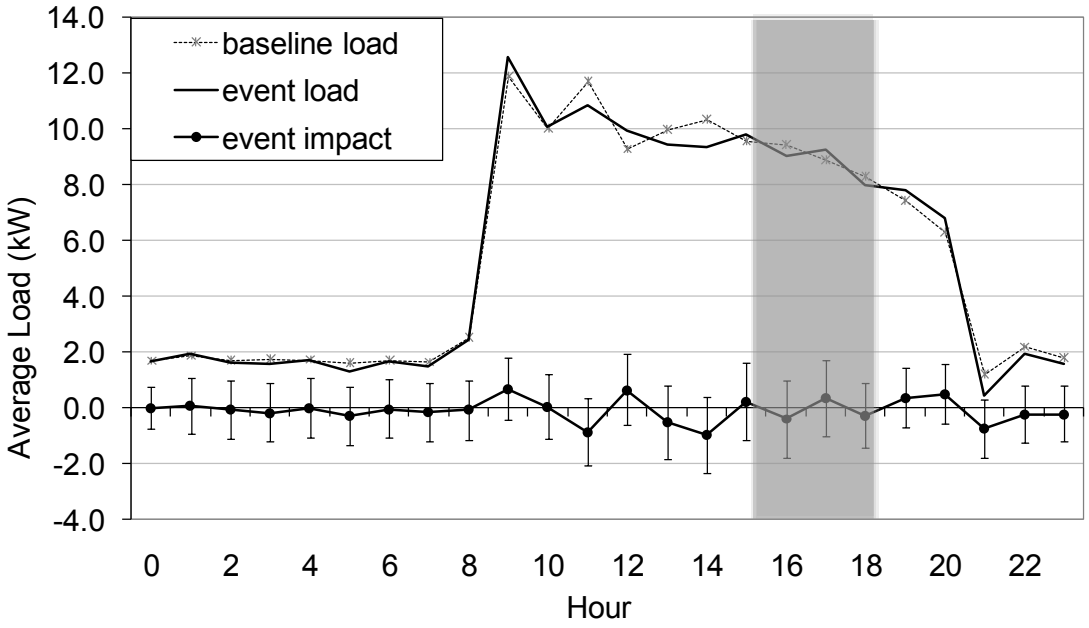

Figure 20. Average loads on event and non-event days, 4-degree restaurants (N=1)

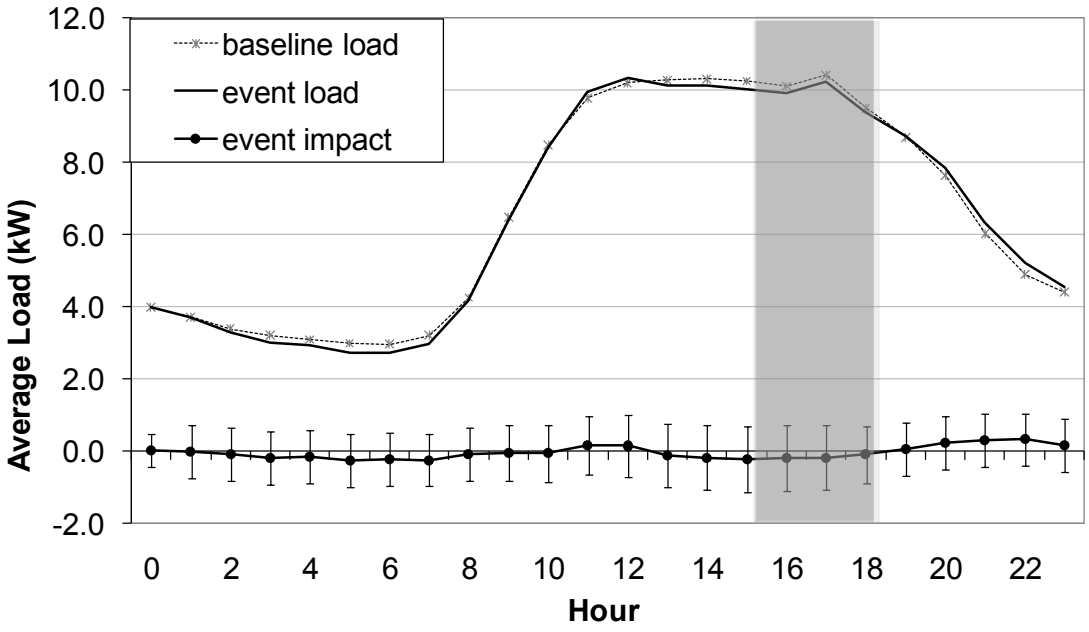

Figure 21. Average loads on event and non-event days, CPP restaurants (N=8)

Retail

Figure 22 shows the hourly load shapes for the 3 retail shops that signed up for the 2-degree ACC program. For these participants, the graph shows a visible but statistically insignificant load increase in the hours directly preceding the events, and a visible but statistically insignificant load drop in the three hours of the event and beyond. No rebound effect is visible following the event.

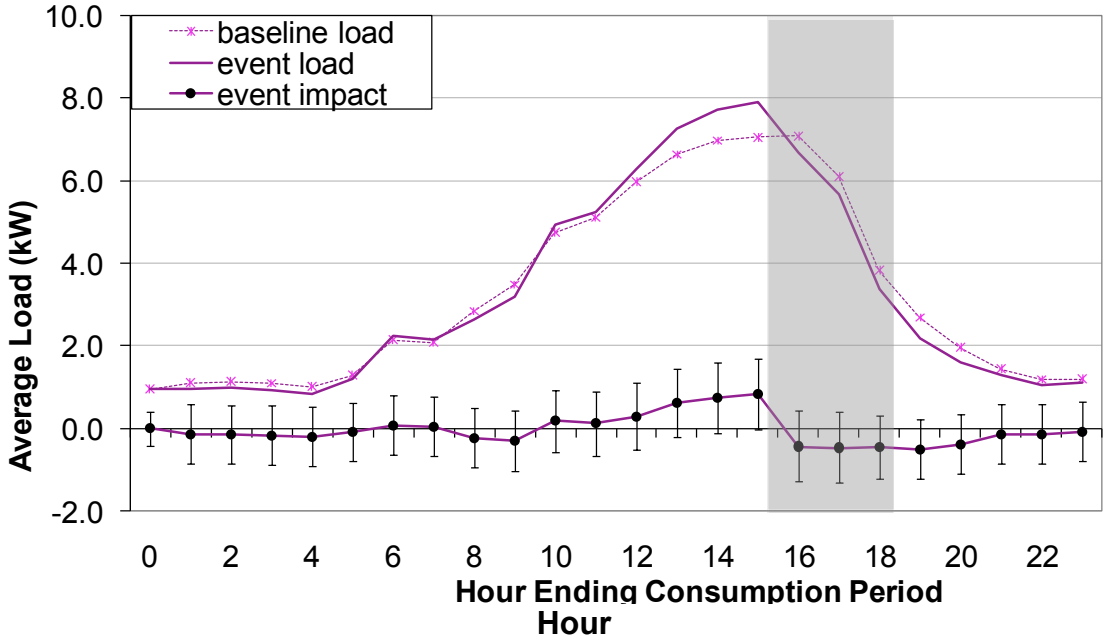

Figure 22. Average loads on event and non-event days, 2-degree retail (N=3)

Figure 23 shows the hourly load shapes for the 8 retail shops that signed up for the 4-degree ACC program. For these participants, there is a visible but insignificant load increase preceding events, followed by a statistically significant load drop in all three hours of the event. No rebound effect can be seen following events.

Figure 24 shows the hourly load shapes for the 20 retail shops that signed up for the CPP rate. For these participants, there is a statistically significant load increase preceding events, followed by significant load drop in all three hours of the event and beyond. No rebound effect can be seen following events.

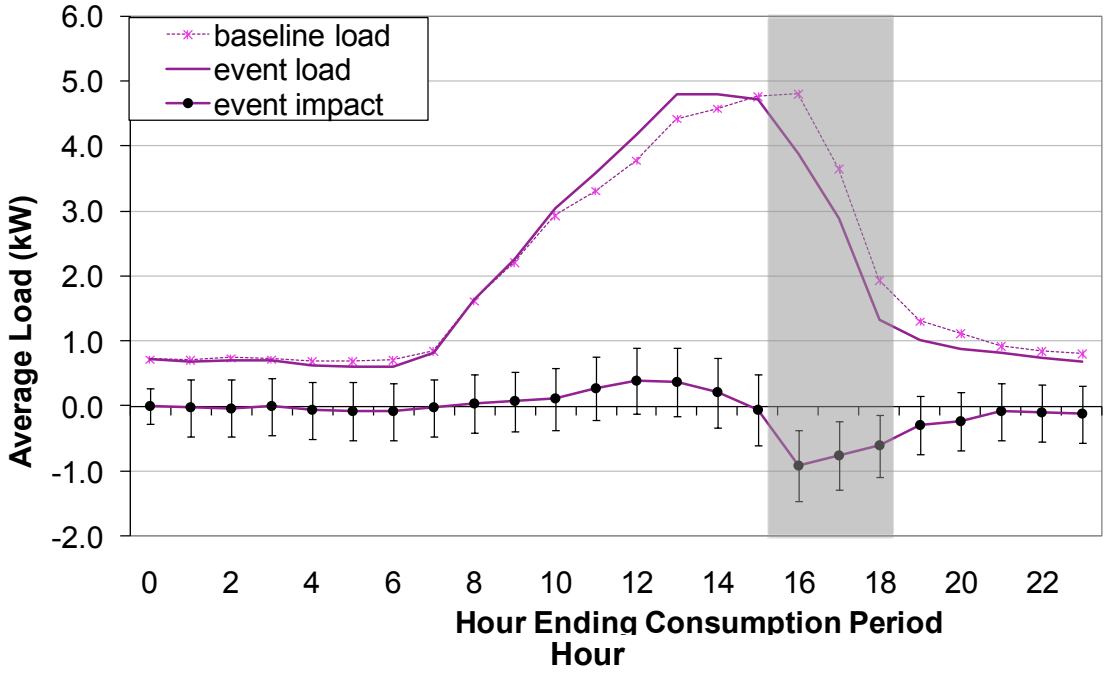

Figure 23. Average loads on event and non-event days, 4-degree retail (N=8)

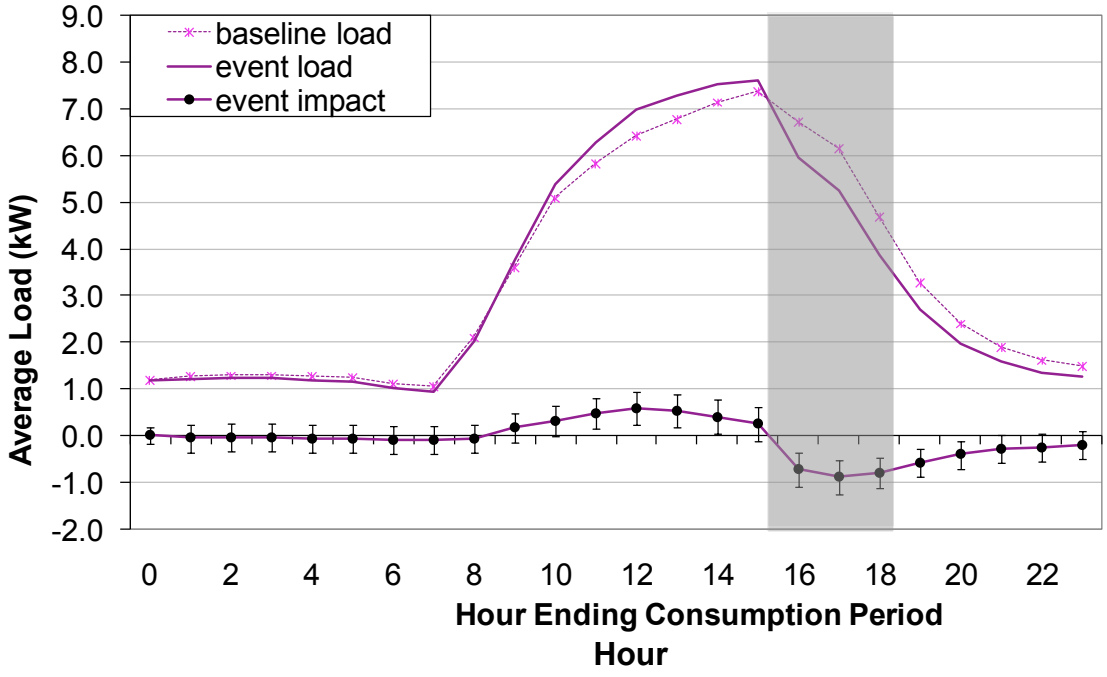

Figure 24. Average loads on event and non-event days, CPP retail (N=20)

4.2.4 Comparison of Load Impacts

This section reviews the hourly load impacts from the most promising business-program combinations: offices and retail stores on the 4-degree ACC and CPP programs. Load impact graphs show 95% confidence intervals for each hour.

CPP vs. 4-degree ACC

Figure 25 shows similar and significant load drops in all three event hours for both programs. For the CPP participants, some increase can be seen in the hours before the event, but in no hours are these increases statistically significant from zero. Hours after the event also show no significant deviation from zero, presumably because all offices in our sample closed before the end of the peak period (see Figure 6).

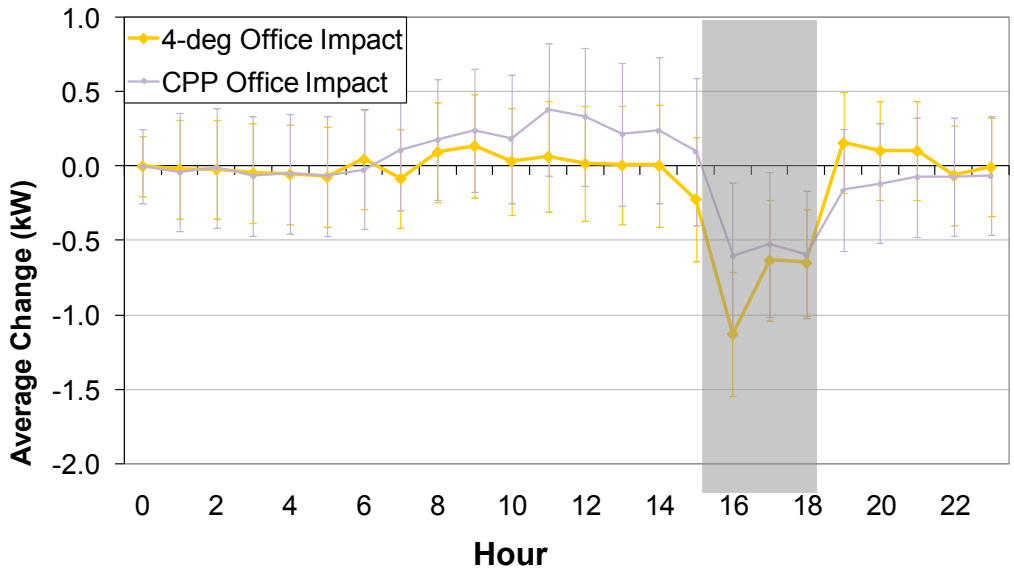

Figure 25. Average kW change on event days, offices

Figure 26 shows the average load change in the four hours directly preceding the event (precool), in the three hours of the event (event), and in the four hours directly following the event (rebound).

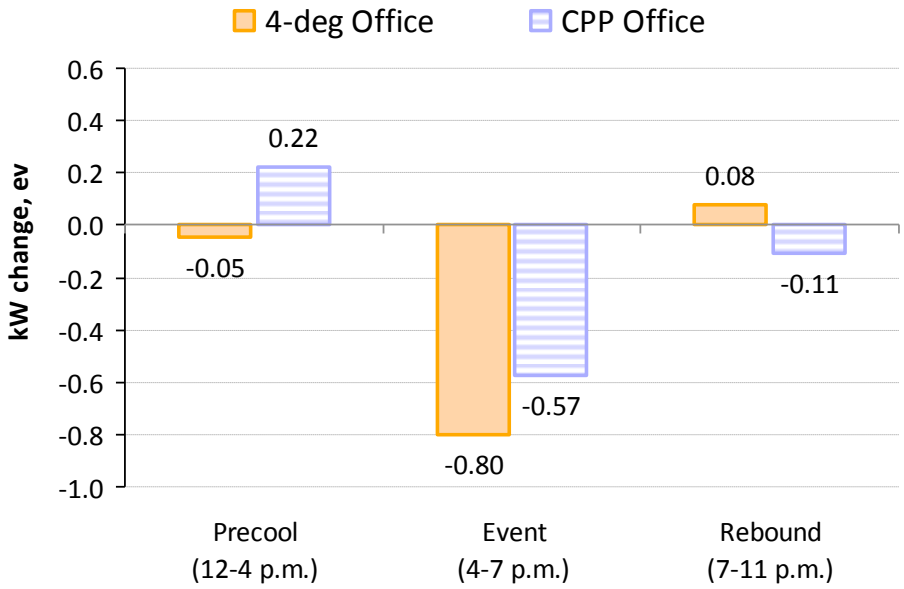

Figure 26. Average precool, event and rebound impacts on event days, offices

Figure 27 and Figure 28 show the load impacts for events at retail stores. Again, there is a significant load drop in each of the three event hours, with the peak load drop reaching nearly 1 kW for both programs. Here, the precooling effect for the CPP program is significant in all four of the five hours preceding the event. A similar precooling shape is apparent for the 4-degree ACC program, but the impacts are not statistically significant. Neither program elicits a rebound after the event, presumably because most retail shops – about 90% – close before end of the event (see Figure 6).

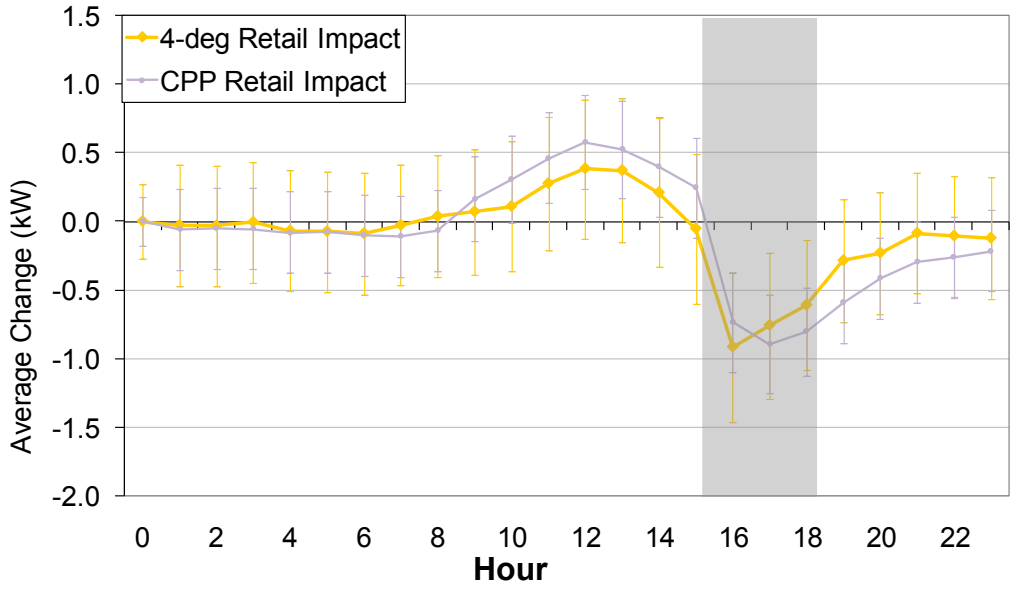

Figure 27. Average kW change on event days, retail stores

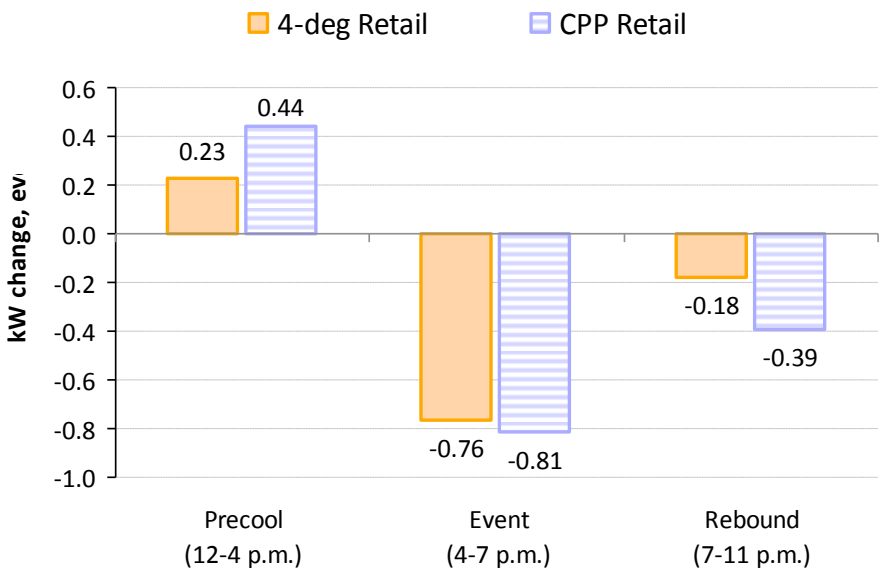

Figure 28. Average precool, event and rebound impacts on event days, retail

Offices vs. Retail

Figure 29 through Figure 32 show the same load impact data shown in

Figure 25 through Figure 28, but with the opposite comparison combinations. Here, we compare the load impacts of offices to the load impacts of retail, when both are on the same program.Figure 29 and Figure 30 show the nearly identical load impacts of offices and retail stores on the 4-degree ACC program.

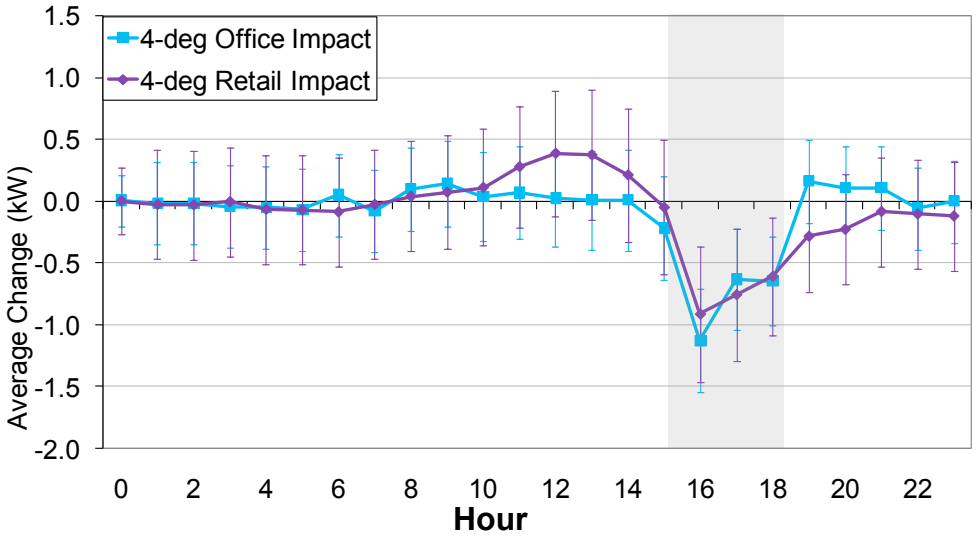

Figure 29. Average kW change on event days, 4-degree ACC

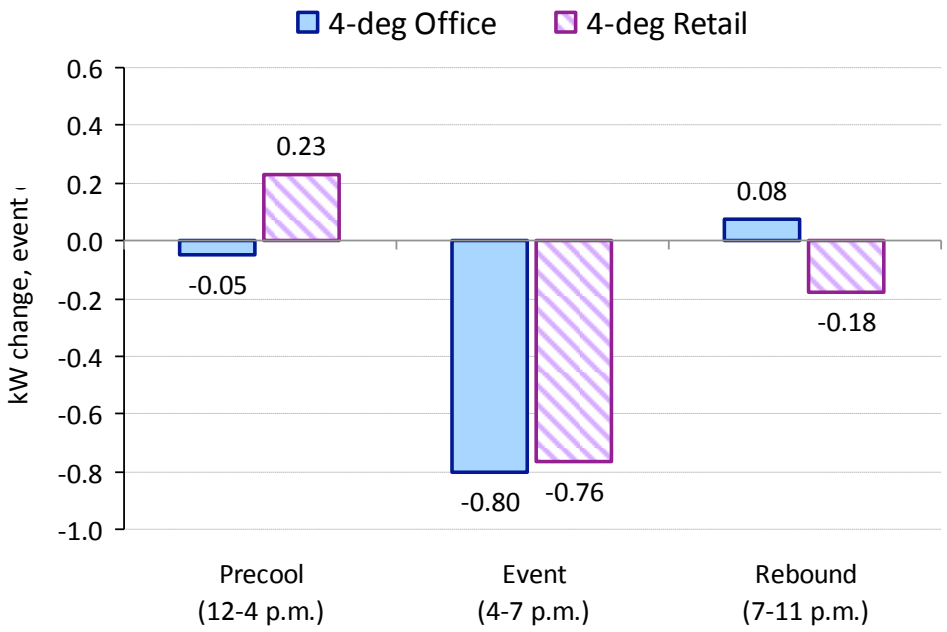

Figure 30. Average precool, event and rebound impacts on event days, 4° ACC

Figure 31 and Figure 32 show that the load impacts for offices and retail stores have similar shapes. Retail has higher precooling and event impacts, but the difference is not statistically significant.

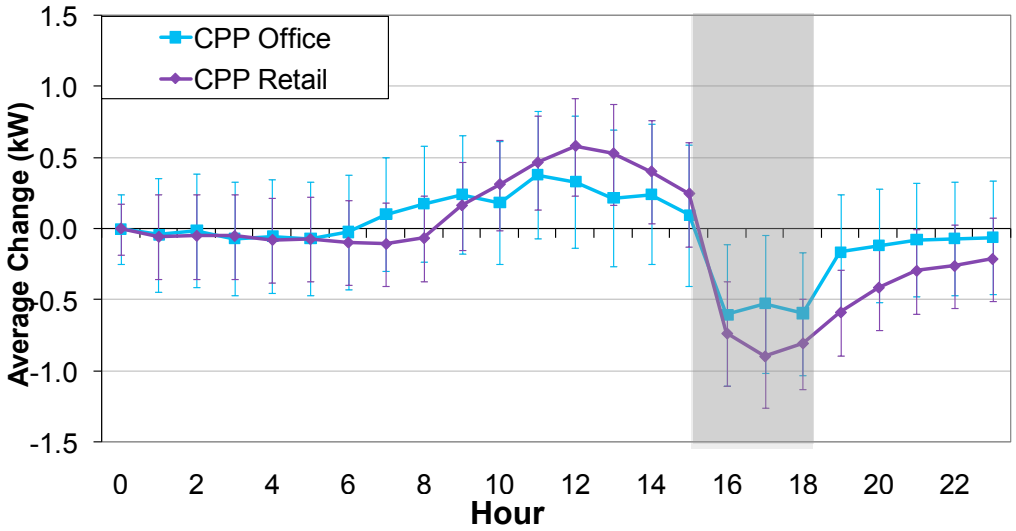

Figure 31. Average kW change on event days, CPP

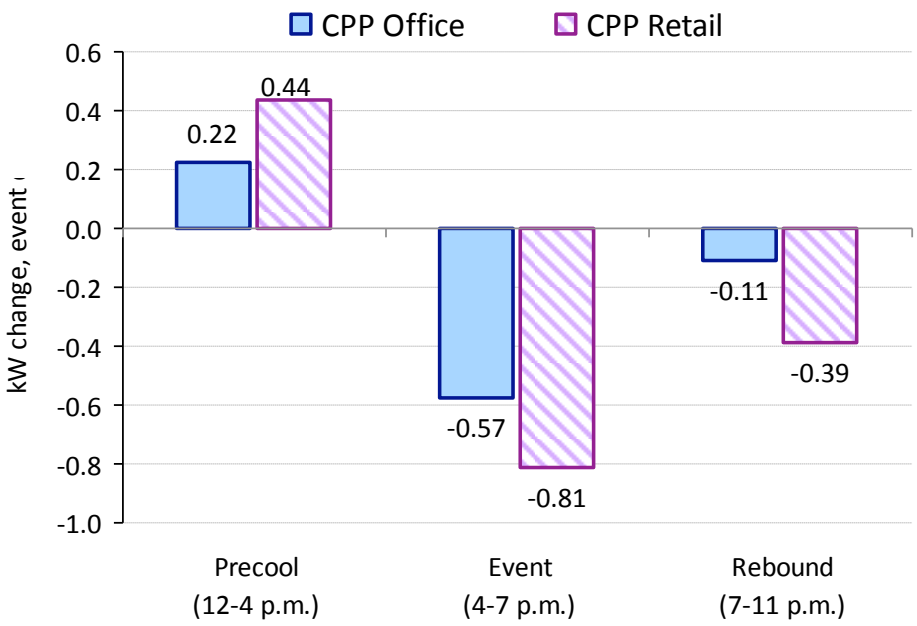

Figure 32. Average precool, event and rebound impacts on event days, CPP

4.3. Energy Impacts: Summer 2007 vs. Summer 2008

A regression of monthly usage (kWh) on average monthly temperature (Equation 3) was used to estimate the weather-corrected energy savings for the 4° ACC participants, the CPP participants, and a control group of non-participants (Table 13). The small number of 2° ACC participants prevented statistically useful results, so are not included here.

$$kWh_{ij} = \beta_0 + \beta_1 CDD_i + \beta_2 Year_i + \beta_{3-4} Program_j + \beta_{5-6} BusinessType_j + \beta_{7-8} Year_{ij} \cdot Program_j + \beta_{9-10} Year_i \cdot BusinessType_j + \varepsilon_{ij} \quad (3)$$

Where:

- kWh_{ij} is the consumption for month i for customer j
- CDD_i is the total cooling degree days (base 75) for month i
- $Year_i$ is a dummy variable equal to one if month i falls in 2008
- $Program_j$ is a set of two dummy variables for program (None, 4-deg offset, CPP)
- $BusinessType_j$ is a set of two dummy variables for business type (Restaurant, Retail, Office)

Table 13. Summer Solutions Participant Energy Savings

Business Type	Program	Average Monthly kWh		2007-2008 Difference		2007-2008 Difference Corrected for Non-Participant Change
		Summer 2007	*Summer 2008*	*(kWh)*	*(%)*	*(%)*
Office	None (control)	1025	976	49*	-5%	
	4° ACC	934	631	303*	-32%	-27%
	CPP	1061	668	393*	-37%	-32%
Restaurant	None (control)	3340	3252	88*	-3%	
	4° ACC	3249	2907	342	-11%	-8%
	CPP	3377	2944	432*	-13%	-10%
Retail	None (control)	1754	1716	38*	-2%	
	4° ACC	1663	1370	292	-18%	-15%
	CPP	1790	1408	383*	-21%	-19%
Average	4° ACC and CPP participants	1543	1197	346*	-23%	-20%

* Statistically significant kWh savings (α=0.05)

Overall, program participants used significantly less energy in 2008 than they did in 2007. Correcting for non-participant savings, the Summer Solutions program participants saved over 300 kWh *per month* on average, representing a 20 percent overall energy savings for the pilot. These results indicate that the pilot was successful in achieving (and surpassing) our original energy savings goal of just 5 percent.

4.4. CPP Bill Impacts

Table 14 shows the mean monthly GSN and CPP bills, CPP savings relative to the standard GSN tariff, estimated bill savings attributable to energy efficiency, and total bill savings. On average, each business type saved about 5% of their bill on the CPP tariff relative to the GSN rate. The inclusion of energy efficiency related savings boosts total bill savings to over $50 for offices and retail, and to $75 for restaurants, representing an estimated savings of over 30% for offices and retail, and a respectable 13% for restaurants.

Table 14. Summary of bill effects for CPP participants

Business Type	N	Average Summer 2008 Monthly Bill		CPP Bill Impacts		2007-2008 Efficiency Savings	Total Bill Savings	
		*GSN**	*CPP*	*$*	*%*	*$*	*$*	*%*
Office	23	$ 139	$ 132	$ 7	5.0%	$ 44	$ 51	37%
Retail	20	$ 164	$ 156	$ 8	4.7%	$ 43	$ 51	31%
Restaurant	8	$ 564	$ 537	$ 26	4.7%	$ 49	$ 75	13%
All	51	$ 215	$ 205	$ 10	4.8%	$ 45	$ 55	26%
Office + Retail	43	$ 151	$ 139	$ 7	4.9%	$ 44	$ 51	34%

** Calculated using 2008 usage and GSN rates*

Assuming similar GSN bills, ACC offices, retail stores and restaurants saved a total of 32%, 26%, and 9%, respectively, for an overall average of 20% bill savings for all ACC participants, and 29% savings for just the office and retail ACC participants.

4.4.1 CPP Impacts (not including 2007-2008 efficiency savings)

Figure 33 plots the difference between GSN and CPP bills - in both dollar and percentage terms, showing that all but four of the CPP participants saved money on the experimental rate. While the greatest savings was $178, the greatest bill increase was only $20 (or about 10% of the standard bill).

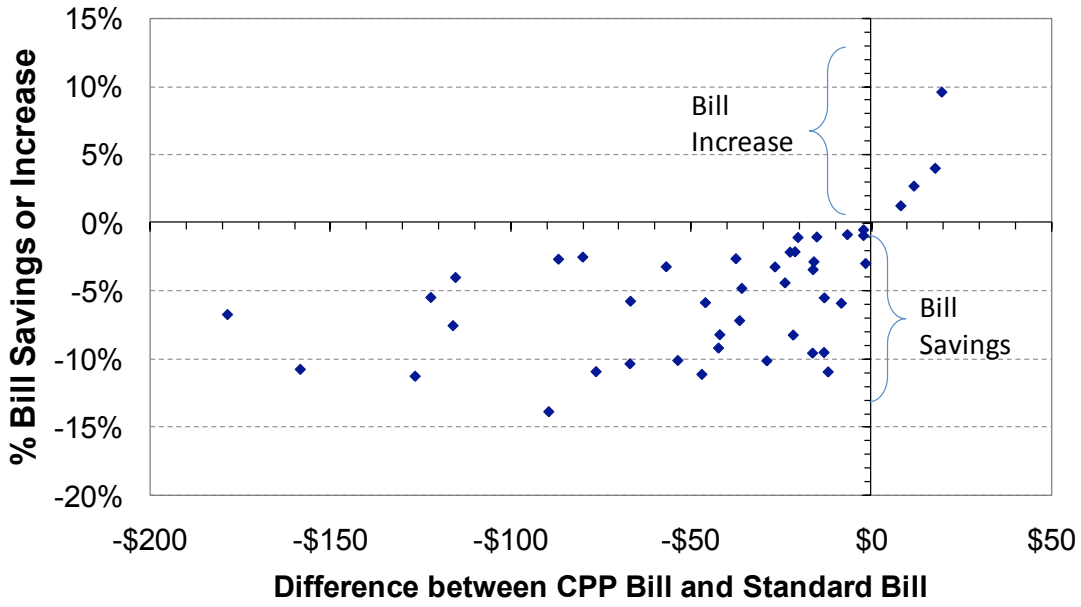

Figure 33. Dollars vs. percent bill change, CPP participants

The participant with the largest dollar savings over the course of the summer was a restaurant-bar, with savings totaling over $178. A likely factor in the large savings was the schedule – a steady 10 a.m. to 2 a.m. seven days a week. This helped to reduce the ratio of peak to non-peak hours, increasing savings. This business also precooled their building every day by opening windows. Unsurprisingly, this customer said they would definitely participate in the program again without an incentive payment.

The largest bill increase, in both dollar and percentage terms, occurred in a suite of offices, with just one thermostat located in one of the three offices sharing a single electric account. The total bill increase for the summer was about $20 (less than 10%). One possible contributing factor is that each office had its own hours of operation, so the thermostat had be set at the lowest common denominator, wasting energy cooling empty offices when there were only one or two people there. Despite the bill increase, this participant said they would probably participate in the program again without a participation payment, and that their already positive opinion of SMUD was not changed by this pilot.

The participant with the largest percent savings on their bill (nearly 14%) was an auto retailer. This participant resided in a relatively new (5 years) and small (500 sq. ft.) building with a window air conditioner. Business is generally conducted outside in the car lot, so customer complaints are not a major concern. Like the restaurant-bar described above, this participant also said they would definitely participate in the program again without an incentive payment. Additionally, this participant indicated that their opinion of SMUD had improved as a result of this pilot.

4.4.2 Bills vs. Usage

Figure 34 and Figure 35 compare load change to bill savings for CPP participants. As before, the size of the bubble indicates the number of events for which each participant received and responded to the event notification. The color of the bubbles indicates whether the participant had installed a communicating thermostat.

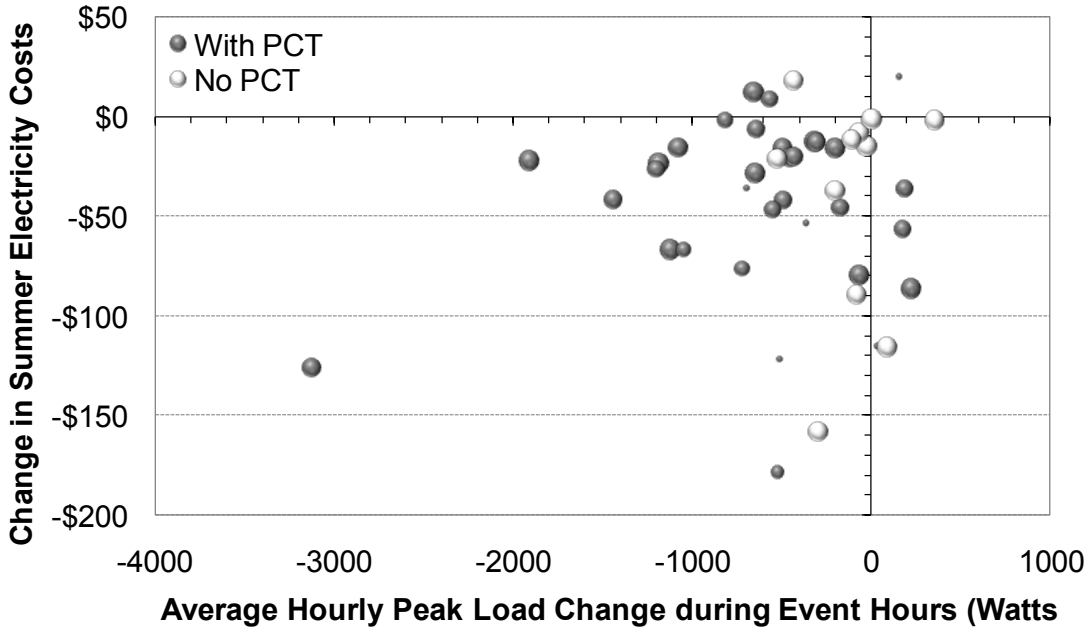

Figure 34. Summer bill savings vs. load change for event period

The white bubbles are all the same size because these customers did not have a thermostat, and therefore received a phone call or email notifying them of each event. The smallest bubbles indicate that no event notifications were received by the thermostat – however, most of these participants were also notified by email, and so could have responded manually. The largest received all twelve event notifications.

Figure 34 shows the change in participant bills compared to the change in their energy usage during the event period (4-7 p.m.). There appears to be a relatively good correlation between event response and bill savings, with all but nine of the CPP participants located in the third (bottom left) quadrant of the plot.

A small group of participants managed to save money despite increasing their usage during event periods, while an even smaller group had increased bills despite dropping some load. However, the vast majority of CPP participants saved money on their bills and dropped load during event periods.

Figure 35 shows the bill savings of CPP participants compared with their change in energy usage on event days. It is interesting to note that all but one of the participants that increased their load on event days managed to reduce their bills overall.

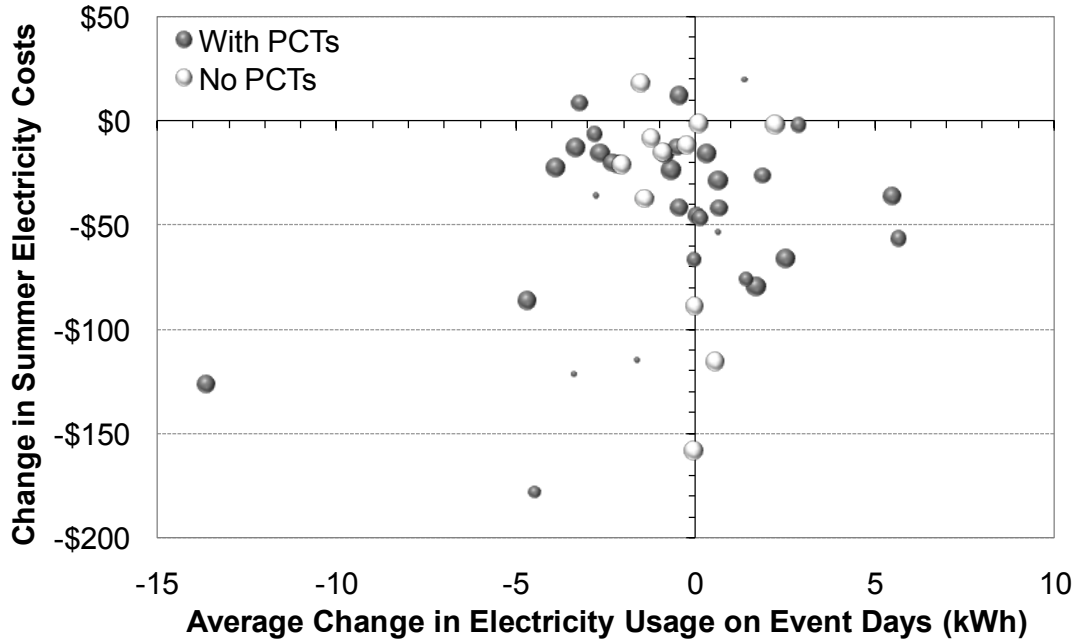

Figure 35. Summer bill savings vs. load change for entire event day

4.5. Participant Surveys

The study included participant surveys before, during and after the summer 2008 field study. The Spring Survey focused on building and customer characteristics. Event Surveys collected after each event recorded information on customer actions and comfort perceptions. After the field study ended, participants were given the Fall Survey, which recorded information about their experience on the program. A list of all questions on all three surveys and summaries of the responses are provided in Appendix B.

4.5.1 Load Shifting and Demand Response Behavior

Figure 36 combines data from the Spring and Fall surveys. It shows the percentage of participants that performed a variety of energy conservation and shifting measures every day before and during the pilot, plus the percentage of participants that performed the same actions only on event days.

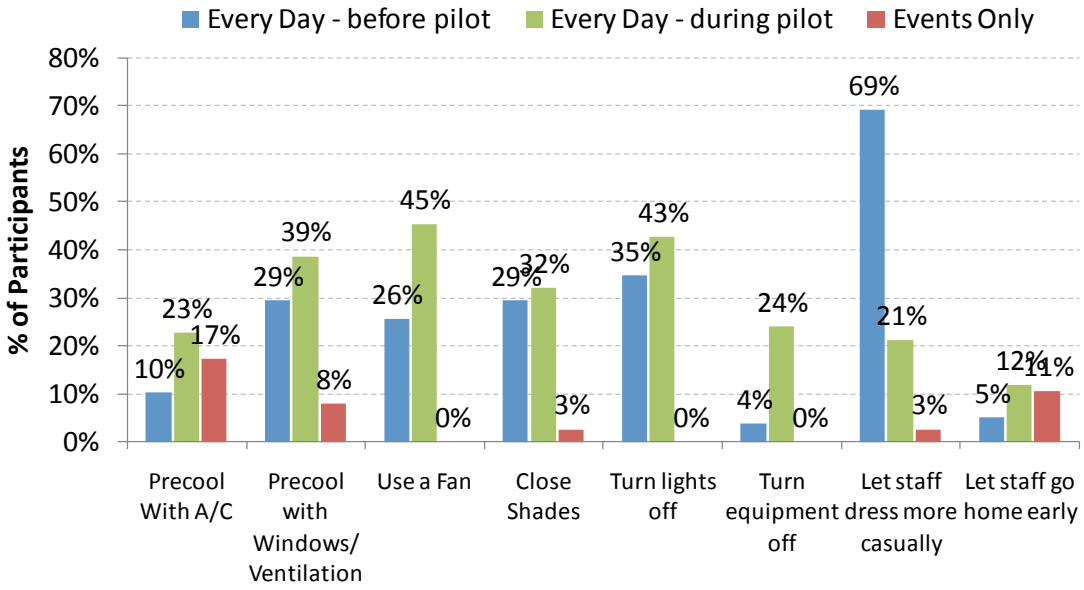

Figure 36. Load shifting and conservation actions before and during the pilot

With the exception of "Let staff dress more casually" question,[1] the survey responses indicate that all actions were performed by a greater percentage of participants at the end of the pilot than at the beginning of pilot. In addition, all actions taken during "events only" are clearly attributable to the pilot, since events did not exist before the pilot.

Figure 37 and Figure 38 show the actions taken by participants as reported in the Fall Survey. Keep in mind that there are a smaller number of restaurants than offices or retail shops, and similarly, fewer participants on the ACC programs than on the CPP rate.

[1] The large decrease in affirmative responses to this question is likely a result of the wording of the question – in particular the use of the word "more" without a clear reference point for comparison.

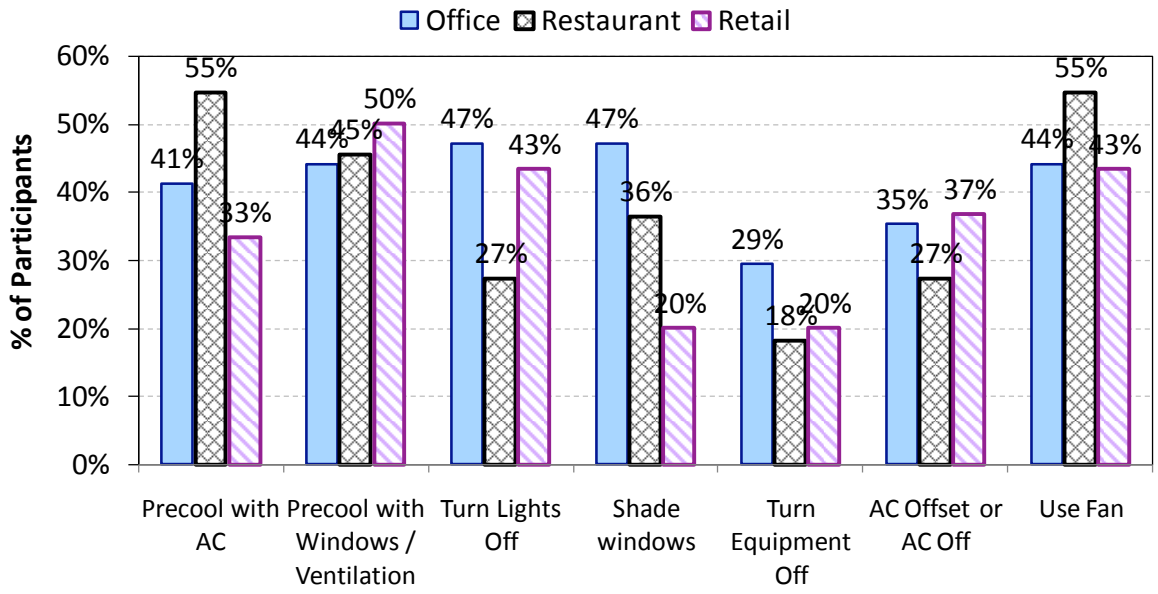

Figure 37. Load shifting and conservation actions during the pilot, by business

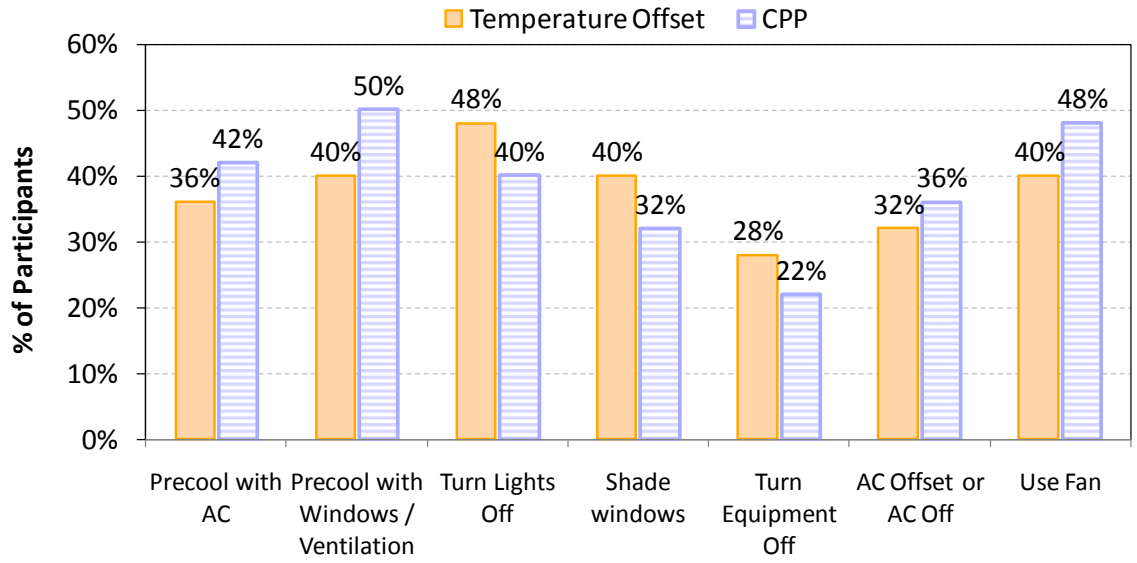

Figure 38. Load shifting and conservation actions during the pilot, by program

4.5.2 Summer Surveys: Effects on Business and Comfort

In general, participants indicated that the demand response events were not very disruptive to their businesses (Figure 39 and Figure 40). Overall, about 90% of participants said that the events did not affect their business at all, while only 10% thought that the events affected businesses negatively.

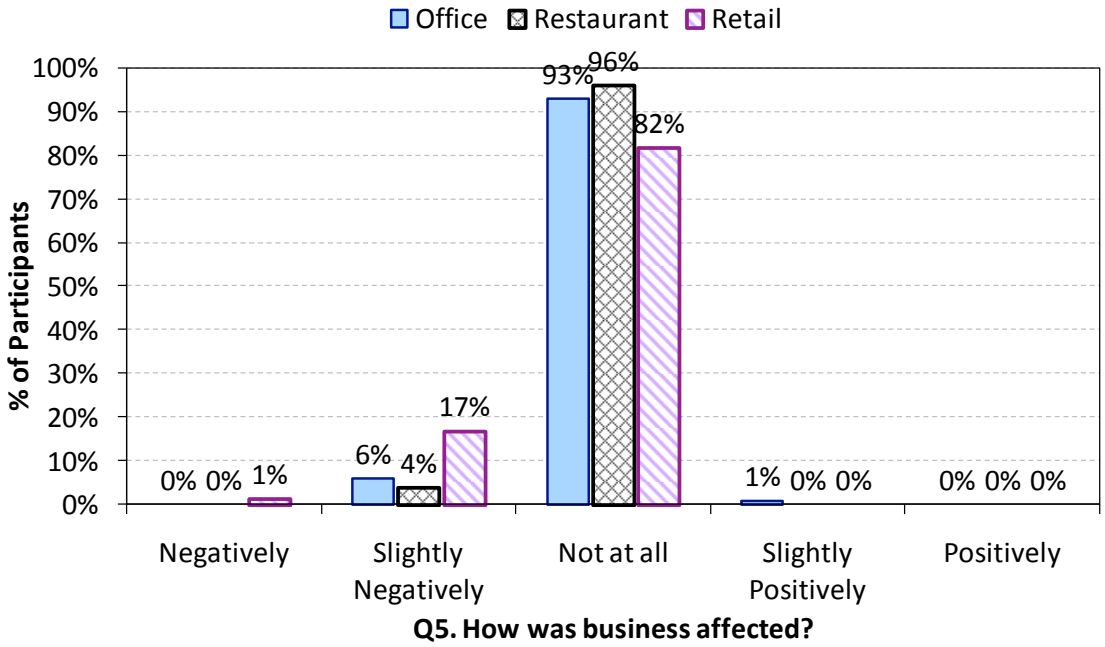

Figure 39. Effects on business, by business type

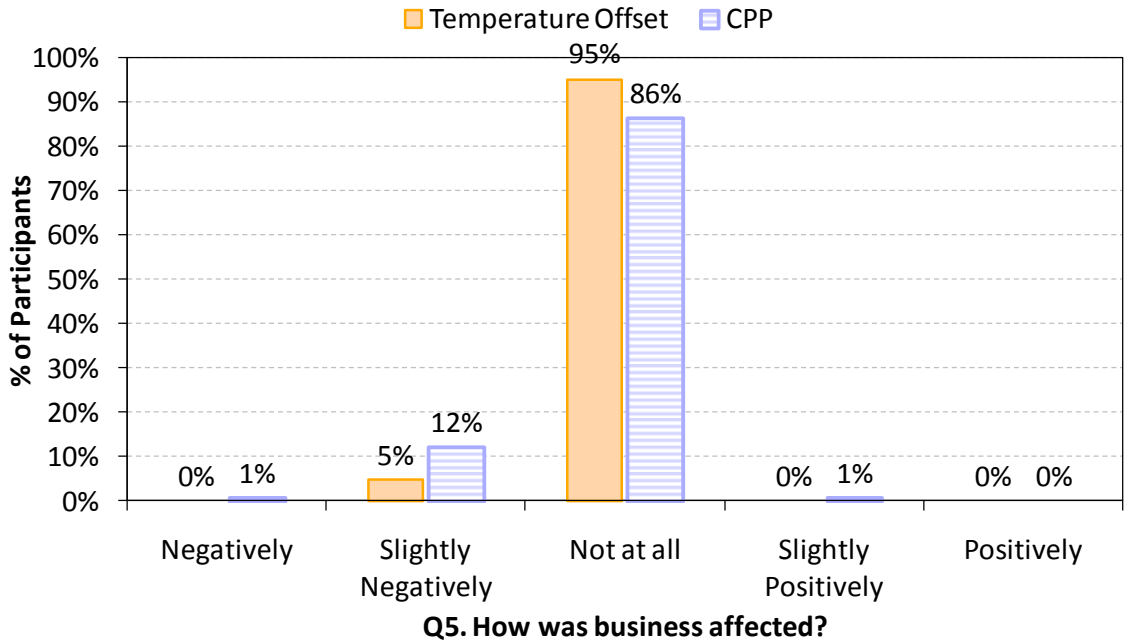

Figure 40. Effects on business, by program choice

Figure 41 and Figure 42 show that on average about 10% of the participants felt that the events made them uncomfortable. This is a positive indicator that demand response for the most part may not be disruptive to the small commercial sector.

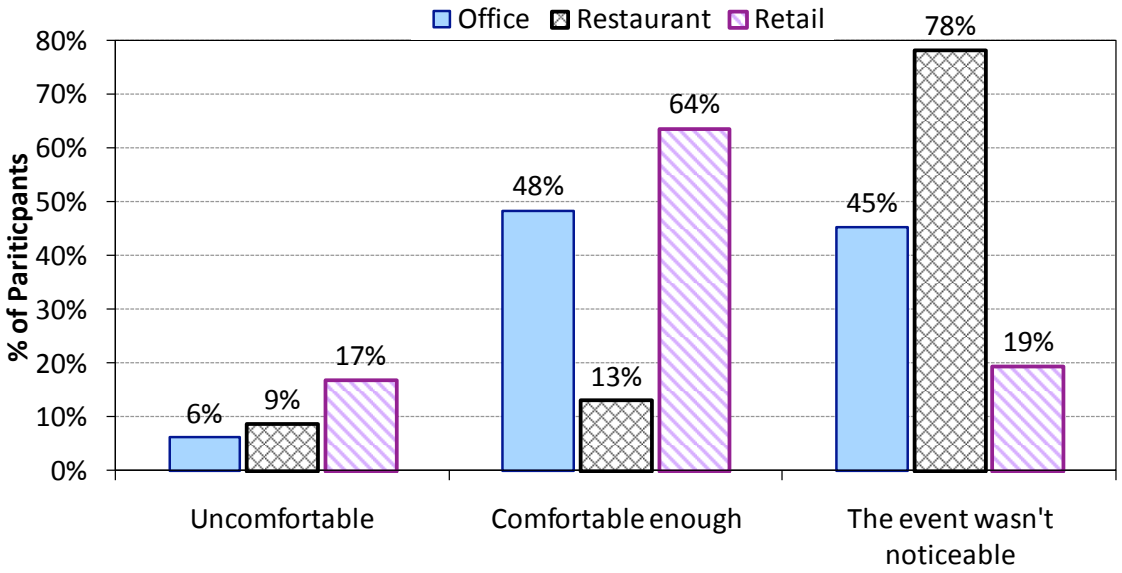

Figure 41. Effects on comfort, by business type

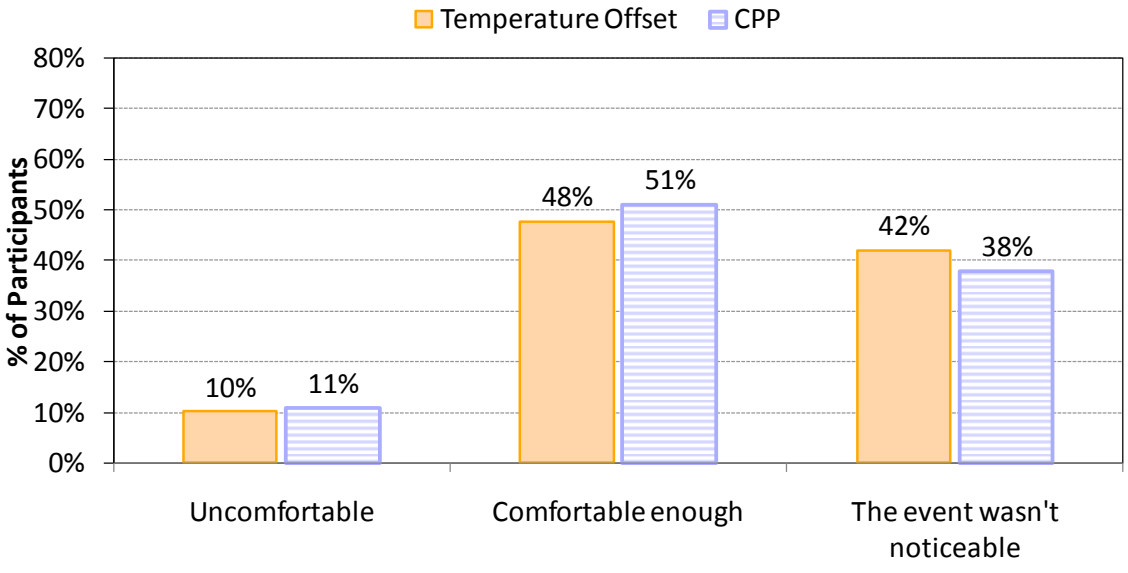

Figure 42. Effects on comfort, by program choice

Figure 43 and Figure 44 show that there were comments from customers or occupants in about 10% of the participant events, with slightly more negative than positive comments.

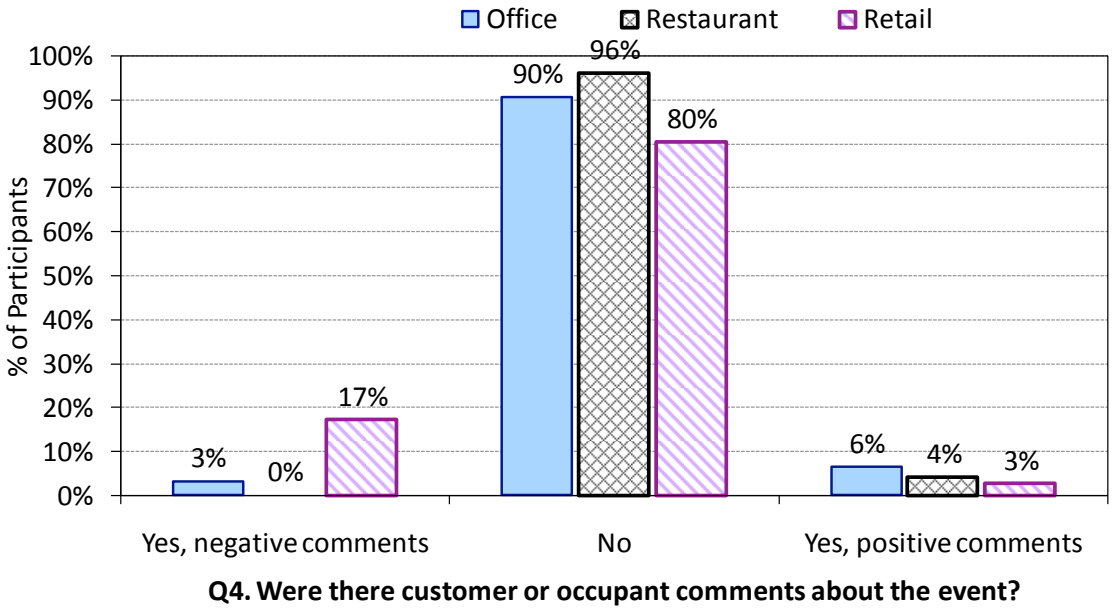

Figure 43. Occupant comments, by business type

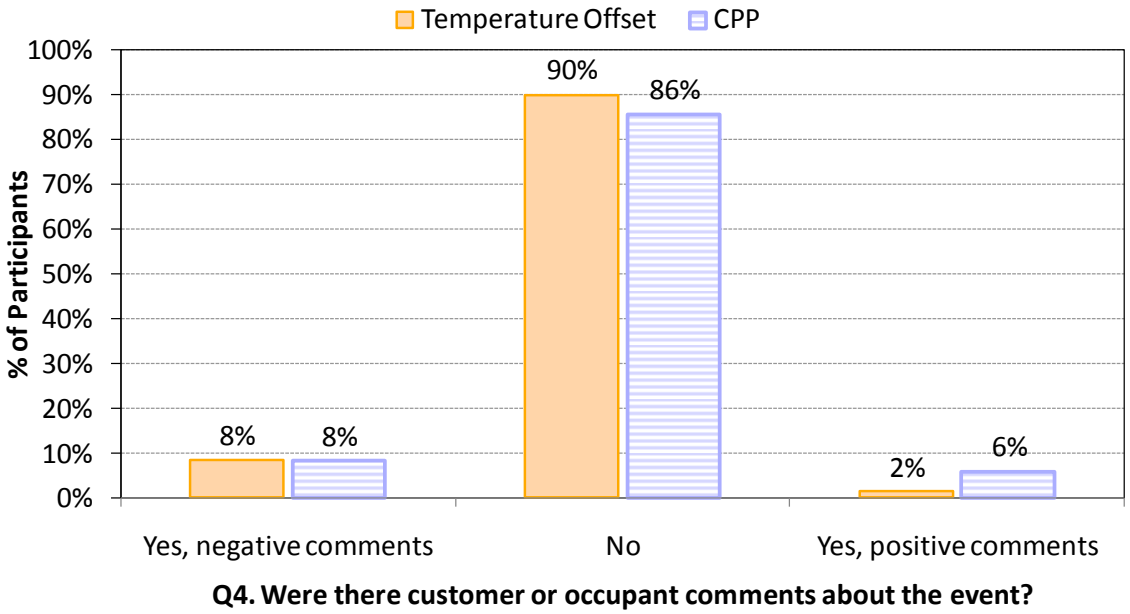

Figure 44. Occupant comments, by program choice

4.5.3 Fall Survey: Participant Satisfaction

The Fall Survey was designed to be administered at the end of the summer pilot. Of the 76 participants who remained on the program at the end of the summer, 75 completed the Fall Survey. For full documentation of the survey questions and results, please refer to Appendix B.

Programs

This section details the results of Fall Survey questions that were related to the ACC and CPP program options.

Figure 45 and Figure 46 depict participants' reasons for choosing their program option. As expected, the majority of participants in all business types signed up for the program they thought would give them the most savings on their electricity bill. The second most common answer was that participants chose the program SMUD recommended.

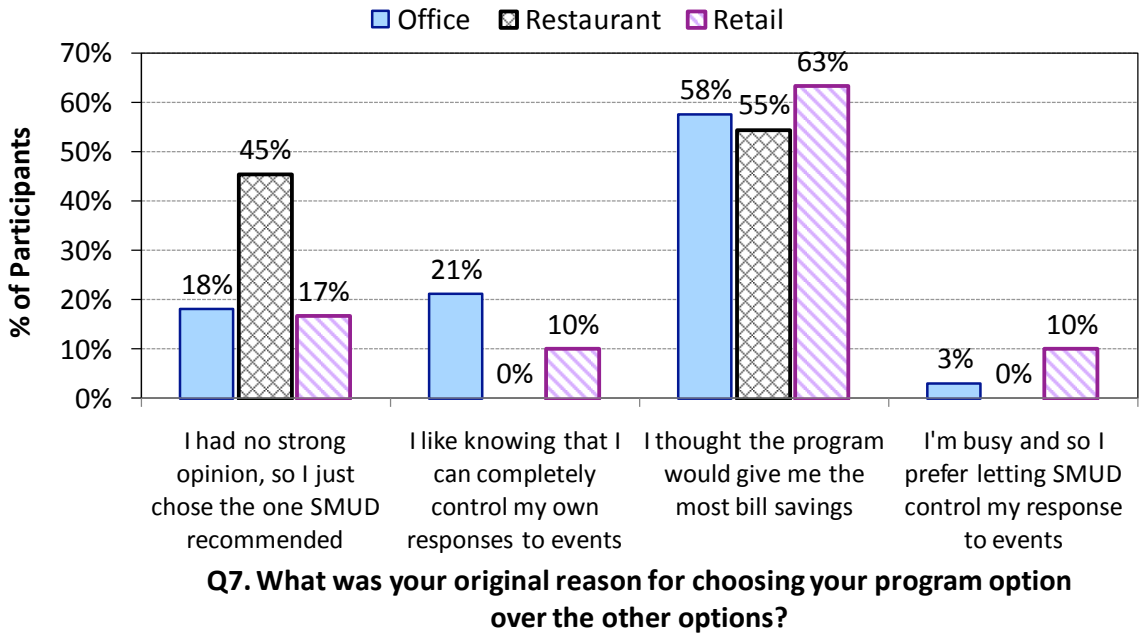

Figure 45. Reason for program choice, by business type

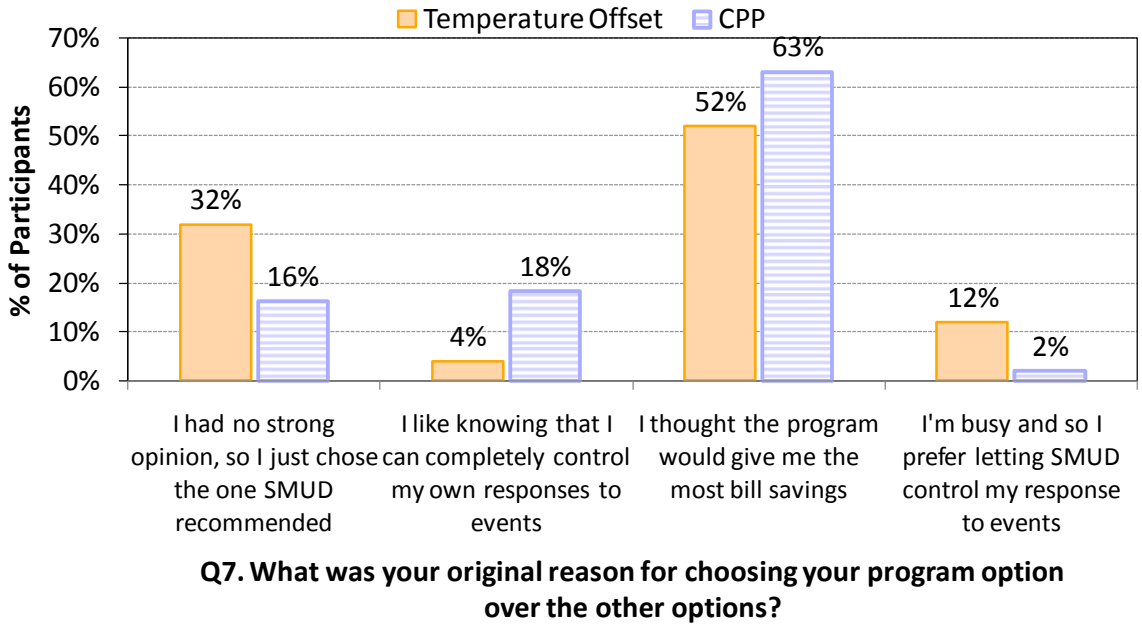

Figure 46. Reason for program choice, by program choice

Seven people added comments on the Fall Survey detailing the reason why they chose to participate in this pilot in their own words. Two cited the environment as their motivation ("Want to help our environment with lower the demand", "It was environmentally sound"), two cited money ("Free money", "I always like to save money on bills"), one referenced control issues ("Much better than peak program previously offered as one has more control"), one wanted the thermostat ("I had old thermostat, which was not function accurately"), and one mentioned energy savings ("I want to be responsible regarding energy savings").

Figure 47 and Figure 48 show that 80% of the participants were satisfied with their experience with the Summer Solutions pilot.

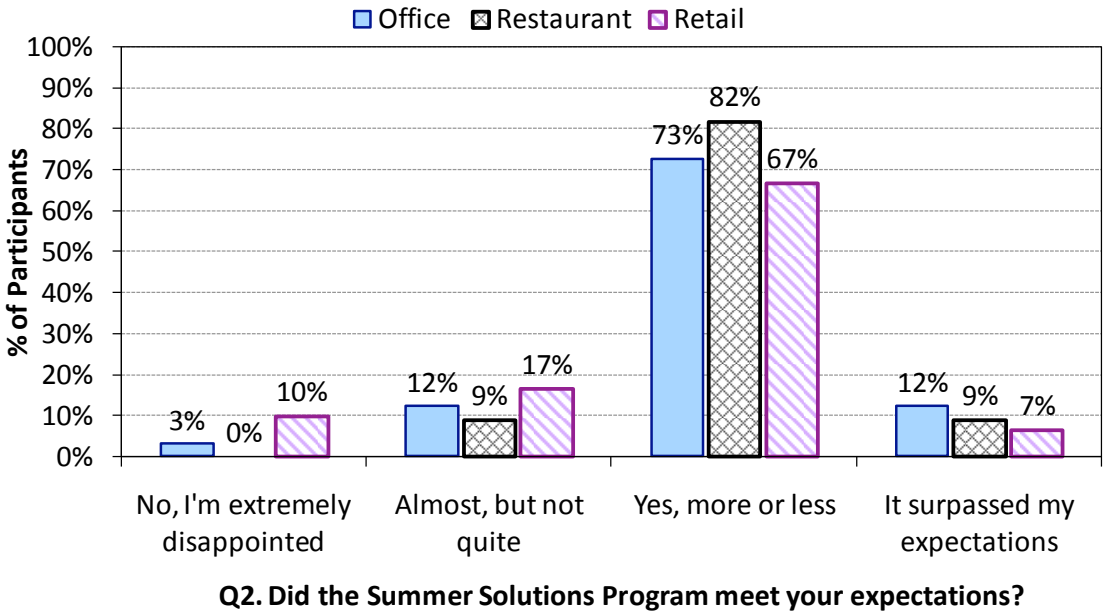

Figure 47. How expectations were met, by business type

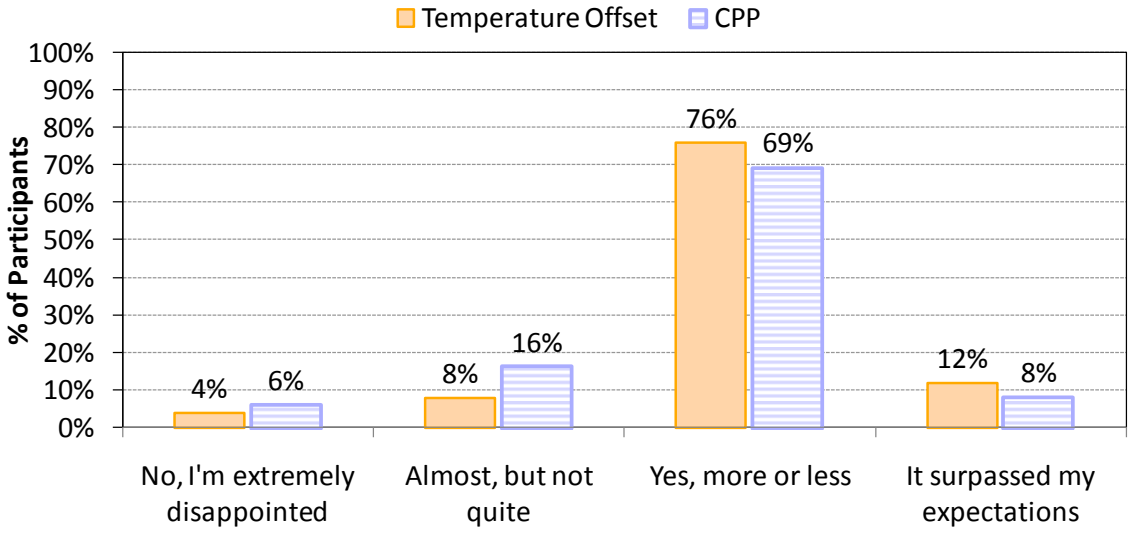

Figure 48. How expectations were met, by program choice

Satisfaction with the program is also demonstrated by Figure 49 and Figure 50. These graphs show that the majority of participants would be willing to participate in the program again next year, without an additional incentive payment.

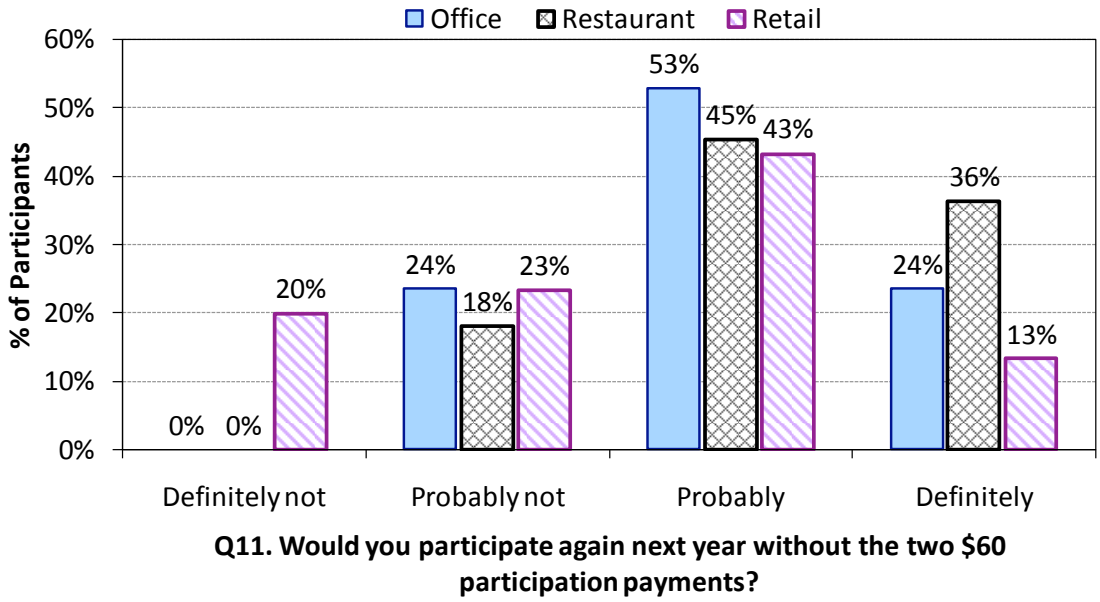

Figure 49. Willingness to participate without participation incentive, by business type

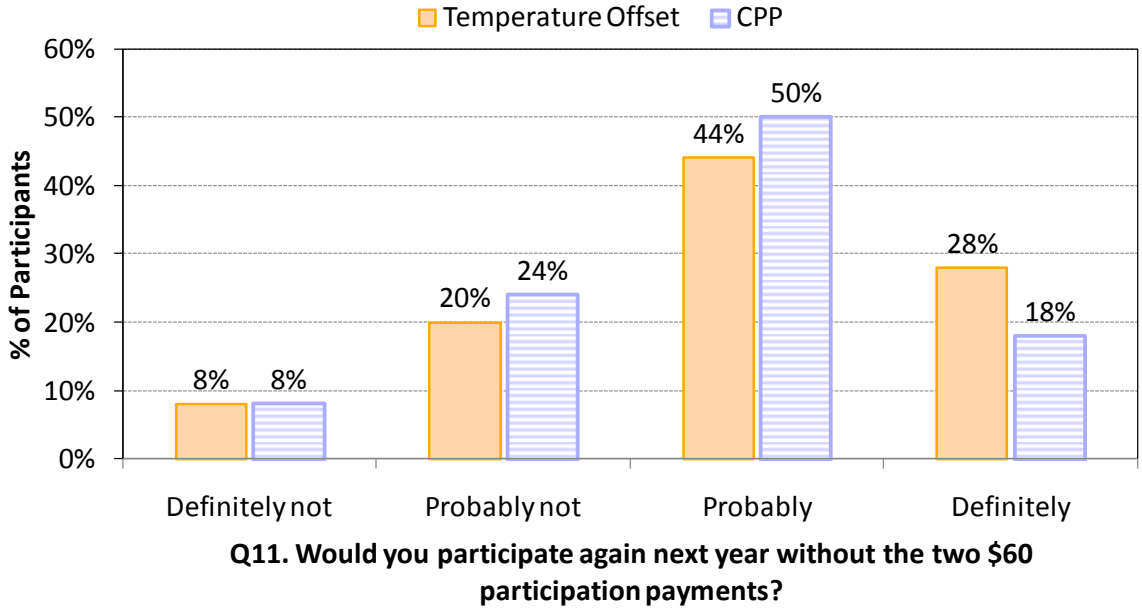

Figure 50. Willingness to participate without participation incentive, by program choice

Thermostats

Participants had positive or neutral feedback about the automatic response to events by the PCT, as shown in Figure 51 and Figure 52.

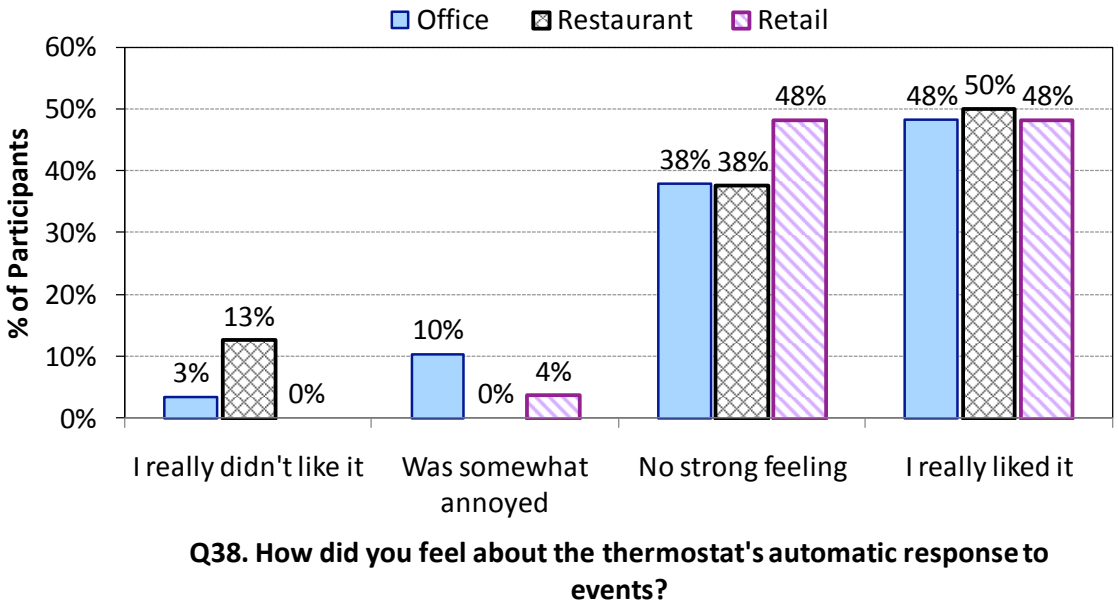

Figure 51. Opinion of automatic response, by business type

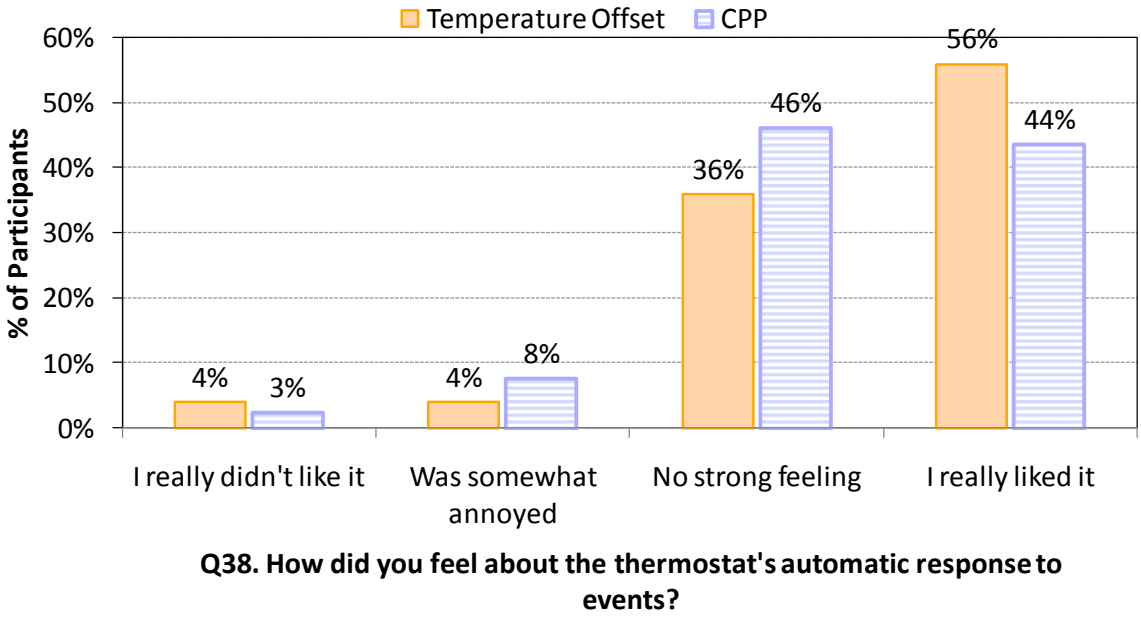

Figure 52. Opinion of automatic response, by program choice

Most participants also found the new thermostats relatively easy to use, as evidenced in Figure 53 and Figure 54. Two participants did have problems to the extent that they requested their old thermostats back at the conclusion of the pilot.

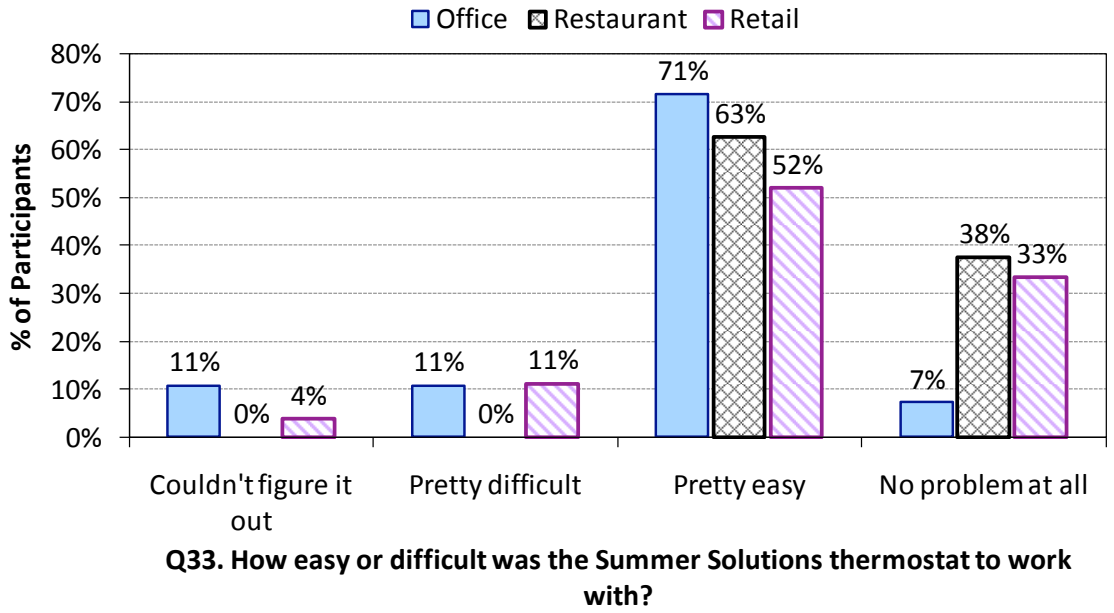

Figure 53. Opinion of thermostat usability, by business type

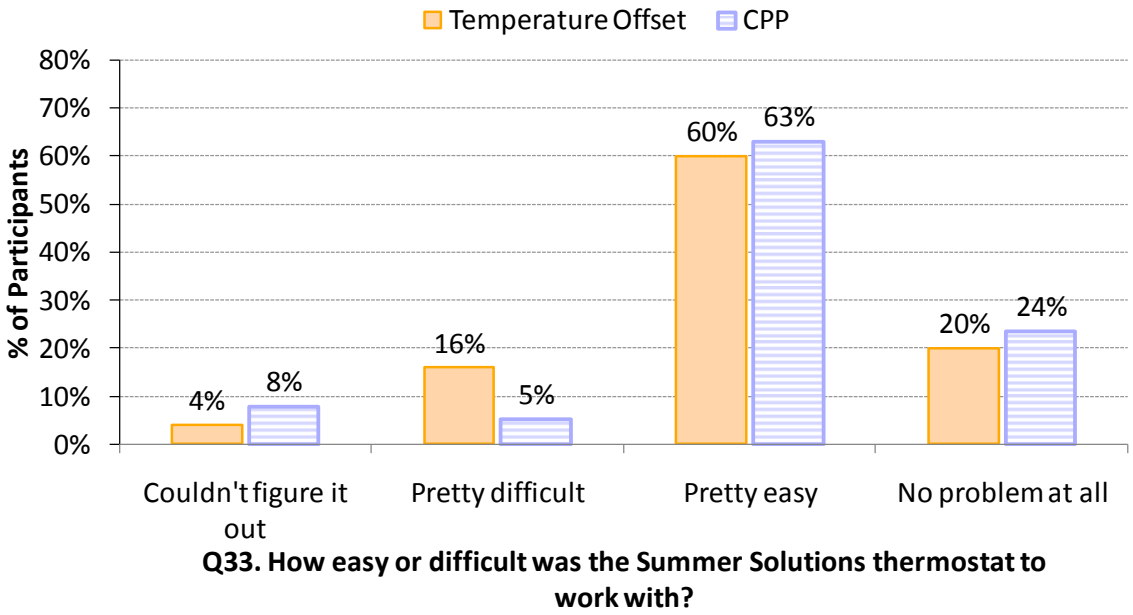

Figure 54. Opinion of thermostat usability, by program choice

The most popular methods of contact were email and thermostats (Figure 55 and Figure 56). In general, participants preferring phone calls or text message were the ones without internet access or a PCT.

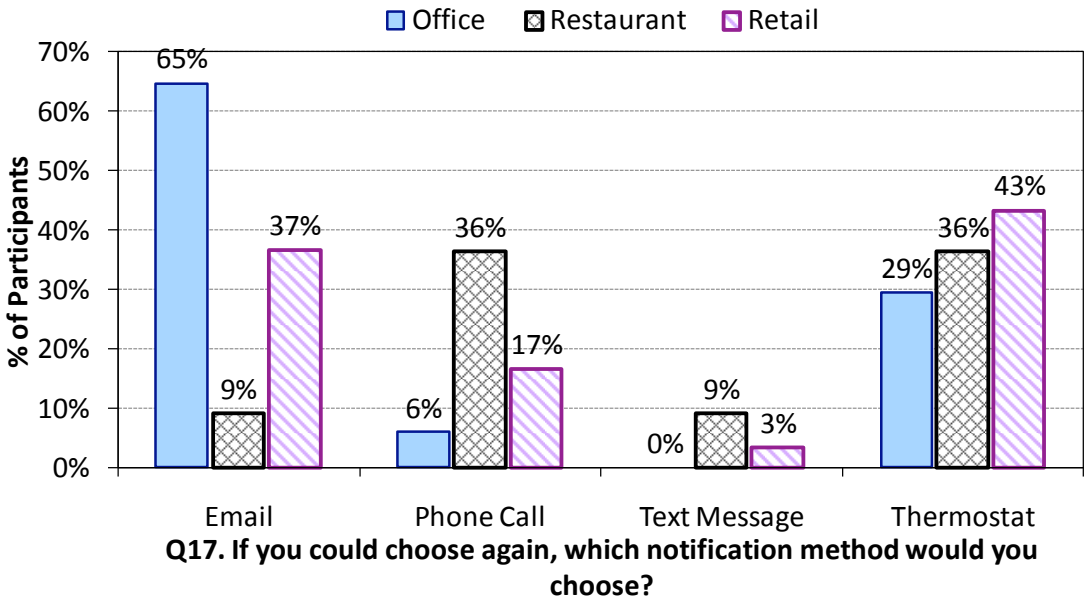

Figure 55. Preferred notification method, by business type

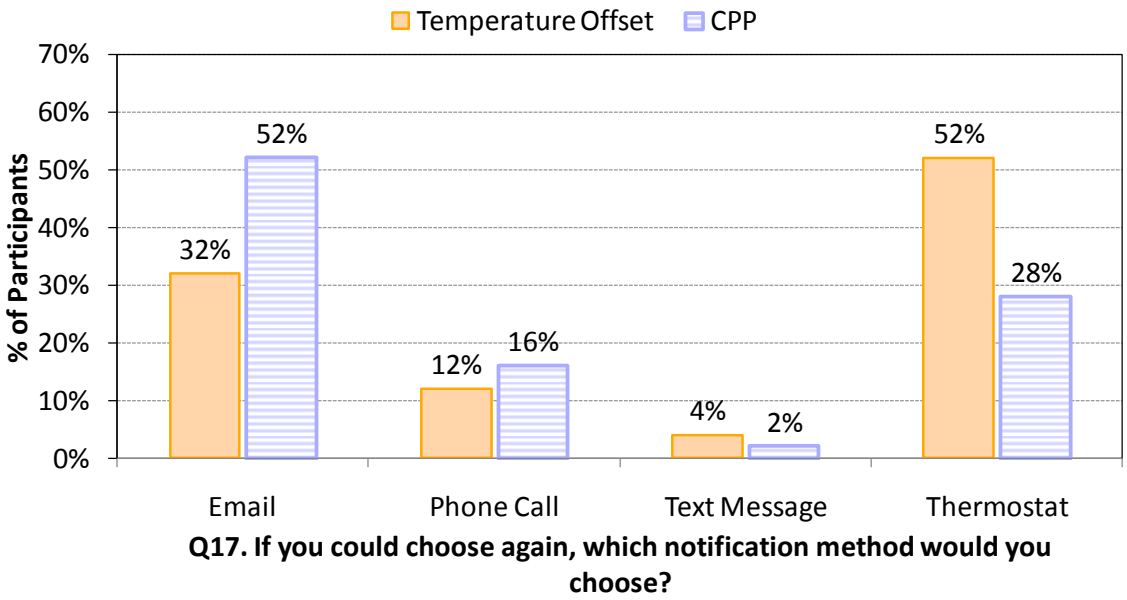

Figure 56. Preferred notification method, by program choice

5.0 Conclusions and Recommendations

We found the Summer Solutions research pilot to be a three-way win, benefiting SMUD, pilot participants, and society in general. SMUD benefited by receiving 20% peak load reductions on event days, participants benefited from 20% to 30% lower bills, and society benefited from the 20% energy-efficiency savings.

This study provides California State policy makers assurance that dynamic rates and load control programs can be used concurrently and effectively in the small business sector. This study also informs California State energy agencies that it is possible to use Radio Data System communications technology to broadcast system alerts to the mass market in support of dynamic rates, demand response programs, and utility service messages – even in the event of a power outage. Finally, this study provides further evidence that communicating thermostats are a viable demand response technology, capable of automatically increasing setpoints to a customer-determined or utility-determined level, thus providing air-conditioning demand response within seconds or minutes.

We learned many lessons over the course of this study – some expected, some not. Below we provide recommendations for future programs and pilots based on our experience with this study.

Utilities should not hesitate to target the small commercial sector, in particular small offices and retail shops, for integrated EE-DR programs.

As hoped, the office and retail participants in this study precooled before events, increased setpoints during events, and shifted load away from the peak hours. Although the restaurants participating in this study changed thermostat settings to precool and offset during events, they were unable to drop load because their air-conditioning units were undersized.

Demand response programs should provide participants with energy efficiency assistance – especially envelope enhancements.

Customers want help with the efficiency of their buildings. Providing assistance in the form of audits, information and/or rebates can be used to entice customers to participate. Efficiency improvements to the building shell will also reduce the comfort effects associated with thermostat setpoint changes during CPP or ACC events, since a better insulated building will retain its temperature longer than would its less insulated counterpart.

Small commercial demand response program offerings should give customers a choice between a dynamic rate and load/temperature control.

This recommendation is based on two findings. First, in the focus groups, some participants preferred the CPP rate for its flexibility, while others preferred the AC control program for its ease of use. This preference split was further supported by the actual program uptake rates of one-third ACC and two-thirds CPP. Since both incentive structures were preferred by such large fractions of the sample population, one would expect that the offering of both incentive structures would results in higher participation rates and happier customers.

Second, both the 4° ACC and CPP programs provided significant and similar load impacts during events. Thus, from the standpoint of load impacts, there is no strong reason for a utility to prefer one over the other. In this study, the 2° ACC was a less popular program option and provided less response. On a larger scale, this option could still be a viable alternative for those customers unwilling to shed a full 4°, however, the cost effectiveness of this option should be carefully considered in the context of both efficiency and demand response benefits, since the demand response benefits alone are less likely to justify the cost of the communicating thermostat.

SMUD should seriously consider expanding this voluntary program model to all of their small commercial customers.

If SMUD is searching for opportunities to simultaneously improve efficiency and demand response in the District, we recommend that they consider the expansion of the Summer Solutions pilot to the general small business customer population on a voluntary basis. Given the results of this study and current pace of communicating thermostat cost reduction, we expect a combination demand response and efficiency program like the Summer Solutions program to be one of the most cost-effective options available. Even so, a cost-benefit analysis of such an expansion is recommended.

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7.0 APPENDICES

Appendix A: Thermostat Functionality

Appendix A: Thermostat Functionality

This appendix describes the functionality of the communicating thermostats purchased for this pilot. There are three sections, one describing each type of event used in this pilot. Message events were used for all participants, price events were used for the CPP participants, and temperature change events were used for the ACC participants.

Message Event

When a message event is chosen, the interface prompts for a message to send. The message is displayed on the PCTs belonging to the chosen group during the time specified or until any button is pressed.

Figure 57 shows the entries made during a test message event. The message "text message test" was transmitted two times to increase the probability of successful receipt by the Programmable Communicating Thermostat, and set to appear 17 April 2008 at 16:03 and clear 17 April 2008 at 16:04. Figure 58 shows the Programmable Communicating Thermostat displaying the message.

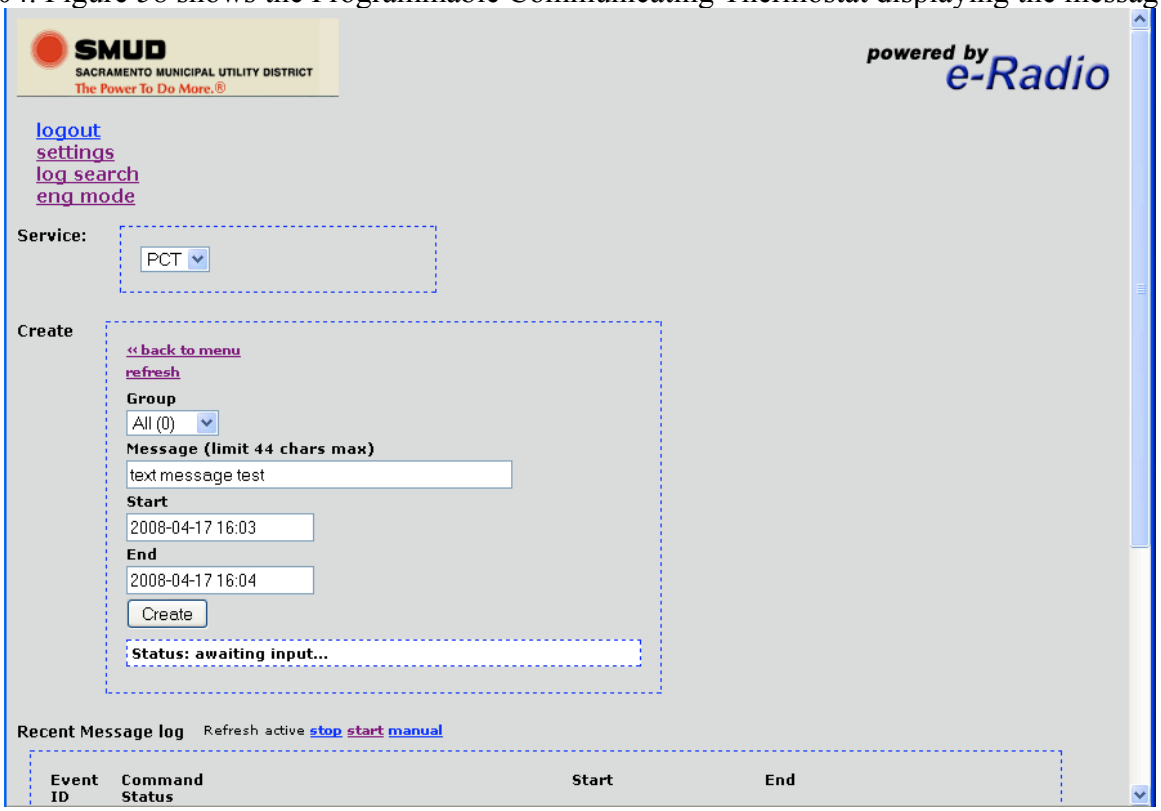

Figure 57. Website Interface for a Message Event

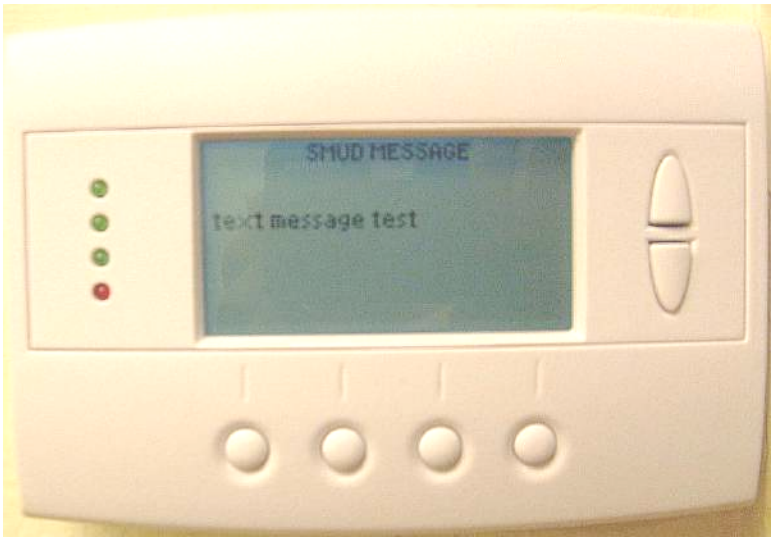

Figure 58. Programmable Communicating Thermostat Displaying a Message

The transmission of the Radio Data System signal was recorded by the eRadio server at the transmission tower site.

The reception of the Radio Data System signal was recorded by the Radio Data System logger which is connected to the Programmable Communicating Thermostat. This log shows that the signal was received at 16:01:30[2] and that the message was displayed on the Programmable Communicating Thermostat from 16:03:01 to 16:04:01.

```
04/17/2008 16:01:30> DL485: Added Message 1: text message test

04/17/2008 16:01:30> DL485: - Start: 04/17/2008 16:03:00

04/17/2008 16:01:30> DL485: - Stop: 04/17/2008 16:04:00

04/17/2008 16:03:01> DL485: Message 1 Activated

04/17/2008 16:04:01> DL485: Removed Message 1
```

[2] Testing immediately prior to these results showed that the time on the receiver log was 8 seconds different than the time on the eRadio server log. The times in the receiver logs have been modified to reflect this.

Price Event

When a price event is chosen, the interface prompts for a price tier. The current system allows for price tiers 1 through 4, but could easily be programmed to accommodate more. Electricity prices corresponding to each tier must be set by utilities in advance. For this project, when Tiers 1-3 are selected, the PCTs will simply display the current price. For Tier 4, PCTs will (a) immediately warn customers of the impending price event, (b) initiate a pre-cooling strategy (if any) on the morning of the event, and (c) initiate the response strategy (if any) at the onset of the event. Customers will also be notified when the event ends. Figure 59 shows the entries made during a test price event. The critical peak (Tier 4) event was transmitted two times to increase the probability of successful receipt by the Programmable Communicating Thermostat, and set to start 17 April 2008 at 16:12 and end 17 April 2008 at 16:16.

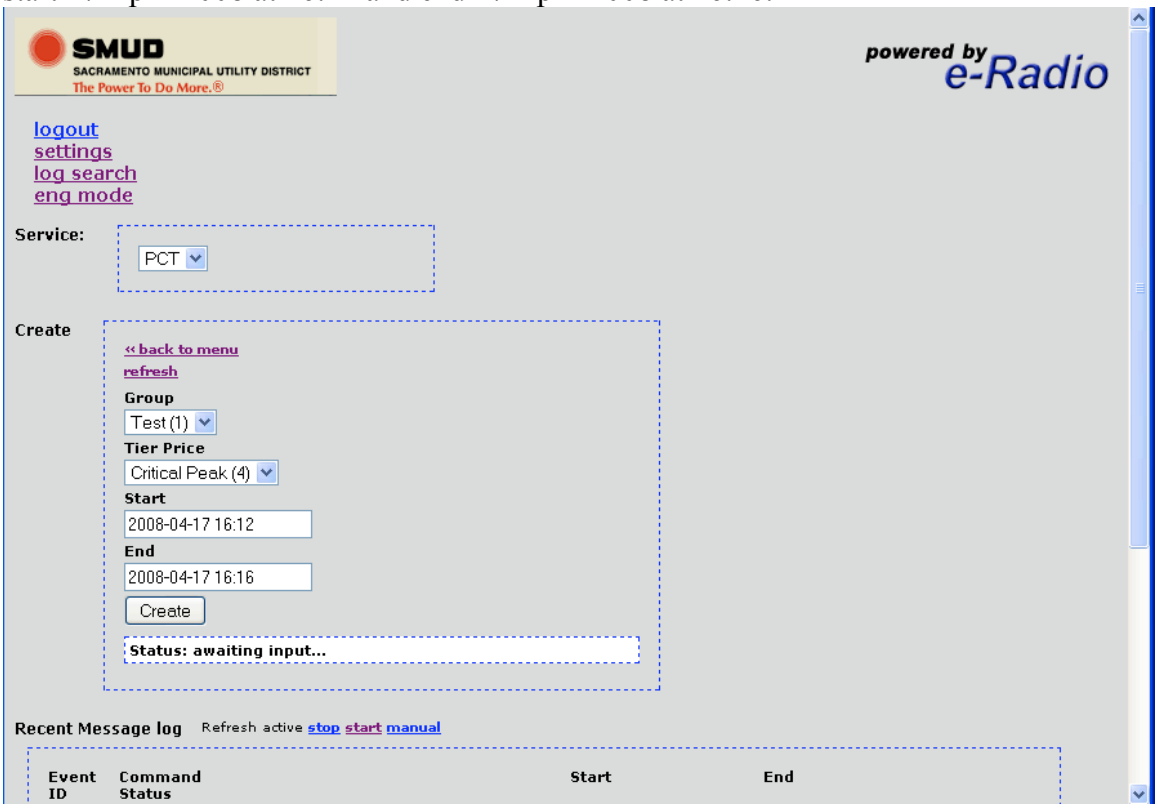

Figure 59. Website Interface for a Price Event

When the Tier = 4, the flashing notice shown in Figure 60 is displayed until any button is pressed.

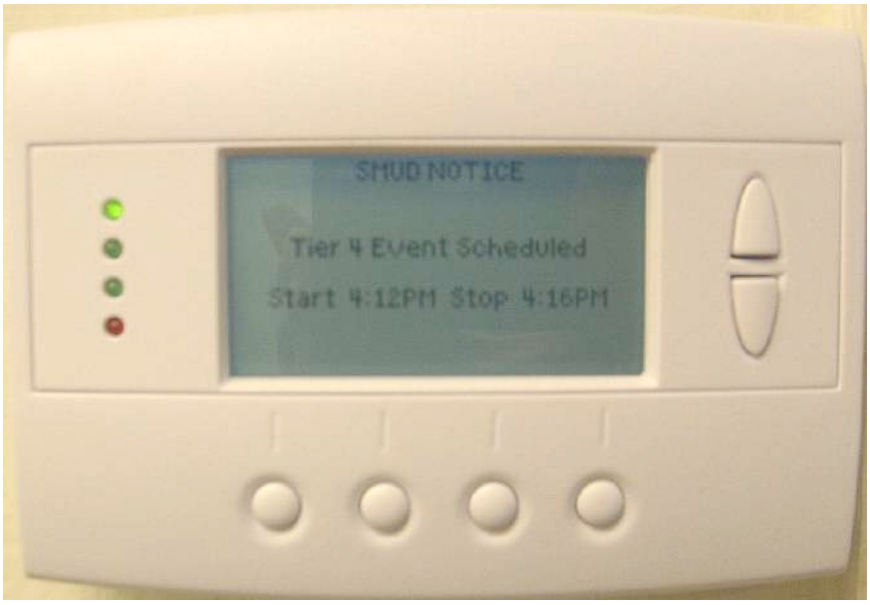

Figure 60. Programmable Communicating Thermostat Displaying Tier 4 Notice

After a button is pressed to acknowledge the event, the current settings are displayed as shown in Figure 61. The cooling set point, shown on the right side of the display, is 76°F and the thermostat is in RUN mode–the AC unit is on.

Figure 61. Programmable Communicating Thermostat Showing Current Settings Before Tier 4 Event

At the beginning of the event the Programmable Communicating Thermostat displays a flashing screen as shown in Figure 62 until any button is pressed.

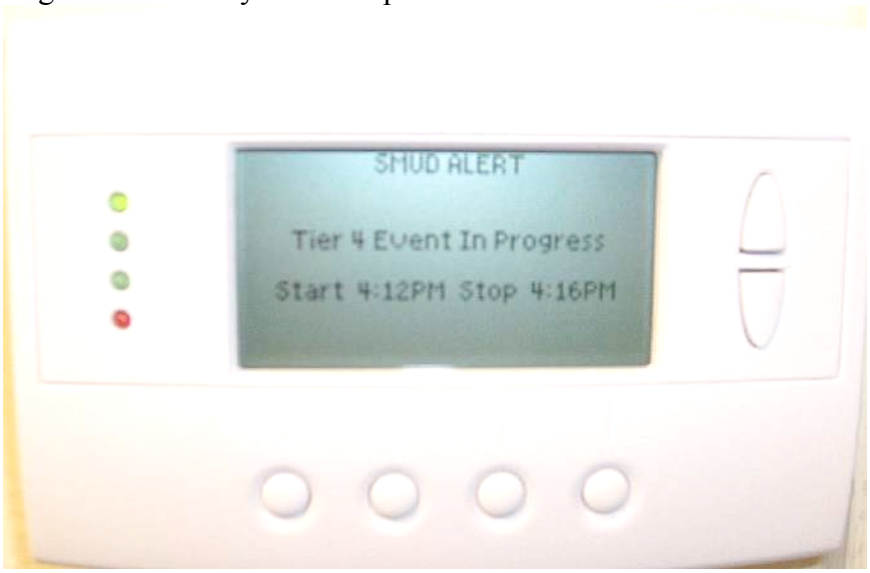

Figure 62. Programmable Communicating Thermostat Displaying Tier 4 Event in Progress

This particular thermostat is programmed to respond to a Tier 4 price event with a 4 degree temperature offset. Note that the cooling temperature set point in Figure 63 has changed from 76°F to 80°F and the thermostat has changed from RUN to HOLD mode–the AC unit is off.

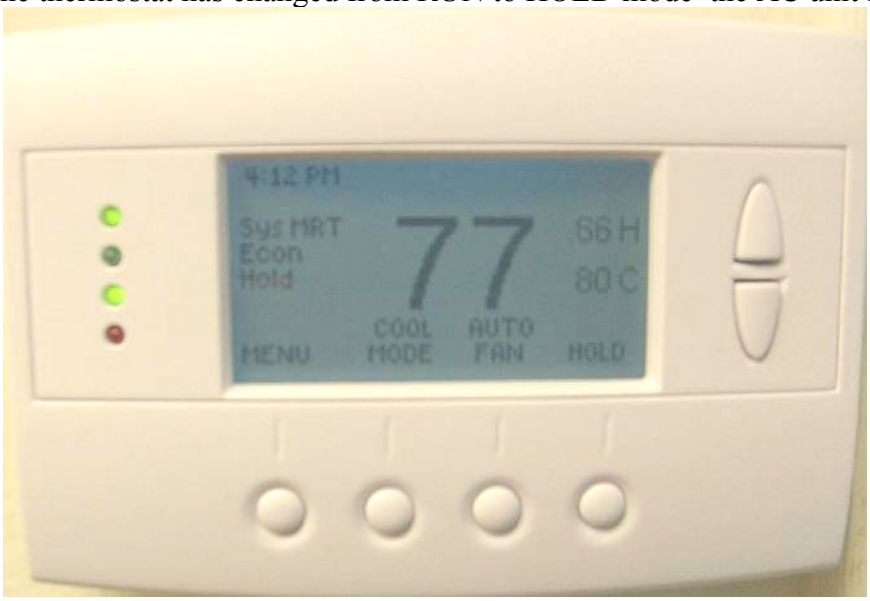

Figure 63. Programmable Communicating Thermostat Showing Current Settings During a Tier 4 Price Event

At the end of the event, the Programmable Communicating Thermostat returns to normal programming and displays the flashing screen shown in Figure 64 until any button is pressed.

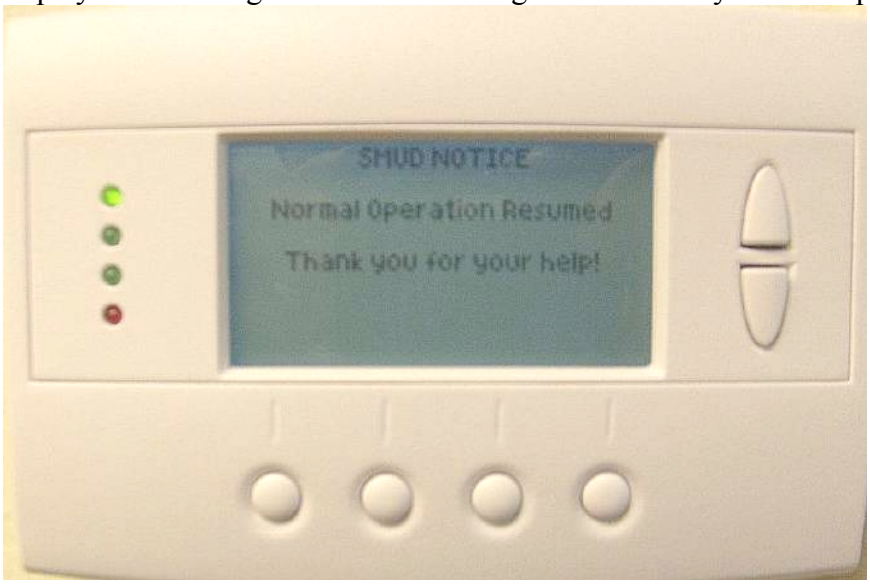

Figure 64. Programmable Communicating Thermostat Displaying End of Price Event Message

The transmission of the Radio Data System signal was recorded by the eRadio server at the transmission tower site. The price event signal required 4 groups (shown in the log as packets) and was repeated twice for a total length of 8 groups. The log for this event shows that the signal transmission started at 16:07:55 and ended at 16:08:03, for a total transmission time of 8 seconds.

```
event_id:2  command_type:PriceEvent total_packets:8

start_time:2008-04-17 16:07:55           end_time:2008-04-17 16:08:03
```

The reception of the Radio Data System signal was recorded by the Radio Data System logger which is connected to the Programmable Communicating Thermostat. This log shows that the signal was received at 16:08:00 and that the event lasted from 16:12:02 to 16:16:02.

```
04/17/2008 16:08:00> DL485: Added Event 2: Price, Tier:4.000000
04/17/2008 16:08:00> DL485: - Start: 04/17/2008 16:12:00
04/17/2008 16:08:00> DL485: - Stop: 04/17/2008 16:16:00
04/17/2008 16:12:02> DL485: Event 2 Activated
04/17/2008 16:16:02> DL485: Removed Event 2
```

Temperature Change Event

When a Temperature Change event is chosen, the interface prompts for an offset. On receiving the signal, PCTs (a) immediately warn customers of the impending curtailment event, (b) initiate the pre-cooling strategy (if any) on the morning of the event, and (c) initiate the response strategy at the onset of the event. Customers are also notified when the event ends.

Figure 65 shows the entries made during a test temperature change event. The message was repeated twice to increase the probability of successful receipt by the Programmable Communicating Thermostat. The event was set to start on 17 April 2008 at 16:22 and end on 17 April 2008 at 16:26 with a temperature offset of 5°F.

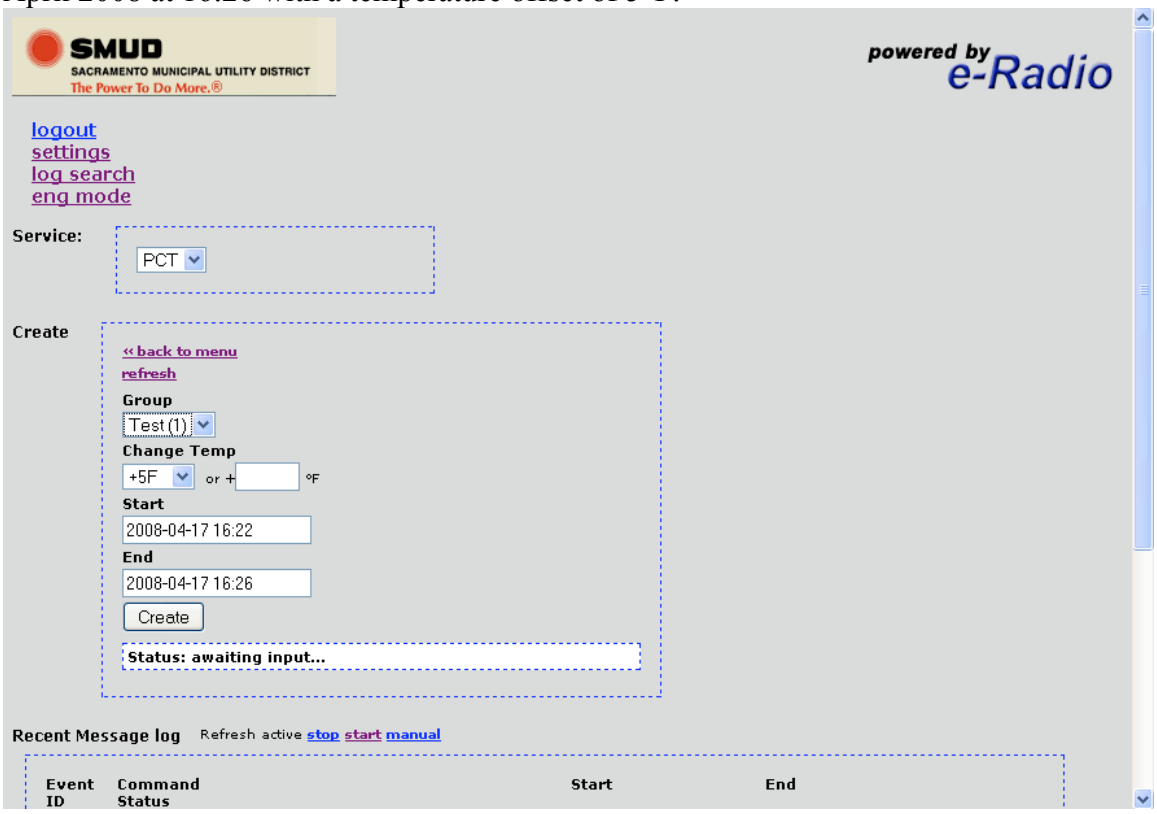

Figure 65. Website Interface for a Temperature Change Event

When the Temperature Change notice is received, the Programmable Communicating Thermostat displays a flashing notice as shown in Figure 66 until any button is pressed.

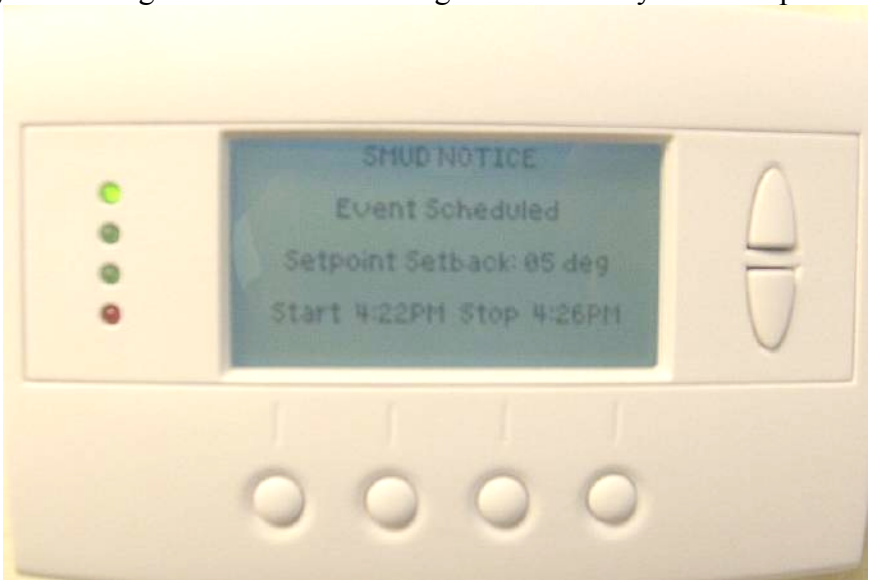

Figure 66. Programmable Communicating Thermostat Displaying Temperature Change Notice

After a button is pressed to acknowledge the event, the current settings are displayed as shown in Figure 67. The cooling set point is 76°F and the thermostat is in RUN mode–the AC unit is on.

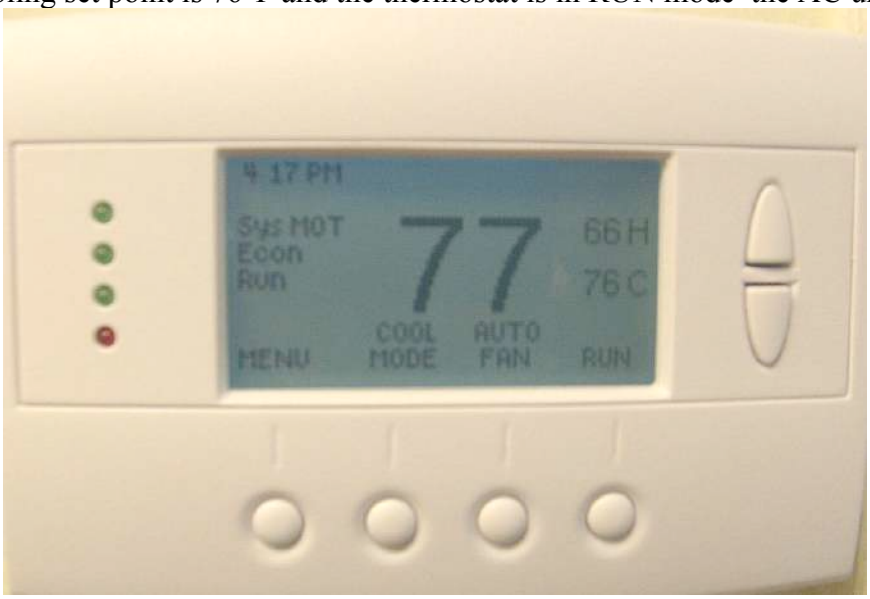

Figure 67. Programmable Communicating Thermostat Displaying Current Settings Before Temperature Event

When the event begins, the Programmable Communicating Thermostat displays a curtailment alert as shown in Figure 68 and changes the setpoint temperature according to the instructions received.

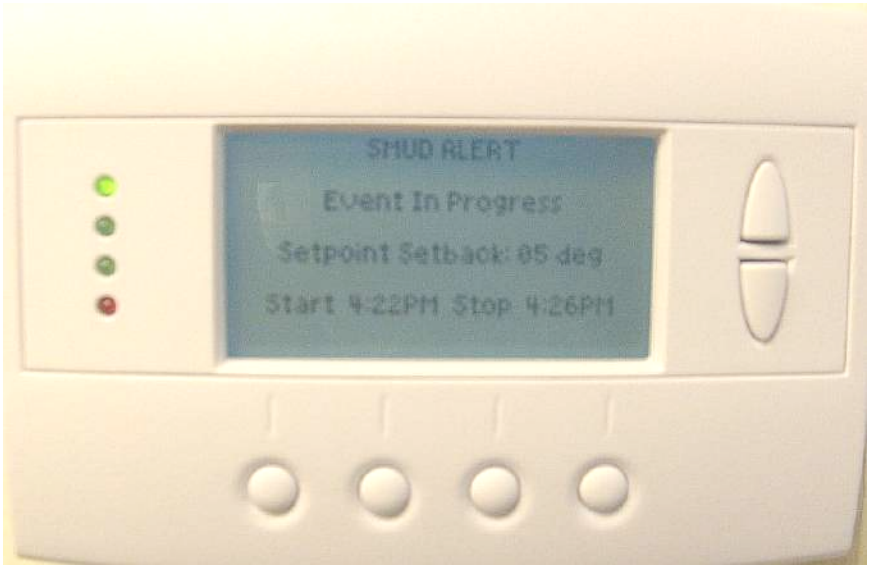

Figure 68. Programmable Communicating Thermostat Displaying Ttemperature Event in Progress Notice

After a button is pressed to acknowledge the event, the new settings are displayed as shown in Figure 69. Note that the cooling set point has increased from 76°F to 81°F, the thermostat has changed from RUN to HOLD mode, and the AC unit is off.

Figure 69. Programmable Communicating Thermostat Displaying Current Settings During Temperature Event

At the end of the event, the Programmable Communicating Thermostat returns to normal programming and displays a flashing notice as shown in Figure 70 until any button is pressed.

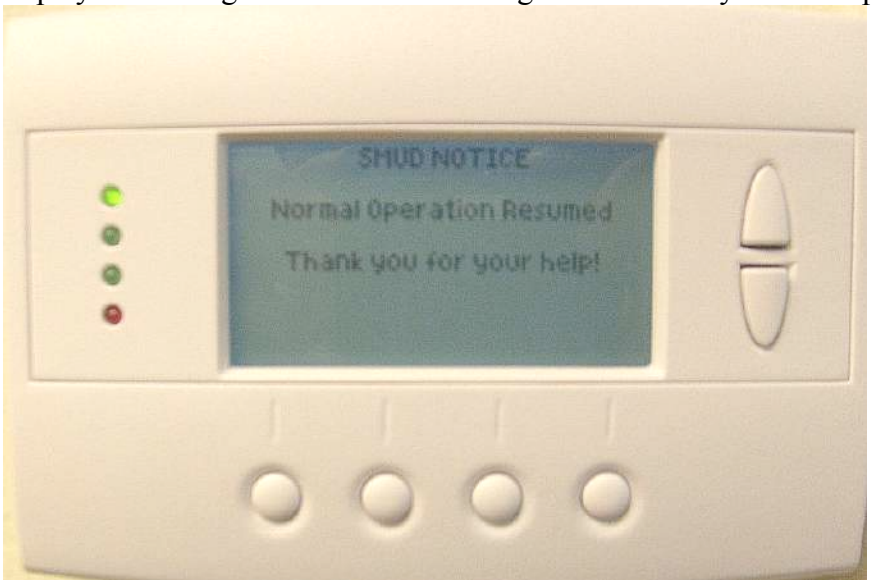

Figure 70. Programmable Communicating Thermostat Displaying End of Temperature Event Notice

The transmission of the Radio Data System signal was recorded by the eRadio server at the transmission tower site. The temperature change event signal was four groups (shown in the log as packets) long and repeated twice for a total length of 8 groups. The log for this event shows that the signal transmission started at 16:19:33 and ended at 16:19:41, for a total transmission time of 8 seconds.

```
event_id:3  command_type:ChangeTemp total_packets:8

start_time:2008-04-17 16:19:33           end_time:2008-04-17 16:19:41
```

The reception of the Radio Data System signal was recorded by the Radio Data System logger which is connected to the Programmable Communicating Thermostat. This log shows that the signal was received at 16:19:38 and that the event lasted from 16:22:02 to 16:26:02.

```
04/17/2008 16:19:38> DL485: Added Event 3: Change Temp 5.000000
04/17/2008 16:19:38> DL485: - Start: 04/17/2008 16:22:00
04/17/2008 16:19:38> DL485: - Stop: 04/17/2008 16:26:00
04/17/2008 16:22:02> DL485: Event 3 Activated
04/17/2008 16:26:02> DL485: Removed Event 3
```

Appendix B: Survey Questions and Summary of Answers

Appendix B: Survey Questions and Summary of Answers

Spring (Pre-Experiment) Survey

Business Information

1. What is your preferred notification method?

Program Choice	Email	Phone Call	Text Message	Thermostat
2 Deg. Offset	4			3
4 Deg. Offset	15			5
CPP	32	8	1	10

Business Type	Email	Phone Call	Text Message	Thermostat
Office	27	1		7
Restaurant	4	2	1	5
Retail	20	5		6

2. Business Hours

M-F Opening Time											
Business Type	**6:00 AM**	**7:00 AM**	**7:30 AM**	**8:00 AM**	**8:30 AM**	**9:00 AM**	**9:30 AM**	**10:00 AM**	**10:30 AM**	**11:00 AM**	**12:00 PM**
Office	1	1	1	11	4	14		2	1		
Restaurant			1	2		1		5		3	
Retail			1	5	2	6	1	13		1	1

M-F Closing Time														
Business Type	**2:00 AM**	**1:00 PM**	**2:00 PM**	**4:00 PM**	**4:30 PM**	**5:00 PM**	**5:30 PM**	**6:00 PM**	**6:30 PM**	**7:00 PM**	**7:30 PM**	**8:00 PM**	**9:00 PM**	**11:00 PM**
Office		1	1	2	2	22	1	3		3				
Restaurant	3			1				1			1	1	4	1
Retail				2	1	7	2	10	1	5		2		

M-F Opening Time											
Program Choice	**6:00 AM**	**7:00 AM**	**7:30 AM**	**8:00 AM**	**8:30 AM**	**9:00 AM**	**9:30 AM**	**10:00 AM**	**10:30 AM**	**11:00 AM**	**12:00 PM**
2 Deg. Offset				2				2		3	
4 Deg. Offset			1	4	1	9		4			1
CPP	1	1	2	12	5	12	1	14	1	1	

M-F Closing Time														
Program Choice	**2:00 AM**	**1:00 PM**	**2:00 PM**	**4:00 PM**	**4:30 PM**	**5:00 PM**	**5:30 PM**	**6:00 PM**	**6:30 PM**	**7:00 PM**	**7:30 PM**	**8:00 PM**	**9:00 PM**	**11:00 PM**
2 Deg. Offset	1			1		1		2					1	1
4 Deg. Offset					1	12		5		1			1	
CPP	2	1	1	4	2	16	3	7	1	7	1	3	2	

3. Are you open most holidays?

Business Type	Yes	No
Office	4	31
Restaurant	5	7
Retail	11	20

Program Choice	Yes	No
2 Deg. Offset	4	3
4 Deg. Offset	3	17
CPP	13	38

4. Is there a seasonal nature to your business?

Program Choice	Operations are pretty consistent all year	Busier in Summer	Busier in Winter	Busier on Certain Holidays
2 Deg. Offset	3	1	1	2
4 Deg. Offset	11	3	1	4
CPP	38	7	4	2

Business Type	Operations are pretty consistent all year	Busier in Summer	Busier in Winter	Busier on Certain Holidays
Office	29	3	1	2
Restaurant	6	5	1	
Retail	17	3	4	6

5. About what percent of the time are you present during work hours?

Program Choice	100%	80-99%	60-79%	40-59%	20-39%	<20%
2 Deg. Offset	1	3		2		1
4 Deg. Offset	3	12	3	2		
CPP	12	19	9	5	3	1

Business Type	100%	80-99%	60-79%	40-59%	20-39%	<20%
Office	5	17	7	4	1	
Restaurant	3	4	1	2	1	1
Retail	8	13	4	3	1	1

6. How many staff are present on a typical workday?

Program Choice	1	2	3	4	5	6	8	11

Program Choice	1	2	3	4	5	6	8	11
2 Deg. Offset	2	2	1	1		1		
4 Deg. Offset	3	7	5	5				
CPP	9	20	12	5	1	2	1	1

Business Type	1	2	3	4	5	6	8	11
Office	6	10	10	5		2	1	1
Restaurant	1	4	3	4				
Retail	7	15	5	2	1	1		

Facility and Appliance Information

7. Business space description

Program Choice	Free standing (detached)	Building attached on one side	Building attached on both sides	Unit in a larger building
2 Deg. Offset		2	5	
4 Deg. Offset	2	11	7	
CPP	13	16	20	1

Business Type	Free standing (detached)	Building attached on one side	Building attached on both sides	Unit in a larger building
Office	10	14	9	1
Restaurant	2	5	5	
Retail	3	10	18	

8. How many floors does the building have?

Program Choice	1	2
2 Deg. Offset	7	
4 Deg. Offset	15	5
CPP	48	3

Business Type	1	2
Office	**30**	**5**
Restaurant	**12**	
Retail	**28**	**3**

9. What floor does the business occupy?

Program Choice	1	2
2 Deg. Offset	7	
4 Deg. Offset	18	2
CPP	51	

Business Type	1	2
Office	33	2
Restaurant	12	
Retail	31	

10. Year the building was built?

Program Choice	0	1900	1920	1930	1950	1960	1970	1980	1990	2000
2 Deg. Offset	2				1		1	2		
4 Deg. Offset	6		1		3	3	1	5	1	
CPP	16	1		1	5	5	7	7	2	5

Business Type	0	1900	1920	1930	1950	1960	1970	1980	1990	2000
Office	8		1		5	2	3	9	3	4
Restaurant	6				2	1	2	1		
Retail	10	1		1	2	5	4	4		1

11. Size of the building, in square feet?

Program Choice	500	1000	1500	2000	2500	3000	3500	33000
2 Deg. Offset	2	2		2	1			
4 Deg. Offset	7	6	3	2	2			
CPP	10	18	9	5	1	5	1	1

Business Type	500	1000	1500	2000	2500	3000	3500	33000
Office	13	12	4		1	3	1	1
Restaurant	2	5	1	2	1	1		
Retail	4	9	7	7	2	1		

12. Window panes, single or double pane?

Program Choice	Double pane	Single pane
2 Deg. Offset		7
4 Deg. Offset	5	15
CPP	15	32

Business Type	Double pane	Single pane
Office	16	19
Restaurant	1	11
Retail	3	24

13. Percent of wall area that is windows on the west or southwest

Program Choice	90-100%	70-89%	50-69%	30-49%	10-29%	1-10%	0%
2 Deg. Offset		1	1			1	4
4 Deg. Offset		4	2		2	1	11
CPP	2	3	4	3	4	10	25

Business Type	90-100%	70-89%	50-69%	30-49%	10-29%	1-10%	0%
Office		4	5	3	4	5	14
Restaurant		1	1		1	3	6
Retail	2	3	1		1	4	20

14. Percent of wall area that is windows on the east or southeast

Program Choice	90-100%	70-89%	50-69%	30-49%	10-29%	1-10%	0%
2 Deg. Offset							7

Program Choice	90-100%	70-89%	50-69%	30-49%	10-29%	1-10%	0%
4 Deg. Offset		2	2	2	1	3	10
CPP	2	2	5	4	4	10	23

Business Type	90-100%	70-89%	50-69%	30-49%	10-29%	1-10%	0%
Office		3	4	4	3	7	13
Restaurant	1	1			1	3	6
Retail	1		3	2	1	3	21

15. Percent of wall area that is windows on the south

Program Choice	90-100%	70-89%	50-69%	30-49%	10-29%	1-10%	0%
2 Deg. Offset	1	1		1			4
4 Deg. Offset	2	1		1	4	1	11
CPP	2	4	2	9	3	5	24

Business Type	90-100%	70-89%	50-69%	30-49%	10-29%	1-10%	0%
Office	1		2	8	4	2	17
Restaurant		2		1	1	3	5
Retail	4	4		2	2	1	17

16. Percent of window area that is tinted or shaded

Program Choice	90-100%	70-89%	50-69%	30-49%	10-29%	<10%
2 Deg. Offset	6	1				
4 Deg. Offset	12	2	1	2	3	
CPP	24	12	5		3	3

Business Type	90-100%	70-89%	50-69%	30-49%	10-29%	<10%
Office	22	8	2	1		1
Restaurant	8	1	2		1	
Retail	12	6	2	1	5	2

17. Roof Insulation type

Program Choice	Batt	Blown in	Don't Know	Foam
2 Deg. Offset	1		4	
4 Deg. Offset	8	1	9	
CPP	15	2	18	2

Business Type	Batt	Blown in	Don't Know	Foam
Office	11	3	16	
Restaurant	3		3	1
Retail	10		12	1

18. Roof Insulation thickness (in inches)

Program Choice	Don’t Know	0	2	3	4	5	6	8	9	10
2 Deg. Offset	6				1					
4 Deg. Offset	8	2	2		2	1	4			1
CPP	31	4	2	1	1		8	1	1	2

Business Type	Don’t Know	0	2	3	4	5	6	8	9	10
Office	22	2			1		8	1		1
Restaurant	7	2	1		1		1			
Retail	16	2	3	1	2	1	3		1	2

19. Do you own or rent this property?

Program Choice	Own	Rent
2 Deg. Offset		7
4 Deg. Offset	3	17
CPP	10	41

Business Type	Own	Rent
Office	13	22
Restaurant		12
Retail		31

20. How many primary air conditioning units cool your space?

Program Choice	0	1	2
2 Deg. Offset		5	2
4 Deg. Offset		17	3
CPP	3	38	10

Business Type	0	1	2
Office		29	6
Restaurant	1	8	3
Retail	2	23	6

21. Tons of A/C unit

Program Choice	unknown	window	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	8.0
2 Deg. Offset	2				1		2		1				1	
4 Deg. Offset	3		4	1	5	2	2		2		1			
CPP	12	3	2	6	7	2	4	1	8	1	3	1		1

Business Type	unknown	window	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	8.0
Office	9		1	7	8	2	3	1	2	1	1			
Restaurant	3	1				1	1		4		1		1	
Retail	4	2	5		5	1	4		5		2	1		1

Values may include more than one unit. All businesses with values greater than 5 tons for A/C have 2 units.

22. Percent of area that is air conditioned

Program Choice	90-100%	70-89%	50-69%	30-49%	10-29%	1-10%
2 Deg. Offset	6	1				
4 Deg. Offset	15	3		1		
CPP	36	4	2	2	2	2

Business Type	90-100%	70-89%	50-69%	30-49%	10-29%	1-10%
Office	29	3			1	
Restaurant	8	2		1		1
Retail	20	3	2	2	1	1

23. Approximate age of primary cooling system, in years

Program Choice	1	2	3	4	5	6	8	10	11	13	14	15	16	17	18	19	20	25	28	30
2 Deg. Offset		1		2						1		1								
4 Deg. Offset			3					3	2	1		1	1	1			1	3	2	
CPP	2	6	2		4	1	1	4	1	1	1	4			2	1	7	4	1	1

Business Type	1	2	3	4	5	6	8	10	11	13	14	15	16	17	18	19	20	25	28	30
Office		2	5		1		1	1	1	2		3		1	2		3	5	3	
Restaurant		1		1	1	1		2		1	1						1	1		
Retail	2	4		1	2			4	2			3	1			1	4	1		1

24. What fuel is used for water heating?

Program Choice	Don't Have	Electric	Gas	Don't Pay	Don't Know
2 Deg. Offset	1	2	3	1	
4 Deg. Offset	7	10	2	1	
CPP	13	23	10	1	4

Business Type	Don't Have	Electric	Gas	Don't Pay	Don't Know
Office	12	14	5	1	3
Restaurant		6	6		
Retail	9	15	4	2	1

25. What fuel is used for cooking?

Program Choice	Don't Have	Electric	Gas
2 Deg. Offset	4		2
4 Deg. Offset	18	1	1
CPP	40	7	3

Business Type	Don't Have	Electric	Gas
Office	30	5	
Restaurant	4	2	6
Retail	28	1	

26. How many refrigeration units?

Program Choice	0	1	2	3	4	5	6	7	8
2 Deg. Offset		2	2	1		2			
4 Deg. Offset	1	14	2	3					
CPP	7	30	6	1	3		2	1	1

Business Type	0	1	2	3	4	5	6	7	8
Office	5	23	5	1			1		
Restaurant			2	2	3	2	1	1	1
Retail	3	23	3	2					

27. How many laundry units?

Program Choice	0	1
2 Deg. Offset	6	1

Program Choice	0	1
4 Deg. Offset	19	1
CPP	49	2

Business Type	0	1
Office	34	1
Restaurant	12	
Retail	28	3

28. What is the primary type of interior lighting?

Program Choice	Incandescent	Standard Fluorescent	Compact Fluorescent	Metal Halide
2 Deg. Offset	1	6		
4 Deg. Offset	1	17	2	
CPP	3	45	2	1

Business Type	Incandescent	Standard Fluorescent	Compact Fluorescent	Metal Halide
Office	1	31	3	
Restaurant	2	9	1	
Retail	2	28		1

29. What is the approximate age of the primary lighting fixtures, in years?

Program Choice	New	1	2	3	4	5	6	7	8	10	12	15	17	18	20	25	28	30	43	46
2 Deg. Offset		1	2																	
4 Deg. Offset	1	3	1	1						1	3		1		1	1	1		1	
CPP	2	6	4	3	3	3	3	1	1	3	1	1		2	6			2		1

Business Type	New	1	2	3	4	5	6	7	8	10	12	15	17	18	20	25	28	30	43	46
Office	1	4	5	2		1				3	3	1	1	2	4		1	1		
Restaurant	2	1			1	1				1					1					1
Retail		5	2	2	2	1	3	1	1		1				2	1		1	1	

30. Approximately how many primary lighting fixtures in the area?

Program Choice	2	3	4	5	6	7	8	9	10	11	12	13	15	16	17	18	19	20	22	25	26	28	31	48	54	86	150
2 Deg. Offset					1			1			2	1						1									
4 Deg. Offset	1			1		1	1		5	1	1		1	2				1	2		1		1				
CPP	1	1	1	3	3	1	3	5	3	4	3	4	3	1	1	2	1			1		1		1	1	1	1

Business Type	2	3	4	5	6	7	8	9	10	11	12	13	15	16	17	18	19	20	22	25	26	28	31	48	54	86	150
Office	1			1	2	1	3	3	4	3	2	3	2					1		1	1	1				1	1
Restaurant				1	1	1	1		2	1			1			1		1									
Retail	1	1	1	2	1			3	2	1	4	2	1	3	1	1	1		2				1	1	1		

31. What is the approximate wattage per fixture?

Program Choice	15	23	25	60	64	66	68	70	72	80	90	100	120	128	136	147	150	160	200	300
2 Deg. Offset				1	4															
4 Deg. Offset		1			4		1			5	1	3		2				1		
CPP	1		1	1	15	1		1	1	6	1	1	2	2	1	1	1	5	1	2

Business Type	15	23	25	60	64	66	68	70	72	80	90	100	120	128	136	147	150	160	200	300
Office		1			6		1	1	1	7	2	3	1	1	1		1	3		
Restaurant	1			1	4					2				1		1				
Retail			1	1	13	1				2		1	1	2				3	1	2

Occupant Behavior and Comfort

32. Do you use a programmable thermostat to automatically adjust temperature settings?

Program Choice	No	Use it manually	Yes
2 Deg. Offset	3	2	2
4 Deg. Offset	6	7	7
CPP	21	16	14

Business Type	No	Use it manually	Yes
Office	10	13	12
Restaurant	5	3	4
Retail	15	9	7

33. What is the summer temperature setting of your primary cooling system when the building is occupied?

Program Choice	60	68	69	70	71	72	73	74	75	76	77	78	80	82	As low as it goes	High	On
2 Deg. Offset			1	3		1		2									
4 Deg. Offset		2		2		2		2	2	2	2	4	1	1			
CPP	1	2		4	1	13	2	6	3	2	4	4	1		1	1	3

Business Type	60	68	69	70	71	72	73	74	75	76	77	78	80	82	As low as it goes	High	On
Office		2		1	1	8	2	7	2	2	5	3	1		1		
Restaurant		1	1	5		1		1				1				1	
Retail	1	1		3		7		2	3	2	1	4	1	1			3

34. What is the summer temperature setting of your primary cooling system when the building is unoccupied?

Program Choice	70	75	78	80	82	84	85	90	Off
2 Deg. Offset						1	1	1	4
4 Deg. Offset		2	3	1					13
CPP	1		2	3	2	1	4	3	32

Business Type	70	75	78	80	82	84	85	90	Off
Office		1	3	2	1	2	1	2	22
Restaurant			1	1			1		8
Retail	1	1	1	1	1		3	2	19

35. Can or does staff (anyone else) adjust the thermostat settings?

Program Choice	No	They're not supposed to	We mostly do it_	Yes
2 Deg. Offset	4	1		2
4 Deg. Offset	5		1	14
CPP	6			41

Business Type	No	They're not supposed to	We mostly do it_	Yes
Office	4			31
Restaurant	5	1	1	4
Retail	6			22

36. Would you prefer they could not or did not adjust the thermostat?

Program Choice	Yes	No	Don’t know
2 Deg. Offset	2	5	
4 Deg. Offset	4	14	2
CPP	14	32	1

Business Type	Yes	No	Don’t know
Office	8	26	1
Restaurant	7	3	1
Retail	5	22	1

37. Does sun through your windows cause visual or thermal discomfort?

Program Choice	Yes	No	Don't know
2 Deg. Offset	3	4	
4 Deg. Offset	7	12	1
CPP	19	30	

Business Type	Yes	No	Don't know
Office	15	19	1
Restaurant	4	8	
Retail	10	19	

38. Is some or all of your space uncomfortably warm during the summer months?

Program Choice	Yes	No	Don't know
2 Deg. Offset	5	1	1
4 Deg. Offset	9	9	2
CPP	23	26	2

Business Type	Yes	No	Don't know
Office	17	17	1
Restaurant	6	5	1
Retail	14	14	3

39. Is some or all of your space uncomfortably warm during the winter months?

Program Choice	Yes	No	Don't know
2 Deg. Offset	1	6	
4 Deg. Offset	1	16	3
CPP	7	42	2

Business Type	Yes	No	Don't know
Office	4	29	2
Restaurant	2	10	
Retail	3	25	3

40. Is your door open during business hours?

Program Choice	Yes	No	Don't know
2 Deg. Offset		7	
4 Deg. Offset	1	17	2
CPP	14	34	1

Business Type	Yes	No	Don't know
Office	6	27	1
Restaurant	2	9	
Retail	7	22	2

41. Are staff members allowed to wear clothing that is appropriate for the weather?

Program Choice	Yes	No	Don't know
2 Deg. Offset	5	2	
4 Deg. Offset	19	1	
CPP	46	3	1

Business Type	Yes	No	Don't know
Office	33		1
Restaurant	8	4	
Retail	29	2	

Peak Reduction Strategies

42. Is this business open during SMUD's peak time?

Program Choice	Yes	No
2 Deg. Offset	7	
4 Deg. Offset	18	2
CPP	44	7

Business Type	Yes	No
Office	30	5
Restaurant	11	1
Retail	28	3

43. Do you precool before peak times (4-7pm) with air 44. conditioning?

Program Choice	Every Day	Sometimes	Never
2 Deg. Offset	1		6
4 Deg. Offset	1	4	14
CPP	6	13	25

Business Type	Every Day	Sometimes	Never
Office	4	8	21
Restaurant	3	2	5
Retail	1	7	19

44. Would you precool before peak times (4-7pm) with air conditioning?

Program Choice	0	During Events Only	Every Day	Sometimes	Never
2 Deg. Offset		3	1		3
4 Deg. Offset		2	2	1	14
CPP	1	9	6	14	16

Business Type	0	During Events Only	Every Day	Sometimes	Never
Office	1	4	4	5	18
Restaurant		4	3	2	3
Retail		6	2	8	12

0 = No answer to this question.

45. Do you precool before peak times (4-7pm) by running the building ventilation system at night?

Program Choice	Every Day	Sometimes	Never
2 Deg. Offset	1		6
4 Deg. Offset			19
CPP	1	2	41

Business Type	Every Day	Sometimes	Never
Office			33
Restaurant	1	1	8
Retail	1	1	25

46. Would you precool before peak times (4-7pm) by running the building ventilation system at night?

Program Choice	During Events Only	Every Day	Sometimes	Never
2 Deg. Offset		1	2	4
4 Deg. Offset		1		18
CPP	1	2	7	37

Business Type	During Events Only	Every Day	Sometimes	Never
Office	1	1	4	27
Restaurant		2	1	9
Retail		1	4	23

47. Do you precool before peak times (4-7pm) by opening doors or windows?

Program Choice	Every Day	Sometimes	Never
2 Deg. Offset	2		5
4 Deg. Offset	3	9	7
CPP	16	12	16

Business Type	Every Day	Sometimes	Never
Office	8	12	13
Restaurant	4	1	5
Retail	9	8	10

48. Would you precool before peak times (4-7pm) by opening doors or windows?

Program Choice	Every Day	Sometimes	Never
2 Deg. Offset	2	1	4
4 Deg. Offset	4	8	6
CPP	16	14	17

Business Type	Every Day	Sometimes	Never
Office	9	13	11
Restaurant	4	1	7
Retail	9	9	9

49. Do you lower A/C use by turning on a floor or desk fan?

Program Choice	Every Day	Sometimes	Never
2 Deg. Offset	1	3	3

Program Choice	Every Day	Sometimes	Never
4 Deg. Offset	3	5	10
CPP	16	9	19

Business Type	Every Day	Sometimes	Never
Office	11	8	14
Restaurant	2	5	3
Retail	7	4	15

50. Would you lower A/C use by turning on a floor or desk fan?

Program Choice	During Events Only	Every Day	Sometimes	Never
2 Deg. Offset	1	1	4	1
4 Deg. Offset	1	3	7	7
CPP		18	10	19

Business Type	During Events Only	Every Day	Sometimes	Never
Office		11	11	11
Restaurant	1	3	5	3
Retail	1	8	5	13

51. Do you close the shades or blinds at the windows?

Program Choice	Every Day	Sometimes	Never
2 Deg. Offset	1		6
4 Deg. Offset	6	4	9
CPP	16	3	25

Business Type	Every Day	Sometimes	Never
Office	18	6	9
Restaurant	1		9
Retail	4	1	22

52. Would you close the shades or blinds at the windows?

Program Choice	During Events Only	Every Day	Sometimes	Never
2 Deg. Offset	1	1		5
4 Deg. Offset	1	7	4	7
CPP	1	19	3	24

Business Type	During Events Only	Every Day	Sometimes	Never
Office	3	20	6	4
Restaurant		2		10
Retail		5	1	22

53. Do you put up an awning or umbrella to shade the windows?

Program Choice	Every Day	Never
2 Deg. Offset	4	3
4 Deg. Offset	2	17
CPP	9	35

Business Type	Every Day	Never
Office	3	30
Restaurant	5	5
Retail	7	20

54. Would you put up an awning or umbrella to shade the windows?

Program Choice	Every Day	Sometimes	Never
2 Deg. Offset	4		3
4 Deg. Offset	2		17
CPP	9	1	34

Business Type	Every Day	Sometimes	Never
Office	4	1	28
Restaurant	4		6
Retail	7		20

55. Do you turn off some electric lights?

Program Choice	Every Day	Sometimes	Never
2 Deg. Offset	4	1	2
4 Deg. Offset	6	6	7
CPP	15	16	13

Business Type	Every Day	Sometimes	Never
Office	13	14	6
Restaurant	2	2	6
Retail	10	7	10

56. Would you turn off some electric lights?

Program Choice	During Events Only	Every Day	Sometimes	Never
2 Deg. Offset		3	2	2
4 Deg. Offset		8	5	6
CPP	3	19	17	7

Business Type	During Events Only	Every Day	Sometimes	Never
Office	2	17	12	2
Restaurant	1	4	2	5
Retail		9	10	8

57. Do you turn off all the electric lights?

Program Choice	Every Day	Sometimes	Never
2 Deg. Offset		1	6
4 Deg. Offset		1	18
CPP	2	1	41

Business Type	Every Day	Sometimes	Never
Office		3	30
Restaurant	1		9
Retail	1		26

58. Would you turn off all the electric lights?

Program Choice	During Events Only	Every Day	Sometimes	Never
2 Deg. Offset			1	6
4 Deg. Offset			1	18
CPP	1	3	2	40

Business Type	During Events Only	Every Day	Sometimes	Never
Office	1		3	29
Restaurant		2		10
Retail		1	1	25

59. Do you turn off some electrical equipment?

Program Choice	Every Day	Sometimes	Never

Program Choice	Every Day	Sometimes	Never
2 Deg. Offset	1		6
4 Deg. Offset		4	15
CPP	2	11	31

Business Type	Every Day	Sometimes	Never
Office		11	22
Restaurant	1		9
Retail	2	4	21

60. Would you turn off some electrical equipment?

Program Choice	During Events Only	Every Day	Sometimes	Never
2 Deg. Offset		1	2	4
4 Deg. Offset			5	14
CPP	4	3	12	28

Business Type	During Events Only	Every Day	Sometimes	Never
Office	2		13	18
Restaurant	2	1	2	7
Retail		3	4	21

61. Do you turn off all electrical equipment?

Program Choice	Sometimes	Never
2 Deg. Offset		7
4 Deg. Offset		19
CPP	3	41

Business Type	Sometimes	Never
Office		33
Restaurant		10
Retail	3	24

62. Would you turn off all electrical equipment?

Program Choice	Sometimes	Never
2 Deg. Offset		7
4 Deg. Offset	1	18

Program Choice	Sometimes	Never
CPP	4	43

Business Type	Sometimes	Never
Office	2	31
Restaurant		12
Retail	3	25

63. Do you let the staff dress more casually?

Program Choice	Every Day	Sometimes	Never
2 Deg. Offset	4	1	2
4 Deg. Offset	17	1	1
CPP	33	7	4

Business Type	Every Day	Sometimes	Never
Office	24	6	3
Restaurant	6	1	3
Retail	24	2	1

64. Would you let the staff dress more casually?

Program Choice	Every Day	Sometimes	Never
2 Deg. Offset	4	1	2
4 Deg. Offset	17	1	1
CPP	35	7	5

Business Type	Every Day	Sometimes	Never
Office	24	6	3
Restaurant	8		4
Retail	24	3	1

65. Do you let some staff go home early?

Program Choice	Every Day	Sometimes	Never
2 Deg. Offset	1	4	2
4 Deg. Offset		10	9
CPP	3	22	19

Business Type	Every Day	Sometimes	Never

Business Type	Every Day	Sometimes	Never
Office	4	18	11
Restaurant		6	4
Retail		12	15

66. Would you let some staff go home early?

Program Choice	During Events Only	Every Day	Sometimes	Never
2 Deg. Offset		1	4	2
4 Deg. Offset			11	8
CPP	4	4	19	20

Business Type	During Events Only	Every Day	Sometimes	Never
Office	3	4	17	9
Restaurant			6	6
Retail	1	1	11	15

67. Do you close the door during peak hours?

Program Choice	During Events Only	Every Day	Sometimes	Never
2 Deg. Offset		6		1
4 Deg. Offset		18		1
CPP	1	37	4	2

Business Type	During Events Only	Every Day	Sometimes	Never
Office		30	2	1
Restaurant		9	1	
Retail	1	22	1	3

68. Would you close the door during peak hours?

Program Choice	Every Day	Sometimes	Never
2 Deg. Offset	6		1
4 Deg. Offset	18		1
CPP	42	3	2

Business Type	Every Day	Sometimes	Never
Office	31	1	1
Restaurant	11	1	
Retail	24	1	3

69. Do you close the business during peak hours?

Program Choice	Every Day	Sometimes	Never
2 Deg. Offset	1	1	5
4 Deg. Offset	1	5	13
CPP	6	7	32

Business Type	Every Day	Sometimes	Never
Office	4	9	20
Restaurant	1	1	8
Retail	3	3	22

70. Would you close the business during peak hours?

Program Choice	During Events Only	Every Day	Sometimes	Never
2 Deg. Offset		1	1	5
4 Deg. Offset		1	5	13
CPP	6	7	7	28

Business Type	During Events Only	Every Day	Sometimes	Never
Office	3	4	10	16
Restaurant		1	1	10
Retail	3	4	2	20

Summer (Post-Event) Surveys

1. Were you aware of the event?

Program Choice	No answer	I wasn't aware an event occurred_	No, not until it was over_	Yes, before the event took place_	Yes, during the event_
2 Deg. Offset				16	
4 Deg. Offset	2	4		41	1
CPP	1	15	1	117	6

Business Type	No answer	I wasn't aware an event occurred_	No, not until it was over_	Yes, before the event took place_	Yes, during the event_
Office	2	5		92	1
Restaurant		8		18	
Retail	1	6	1	64	6

2. What actions did you take?

Program Choice	n	Precooled by Opening Windows	Precooled using t-stat precool option	Used less A/C	Used less lighting	Closed business early	N/A already closed
2 Deg. Offset	6	0	1	5	2	1	0
4 Deg. Offset	19	7	1	17	11	2	2
CPP	51	10	13	38	33	14	7

Business Type	n	Precooled by Opening Windows	Precooled using t-stat precool option	Used less A/C	Used less lighting	Closed business early	N/A already closed
Office	35	6	7	30	25	10	4
Restaurant	11	2	0	5	3	0	1
Retail	30	9	8	25	18	7	4

3. What was the comfort level during the event?

Program Choice	No answer	Comfortable enough	The event wasn't noticeable	Uncomfortable

Program Choice	No answer	Comfortable enough	The event wasn't noticeable	Uncomfortable
2 Deg. Offset		10	5	1
4 Deg. Offset	4	19	20	5
CPP	3	70	51	15

Business Type	No answer	Comfortable enough_	The event wasn't noticeable_	Uncomfortable_
Office	4	47	43	6
Restaurant	2	3	18	2
Retail	1	49	15	13

4. Were there customer or occupant comments about the event?

Program Choice	No answer	No	Yes, negative comments_	Yes, positive comments_
2 Deg. Offset		15		1
4 Deg. Offset	3	40	5	
CPP	8	113	11	8

Business Type	No answer	No	Yes, negative comments_	Yes, positive comments_
Office	7	84	3	6
Restaurant	2	23		1
Retail	2	61	13	2

5. How was business affected?

Program Choice	No answer	Negatively	Not at all	Slightly Negatively	Slightly Positively
2 Deg. Offset			15	1	
4 Deg. Offset	1		45	2	
CPP	1	1	119	17	1

Business Type	No answer	Negatively	Not at all	Slightly Negatively	Slightly Positively
Office	1		92	6	1
Restaurant	1		24	1	
Retail		1	63	13	

Fall (Post-Experiment) Survey

General Questions

1. Excluding the incentive payment, what were your expectations for this program?

Program Choice	I had a high expectation that it would benefit me	I had some expectation that it might benefit me	I was hopeful, but not expecting much	I was not optimistic that it would benefit me
2 Deg. Offset	2	2	2	
4 Deg. Offset	5	10	3	1
CPP	5	28	15	2

Business Type	I had a high expectation that it would benefit me	I had some expectation that it might benefit me	I was hopeful, but not expecting much	I was not optimistic that it would benefit me
Office	4	18	10	2
Restaurant	2	7	2	
Retail	6	15	8	1

2. Did the Summer Solutions program meet your expectations?

Program Choice	No, I'm extremely disappointed	Almost, but not quite	Yes, more or less	It s
2 Deg. Offset		1	3	
4 Deg. Offset	1	1	16	
CPP	3	8	34	

Business Type	No, I'm extremely disappointed	Almost, but not quite	Yes, more or less	It surpassed my expectations
Office	1	4	24	4
Restaurant		1	9	1
Retail	3	5	20	2

3. How did your participation in this pilot affect your opinion of SMUD?

Program Choice	My opinion of SMUD improved as a result of this pilot	My opinion of SMUD was already negative and did not change_	My opinion of SMUD was already positive and did not change	My opinion of SMUD was made worse as a result of this pilot_

Program Choice	My opinion of SMUD improved as a result of this pilot	My opinion of SMUD was already negative and did not change_	My opinion of SMUD was already positive and did not change	My opinion of SMUD was made worse as a result of this pilot_
2 Deg. Offset	3		3	
4 Deg. Offset	7		12	
CPP	21	1	25	2

Business Type	My opinion of SMUD improved as a result of this pilot	My opinion of SMUD was already negative and did not change_	My opinion of SMUD was already positive and did not change	My opinion of SMUD was made worse as a result of this pilot_
Office	11		23	
Restaurant	7	1	3	
Retail	13		14	2

4. What did you like most about the program?

Program Choice	I benefited financially	I learned to manage my energy use better_	I liked the increased interaction with SMUD_	Nothing
2 Deg. Offset	1	4	1	
4 Deg. Offset	4	7	4	4
CPP	15	24	5	6

Business Type	I benefited financially	I learned to manage my energy use better_	I liked the increased interaction with SMUD_	Nothing
Office	11	15	5	3
Restaurant	3	5	1	2
Retail	6	15	4	5

5. What did you dislike most about the program?

Program Choice	I did not benefit financially_	I didn't get the attention I was hoping to get_	I didn't learn anything_	Nothing_
2 Deg. Offset	1	1		4
4 Deg. Offset			1	16
CPP	8	1	2	39

Business Type	I did not benefit financially_	I didn't get the attention I was hoping to get_	I didn't learn anything_	Nothing_
Office	3		2	28
Restaurant	2	1		8
Retail	4	1	1	23

6. Other likes and dislikes:

Program Choice	Other likes and dislikes
2 Deg. Offset	Interaction with SMUD and its research concepts.
4 Deg. Offset	Also like the financial benefit
4 Deg. Offset	Didn't like the thermostat
4 Deg. Offset	Had difficults at first with several bad thermostats.
4 Deg. Offset	I didn't really change, didn't like the issue with overriding the programming.
4 Deg. Offset	Liked not doing anything, just letting it do its thing
4 Deg. Offset	Periodic checkups from SMUD confirming everything was working and functioning correctly
4 Deg. Offset	programable thermostats are useful
4 Deg. Offset	Thermostat did not seem to work properly, second unit was altered, rendered unusable
CPP	Disliked Thermostat - keeps compressor off for 6 minutes - gets too hot during that time.
CPP	Great customer service and decent savings.
CPP	irregular temp control during pm hrs
CPP	Josh was pleasant to work with
CPP	LEARNED TO BE MORE CONCIOUS OF ENERGY USE
CPP	Like that the program is simple.
CPP	Liked helping the community
CPP	Liked reducing my energy usage and bill
CPP	Liked that it was simple
CPP	likes about awareness created in customer
CPP	My bill increased. I expected a decrease.
CPP	now have a more accurate/reliable meter
CPP	Opportunity to learn how to save energy
CPP	the critical periods seemed to be on the back to back hottest days
CPP	The people in your program were very responsive and helpful. The financial gain was extremely minimal
CPP	Thermostat was not too user friendly
CPP	Too much reporting, or surveys

Program Choice	Other likes and dislikes
CPP	Would like more individualized feedback on potential and actual bill savings.

Business Type	Other likes and dislikes
Office	I didn't really change, didn't like the issue with overriding the programming.
Office	Liked helping the community
Office	Liked reducing my energy usage and bill
Office	My bill increased. I expected a decrease.
Office	Periodic checkups from SMUD confirming everything was working and functioning correctly
Office	Thermostat was not too user friendly
Office	Too much reporting, or surveys
Restaurant	Also like the financial benefit
Restaurant	Josh was pleasant to work with
Restaurant	Like that the program is simple.
Restaurant	Would like more individualized feedback on potential and actual bill savings.
Retail	Didn't like the thermostat
Retail	Disliked Thermostat - keeps compressor off for 6 minutes - gets too hot during that time.
Retail	Great customer service and decent savings.
Retail	Had difficults at first with several bad thermostats.
Retail	Interaction with SMUD and its research concepts.
Retail	irregular temp control during pm hrs
Retail	LEARNED TO BE MORE CONCIOUS OF ENERGY USE
Retail	Liked not doing anything, just letting it do its thing
Retail	Liked that it was simple
Retail	likes about awareness created in customer
Retail	now have a more accurate/reliable meter
Retail	Opportunity to learn how to save energy
Retail	programable thermostats are useful
Retail	the critical periods seemed to be on the back to back hottest days
Retail	The people in your program were very responsive and helpful. The financial gain was extremely minimal
Retail	Thermostat did not seem to work properly, second unit was altered, rendered unusable

7. What was your original reason for choosing your program option over the other options?

Program Choice	I had no strong opinion, so I just chose the one SMUD recommended	I like knowing that I can completely control my own responses to	I thought the program would give me the most bill savings_	I'm busy and so I prefer letting SMUD control my response to eve
2 Deg. Offset	4		1	1
4 Deg. Offset	4	1	12	2
CPP	8	9	31	1

Business Type	I had no strong opinion, so I just chose the one SMUD recommended	I like knowing that I can completely control my own responses to	I thought the program would give me the most bill savings_	I'm busy and so I prefer letting SMUD control my response to eve
Office	6	7	19	1
Restaurant	5		6	
Retail	5	3	19	3

8. If you were offered the same choices for next summer, how would you choose?

Program Choice	I had no strong opinion, so I just chose the one SMUD recommended	I like knowing that I can completely control my own responses to	I'd choose the program that would give me the most bill savings_	I'm busy and so I prefer letting SMUD control my response to eve
2 Deg. Offset	2		1	
4 Deg. Offset	4	3	9	1
CPP	4	8	35	

Business Type	I had no strong opinion, so I just chose the one SMUD recommended	I like knowing that I can completely control my own responses to	I'd choose the program that would give me the most bill savings_	I'm busy and so I prefer letting SMUD control my response to eve
Office	2	6	21	
Restaurant	3	1	6	

Business Type	I had no strong opinion, so I just chose the one SMUD recommended	I like knowing that I can completely control my own responses to	I'd choose the program that would give me the most bill savings_	I'm busy and so I prefer letting SMUD control my response to eve
Retail	5	4	18	1

9. Other reasons

Program Choice	Other Reason
4 Deg. Offset	Free money
4 Deg. Offset	Much better than peak program previously offered as one has more control
CPP	I always like to save money one bills
CPP	i had old termostate, which was not function accuratly
CPP	I want to be responsible regarding energy savings
CPP	It was environmentally sound
CPP	Want to help our environment with lower the demand.

Business Type	Other Reason
Office	I always like to save money one bills
Retail	Free money
Retail	i had old termostate, which was not function accuratly
Retail	I want to be responsible regarding energy savings
Retail	It was environmentally sound
Retail	Much better than peak program previously offered as one has more control
Retail	Want to help our environment with lower the demand.

10. How important a factor was the $120 incentive payment in your choice to participate in this pilot?

Program Choice	Very important_	Important_	Nice, but not critical_	Unimportant_
2 Deg. Offset		3	3	
4 Deg. Offset	7	3	7	2
CPP	5	10	31	4

Business Type	Very important_	Important_	Nice, but not critical_	Unimportant_
Office	4	5	21	4
Restaurant	3	4	3	1
Retail	5	7	17	1

11. Would you participate again next year without the two $60 participation payments?

Program Choice	Definitely not	Probably not_	Probably_	Definitely_
2 Deg. Offset		2	3	1
4 Deg. Offset	2	3	8	6
CPP	4	12	25	9

Business Type	Definitely not	Probably not_	Probably_	Definitely_
Office		8	18	8
Restaurant		2	5	4
Retail	6	7	13	4

12. When you signed up, how did you think the program would affect your business?

Program Choice	Negatively_	Not at all	Positively_	Slightly negatively, if at all_	Slightly positively, if at all_
2 Deg. Offset	1		3	1	1
4 Deg. Offset		3	5	2	9
CPP		9	8	10	23

Business Type	Negatively_	Not at all	Positively	Slightly negatively, if at all_	Slightly positively, if at all_
Office		3	7	6	18
Restaurant	1	4	2	2	2
Retail		5	7	5	13

13. How was business affected by your participation?

Program Choice	No answer	Negatively_	Not at all	Positively_	Slightly negatively, if at all_	Slightly positively, if at all_
2 Deg. Offset				1	2	3
4 Deg. Offset	1		3	5	4	6
CPP		1	11	5	15	18

Business Type	No answer	Negatively_	Not at all	Positively_	Slightly negatively, if at all_	Slightly positively, if at all_
Office			3	4	7	20
Restaurant			5	1	2	3
Retail	1	1	6	6	12	4

14. Other comments on business effects:

Program Choice	Other_effects
4 Deg. Offset	always aware of energy use
4 Deg. Offset	Notify email and Tstat. Precooled for 30-45min
4 Deg. Offset	Occasionally the heat would creep up, and having it shut down at 4 was a problem
4 Deg. Offset	Sometimes a customer would comment about how hot it was in the office, but realy no other effects.
4 Deg. Offset	Wen were not open during the time frame
CPP	Don't need any notifications
CPP	if you pledge to affect only 12 days, do so. I counted 15 notifications
CPP	It only affected my business on the extreme hot days and we were unable to be cool. Yet it was manageable.
CPP	It was like we did not have any air conditioning at all and had to cancel client's services many times due to the extreme heat. I believe the probably was with your thermostat.
CPP	Josh does a good job
CPP	Lights off, customers thought we were closed
CPP	other than coustomer it was difficult for us to work
CPP	REDUCTION IN SMUD BILL
CPP	See answer to No. 6.
CPP	There were additional issues with the landlord.

Business Type	Other_effects
Office	Notify email and Tstat. Precooled for 30-45min
Office	Occasionally the heat would creep up, and having it shut down at 4 was a problem
Office	See answer to No. 6.
Office	We were not open during the time frame
Restaurant	Don't need any notifications
Restaurant	Josh does a good job
Restaurant	There were additional issues with the landlord.
Retail	always aware of energy use
Retail	if you pledge to affect only 12 days, do so. I counted 15 notifications
Retail	It only affected my business on the extreme hot days and we were unable to be cool. Yet it was manageable.
Retail	It was like we did not have any air conditioning at all and had to cancel client's

Business Type	Other_effects
	services many times due to the extreme heat. I believe the probably was with your thermostat.
Retail	Lights off, customers thought we were closed
Retail	other than coustomer it was difficult for us to work
Retail	REDUCTION IN SMUD BILL
Retail	Sometimes a customer would comment about how hot it was in the office, but realy no other effects.

15. When you signed up, how difficult did you think it would be to adjust to the events?

Program Choice	Couldn't do it_	Difficult_	No problem at all	Pretty easy_
2 Deg. Offset			4	2
4 Deg. Offset	1	1	8	9
CPP	1	4	23	21

Business Type	Couldn't do it_	Difficult_	No problem at all	Pretty easy_
Office	1	2	12	19
Restaurant			7	3
Retail	1	3	16	10

16. How difficult was it for you to adjust to the events?

Program Choice	Couldn't do it	Difficult	No problem at all	Pretty easy
2 Deg. Offset			4	2
4 Deg. Offset			11	8
CPP	2	4	25	19

Business Type	Couldn't do it_	Difficult_	No problem at all	Pretty easy_
Office	1		16	17
Restaurant			8	3
Retail	1	4	16	9

17. If you could choose again, which notification method would you choose?

Program Choice	Email	Phone Call	Text_	Thermostat
2 Deg. Offset	2	2		2

Program Choice	Email	Phone Call	Text_	Thermostat
4 Deg. Offset	6	1	1	11
CPP	26	8	1	14

Business Type	Email	Phone Call	Text_	Thermostat
Office	22	2		10
Restaurant	1	4	1	4
Retail	11	5	1	13

Actions taken as a result of this pilot

18. I precooled before peak times with air-conditioning

Program Choice	Events only_	Every day_	Not possible or didn't try_	Tried, but it didn't work for me_
2 Deg. Offset	1	1	2	2
4 Deg. Offset	3	4	8	3
CPP	9	12	21	5

Business Type	Events only_	Every day_	Not possible or didn't try_	Tried, but it didn't work for me_
Office	7	7	12	7
Restaurant	3	3	2	1
Retail	3	7	17	2

19. I precooled before peak times by running ventilation system or opening windows/doors

Program Choice	Events only_	Every day_	Not Possible or didn't try	Tried, but it didn't work for me_
2 Deg. Offset	1		4	1
4 Deg. Offset	1	8	10	
CPP	4	21	18	4

Business Type	Events only_	Every day_	Not Possible or didn't try	Tried, but it didn't work for me_
Office	2	13	17	2
Restaurant	2	3	3	1
Retail	2	13	12	2

20. I turned on a floor or desk fan

Program Choice	Events only	Every day_	Not possible or didn't try_	Tried, but it didn't work for me_
2 Deg. Offset		3	2	1
4 Deg. Offset	2	7	10	
CPP	6	24	16	1

Business Type	Events only	Every day_	Not possible or didn't try_	Tried, but it didn't work for me_
Office	2	15	17	
Restaurant	2	6	1	
Retail	4	13	10	2

21. I shaded the windows

Program Choice	Events only_	Every day_	Not possible or didn't try_
2 Deg. Offset		2	4
4 Deg. Offset	1	7	11
CPP	1	15	30

Business Type	Events only_	Every day_	Not possible or didn't try_
Office	2	14	18
Restaurant		4	5
Retail		6	22

22. I turned off some or all of the electric lights

Program Choice	Events only	Every day_	Not Possible or didn't try	Tried, but it didn't work for me_
2 Deg. Offset	1	3	2	
4 Deg. Offset	4	9	5	1
CPP	10	20	12	5

Business Type	Events only	Every day_	Not Possible or didn't try	Tried, but it didn't work for me_
Office	8	16	8	2
Restaurant	1	3	3	2
Retail	6	13	8	2

23. I turned off some or all of the equipment

Program Choice	Events only	Every day_	Not Possible or didn't try	Tried, but it didn't work for me_
2 Deg. Offset	1	1	3	1
4 Deg. Offset	1	6	12	
CPP	12	11	20	3

Business Type	Events only	Every day_	Not Possible or didn't try	Tried, but it didn't work for me_
Office	7	10	15	1
Restaurant	1	2	4	2
Retail	6	6	16	1

24. I let the staff dress more casually

Program Choice	Events only_	Every day_	Not Possible or didn't try	Tried, but it didn't work for me_
2 Deg. Offset		1	4	1
4 Deg. Offset		5	14	
CPP	2	10	29	4

Business Type	Events only_	Every day_	Not Possible or didn't try	Tried, but it didn't work for me_
Office	2	7	23	2
Restaurant		1	7	1
Retail		8	17	2

25. I let some staff go home early

Program Choice	Events only_	Every day_	Not Possible or didn't try	Tried, but it didn't work for me_
2 Deg. Offset		1	5	
4 Deg. Offset		2	15	
CPP	8	6	30	1

Business Type	Events only_	Every day_	Not Possible or didn't try	Tried, but it didn't work for me_

Business Type	Events only_	Every day_	Not Possible or didn't try	Tried, but it didn't work for me_
Office	4	3	25	1
Restaurant		3	6	
Retail	4	3	19	

26. I closed the door to the outside during peak hours

Program Choice	Every day_	Not possible or didn't try_	Tried, but it didn't work for me_
2 Deg. Offset	3	3	
4 Deg. Offset	12	7	
CPP	28	15	2

Business Type	Every day_	Not possible or didn't try_	Tried, but it didn't work for me_
Office	20	13	1
Restaurant	5	4	
Retail	18	8	1

27. Raised AC temperature setpoint

Program Choice	Events only	Every day_	Not Possible or didn't try	Tried, but it didn't work for me_
2 Deg. Offset		2	4	
4 Deg. Offset	6	6	7	
CPP	16	11	14	6

Business Type	Events only	Every day_	Not Possible or didn't try	Tried, but it didn't work for me_
Office	10	9	12	3
Restaurant	4	1	3	1
Retail	8	9	10	2

28. Turned AC off

Program Choice	Events only_	Every day_	Not Possible or didn't try	Tried, but it didn't work for me_
2 Deg. Offset		2	4	
4 Deg. Offset	1	2	13	1
CPP	6	9	25	7

Business Type	Events only_	Every day_	Not Possible or didn't try	Tried, but it didn't work for me_
Office	4	4	22	1
Restaurant	1	2	6	1
Retail	2	7	14	6

29. Other Actions

Program Choice	OtherDR
4 Deg. Offset	Always conservative with usage - no real change
4 Deg. Offset	controlled temperatures
4 Deg. Offset	Turned on a fan when it was hot.
CPP	ceiling fans
CPP	Did not do any laundry (we're a spa) after 3:30 pm
CPP	event day were on peak day, it was difficult to try other thing.
CPP	Leave at 530
CPP	Left AC on if it was hot
CPP	Left early almost everyday (and every event)
CPP	my office closes before the events took place
CPP	NO A/C
CPP	shutdown aircompressor & Parts cleaner
CPP	Turn AC off most of the time, just one when needed
CPP	turned off lights on real hot days

Business Type	OtherDR
Office	ceiling fans
Office	my office closes before the events took place
Restaurant	NO A/C
Restaurant	turned off lights on real hot days
Restaurant	Turned on a fan when it was hot.
Retail	Always conservative with usage - no real change
Retail	controlled temperatures
Retail	Did not do any laundry (we're a spa) after 3:30 pm
Retail	event day were on peak day, it was difficult to try other thing.
Retail	Leave at 530
Retail	Left AC on if it was hot
Retail	Left early almost everyday (and every event)
Retail	shutdown aircompressor & Parts cleaner
Retail	Turn AC off most of the time, just one when needed

30. What energy efficiency investments did you make as a result of this pilot?

Program Choice	Added window shades or insulation_	Improved AC efficiency_	Improved lighting efficiency_	None
2 Deg. Offset	1		3	2
4 Deg. Offset	1	1	3	12
CPP		11	5	33

Business Type	Added window shades or insulation_	Improved AC efficiency_	Improved lighting efficiency_	None
Office	1	6	6	20
Restaurant	1	2	1	6
Retail		4	4	21

31. Other Energy Efficiency Investments:

Program Choice	OtherEE	Business Type
4 Deg. Offset	The owner is not receptive to maintenance at all	Office
4 Deg. Offset	Added blinds prior to program	Retail
4 Deg. Offset	Lighting already improved	Retail
CPP	Already installed dual-pane windows and new lights	Office
CPP	Want to add tinting to the windows.	Restaurant
CPP	disconnected eight tube light.	Retail
CPP	found illegal taps off of my meter	Retail
CPP	got different spot lights, but they do not last or cut costs either	Retail
CPP	Improved lighting last year	Retail
CPP	New lights prior to program	Retail
CPP	Not cost-effective	Retail

32. Would you be more likely to make (or encourage your owner to make) energy efficiency improvements if this were a permanent program?

Program Choice	Definitely not	Definitely_	Probably not_	Probably_
2 Deg. Offset		1	3	2
4 Deg. Offset	3	4	4	7
CPP		8	11	30

Business Type	Definitely not	Definitely_	Probably not_	Probably_
Office		6	9	17
Restaurant		2	4	5
Retail	3	5	5	17

Participants with a Summer Solutions Thermostat

33. How easy or difficult was the Summer Solutions thermostat to work with?

Program Choice	Couldn't figure it out_	No problem at all	Pretty difficult	Pretty easy_
2 Deg. Offset		2		4
4 Deg. Offset	1	3	4	11
CPP	3	9	2	24

Business Type	Couldn't figure it out_	No problem at all	Pretty difficult	Pretty easy_
Office	3	2	3	20
Restaurant		3		5
Retail	1	9	3	14

34. How does it compare to your old thermostat?

Program Choice	I don't like it_ Please remove it_	It's about the same_	It's harder to use, but I'll keep it_	It's much better_
2 Deg. Offset				6
4 Deg. Offset	1	4	3	11
CPP	2	14	7	16

Business Type	I don't like it_ Please remove it_	It's about the same_	It's harder to use, but I'll keep it_	It's much better_
Office		12	6	11
Restaurant			1	7
Retail	3	6	3	15

35. What changes do you feel should be made to the Summer Solutions thermostat?

Program Choice	Business Type	ChangesTstat
4 Deg. Offset	Office	A little easier to decipher when changing the temp versus what temperature it currently is

Program Choice	Business Type	ChangesTstat
4 Deg. Offset	Office	better operating manual
4 Deg. Offset	Office	control panel made easier to navigate through
4 Deg. Offset	Office	TOO MANY SETTINGS
4 Deg. Offset	Retail	During an event stop the thermostat from flash after an hour or two.
4 Deg. Offset	Retail	It should be simpler to operate
CPP	Office	Had to change mine three times
CPP	Office	Having the instruction booklet would make it easier but overall it was easy to manage
CPP	Office	Never touched the T-STAT
CPP	Restaurant	Need to speak with Staff to answer
CPP	Retail	a single sheet easy programming guide would be helpful
CPP	Retail	already removed it as it did not work properly--you saved energy because it would not allow for air conditioner to work!
CPP	Retail	it is very good.
CPP	Retail	Kill the 6 min. off compressor time.
CPP	Retail	Wants the old T-stat back up

36. How did you feel about receiving real-time event messages through your thermostat?

Program Choice	I really didn't like it_	I really liked it_	No strong feeling_	Was somewhat annoyed_
2 Deg. Offset		3	2	1
4 Deg. Offset		14	4	1
CPP	3	18	16	2

Business Type	I really didn't like it_	I really liked it_	No strong feeling_	Was somewhat annoyed_
Office	3	17	8	1
Restaurant		4	3	1
Retail		14	11	2

37. What changes do you feel should be made to the messaging feature?

Business Type	Program Choice	ChangesMessages
Office	4 Deg. Offset	maybe a soft tone or some sort of noise to indicate that there is a message
Office	CPP	None, it was very effective
Office	CPP	REALLY LIKED THE NEW BILL

Business Type	Program Choice	ChangesMessages
Office	CPP	Thermostat should make a beep that can be cleared after message is read
Restaurant	CPP	An audible beep to notify you of events
Restaurant	CPP	need to speak with staff
Retail	2 Deg. Offset	Maybe add an alert tone
Retail	4 Deg. Offset	Messages seemed to lock up system.
Retail	CPP	Added beep until it was acknowledged.
Retail	CPP	it is appropriate
Retail	CPP	More detail.
Retail	CPP	The message didn't tell the date!

38. How did you feel about the thermostat's automatic response to events?

Program Choice	I really didn't like it_	I really liked it_	No strong feeling_	Was somewhat annoyed_
2 Deg. Offset	1	3	2	
4 Deg. Offset		11	7	1
CPP	1	17	18	3

Business Type	I really didn't like it_	I really liked it_	No strong feeling_	Was somewhat annoyed_
Office	1	14	11	3
Restaurant	1	4	3	
Retail		13	13	1

39. What changes do you feel should be made to the automated response feature?

Program Choice	Business Type	ChangesAutoResponse
2 Deg. Offset	Retail	Alert tone to advise the staff of the change.
4 Deg. Offset	Retail	none
4 Deg. Offset	Retail	Was never here at 4pm anyway
CPP	Office	Actively managing it manually (turning it off)
CPP	Office	I did not have a SMUD thermostat at the office
CPP	Office	It worked well for my office
CPP	Office	None or a single beep every 10 minutes until acknowledged...
CPP	Office	Sound with it
CPP	Restaurant	need to speak to staff

Program Choice	Business Type	ChangesAutoResponse
CPP	Retail	on a peak day raising temp. by 2 degree is ok

40. About how many times did you override the event signal?

Program Choice	0	1	2	3 (actually bumped it up)	5	9	a few	A lot	ALWAYS	couple of times	DON'T KNOW	only when clients were in on those days and needed to get some air--if it worked at all.
2 Deg. Offset	2		1								1	
4 Deg. Offset	14	1		1				1				
CPP	20	1	1		1	1	3	1	1	1		1

Business Type	0	1	2	3 (actually bumped it up)	5	9	a few	A lot	ALWAYS	couple of times	DON'T KNOW	only when clients were in on those days and needed to get some air--if it worked at all.
Office	19	2	2				1	2				
Restaurant	3					1	1					
Retail	14			1	1		1		1	1	1	1

Participants on the Summer Solutions Rate

41. How easy or difficult was the Summer Solutions rate to understand?

Program Choice	Couldn't figure it out_	No problem at all_	Pretty difficult_	Pretty easy_
2 Deg. Offset		2		2
4 Deg. Offset	1	3	1	6
CPP	6	12	6	20

Business Type	Couldn't figure it out_	No problem at all_	Pretty difficult_	Pretty easy_
Office	3	9	5	12
Restaurant		3	1	6
Retail	4	5	1	10

42. What were your total savings - for the whole summer - on the new rate?

Program Choice	Business Type	Savings
2 Deg. Offset	Retail	I think around 5 to 10 a month
2 Deg. Offset	Retail	not sure
4 Deg. Offset	Office	dont know
4 Deg. Offset	Office	don't know
4 Deg. Offset	Office	it looked like my bill was higher, haven't analyzed
4 Deg. Offset	Office	not sure
4 Deg. Offset	Retail	$30
4 Deg. Offset	Retail	don't know
CPP	Office	$150
CPP	Office	$32.99
CPP	Office	$40
CPP	Office	$400
CPP	Office	$5.60
CPP	Office	couldnt tell besides 120 dollars
CPP	Office	didn't pay attention to the bill
CPP	Office	I really don't know how to answer this question since I didn't have a thermostat
CPP	Office	I saw some saving
CPP	Office	more expensive
CPP	Office	not sure
CPP	Restaurant	$100
CPP	Restaurant	$200
CPP	Restaurant	$30
CPP	Restaurant	$35
CPP	Restaurant	Don't know, just paid whatever it said.
CPP	Restaurant	more expensive
CPP	Restaurant	unknown--Smud messed up our bills this summer not clear.
CPP	Retail	$100
CPP	Retail	$50 - $75
CPP	Retail	$50.00
CPP	Retail	0
CPP	Retail	10 - 15%
CPP	Retail	10%
CPP	Retail	dont know
CPP	Retail	don't know
CPP	Retail	more expensive
CPP	Retail	more than 50%
CPP	Retail	Not much if anything!

Program Choice	Business Type	Savings
CPP	Retail	not very much. I'd say under $30 total if that

43. Were your savings lower, higher, or about what you expected?

Program Choice	I had no expectation for savings_	Savings were about what I expected	Savings were lower than I had expected_	Savings were more than I had expected
2 Deg. Offset	1	1	1	1
4 Deg. Offset	5	2	4	
CPP	12	12	15	4

Business Type	I had no expectation for savings_	Savings were about what I expected	Savings were lower than I had expected_	Savings were more than I had expected
Office	11	8	9	1
Restaurant	3	2	3	2
Retail	4	5	8	2

44. If you were on this rate permanently, and SMUD did not provide a similar thermostat, would you purchase one yourself to help you respond to events?

Program Choice	Definitely not_ I'd rather do it manually_	Definitely_ I would save enough money to cover the cost_	Only if it were less than $100	Only if it were less than $50_
2 Deg. Offset	1	2		1
4 Deg. Offset	5	2		4
CPP	25	7	3	7

Business Type	Definitely not_ I'd rather do it manually_	Definitely_ I would save enough money to cover the cost_	Only if it were less than $100	Only if it were less than $50_
Office	14	5	3	8
Restaurant	5	3		1
Retail	12	3		3

45. Would you be able to install the thermostat yourself?

Program Choice	--	Definitely	Definitely not	Definitely not_	Definitely_	Probably	Probably not	Probably not_	Probably_
2 Deg. Offset	2			1	1			2	
4 Deg. Offset	5			2	2			4	2
CPP	3	2	2	5	3	4	3	9	15

Business Type	--	Definitely	Definitely not	Definitely not_	Definitely_	Probably	Probably not	Probably not_	Probably_
Office	3	1		4	2	3		9	11
Restaurant	1	1	2		1		1	4	
Retail	6			4	3	1	2	2	6

46. How easy or difficult was the new Summer Solutions bill to understand?

Program Choice	Couldn't figure it out_	No problem at all_	Pretty difficult_	Pretty easy_
2 Deg. Offset		2		2
4 Deg. Offset	2	2		7
CPP	6	7	6	20

Business Type	Couldn't figure it out_	No problem at all_	Pretty difficult_	Pretty easy_
Office	4	6	4	15
Restaurant		1	1	6
Retail	4	4	1	8