

# **Residential Time-of-Use with Critical Peak Pricing Pilot Program: Comparing Customer Response between Educate-Only and Technology-Assisted Pilot Segments**

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## **Abstract**

In 2006 and 2007 PSE&G offered residential customers in two selected municipalities an opportunity to participate in a residential time-of-use (TOU) pilot program. The TOU rate incorporated fixed low, medium and high-cost time periods with an “extra high” cost period, called the “Critical Peak Price” (CPP) that was utilized on an as-needed basis. There were two TOU segments included in the pilot program. The first, myPower Sense, was designed to test how well customers would respond to TOU pricing and reduce demand during CPP events when given advance warning and educational information only. PSE&G used e-mail and telephone calls to notify participants the night before a CPP event. The second segment, myPower Connection, offered customers the same TOU/CPP rate and advanced warning of CPP events, but also provided customers with a free programmable thermostat that received price signals from PSE&G and could be programmed to adjust air conditioning set points in response changes in the TOU/CPP price signals.

The educate-only segment, myPower Sense, required participants to take explicit self-imposed actions on peak price days (or else pay a significant price). The technology-enabled segment, myPower Connection, should, in theory, have produced greater demand reduction from customers, since they had the ability to pre-program their thermostat to automatically respond to higher priced time periods.

This paper compares the two segments on program recruitment issues, participant satisfaction, and demand impacts, as well as other factors.

## **Introduction**

PSE&G launched a pilot program to test customer response to pricing signals, particularly on days when the marketplace experiences extremely high costs. PSE&G developed a residential time-of-use (TOU) rate incorporating fixed low, medium, and high-cost time periods with an “extra high” cost period, called the “Critical Peak Price” (CPP), that was utilized on an as-needed basis. A TOU-only rate (minus the CPP component) does not necessarily require substantial communication with customers once they are on the rate. Adding the CPP component, however, means that PSE&G must somehow communicate with participants when a CPP day is being called. PSE&G designed a pilot program called **myPower Sense** to test how much demand customers would reduce during CPP events when educated about their TOU tariff and given advance warning of CPP events. PSE&G used email and telephone calls to notify participants the night before a CPP event. At the beginning of the season PSE&G also provided participants with suggestions for actions they could take to reduce demand in high and CPP periods.

PSE&G hired Summit Blue to advise it on the design of the pilots to ensure that they would provide data to answer key questions. Summit Blue also provided input to the process evaluation and implemented the impact evaluation. In designing the pilot programs, PSE&G wanted to ensure it would be able to estimate demand impacts from the pilots. It also wanted to know if information and communication was

enough to inspire participants to take significant actions to reduce demand? Did participants reduce demand consistently? What else might PSE&G do to help them reduce demand?

In answer to the last question and to provide data to answer the first two questions, PSE&G designed a second segment of the pilot program, called **myPower Connection**. Participants in this segment were on the same TOU/ CPP rate and received the same communication as myPower Sense participants; however they also received a free thermostat that received pricing signals from PSE&G and was programmed to adjust air conditioning set points in response to those pricing signals. For example, participants could program their thermostat to raise the temperature set point 2 degrees during medium price periods, 4 degrees during high price periods, and 6 degrees during CPP events. Contractors programmed the thermostats when they first installed them, based on the participants’ preferences, and showed the participants how to modify the settings.

myPower Sense required participants to take explicit action on peak days to save energy during the CPP and high price hours. The technology-enabled segment, myPower Connection should, in theory, have produced greater demand reduction from customers since they had the ability to pre-program their thermostat to automatically respond to higher priced time periods. They did not have to be aware that a CPP event had been called or take specific actions during high price periods in order to reduce consumption from their air conditioning and save money. (Of course they would have to be aware of the CPP event to reduce usage from other equipment.) Providing the means to reduce consumption during high price hours via the programmable thermostat might have reduced the barriers to participating in the TOU/ CPP rate.

Over 450 customers were participating in myPower Sense and 377 in myPower Connection as of November, 2006 (Table 1).

**Table 1. myPower Pricing Program Participants**

Segment	Number of Participants
myPower Sense – TOU/ CPP Educate Only	459
myPower Connection – TOU/ CPP Technology Enabled	377
Control Group	450
Total	1,286

The evaluation was designed to answer a number of questions about the two CPP program elements covering a number of subject areas:

- **Recruitment/retention:** Was it easier to recruit participants into myPower Sense or myPower Connection? What were the biggest recruiting issues for the two different program segments?
- **Program Administration and Notification:** Were the reasons that customers declined program participation significantly different between the two segments? Did the two segments experience different dropout rates and what were the reasons given for dropping out different between the segments?
- **Customer Actions/Behavior:** What did the participants do to reduce demand? Did the myPower Sense participants report taking significantly different actions on CPP days than the myPower Connection participants? What did the technology-enabled participants report doing with their programmable thermostat and what other behaviors did they adopt to reduce demand? Did their actions correlate with the demand reduction visible in their metered data? Was there any difference in participant satisfaction between the two approaches?
- **Impacts:** Was the educate-only approach good enough? Did it produce demand reduction reasonably near its expected reductions? Were its savings consistent? On the other hand, did the technology-enabled segment produce significantly more benefits? Did it deliver greater demand reduction? Did it deliver more consistent demand reduction? What did the technology-enabled participants report doing with their

programmable thermostat and what other behaviors did they adopt to reduce demand? Did their actions correlate with the demand reduction visible in their metered data?

- **Customer Satisfaction:** Was there any difference in participant satisfaction between the two approaches?

We address these questions in this paper.

During the summer of 2006, PSE&G successfully implemented both pilot efforts and initiated two CPP events. They collected 15-minute interval whole-house meter data from all participants to be used to perform an impact analysis. They also implemented a variety of participant surveys including pre-program surveys, participant eligibility screening, CPP event surveys, post season surveys, and a control group survey. We have combined that data with the customer recruitment results and program dropout rates to compare the two distinct pilot segments. From that, we have drawn conclusions about customer recruitment, retention, CPP event actions, customer satisfaction, and other factors that address how effective each segment strategy was in meeting its objectives. We have then used that data in a time-series, cross-section regression analysis to estimate demand reduction impacts. Thus, conclusions were drawn about the features of the pilot segments that seem to be most important for achieving significant and reliable demand reduction.

## The Technology

Both the myPower Sense and myPower Connection participants were placed on the TOU/CPP tariff and received educational materials. myPower Connection participants also received a programmable thermostat which was programmed by the installers to automatically adjust the central air conditioner temperature during the various myPower price periods to help reduce usage at times of high and critical prices. Participants were also trained to adjust the programming. The thermostats received signals sent by PSE&G to indicate price period changes including CPP events. The thermostats reacted to the signal and automatically implemented the specific temperature adjustments pre-programmed by the customer. Thus the thermostats allowed participants to program an aggressive response to high and critical peak prices.

## The TOU/CPP Rate

Generally speaking, one of the goals of a TOU rate is to induce customers to reduce their electricity consumption during peak-periods by making it relatively more expensive compared to off-peak periods. In other words, the TOU rate is designed to induce a peak/off-peak substitution of electricity usage. In the case of myPower, this was done by having an 8¢ per kWh peak (1 PM to 6 PM) adder and a 5¢ per kWh off-peak (10 PM to 9 AM) discount. The CPP aspect of the rate is a significant (\$0.69/kWh) adder to customer bills applied during summer 2006 CPP event periods (1 PM to 6 PM).

**Table 2. TOU/CPP Rate – Summer Months (June to September) Effective July 15, 2006**

Period	Charge	Applicable
Base Price	9.2032¢ per kWh	All Hours
Night Discount	-5¢ per kWh	10 PM to 9 AM Daily
On-Peak Adder	8¢ per kWh	1 PM to 6 PM Weekdays
Critical Peak Adder	69¢ per kWh	When called 1 PM to 6 PM Weekdays. When called is added to the Base Price.

## Impacts

Summit Blue implemented an interim impact analysis to estimate the per-participant reduction in load and any load shifting created by the myPower pilot program. This evaluation addressed both the TOU and CPP aspects of the myPower program during the summer of 2006. The focus of the impact evaluation was to determine the effect on participants' load shape going from a flat rate to the myPower time differentiated rate, and to determine the effect of the CPP rate. The analysis also investigated whether or not there was any difference between the impacts from both the TOU and CPP aspects of the program between the myPower Sense participants and the myPower Connection participants.

The TOU and CPP results are presented in Table 3 and Table 4, respectively. The TOU impacts are expressed as substitution elasticities. The implication of these elasticity estimates are that a 100% increase in the on-peak price of electricity relative to the off-peak electricity periods will result in an 8.5% decrease for myPower Sense customers and a 13.7% decrease in on-peak usage for the technology-enabled myPower Connection customers. The CPP impacts are expressed as average kW per hour.

**Table 3. Estimated TOU Impacts (substitution elasticity) – 90% confidence interval**

Impact Estimate	Lower Bound	Coefficient	Upper Bound
myPower Sense	-0.079	-0.085	-0.090
myPower Connection	-0.131	-0.137	-0.142

**Table 4. Estimated CPP Event Impacts (average kW per hour) - 90% confidence interval**

Impact Estimate	Lower Bound	Coefficient	Upper Bound
myPower Sense	0.133	1.11	2.08
myPower Connection	1.09	2.12	3.17

These results can be understood by looking at the situation in the myPower program. The prices for peak electricity are about 17¢ (the base rate of 9¢ plus the peak adder of 8¢), and the prices for the night off-peak are about 4¢ (the 9¢ base plus less the 5¢ discount). Thus, there is a price differential of 400%. Using the estimated substitution elasticities, this implies that if a customer's peak demand before the program was, for example, 3.5 kWh, then the TOU rate design alone results in a reduction of 0.40 kWh for the myPower Sense segment and 0.63 kWh for myPower Connection segment of peak electricity that is shifted to off peak periods. These represent a 12% reduction in peak demand for myPower Sense and an 18% reduction in peak demand for myPower Connection at the current TOU rate structure.

The elasticity of substitution found for the myPower Sense component is similar to that found for programs throughout the country and the statistically distinct result for the technology-enabled myPower Connection segment is noticeably greater. This indicates that the myPower Connection customers shifted more of their load to off-peak periods or reduced load when the thermostat automatically adjusts their air conditioning set point or target temperature.

Given the TOU rate structures used in this pilot, the achieved reductions in peak demand were 12% for myPower Sense and 18% in myPower Connection. Thus the technology-enabled myPower Connection segment attained approximately a 50% greater impact than the myPower Sense segment which relied upon customer taking actions.

The 1.1 and 2.1 kWh impacts during the CPP events for myPower Sense and myPower Connection participants are sizeable reductions in peak demand. Note that the difference between the two was not statistically significant due to the small number of CPP events (only two). We suspect that additional events will confirm that the technology-enabled myPower Connection segment will continue to produce impacts

higher than that attained by the myPower Sense segment with the preliminary data showing impacts for myPower Connection greater than myPower Sense by as much as a factor of 2.

A key finding in this rate impact analysis is the increase in impacts that was provided by the enabling technology in the myPower Connection segment. In this case, the use of a thermostat that was programmed with the pricing structure to automatically change the temperature setting produced almost a 50% increase in impacts over the customer-action only myPower Sense segment.

With respect to the CPP event, myPower Connection showed impacts that were almost double the impacts of myPower Sense (2.1 kW to 1.1 kW); but, due to the fact that there were only two CPP events called, these results are preliminary. However, an analysis of the underlying data provides some indication that the observed greater reduction in peak demand in response to CPP events will persist for the technology-enabled segment.

## Recruiting

Customers were identified for participation in specific pilot segments and were not offered the opportunity to choose between segments. This was done to help simplify and streamline the marketing offer to customers. PSE&G used direct mail and telemarketing to solicit customer participation. The promotional campaign included letters supplemented by a brochure insert to convey segment-specific information of the marketing offer, such as program description and benefits, technology to be installed (if any), and applicable rate structure (pricing plan). The direct mail campaign offered people the option of calling a toll free number or sending in a postage-paid reply card. Approximately one half chose each approach, with myPower Sense respondents slightly more likely to use the reply card and myPower Connection respondents slightly more likely to make a call (see Table 5). Across both programs, four percent of those who received the direct mail material responded either by phone or with the reply card. By comparison, the Direct Marketing Association’s 2006 Response Rate Trend Report states that the average response rate for direct mail is 2.18%.<sup>1</sup> The direct mail was supplemented heavily with telemarketing to ensure adequate enrollment. Of the people called to recruit into myPower Sense, 15% agreed to participate. Slightly more (17%) agreed to participate in myPower Connection.

**Table 5. Lead Generation Results**

	myPower Sense	myPower Connection	Total
Percent of responses to direct mail campaign that came in as telephone calls	47%	53%	50%
Percent of responses to direct mail campaign that came in as Reply Card	53%	47%	50%
Direct Mail Response Rate			4%
Telemarketing Response Rate	15%	17%	16%

myPower Sense participants received a \$25 incentive after enrollment and will receive a second incentive payment of \$75 upon conclusion of the two-year pilot program. myPower Connection participants received the free programmable thermostat at the beginning of the program and will receive \$75 upon conclusion of the program.

During telemarketing, the reasons customers gave when declining to participate were recorded. The most common was simply “not interested” for both segments (see Table 6) with over two thirds of those

<sup>1</sup> <http://www.the-dma.org/cgi/disppressrelease?article=836>

offered myPower Sense being not interested. The myPower Connection segment was more likely to get past the customer’s initial interest screen and had a slightly higher telemarketing response rate.

**Table 6. Reasons Given During Telemarketing For Not Participating**

<b>Reason Did Not Want to Participate</b>	<b>myPower Sense</b>	<b>myPower Connection</b>
Not interested	64.7%	44.2%
Program too complicated	14.3%	23.2%
Questions validity of program	10.1%	15.8%
No guarantee of savings, therefore not interested	5.9%	10.5%
Returned Reply Card but not interested when called	2.5%	4.2%
Afraid of slamming	2.5%	2.1%
Total	100.0%	100.0%

Note: Eliminated from the table were reasons that could not reasonably be connected to differences between the program offerings, e.g., no central air conditioner, language barrier, deceased, no longer PSE&G customer, etc.

Over 90% of myPower participants said their primary reason for participating was to save money on their electric bill. Significantly more myPower Connection participants mentioned conserving energy and helping the environment as a reason for participating. Relatively few thought getting Internet access to their thermostat was a driving reason to participate.

**Table 7. Reasons for Participating in myPower**

<b>Reason</b>	<b>myPower Connection</b>	<b>myPower Sense</b>
To save money on electric bills	91%	94%
To conserve energy	40	27
Interested in new technology	17	NA
Free thermostat	17	NA
To help the environment	13	6
Incentive payment	7	7
Internet access to thermostat	3	NA
Some other reason	0	1
Don’t know/Refused	1	1

Note: Multiple responses were allowed.

myPower Connection participants tended to be slightly older, have more education, and be wealthier than myPower Sense participants, but the differences were not large. myPower Connection participants were required to have central air conditioning to accommodate the in-home technology. myPower Sense participants were not required to have air conditioning, however 62% of them have central air-conditioning in their homes. myPower Sense respondents without central air conditioning generally had more than one room air conditioning unit and operated them usually when someone was at home. Nine in ten myPower Connection customers and 80 percent of myPower Sense customers live in single-family homes. Over half (52%) of participants in both segments have broadband Internet access in their homes.

## Dropout Rates

As the pilot progressed, customers dropped-out of the myPower program for a number of reasons. By November 3, 2006, 14% of the myPower Sense and 11% of the myPower Connection participants had dropped out. When participants who dropped out of the program because they were moving were eliminated from the counts, the dropout rate was identical between the two segments at 10%.

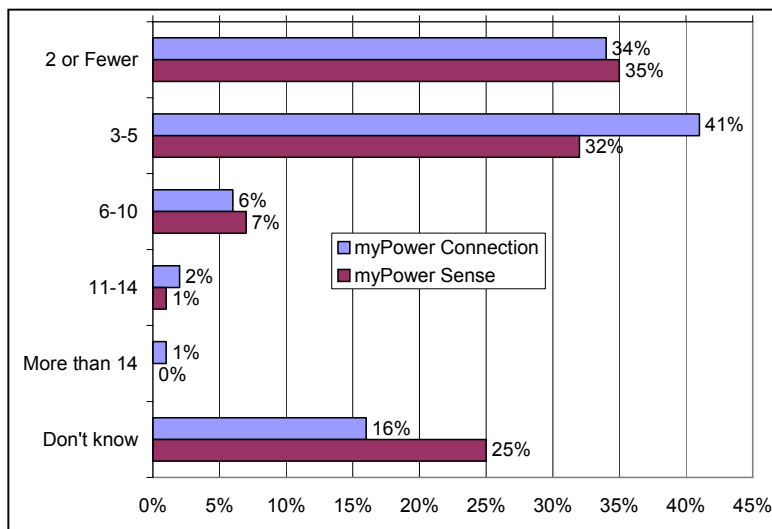
Most participants in the myPower Sense pilot dropped out because of billing issues (see Table 8). More people dropped out for technology issues among myPower Connection participants, which makes sense given that they received thermostats while myPower Sense participants did not. The “Miscellaneous” category includes: Changed mind, No reason given, Not happy with program, Special circumstance (illness, death in family).

**Table 8. Reasons for Dropping out of the Program (not counting those who moved)**

	myPower Sense	myPower Connection
Technology Issues	2%	43%
Billing	70%	39%
Miscellaneous	28%	17%
Total	100%	100%

## Customer Actions

Forty-one percent of myPower Connection and 32 percent of myPower Sense participants thought that they had experienced from three to five CPP events whereas only two events were actually called. One possible interpretation of this result is that a significant number of participants are confused about what constitutes a CPP event. Another possible interpretation is that the CPP events were not so dramatic that they made a strong impression on the participants and so they had only a vague impression of how many actually occurred. In that event, they may have just guessed and chosen what they thought of as a likely number, especially since educational materials indicated that there would be up to five events.



**Figure 1. How Many CPP Events Took Place Over This Past Summer?**

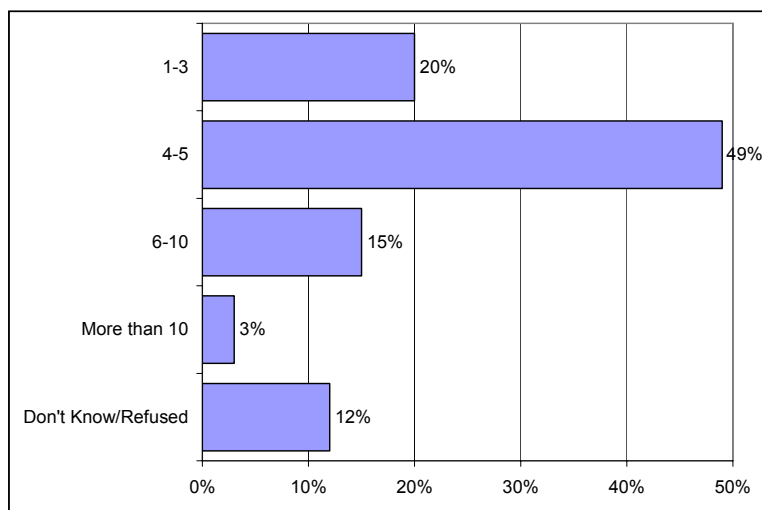
Eighty-seven percent of myPower Connection and 52 percent of myPower Sense participants who have programmable thermostats believed that they have programmed them to adjust the temperature of the house throughout the day. Given that all of the myPower Connection customers were given thermostats and that the installer programmed those thermostats at the time of installation, and that PSE&G analysis suggests that almost all equipment was in fact programmed, it appears that some myPower Connection participants may not have realized that their thermostats were programmed.

When asked how they became aware of the CPP event, 55% of myPower Connection and 64% of myPower Sense participants remembered (unprompted) receiving an automated call about a CPP event. All participants should have received an automated call about the CPP events. Those not mentioning that they became aware of the CPP event through the automated call were asked specifically if they recalled receiving the automated call. Of those customers asked specifically, just 30% of myPower Connection and 39% of myPower Sense participants recalled receiving the automated call. Forty-five percent of myPower Connection respondents remembered learning about the CPP event from the signal on their thermostat. Approximately one-half of those who were sent emails about the event remembered the email.

One-half of both myPower Connection and myPower Sense respondents reported that they refrained from using electric appliances during high-price hours. And one-fifth of participants in both programs set their thermostat at a higher temperature to reduce electric usage during CPP events.

When asked what actions they took to reduce their energy usage during the CPP event, myPower Connection participants were much more likely than myPower Sense participants to say they stopped using all electrical appliances during the event—35% vs.18% respectively.

Seven in ten myPower Connection participants had their thermostats programmed to increase the temperature during high price periods. Most (65%) myPower Connection participants had their thermostats programmed to increase the temperature during CPP events and a majority (55%) have changed their thermostat’s programming since its original installation. Half (49%) of the respondents programmed their thermostat to increase four to five degrees (see Figure 2).

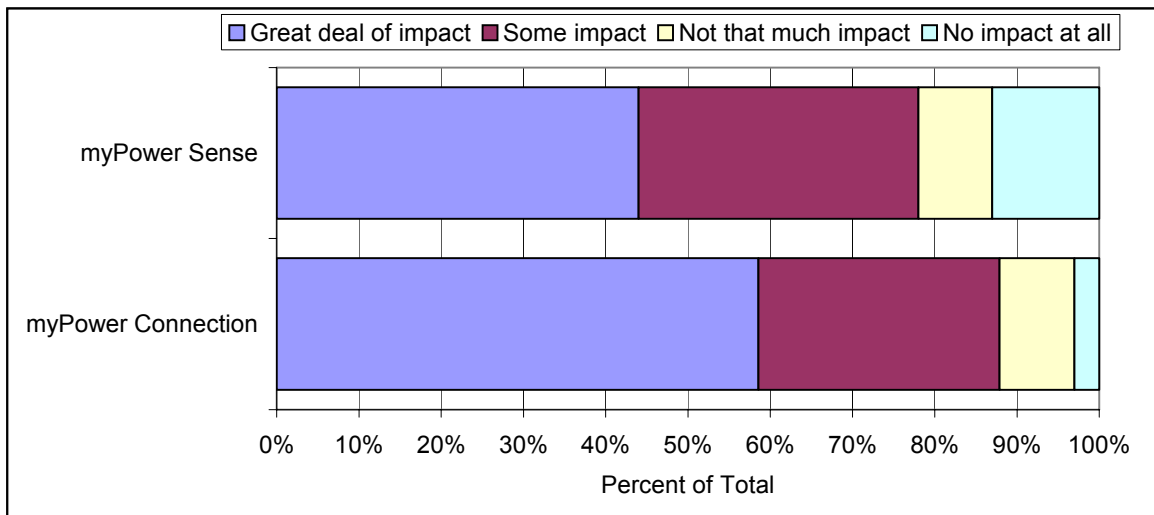


**Figure 2. During a Critical Price Event, by How Many Degrees Was Your Thermostat Programmed to Increase? myPower Connection**

Seven out of ten myPower Connection respondents changed the operation of other equipment (besides their air conditioner) to lower-priced times of day. Washing machines (87%), clothes dryers (68%), and dishwashers (64%) were the equipment most often operated at lower-priced times of day.



myPower participants received a notification by phone or email that there was going to be a CPP event the day before the event. More myPower Connection participants than myPower Sense participants thought that the notification had some impact on their decision to reduce consumption during the CPP event (Figure 3).



**Figure 3. Impact of Notification on Decision to Reduce Consumption During the CPP Event**

Relatively more myPower Connection participants than myPower Sense participants said they did not use electric appliances during a CPP event (Table 9). As might be expected given that myPower Connection participants were given programmable thermostats that should have been programmed to respond to CPP events, relatively more myPower Sense participants reported adjusting their thermostats during CPP events.

**Table 9. Actions Taken to Reduce Usage During CPP Event**

Actions taken	myPower Connection	myPower Sense
Did not use electric appliances	89%	79%
Turned up thermostat	2%	10%
None – unaware of critical price event	1%	5%
None - general	9%	13%
Other	0%	4%

## Customer Satisfaction

On a 10 point scale where one means extremely dissatisfied and ten means extremely satisfied, myPower Connection participants reported mean scores of 7.5 and myPower Sense participants 7.4. Seventeen percent of myPower Connection and 21% of myPower Sense participants were dissatisfied with the program. The key reasons for dissatisfaction were:

- Not saving money on their electricity bill
- Bad installation experience (myPower Connection only)

- Higher bills as a result of their participation
- The program was too complicated or the participant did not understand the program
- The myPower program thermostat did not work as programmed (myPower Connection only)

By the end of the summer, myPower Connection customers reported having a much better understanding of how the program worked than myPower Sense customers. myPower Connection participants are somewhat more satisfied with the myPower program than myPower Sense participants (82% vs. 74%).

myPower Connection participants were more satisfied than myPower Sense participants with respect to the number of CPP events that took place (71% satisfied or very satisfied vs. 67%). (There were two CPP events during the summer.) Only 13% of the myPower Connection and 12% of the myPower Sense participants said they were dissatisfied with the number of events.

Those dissatisfied with the number of CPP events gave a wide range of estimates of how many CPP events took place. Of the 7 participants that were dissatisfied with the number of CPP events and provided their estimate of the number of CPP events that took place, one said there were not any CPP events, two said there were 2 events, three said there were 3 events and one said there were 10 events. When asked what PSE&G could do to improve its myPower Connection Program, those who were dissatisfied with the number of events did not mention the number of events in their answers.

myPower Connection participants were more likely than myPower Sense participants to be very satisfied with the information they received regarding how to save money on their energy bills. myPower Sense customers were more likely than myPower Connection customers to say they did not know how many CPP events took place this summer (25% vs. 16% of myPower Connection participants).

myPower Sense participants were more comfortable during the CPP events than myPower Connection participants (71% were comfortable or very comfortable vs. 63% of myPower Connection participants). Additionally, 78 percent of myPower Connection respondents and 90 percent of myPower Sense respondents said that their home was “comfortable” during high-priced hours that were outside of CPP events. Given that myPower Connection participants actually reduced demand more than myPower Sense participants, these results probably conform to actual conditions.

## Conclusions

In this paper, we set out to examine the effects of a residential TOU rate with a CPP component and whether providing participants with a communicating, programmable thermostat that could respond to price signals would significantly increase their demand savings. The PSE&G myPower pricing segments of the pilot program tested a rate with an on-peak adder of 8¢ per kWh and a CPP adder of 69¢ per kWh. Dropout rates were essentially identical between the two program segments. Satisfaction with the program was not significantly different between the two segments. myPower Sense participants produced average demand savings of 1.11 kW during CPP events, responding to messages from PSE&G and scheduling their own actions. myPower Connection participants produced average demand savings of 2.12 kW with the assistance of the programmable thermostat that could raise the setpoint during CPP events. The results of the first summer season seem to indicate that providing customers with a communicating thermostat does provide significant additional impacts and is an attractive approach to many participants. PSE&G will continue the pilot program through the summer of 2007 to gather more data to increase the precision in the impact estimates and to obtain data on ongoing customer reactions to the offering. Additional data from CPP events will produce more definitive conclusions about the two approaches. At the end of the pilot, PSE&G will have data to support a cost-benefit analysis and will draw final conclusions about the benefits and drawbacks of both approaches.