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SmartPricing Options Final Evaluation

The final report on pilot design, implementation, and evaluation of the Sacramento Municipal Utility District's Consumer Behavior Study

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U.S. Department of Energy

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Contents

1.0 PILOT PROJECT CONTINUATION 4

1.1 About SMUD 4
1.2 Consumer Behavior Study Background 4
1.3 How This Report Is Organized 5

SECTION I: PROJECT OPERATIONS 7

2.0 THE SECOND SUMMER OF SMARTPRICING OPTIONS 7

3.0 PROJECT ADMINISTRATION: BUDGET AND SCHEDULE 10

3.1 Overview 10
3.2 Details 10
3.2.1 Budget 10
3.3 Quality Assurance 16
3.4 Lessons Learned and Key Takeaways 17

4.0 MARKETING AND MARKET RESEARCH 18

4.1 Overview 18
4.2 Details 18
Additional retention activities 22

5.0 PILOT OPERATIONS AND CUSTOMER SUPPORT 26

5.1 Overview 26
5.2 Details 26
Conservation Day Execution (CPP Events) 26
Supporting the In-home Displays 27
5.3 Lessons Learned 28

SECTION II: SMUD SMARTPRICING OPTIONS PILOT EVALUATION 1

APPENDICES 133

1.0 Pilot Project Continuation

The Department of Energy's Smart Grid Investment Grant (SGIG) offered SMUD the opportunity to test the impacts of dynamic pricing and enabling smart grid technology on peak load shaving, energy conservation, and customer satisfaction using rigorous experimental research methods. SMUD implemented the first year of the SmartPricing Options (SPO) pilot in June 2012 and second year of the pilot in June 2013. SMUD is one of eleven utilities conducting a Consumer Behavior Study (CBS), a dynamic pricing trial, funded in part by the SGIG. This report examines the implementation, operations, and load impacts of the SPO pilot after the completion of the second year.

1.1 About SMUD

SMUD is a publicly-owned electric utility governed by a seven-member Board of Directors. Serving approximately 600,000 customers and a total population of about 1.4 million, SMUD is the sixth-largest public utility in the United States. SMUD's 900-square-mile service territory encompasses Sacramento County and a small portion of Placer County.

SMUD has been providing public power to the Sacramento region since 1946, and our energy efficiency and renewable energy programs are recognized nationally for leadership and innovation. For each of the last eight years, SMUD has received the highest customer satisfaction ratings of any utility in California in the J.D. Power and Associates survey and received the second-highest score in the United States for commercial customer satisfaction in 2010.

1.2 Consumer Behavior Study Background

SMUD was awarded a $127M grant toward a $308M smart grid project from the U.S. Department of Energy (DOE) as part of the American Recovery and Reinvestment Act of 2009 (ARRA). SMUD's SmartSacramento®[1] project is a result of an effective and strategic partnership between SMUD, California State University Sacramento, State of California's Department of General Services, County of Sacramento, Los Rios Community College District, Elk Grove Unified School District, and the Sacramento City Unified School District. Together with our partners, SMUD is implementing a smart grid in Sacramento that can serve as a model for California and the rest of the United States.

[1] ®A registered service mark of the Sacramento Municipal Utility District.

Included in SMUD's proposal to DOE was an agreement to participate in a cross-utility research effort to study the impacts of dynamic pricing in various regions. This study accounted for approximately 4% of SMUD's proposed smart grid project budget. Utility participants who conducted a consumer behavior study would not only benefit from the research opportunity within their own service territory, but the findings would be publicly available as individual utility analyses as well as an aggregate assessment across consumer behavior studies to be conducted by Lawrence Berkeley National Laboratory. Eleven utilities participated in the research effort and many studies have been completed. The research results are anticipated to be referenced by strategic planners within utilities, policy makers, technology developers and manufactures, and others in the utility space with an interest in pricing design, behavior change, and enabling technology development.

Please refer to the Interim Evaluation report of SMUD's Smart Pricing Options for a detailed description of the study background, objectives, planning and design. The interim report can be found at:

https://www.smartgrid.gov/sites/default/files/MASTER_SMUD%20CBS%20Interim%20Evaluation_Final_SUBMITTED%20TO%20TAG%2020131023.pdf

1.3 How This Report Is Organized

This report is divided into two sections and an appendix.

Section I: Project Operations discusses the logistics of putting the project plan and research design into action for the second year of the pilot. Details on recruitment and first year implementation can be found in the interim evaluation report at the above link. Section 1 focuses on additional lessons learned and key takeaways in terms of pilot operations.

Section II: The Final Evaluation is a comprehensive load impact report covering the load impacts, average impacts over the two summers, customer attrition, impact persistence, customer satisfaction, and customer choice analysis from the second summer conducted by Nexant.[2] The report is included in its entirety as it was prepared for SMUD. This section was written in a manner in which it can be extracted from this report and stand alone as an independent document. As such, it contains some brief areas of redundancy with *Section I* of this report, providing high level details for contextual value within the impact discussion.

[2] The interim report was produced by Freeman, Sullivan & Co., (FSC), which was acquired by Nexant in January 2014.

From this point forward, when referring to SMUD's consumer behavior study, we use the pilot's marketing name, "SmartPricing Options." We also use the terms "study" or "pilot" to refer to the SmartPricing Options. The term "Consumer Behavior Study" or "CBS" refers to the overall consumer behavior study data being collected by the DOE in consultation with Lawrence Berkeley National Lab.

SECTION I: PROJECT OPERATIONS

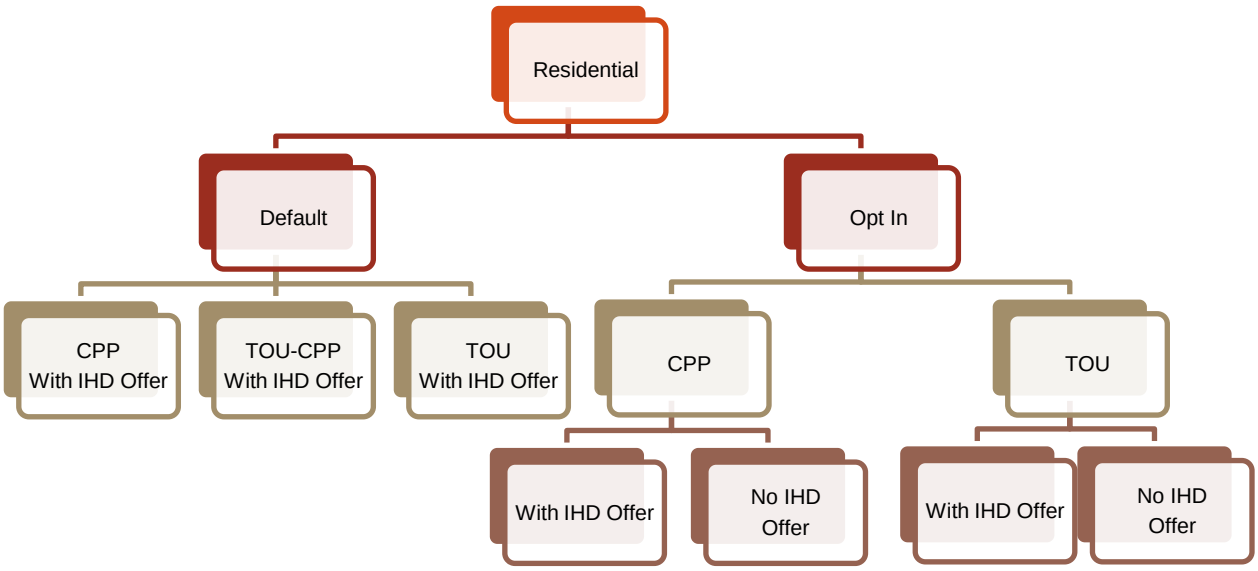
The second year of the pilot focused on operational process improvements, customer retention, and application of lessons learned from the first summer.

2.0 The Second Summer of SmartPricing Options

In early 2013, the second year of the pilot, SMUD staff began planning for improvements in the operational processes for the pilot's Conservation Days, customer services, and customer retention. From the research completed, the experiences gained and lessons learned from the first year of operations, SMUD was able to refocus on what could be done to improve communication to pilot participants and ensure customer retention.

The seven treatment groups for the pilot included a representative sample of SMUD's customer base except for the following exclusions: photovoltaic customers, air conditioning load management customers, and medical rate customers. Low income customers were included in the study population and represented 33% of study participant. The SPO treatment groups are detailed below.

Figure 1: SmartPricing Options Treatment Groups



The experimental rate options were offered to the sample population beginning in October, 2011 and were in effect from June through September, in both 2012 and 2013. The research objectives were to determine:

1. Electric energy and demand impacts for each treatment;
2. Customer characteristics related to energy usage behaviors;
3. The role of IHDs in customers' daily electricity management;
4. Program impacts on customer bills and satisfaction;
5. Expected value of rate and IHD programs;
6. Expected market penetration for rate and enabling technology programs; and
7. Effective educational and marketing strategies for customers.

It is not uncommon in utility research to rely on quasi-experimental methods and limited sample sizes due to resource constraints, technology limitations, and concerns about negative impacts on customer satisfaction. The Technical Assistance Group (TAG) that was under contract to DOE to provide guidance for the consumer behavior studies had a much higher standard for implementation of the consumer behavior studies for all SGIG recipients. In SMUD's case, the resulting research plan included three methodologies: Randomized Control Trials (RCT), Random Encouragement Design (RED), and Within Subjects.[3]

It was important to SMUD to manage the size of the study, and the RCT and RED designs with the agreed upon statistical power required much larger sample sizes than the methods typically employed by SMUD. In an effort to manage the study's footprint on our service territory, we assigned research rigor and associated sample sizes based on the priority of the research questions that could be answered by the treatment group. This resulted in the following design:

- RED: CPP with technology offer (opt-in and default) and TOU with technology offer (default)
- RCT: TOU with and without technology offer (opt-in)
- Within Subjects: CPP without technology offer (opt-in) and TOU-CPP with technology offer (default)

[3] These terms are defined in detail in the appendix of this report on page 136.

Ultimately, sample sizes were larger than expected after the first summer due to much higher than expected recruitment and retention rates, which allowed Nexant to conduct the evaluation using RED and RCT methods for all treatments.

SMUD had predicted that approximately 20% of pilot participants would leave before the end of the study period on October 1, 2014. It became clear in early 2013 that attrition would be greater than 20%, primarily due to customers moving from premises that were in the study. If a customer moved from a home included in the study, they were dropped from the evaluation. During the course of the two year pilot, approximately 25% of customers in the study moved, exceeding SMUD's forecasted attrition levels. These move-out rates, upon further investigation, were only slightly higher than average, which was most likely a result of the economic recession. However, dropout rates, that is, customers that elected to leave the pricing pilot, were very low across all treatment plans, ranging from 4%-9%. Because SMUD had overenrolled customers in each of the treatment groups, this attrition did not compromise the validity of the study.

SMUD focused significant attention on customer retention and improved communications regarding the pilot goals and objectives. The shift in marketing from a recruitment campaign to an educational and retention campaign allowed for a deeper dive into customer preferences and targeted marketing. Market research conducted in the first year allowed the team to identify improvements that could be made to communications. The team applied this customer feedback to marketing collateral and produced higher customer satisfaction ratings among pilot participants than during the first year. Additional information on Marketing and Market Research can be found in Section III.

By the second year of the pilot, experience was on the side of the operations team. We had learned a great deal from the challenges during the first summer and the team implemented new operational processes that improved CPP event execution, reporting, and customer service. More on these efforts can be found in Section 5, which discusses pilot operations.

The project schedule included over 1260 tasks with start and finish dates for each task of the project. This schedule was critical for the project team to stay on task and recover from delays and surprises that are inevitable in any project.

3.0 Project Administration: Budget and Schedule

3.1 Overview

The SmartPricing Options pilot was one of the larger SGIG funded pilot projects in terms of scope, schedule and budget. The two-year pricing pilot required a seven month recruitment period and over a year and a half of planning and implementation before the pricing plans went into effect.

3.2 Details

3.2.1 Budget

The budget process at SMUD is completed annually for the upcoming year and includes a three year planning budget. The SmartPricing Budget was created in 2010-2011 and updated annually for the pilot covering 2010 through 2014.

Total Project Budget

The initial projected total costs for the pilot totaled $12.8 million. All budget figures discussed in this section include the cost of product, services, and internal labor to administer the pilot, as well as the surcharge rate used to account for organizational overhead[4]. The costs reported here are total budgets, not just SMUD's cost share of the pilot. Due to some efficiencies and overestimated support requirements, project expenditures equaled approximately $9.9 million.

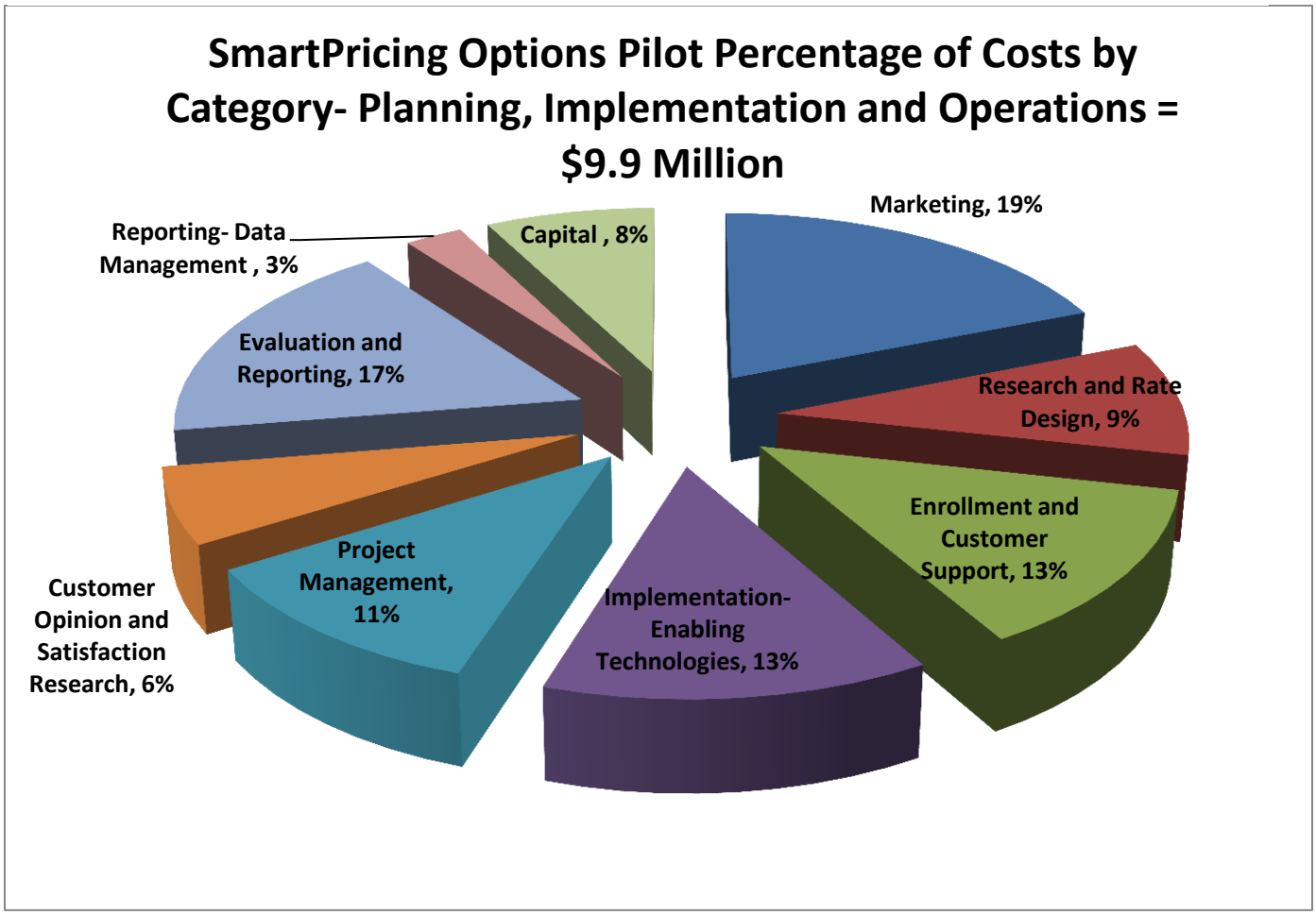
As depicted in Figure 2, the two largest costs were the implementation of IHDs and the marketing activities, followed closely by evaluation and reporting. This is an interesting

[4] All budget figures reflect allowable expenses allocated in accordance with guidelines dictated by the U.S Department of Energy. Figures presented in this report do not replace or supersede any reports provided to DOE and should be considered estimates.

point for rate implementation planning, since many of the costs associated with the evaluation and offer-specific communications may not be applicable in a standard program deployment, and it is common for the price of enabling technology to be reduced for customers by offering a rebate or incentive rather than giving the device to customers for free. While these allocated expenses were appropriate in the research study environment, they may not be applicable for actual program deployment.

The initial stages of the project were heavy in design, recruitment, technology and project management costs, some of which would not be applicable to a system-wide implementation since they concern research design, study set up, and DOE reporting. Also, the complexity of managing seven treatment groups and the redundant efforts required to support each task for each of the treatment groups would be eliminated if the program manager could market the offers without mutual exclusivity. Alternatively, much of the infrastructure that was developed to support time-variant rates and pilot oversight would be leveraged if a system-wide program rollout was deployed after the pilot period. For example, billing validation and bill presentment could be leveraged indefinitely, and project management tasks to oversee the pilot would be absorbed by program staff.

Figure 2: Actual Budget for SmartPricing Options, through May 2014



The following descriptions provide a summary of the expense types in each category and provide additional details.

MARKETING

The marketing costs for recruitment and retention through May 2014 totaled $1.9M, or 19% of the total project costs through the end of the study period. The pilot study design coupled with the diverse and comprehensive marketing effort required that the marketing team create seven versions of most marketing pieces, which was very labor intensive. The team worked with several local marketing firms to design materials that would resonate with customers and give them the tools that would help them be successful on the new pilot pricing plans.

The marketing total also includes a full time, dedicated marketing professional for 35 months during this period. Of note is the reduction in expenses for outside services

relative to the initial budget plan (total planned marketing budget was $2.8M). This reduction resulted from a change in strategy from our marketing team to exclude radio spots, billboard advertisements, and other mass marketing strategies for recruitment that were originally planned but not implemented.

A full description of the marketing plan and the components that make up these costs can be found in Section I, 7.0 Marketing, in the Interim Evaluation Report, and in Section 1, 4.0 of this Final Evaluation report.

Enrollment and Customer Support

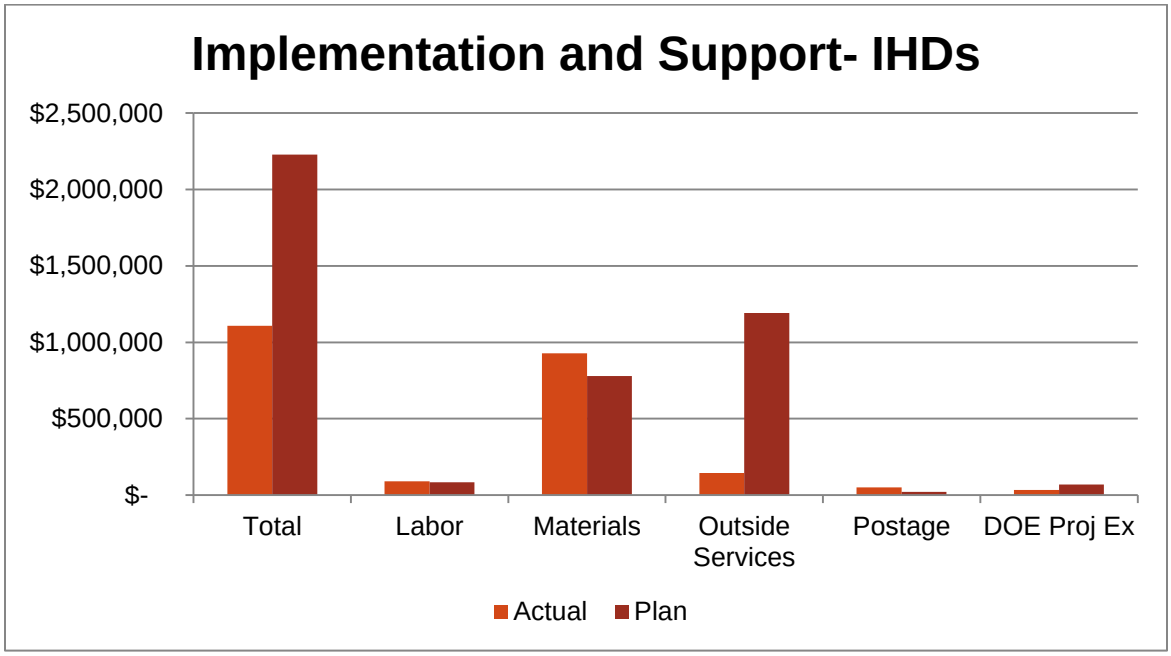
Enrollment and customer support costs for the pilot account for approximately 13% of the total costs for the duration of the pilot, for a total of $1.3M. These costs include tasks such as customer service, billing, enrollment, un-enrollment, support for the enabling technology, and deployment of customer notifications related to the daily operations of the pilot, such as reminder postcards to call with questions or informational notifications provided for billing clarification.

The original plan had estimated hours for customer support very conservatively. However, call volumes were much lower than the original estimate and customer support labor hours were about half of what was originally planned. In addition, we were able to achieve efficiencies in the enrollment process due to automation of several transactions for enrolling customers.

Implementation and support: In Home Displays

Figure 3 compares planned costs in the original budget to the actual expenditures for the implementation of IHDs through December 2014. Significant reduction in the expenses for outside services was due to providing internal technical support for IHDs rather than utilizing outside services for that role. After careful evaluation of the proposed support services provided from an external party, we decided to keep all support for the devices in house, which resulted in large costs savings for those services, since added labor costs were offset by efficiencies in other areas.

Figure 3: Implementation - IHD Costs



IMPLEMENTATION: PROJECT MANAGEMENT

Project management includes all tasks associated with keeping the project planned and implemented within scope, on schedule, and within budget. Many tasks that might otherwise be handled by a program manager in a program environment, such as running reports and validating mail lists, were also handled by the project manager, since no program manager was planned for this research project. The costs for these tasks were approximately $1.1M from the planning stages to the completion of the pilot. There were several team members billing to the project under project management based on the nature of their tasks. These tasks include development of requests for proposals for support services; development of schedules, scope, and budgets; review of all marketing materials; and data management for reporting and evaluation, among other tasks.

CUSTOMER OPINION AND SATISFACTION RESEARCH

Market research costs, totaling 6% of the total project budget, include research conducted prior to recruitment and customer opinion and satisfaction research performed before, during and after the pilot. This includes the portfolio of research projects presented in Section I, 6.0 Market Research, in the interim evaluation report and in Section 1, 4.0 of this report.

Evaluation and Reporting

When conducting a pilot, the costs of evaluating the results and answering the research questions are a major consideration when scoping the project. During the planning period, SMUD had considered both quantitative and qualitative research questions and looked at how to best plan for the expenditures throughout the pilot period. SMUD agreed to produce an interim evaluation report at the end of the first summer and a final evaluation report at the end of the second summer that looked at results from across both summers that the rates were on effect. In order to accommodate these costs across multiple years, several different budgets were established for each of the broad research areas under the pilot. The interim and final evaluations were grouped together with reporting metrics and data, and the funding was budgeted across three years, 2012 through 2014, in the Evaluation and Reporting category.

The total expenditures for the evaluation and reporting category were17% of the total budget across the three year study period and were primarily spent on outside services for consulting work completed to evaluate the pricing pilot. The detailed final evaluation report is included in Section two of this report and the interim evaluation report can be found at:
https://www.smartgrid.gov/sites/default/files/MASTER_SMUD%20CBS%20Interim%20Evaluation_Final_SUBMITTED%20TO%20TAG%2020131023.pdf.

Reporting: Data Management

Although data management is not a large part of the overall budget, it is an important task operationally and strategically. Data management and reporting accounted for 3% of the total budget. The majority of these costs included data analytics and statistical software (SAS) and labor expenses.

Capital

Capital expenses include those costs required to upgrade system infrastructure to support time based rates through the Customer Information System (SAP), Meter Data Management systems, and the HAN Communication Manager. These expenditures accounted for approximately 8% of the costs through May 2014.

3.2.2 Schedule

The SmartPricing Options project schedule was developed to accommodate implementation of a large study that included the integration of smart grid technology. The outside boundaries of the schedule were dictated by the two-year study period allowed by DOE and the start date of the grant award. DOE reportable milestones and deliverables are noted in Table 2. Customer recruitment began in late October 2011 and customers were placed on the new pricing plans on June 1, 2012.

Table 2 represents the milestone schedule covering some of the primary activities associated with the SmartPricing Options pilot.

Table 1: SmartPricing Options Schedule of Milestones

Milestone	Completion Date
White Paper summary submitted to TAG	08/09/2010
Rate Development	12/31/2010
Final Plan Submitted to DOE	03/30/2011
SMUD Board Rate Approval	03/31/2011
Development of Marketing and Educational Materials	08/01/2011
Sample Selection	09/20/2011
Begin Recruiting	10/24/2011
Select IHD	12/31/2011
Deliver IHDs	05/01/2012
New Rates In Effect	06/01/2012
Interim Evaluation	09/01/2013
Market Research – Conjoint Study	12/31/2013
Residential Attributes and Consumer Behavior Survey	10/31/2013
Market Research – End of Pilot Satisfaction Survey	1/31/2014
Final Evaluation	06/30/2014

3.3 Quality Assurance

The project manager and business unit leads created a detailed task-level schedule for the SPO using Microsoft Project. The project schedule included over 1,360 tasks with start and finish dates for each. Because the project team included representatives from each of the Customer business units and a number of middle/back office business units, the schedule was critical for the project team to stay on task and recover through delays and surprises that are inevitable in any project. During core team meetings, team members stepped through the project schedule so that each individual was accountable

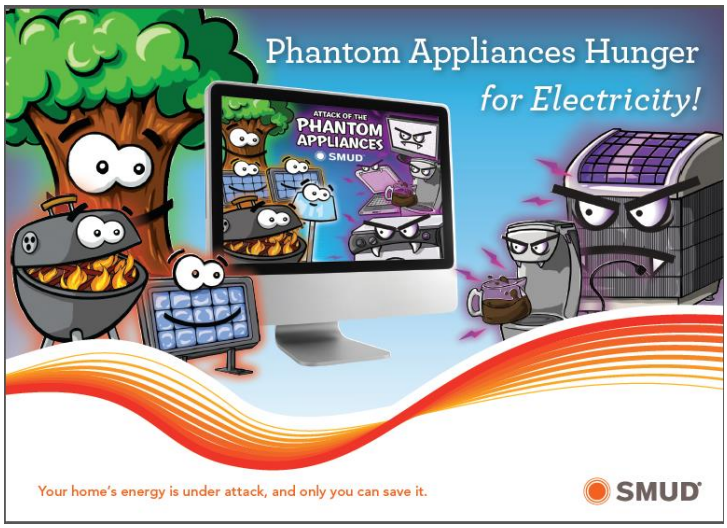
for their assigned tasks. In this way, the team identified any issues or delays and worked collaboratively to find solutions to overcome them. The project schedule was stored as a protected document on SharePoint so that all team members could view it, and it was distributed to the team each month after it was updated.

In addition to regularly managing the schedule at the team level, monthly reporting to the SmartSacramento Project Management Office was required to sync up DOE milestones from the SmartPricing Options schedule with the entire SmartSacramento schedule that is used to report to DOE. This multilevel reporting process was more work than the standard approach, but it was a valuable process in terms of accountability and forecasting due to the number of reviewers included in the process and the need to seamlessly synchronize multiple tools.

3.4 Lessons Learned and Key Takeaways

The SmartPricing Options pilot was a huge undertaking for the team to implement and manage on a very tight timeline. Managing the tasks of more than 140 contributors over the course of several years requires strict schedule oversight. It is not uncommon for project schedules to be less detailed than the schedule used for this project, but having a highly detailed schedule with a corresponding line item in the budget using the same naming conventions was extremely useful in managing tasks, budget, and resources. Using a dynamic project management scheduling software (MS Project) and budget reporting system (SAP) provided access to information that allowed for schedule and budget recovery, variance explanation, sound forecasting and on-time and under-budget delivery.

4.0 Marketing and Market Research



4.1 Overview

SMUD worked diligently to engage customers through a variety of channels and to maintain communications with pilot participants. This dedication to the customer experience not only paid off in terms of very low attrition from the pilot, but also helped customers understand pilot goals and maintain load reductions across both summers.

4.2 Details

SMUD's marketing strategy included education and retention components and leveraged multiple channels of communication with customers. The campaigns focused on four specific messages highlighting the benefits of participating in a SmartPricing Options pricing plan.

1. Get a discount on your electricity during off-peak hours;
2. Take control of your summer electricity costs;
3. Manage your energy use; and
4. Contribute to a cleaner environment.

Materials and messaging were developed based on findings from market research efforts that continued throughout the planning and implementation periods. The focus group research indicated that customers preferred images and content that were local and reflected real-life, residential activities. The marketing strategy included several dedicated photo shoots to capture the intention and feeling of SmartPricing Options. The resulting photographs, (example below), showed local families engaging in summertime activities, including family barbeques, children playing in sprinklers, and families relaxing outside. The photos also demonstrated energy-saving actions such as installing weather stripping, CFLs and using smart strips.

French's

Table 2 summarizes the communication channel schedule, including a summary of the target audience and objectives for each channel. SMUD's marketing team was aware that some channels were likely to be more effective than others; however, the team felt that it was important to optimize communications by providing access to information through a variety of channels spanning customers' personal preferences.

The mass media campaign, "Little Things, Big Potential", was conducted in the summer of 2011 and focused on increasing general awareness of energy usage, saving energy, and reducing peak load. This larger campaign allowed SMUD to test the language and images that would be used for SmartPricing Options, but also reinforced the SmartSacramento initiative to the entire SMUD population. Mass marketing for "Little Things, Big Potential" was discontinued after recruitment for the pilot began, largely because mass marketing can not be used in a RCT and RED quasi-experimental designs, since you are offering the rate plan to only a sample of the population. By discontinuing the campaign, we focused on targeted marketing for SPO to only the sample of study participants.

Table 2: Schedule of Marketing Activities by Channel

Channel	Start Date	End Date	Target Audience	Objectives
Mass Media	Jun-11	Sep-11	All residential customers	Education
Direct Mail	Oct-11	Oct-14	All eligible customers	Recruitment, Education, Retention
Email[5]	Mar-12	Oct-14	Opt-in and Default customers	Education, Retention
Outbound Calling	Apr-12	May-12	Eligible opt-in customers	Recruitment
Door Hangers	Mar-12	Apr-12	Eligible opt-in customers	Recruitment
Microsites	Oct-12	Oct-14	All eligible customers	Education, Retention
Facebook Groups	Jul-12	Oct-14	All enrolled participants	Education, Retention
Pinterest	Jul-12	Oct-14	All enrolled participants	Education, Retention
YouTube	Jul-12	Oct-14	All enrolled participants	Education, Retention

In preparing for the second summer of the pilot, SMUD's marketing team utilized information that was collected through customer feedback and surveys in developing ongoing communication materials. Although some of the customer feedback requests were items that we could not provide due to the research design constraints, such as rate comparison tools and shadow billing, we were able to provide customers with general feedback. We included average savings for SPO customers and total kWh reductions for all participants in correspondence with the customers. From customer feedback, we learned that customers wanted to know what the collective energy savings from all participants amount to in kWh and carbon offset equivalents. Customers valued information about how they were impacting the community as a whole.

Since the SmartPricing Options pilot participants only face time-based rates in the summer months, (June through September), there was a 6 month hiatus from SMUD communications regarding the pilot. In late April 2013, SmartPricing Options pilot participants were sent a reminder letter, stating that the pricing plans would go into effect again starting in a few short weeks. As a result of this letter, we had approximately 100 customers call in to de-enroll for the second summer. Drop outs had been lower up to that point and the initial up-tick in response to the letter was a concern. In retrospect, SMUD probably should have not sent the letter and only sent the "Welcome Back Kit", which provided more incentive for customers to stay in the pilot.

[5] Only enrolled customers with an email address on file received email communication. Email messages were consistent with the direct mail messages. The email notifications did not replace direct mail, rather they were sent in addition to direct mail.

For the second summer, the marketing team prepared a “Welcome Back Kit”, which closely resembled the “Welcome Kit” distributed prior to the first summer of the pilot. The kit included magnets, recipe cards, energy saving tips, information about the pricing plan, and a discount card to local restaurants and venues. The purpose of the kit was to provide engaging materials for pilot participants and to remind them that the pilot was continuing for the 2013 summer. Since marketing and communications were limited during the winter and spring months, the marketing team created a folder of marketing materials that would stand out from other mail and encourage customers to open the envelope and read the materials. The same concept was used the year before, with success; customers reported remembering receiving the welcome kits at a higher rate than any other marketing materials that were sent through direct mail.

For the second summer, the contents of the “Welcome Back Kit” were modified to encourage retention and increase customers’ understanding of the pilot objectives. Customers were reminded about the pilot objectives - “SMUD is offering these time based pricing programs to reduce peak demand hot summer hours. SMUD is hoping to learn how customers use energy when on time based rates and how it impacts peak demand and energy use. During last summer, with your help, we reduced peak demand by 4 MW and reduced electricity use by 476 MWh.”

4.3 Additional retention activities

For the SmartPricing Options pilot, SMUD’s marketing team created the most robust retention campaign that SMUD has deployed to date. The retention campaign focused on engaging customers through various channels, including social networks, online games, infographics, email, direct mail, you-tube videos, and dedicated websites loaded with information and interactive graphics on energy use.

An example of the retention campaign is highlighted in SMUD’s online game, Attack of the Phantom Appliances, which is available at http://phantomappliances.com/

The tower defense game is peppered with quizzes that test the customer's knowledge on what it costs to operate electric appliances. The game is packed with energy saving information and energy saving heroes, such as Watson the floor lamp, who slings CFL bulbs to stop the phantom appliances as they approach your home and kitchen. If you do not place enough energy saving devices in the path of the phantom appliances, your home is overrun and you must restart the game.

SMUD created plan specific microsites that served as an auxiliary website with independent links and address that was accessed mainly from a SMUD.org, or by directly typing the URL into a web browser. Microsites were provided for each treatment group to encourage participants to stay engaged and learn strategies to help reduce peak period usage. At the beginning of the summer of 2013, SMUD launched a sweepstakes for SPO customers to win a new grill. This effort helped drive customers to the websites to register for the sweepstakes and also provided educational information. Each microsite, a total of seven (see links below), has pricing plan specific information, but all sites are identical in content, (e.g. cost to run charts are available on all microsites, although the prices vary by treatment plan.)

Opt-In Treatment Group Sites

- Summer Weekday Value Plan w/ technology: https://www.smud.org/smartvalue
- Summer Weekday Value Plan w/o technology: https://www.smud.org/valuepricing
- Off-Peak Discount Plan w/technology: https://www.smud.org/smartdiscount
- Off-Peak Discount Plan w/o technology: https://www.smud.org/discountpricing

Default Treatment Group Sites

- Summer Weekday Value Plan w/technology: https://www.smud.org/valueoption
- Off-Peak Discount Plan w/technology: https://www.smud.org/discountoption
- Optimum Off-Peak Plan: https://www.smud.org/optimumoption

The microsites were a platform where customers could access several other social networking sites, including Facebook, Pinterest, and YouTube. SMUD created a number of videos that were published on YouTube and focused on cooking tips during peak hours. This complimented the recipe cards that were included in the Welcome Back Kit, that provided easy and energy efficient recipes for customers to create during peak hours. The SMUD team focused on ways to make behavioral changes convenient and on providing actionable marketing materials that resonated with customers. The Pinterest page focused on activities, pet care, recipes, fun facts, and safety tips. The links below can be used to access this content.

Peak Hour Kitchen Tips:
http://www.youtube.com/watch?v=NznL9JhD6Bs&list=PL9C25A4626E0E7668&index=4

Pinterest: http://www.pinterest.com/smartpricing/

The numerous platforms that SMUD utilized to reach out and engage customers helped improve understanding of the pricing plans and the program goals of reducing peak usage. By utilizing a multifaceted campaign that employed everything from direct mail to social networks, SMUD successfully engaged customers to reduce peak demand throughout the two year pilot. As SMUD continues to roll this program out to new customers in 2014, while successfully retaining pilot participants, the marketing team will continue to use this multifaceted approach.

4.4 Market Research

The project team understood the importance of market research of customer choice and satisfaction and conducted numerous surveys over the pilot period to better understand customer preferences and satisfaction. As mentioned previously, the objectives of the pilot included understanding the customer characteristics associated with behavior, program impacts on customer satisfaction, effective educational and marketing strategies for customers, and the role of enabling technology in customers daily electricity management. As such, SMUD partnered with Nexant to conduct the End of pilot survey and a Conjoint Survey that focused on dynamic pricing. The results from those research efforts are discussed in detail in Sections 9 and 11 of the Nexant report.

5.0 Pilot Operations and Customer Support

5.1 Overview

By the end of the first summer of the pilot, SMUD staff had gained a tremendous amount of operational knowledge and useful insights about pilot operations. This knowledge and insight were applied in the second year of operations to make improvements to conservation day (CPP event) execution and support for customers with In-home displays. The focus of this section will be on the operational improvements made to the pilot in the second summer.

5.2 Details

Conservation Day Execution (CPP Events)

One of the most challenging components of operations was notifying customers about CPP event days (referred to as Conservation Days). The notification options available to participants included email, phone call, and text messaging. SMUD continued to work with a third party vendor on the messaging campaigns for the second summer and designed a new business process and Core team to facilitate the implementation of the Conservation Days. At the beginning of the second summer, SMUD implemented several new demand response pilots to its portfolio and they all leveraged the same processes as the SPO pilot. Events across the pilots used the same "conservation days" and leveraged the same messaging vendor and settlement processes for all residential participants. This increase in volume of customers as well as the complexity of the different pilots made it critical for SMUD to make changes to the operations team responsible for the successful dispatch of these events.

Staff created a conservation day core team from across various departments that would be responsible 7 days a week for the conservation day efforts. This team was required to be available each morning throughout the summer months to execute conservation days if necessary. Each pilot project manager was responsible for messaging to their pilot's participants 24 hours prior to events and for same day execution of price messaging and temperature offsets to enabling technology in customer's homes. In addition, the Conservation Day Core team included individuals from Information technology that were tasked with monitoring the progress of messages and signals across SMUD's systems and at vendor platforms. This allowed IT staff to step in at anytime the systems were not executing properly.

The entire Core team held webinars with shared computer monitors for several hours during each event to ensure that all steps were properly executed and that systems were handling the dispatch. This differed from the first summer when there was no formal Core team and events were executed by one individual and tested for accuracy after the dispatch had occurred.

This new Core team ensured that quality assurance was happening during the dispatch and all processes had a set of eyes watching to ensure accuracy. The SMUD IT staff had direct contact with vendors in the event that messages were not properly deployed by vendor systems, which did occur during the second summer on a Sunday afternoon. Because of this new team structure, the IT team contacted the vendor and ensured that the messages were dispatched within minutes, thus avoiding another messaging mishap, like one that had occurred during the first summer. This new Core team process, although resource intensive, ultimately resulted in a successful second summer of CPP messaging to all customers.

Supporting the In-home Displays

SMUD continued to provide comprehensive support for In-home displays, (IHDs) and formalized a group in Customer Operations that was in charge of inventory, troubleshooting, and device provisioning for the IHDs. This group worked as tier 2 support, with SMUD's CSRs serving as tier 1 support. SMUD recognized the importance of having a dedicated Home Area Network (HAN) group in operations that could manage the support of HAN devices over the long term. HAN devices and enabling technology are viewed as a permanent item in SMUD's portfolio of energy information tools that will continue to become more popular.

A reminder postcard was sent to SPO participants that had elected to receive an IHD from SMUD during enrollment in the first year of the pilot. The postcard reminded customers to use the IHD again in the second summer to discover energy saving opportunities and patterns. Although SMUD had experienced a significant connectivity drop-off of devices during the winter months, the off season for the pilot, we had hoped that a reminder postcard would encourage customers to reactivate their devices for the second summer. In fact, a significant increase was observed in the number of devices that connected to the HAN network following the delivery of the postcard and the "Welcome Back Kit".

After the first year of supporting IHDs, the second year was relatively quiet. The majority of connectivity issues were addressed in the first summer. However, only 30% of the customers with IHDs actually had the devices connected to the network, during the second summer, or approximately 1,200 devices. Most of the issues that our

support team addressed concerned replacing the rechargeable battery in the devices and re-activating the HAN radio in the meter.

It is interesting to note that there is a population of SPO participants that have maintained connectivity of their IHD for the duration of three years now, year round, and we have named them “super users.” These folks account for approximately 12% of all the IHD users.

5.3 Lessons Learned

SMUD has learned that messaging for CPP events is much more complex and requires more resources than was originally planned. A core team was created for implementing CPP events that had multi-departmental representation tasked with ensuring operational success. The accuracy of messaging is critical since it involves direct contact with customers and involves a call to action. In the first summer, there were instances of the wrong date being included in messages and wrong event numbers, all of which caused customer confusion and resulted in increased call volumes to the contact center. By ensuring that staff resources were available at every step of the execution, SMUD was able to improve the customer notification process.

Additional lessons include:

- ✓ Messaging for CPP events is complex and requires adequate staff resources to deal with quality control
- ✓ Customers were interested not only in their own savings, but also in how much everyone in the group saved (e.g., they care about the social benefits of the program)
- ✓ SMUD used pricing plan specific recruitment marketing materials, rather than mass marketing materials. This cost less, and also resulted in higher than expected enrollment rates.

SMUD SmartPricing Options Pilot Evaluation

Submitted to Sacramento Municipal Utility
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Table of Contents

1 Executive Summary 1

1.1 Customer Acceptance and Attrition 1

1.2 Load Impacts 3

1.3 The Influence of IHDs 5

1.4 The Impact of Rate Attributes on Customer Acceptance 7

1.5 Cost Effectiveness Analysis 7

1.6 End-of-Pilot Survey Summary 9

2 Introduction and Pilot Overview 10

2.1 Pricing Plans 11

2.2 Marketing and Recruitment Strategies 12

2.3 In Home Displays 16

2.4 Web Portal Information 17

2.5 Terminology 18

2.6 Report Organization 20

3 Analytical Methodology for Load Impact Estimation 21

3.1 General Approach 21

3.2 Analysis of RCT and RED Treatment Groups 27

3.2.1 Opt-in TOU With and Without IHD Offer (RCT) 27

3.2.2 Default TOU Plus IHD Offer and TOU-CPP Plus IHD (RED) 29

3.2.3 Opt-in CPP, Default CPP and Default TOU-CPP (RED) 30

3.3 Standard Errors 30

4 TOU Pricing Plan Impacts 32

4.1 Peak Period Load Reductions by Pricing Plan 32

4.2 Impact Persistence 34

4.3 Load Impacts by Month 35

4.4 Load Impacts by Customer Type 36

4.5 Load Impacts Outside the Peak Period 38

4.6 Energy Savings 39

5 CPP Pricing Plan Impacts 40

5.1 Peak Period Load Reductions 40

5.2 Impact Persistence 45

5.3 Load Impacts by Customer Type 45

5.4 Load Impacts Outside the Peak Period 47
5.5 Overall Energy Savings 48
5.6 TOU Impacts on CPP Event Days 49
6 The Influence of In Home Displays 51
6.1 IHD Acceptance and Use 51
6.2 Customer Characteristics of IHD Users 53
6.3 Load Impacts for Treatments With and Without an IHD Offer 56
7 Price Elasticity Estimation 65
7.1 Analysis Methodology 65
7.2 Price Elasticity Estimates 67
7.3 Simulating the Impact of Changes in Prices 70
8 Program Marketing, Customer Acceptance and Retention 72
8.1 Opt-in Pricing Plans 73
8.1.1 Customer Acceptance of Opt-in Pricing Plans 74
8.1.2 Choice Analysis 75
8.1.3 Customer Retention and Attrition for Opt-in Pricing Plans 78
8.1.4 Modeling Opt-Out Decisions for Opt-in Pricing Plans 80
8.2 Default Treatments 83
8.2.1 Customer Acceptance of Default Pricing Plans 83
8.2.2 Customer Retention and Attrition for Default Pricing Plans 84
8.2.3 Modeling Opt-Out Decisions for Default Pricing Plans 85
9 Analysis of the Impact of Changes in Rate Characteristics on Customer Acceptance 89
9.1 Survey Instrument Design 91
9.2 Survey Analysis and Model Estimation 93
9.3 Predicted Enrollment Likelihoods 97
10 Cost Effectiveness Analysis 105
10.1 Cost Effectiveness Framework 106
10.2 Overview of Input Values 111
10.3 Cost-Effectiveness Estimates and Sensitivity Analysis 113
11 End of Pilot Survey 119
11.1 Customer Satisfaction with SMUD Services 122
11.2 Customer Satisfaction with and Perceptions of Pricing Plans 122
11.3 Reported Behavioral Changes 127
11.4 Reasons for Staying on the Pricing Plan 130

11.5 In Home Displays 132
Appendix A Glossary of Terms for SPO Study Design 134
Appendix B Hourly Load Impacts by Month for TOU Pricing Plans 137
Appendix C Hourly Load Impacts for Each Event for CPP Pricing Plans 139
Appendix D Customer Behavior and Characteristics for Study Populations in the Conjoint Survey ... 143
Appendix E Steps for Developing Choice Dataset for the Conjoint Survey 156
Appendix F End of Pilot Survey Questionnaire 157
Appendix G End of Pilot Survey Results 173

1 Executive Summary

This report documents the final evaluation results for Sacramento Municipal Utility District's (SMUD) SmartPricing Options (SPO) pilot. SPO is a multi-year pricing pilot that tested three time-variant pricing plans (e.g., time-of-use, critical peak pricing and the combination of the two) and two different recruitment strategies (opt-in and default). To our knowledge, this is the first pilot in the industry that compared enrollment and load impacts on a side-by-side basis for identical customer segments based on both opt-in and default recruitment. The SPO also tested the impact of the offer of an in-home display (IHD) on customer enrollment for opt-in recruitment. The pilot research design involved both randomized control trials (recruit and delay) and randomized encouragement designs.

Opt-in recruitment began in October 2011 and marketing continued until June 1, 2012, when the new pricing plans went into effect. Default treatment groups were notified in early April 2012 that they would be placed on a new, time-variant pricing plan by June 1 unless they contacted SMUD indicating that they did not wish to be placed on the new plan. Time-variant rates were effective from June 1 through September 30 for the summers of 2012 and 2013. In between the two summers, customers reverted to their otherwise applicable SMUD tariff.

In addition to analyzing customer enrollment and load impacts, this report summarizes the results from two surveys. A conjoint survey was conducted to examine the likely impact of changes in rate attributes (e.g., price ratios, the number of rate periods, the number of event days for CPP pricing plans, etc.) on customer enrollment for opt-in pricing plans. An end-of-pilot survey was conducted to assess customer satisfaction, awareness of the attributes of each pricing plan, customer perceptions, reasons that customers stayed on the new pricing plans, IHD use and other topics of interest. The cost-effectiveness of various pricing plans under the assumption that SMUD would offer the plan to the entire residential population is also reported.

1.1 Customer Acceptance and Attrition

Customer acceptance rates for opt-in pricing plans were high by industry standards and much higher than expected for default plans, and opt-out rates were low for all plans. Table 1-1 shows the number of offers made to customers for each pricing plan, the number of customers who accepted each offer and enrollment at various points during the two year pilot. Figures 1-1 and 1-2 show the acceptance and attrition rates for each pricing plan.

As seen in Figure 1-1, acceptance rates across the four opt-in treatment groups were between 16% and 19%, which is quite high when compared with most other utility rate programs and pilots (especially considering that all recruitment was done over roughly an 8 month period, not over multiple years). Differences in acceptance rates across the four pricing plans are small. The offer of an IHD has no apparent influence on acceptance rates for CPP plans and only a slight impact for TOU plans.[1] Acceptance rates for CPP plans are slightly higher than for TOU plans and the difference for the CPP and TOU plans that did not include the offer of an IHD was statistically significant at the 95% confidence

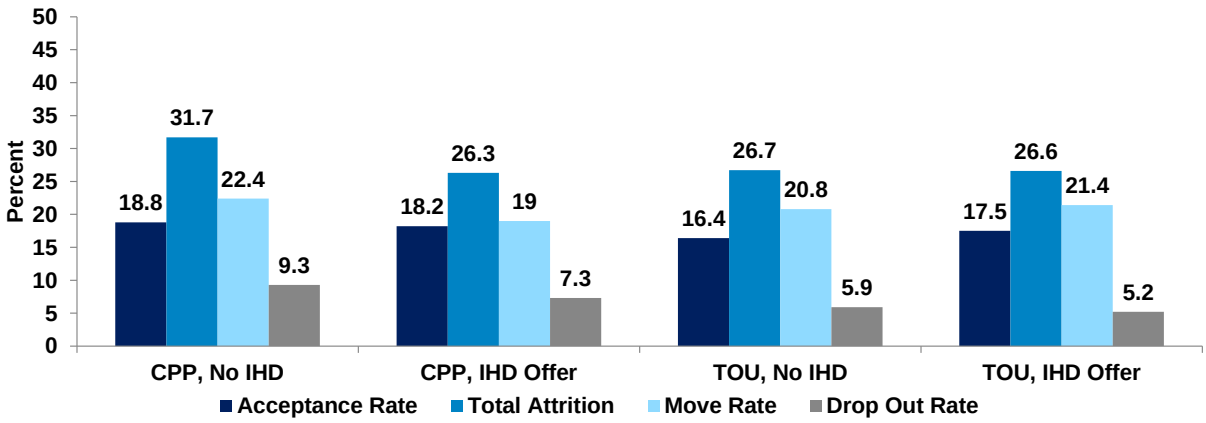
[1] The difference in acceptance rates between the TOU plan with and without the IHD offer is statistically significant at the 95% confidence level. However, when choice models were estimated that included other explanatory variables, the offer of an IHD was not statistically significant.

level. However, customers were not given a choice of multiple time-variant pricing plans, so this difference should not be interpreted as a preference for one plan over the other. Indeed, the conjoint survey that was done included choice exercises where both pricing plans were offered simultaneously. Results from this survey show that, when given a choice of both plans, customers prefer TOU to CPP by a factor of roughly 2 to 1.

Table 1-1: Offers Made and Customers Enrolled by Pricing Plan

Recruitment Approach	Rate	IHD Offer	# of Offers Made	# of Customers Accepting	# of Customers Enrolled on Date		
					6/1/12	6/1/13	9/30/13
Opt-in	CPP	No	1,187	223	212	161	147
		Yes	9,060	1,651	1,569	1,265	1,172
	TOU	No	7,500	1,229	1,157	941	877
		Yes	12,554	2,199	2,092	1,664	1,554
Default	CPP	Yes	846	701	701	566	536
	TOU	Yes	2,410	208	2,018	1,628	1,508
	TOU-CPP	Yes	729	588	588	465	431

Figure 1-1: Customer Acceptance and Attrition for Opt-in Pricing Plans

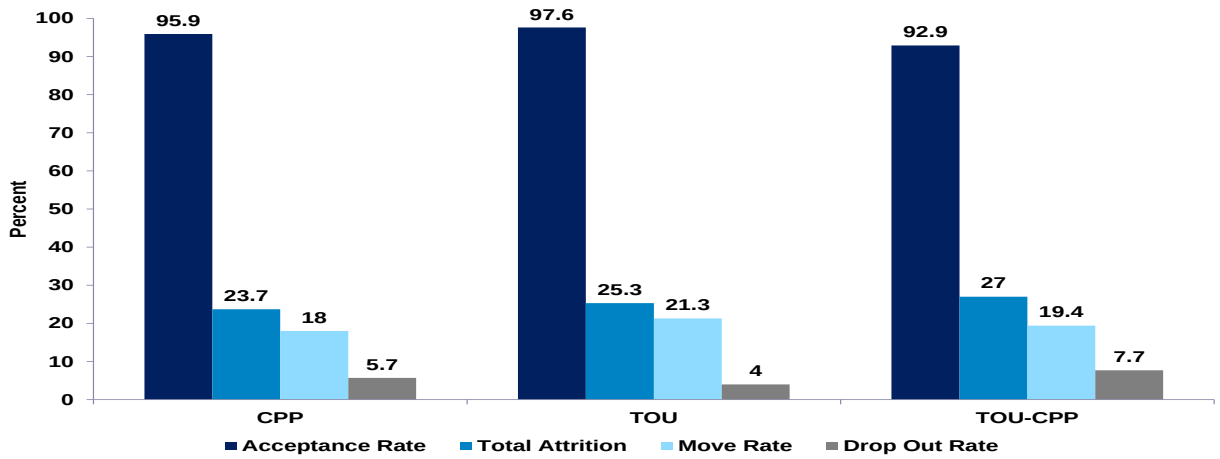


The attrition, move rates and dropout rates shown in the figure cover the period from June 1, 2012 to September 30, 2013. Total attrition ranged from roughly 21% to 27%. However, the majority of this attrition was due to customers moving. Dropout rates represent the percent of customers who actively de-enrolled over the two summers and range from a low of 5.2% for the TOU plan that included an IHD offer to a high of 9.3% for the CPP plan with no IHD offer.

Figure 1-2 summarizes the acceptance and attrition rates for the default pricing plans. The acceptance rate equals the percent of customers who were notified that they would be placed on the new pricing plan and who did not notify SMUD that they wished to opt-out prior to being placed on the plan. As

seen, only roughly 3% to 7% of customers chose not to go on the new pricing plan. This acceptance rate was much higher than the 50% rate that SMUD had planned for. Over the next two summers, an additional 4% to 8% of enrolled customers dropped out, and between 18% and 22% moved. The dropout rates for opt-in plans were actually higher than for the default plans. This likely reflects a lower level of awareness and engagement by default customers compared with opt-in customers, as evidenced by findings from the end-of-pilot survey reported later.

Figure 1-2: Customer Acceptance and Attrition for Default Pricing Plans



Choice models were estimated to determine whether opt-in and opt-out rates were correlated with customer characteristics. The primary variables examined were participation in other SMUD programs, the magnitude of the reduction in customers' bills from going on the rate without changing usage (e.g., the magnitude of the "structural win" from going on the rate) and participation in SMUD's low income tariff, known as the Energy Assistance Program Rate (EAPR). In general, opt-in rates were higher and dropout rates were lower for EAPR customers, structural winners and customers enrolled in other SMUD programs for most pricing plans.

1.2 Load Impacts

Table 1-2 summarizes the average peak-period load reductions across the two summers for each pricing plan. The first three numerical columns show the impacts averaged across the 23 days on which critical peak prices were in effect. Values for CPP days are shown for both CPP and TOU pricing plans so that an apples-to-apples comparison can be made for those two rate options under the same set of weather conditions. The last three columns in the table show the peak period load reductions across the average weekday for both summers for the TOU pricing plans. These values include impacts on days when events were and were not called for the CPP pricing plans.

Table 1-2: Peak Period Load Reductions for All Pricing Plans

Group	CPP Day Impacts			Average Weekday Impacts		
	Impact	Reference Load	% Impact	Impact	Reference Load	% Impact
Opt in TOU, IHD Offer	0.32	2.38	13.3%	0.21	1.79	11.9%
Opt in TOU, No IHD Offer	0.23	2.24	10.1%	0.16	1.72	9.4%
Opt-in CPP, IHD Offer	0.64	2.53	25.1%	n/a	n/a	n/a
Opt-in CPP, No IHD Offer	0.49	2.33	20.9%	n/a	n/a	n/a
Default TOU, IHD Offer	0.15	2.47	5.9%	0.11	1.86	5.8%
Default CPP, IHD Offer	0.36	2.56	14.0%	n/a	n/a	n/a
Default TOU-CPP, IHD Offer	0.31	2.54	12.3%	0.17	1.91	8.7%

A key conclusion is that the absolute and percent impacts per customer are roughly half as large for default plans compared with the same opt-in pricing plans. Another key conclusion is that, under CPP event-day weather conditions, average load reductions for CPP pricing plans are roughly twice as large as for TOU pricing plans. Importantly, the fact that average impacts are roughly half as much under default plans compared with opt-in plans does not mean that aggregate impacts would be smaller under default plans. Indeed, quite the opposite is true. When the differential enrollment rates are factored into the equation, default plans offered to the same population of customers as opt-in plans are likely to produce much higher aggregate load reductions. For example, the aggregate load reduction in the initial summer of an opt-in CPP pricing plan that included the offer of an IHD would equal 11.6 MW if offered to 100,000 customers.[2] The same plan offered on a default basis would produce 34.5 MW of load reduction, nearly three times more than for the opt-in plan. Similarly, if the TOU plan with an IHD offer was marketed to 100,000 customers on an opt-in basis, the load reduction on the average weekday would be 3.7 MW (and 14.7 MW on the average CPP day). When offered on a default basis, the estimated load reduction is 10.8 MW, once again roughly three times as large as for the opt-in plan.

Other key findings from the load impact analysis include the following:

- For 6 of the 8 pricing plans, average load reductions per customer were not statistically significantly different across the two summers – that is, load impacts persisted over two years – after controlling for movers. For the opt-in TOU plan with the IHD offer, impacts fell from 0.26 kW in the first summer to 0.20 kW in the second and this difference was statistically significant. For the default CPP pricing plan, impacts increased from 0.31 kW to 0.42 kW, and this difference was statistically significant.
- For default TOU pricing plans, EAPR and non-EAPR customers produced very similar absolute and percent reductions. For default CPP and for all opt-in pricing plans, average load reductions for EAPR customers were less than for non-EAPR customers.
- Absolute load reductions increase by as much as a factor of 10 across customers segmented into quartiles based on summer usage. This suggests that any opt-in program will likely be much more cost-effective if focuses its marketing resources primarily on large users.

[2] 11.6 MW = (100,000x.18.2x.64kW)/1,000

- Energy savings were small or statistically insignificant for all pricing plans. Three pricing plans showed statistically significant energy savings across the summer. Savings for the default TOU plan equaled 1.3%, for the opt-in CPP plan (with IHD offer) savings equaled 3.5% and for the default CPP plan, savings equaled 2.6%.
- A structural economic model of demand was estimated so that load impacts could be predicted for prices other than those tested in the SPO. The estimated price elasticities were comparable to those found through other pricing pilots, including California's Statewide Pricing Pilot.[3] Based on the estimated demand model, increasing critical peak prices by roughly 60% over SPO price levels (from $0.75/kWh to $1.20/kWh) would increase the percent load reduction during the peak period by roughly 20% for both opt-in and default CPP pricing plans. For TOU pricing plans, a 55% increase in peak period prices, all other things equal, would increase the percent load reduction by 30 to 40%.

1.3 The Influence of IHDs

The SPO was designed to assess the impact of the offer of an IHD on customer acceptance of opt-in pricing plans. As discussed above, the offer of an IHD did not have a material impact on acceptance rates.

Another useful investigation concerns the acceptance of and connection rates for IHDs among treatment groups that received an IHD offer. What percent of customers who received an IHD offer accepted it and what percent of those customers receiving an IHD connected the device with their meter?

Two of the opt-in treatment groups were offered a free IHD if they enrolled on the rate. Acceptance of the IHD was not a condition of going on the pricing plan. Opt-in customers could indicate at the time of enrollment whether or not they wanted an IHD. If they did, the IHD was mailed to them pre-commissioned, so that when they unpacked it and turned it on, it was supposed to automatically connect with their meter and start displaying information. All customers in the default treatment groups were offered a free IHD. Because customers were automatically enrolled unless they opted-out, there was not the same opportunity to simply "check a box" at the time of enrollment to indicate whether or not they wanted an IHD. Instead, those who wanted an IHD had to take a proactive step to request it

In summer 2012, SMUD was able to determine from the meter data management system the number of IHD devices that were connected to meters at any point in time but was not able to link those devices to individual customer accounts. However, in summer 2013, data became available that provided a daily log for each customer indicating whether or not their IHD was connected to the customer's meter.[4] As such, for the second year of the pilot, it was possible to identify customers who had their IHDs

[3] Stephen S. George and Ahmad Faruqui, *Impact Evaluation of California's Statewide Pricing Pilot*. Final Report, March 16, 2005.

[4] Reporting functionality from the HAN Communication Manager (HCM) had not been established prior to the launch of the technology and took approximately a year after go-live to established automated reporting out of HCM. However, it should be noted that the functionality was available in HCM, but SMUD had not created business requirements to set-up that functionality before the program launch, primarily because reporting on IHD connectivity had not been part of the critical path for program launch or reporting to the DOE.

connected during the entire summer, those who never had it connected during summer 2013, and those who were connected on some days and not others.

For each treatment group, Table 1-3 shows the number of customers who requested an IHD at the beginning of the pilot, the IHD acceptance rate (the number accepting divided by the number offered), the number of customers who accepted the IHD that were still enrolled at the beginning of the summer period in 2013 and, of those, the percent that had their device connected with their meter during the entire summer, the percent that were connected at some point in time during summer 2013 and the percent that were never connected in 2013. As seen in the table, roughly 96% of opt-in customers requested an IHD whereas fewer than 25% of default customers did so.

Table 1-3: IHD Acceptance and Connection Rates

Group	Enrolled 6/1/12	# That Accept IHD	Acceptance Rate	# of Customers With IHDs Still Enrolled as of 6/1/13	% Connected All the Time	% Connected Some of the Time	% Never Connected
Opt-in CPP, IHD Offer	1,569	1,498	95%	1,195	11.6%	27.4%	61.0%
Opt-in TOU, IHD Offer	2,092	2,017	96%	1,597	11.6%	22.8%	65.6%
Default TOU-CPP, IHD Offer	588	136	23%	112	18.8%	39.3%	42.0%
Default CPP, IHD Offer	701	167	24%	140	14.3%	42.9%	42.9%
Default TOU, IHD Offer	2,018	418	21%	363	18.2%	23.1%	58.7%

As seen in the last three columns in the table, roughly two thirds of opt-in customers who accepted the IHD and who were still enrolled at the beginning of the 2013 summer never had their device connected in 2013. This “never connected rate” was much lower for two of the three default groups, equal to roughly 42% for the default TOU-CPP and CPP groups. The higher connection rate for default customers compared with opt-in customers is consistent with a hypothesis that, since default customers had to take a proactive step to request the device compared with the passive “check the box” approach for opt-in customers, they were more invested in using the device once it arrived. Why the “never connected rate” for default TOU customers is closer to that of opt-in customers than it is to that of the other default groups is unclear.

The SPO was not designed to assess the impact of an IHD on demand response. However, careful observers will note in Table 1-2 that load impacts for opt-in treatments that include an IHD offer are larger than for those that don’t include an IHD offer. However, it is not appropriate to attribute these differences to the offer or use of the IHD. After correcting for pre-treatment differences across treatment groups, the load impact differences are not statistically significant. Put another way, there is no evidence from the SPO indicating that IHDs significantly increase load impacts associated with time-variant pricing plans.

1.4 The Impact of Rate Attributes on Customer Acceptance

A conjoint survey was conducted to assess the impact of changes in rate attributes on customer acceptance. A conjoint survey asks respondents to select their preferred choice from among several options that vary according to selected attributes, such as peak to off-peak price ratios, the length and number of rate periods, the number of event days for CPP plans, and others. Because most rate plans implemented by utilities are revenue neutral for the average customer, when selected attributes were changed across options, prices also changed. For example, as the length of the peak period increased, the average peak period price fell since the avoided capacity costs underlying peak period prices are spread over more hours.

In order to avoid survey fatigue and so as not to influence customer behavior, the conjoint survey was not administered to SPO treatment customers. Rather, it was administered to SPO control group customers, to those who were ineligible for the SPO because they were participants in SMUD's balanced billing or direct load control programs, and to customers who were eligible for the SPO but were not included in the study. These groups were segmented and analyzed separately. 1,142 surveys were completed and the survey response rate was almost 40%. Each respondent was given 9 groups of 3 choices, for a total of 27 observations per respondent that could be used for analysis purposes. Key findings from the survey included the following:

- Acceptance rates fall as the length of the peak period increases. The percent of customers who opt-in falls by 25% to 50% as the peak period length goes from 3 to 6 hours.
- Acceptance rates are essentially the same for pricing plans that are based on 6 and 12 event days, but increasing the number of events days beyond 12 decreases acceptance rates.
- Increasing the peak-to-off-peak price ratio has only a modest impact on acceptance rates for TOU plans but has a stronger, negative impact on acceptance rates for CPP plans.
- Respondents prefer time-variant rates that do not also have a tiered structure in which prices increase as usage increases.
- Customers prefer TOU plans over CPP plans by a factor of nearly 2 to 1.
- Almost 60% of respondents said they preferred some type of time-variant rate over the standard tiered rate.
- Almost 30% of respondents would take any time-variant rate over the standard rate and another 30% would choose one time-variant option over the standard rate but not another.

1.5 Cost Effectiveness Analysis

The cost-effectiveness of each of the 7 pricing plans tested in the SPO was estimated based on the assumption that the plans were offered to SMUD's entire residential population (about 540,00 customers) and the two-year average enrollment rates and load impacts found in the SPO were observed for this larger population. Recruitment, notification and other variable costs from the SPO were used and startup and other costs were adjusted where appropriate to reflect changes that might be needed to support a larger scale operation. The primary benefit included in the analysis was avoided capacity costs resulting from lower peak period usage. Estimates were also developed for three non-SPO scenarios in which customers were defaulted onto the CPP, TOU or TOU-CPP rates but without the

offer of an IHD. Given the fact that there were no measurable incremental load reductions associated with an IHD for opt-in treatments, we assumed that enrollment rates and load reductions would be the same with and without the IHD offer. The present value of net benefits was calculated over a 10 year period.

Table 1-4 shows the NPV of benefits, costs and net benefits over a ten year period for each pricing plan. It also shows the benefit-cost ratio for each plan, based on the inputs and methods described above. The values in the table are for overall cost-effectiveness, which includes both start-up and ongoing costs, and addresses the policy question of which plan would be most cost effective if it were to be implemented from scratch. Marginal cost effectiveness estimates, which address the question of whether it is cost effective to continue to enroll more customers onto a plan once it is up and running, are discussed in Section 10.

As seen in the table, all but one of the pricing plans, opt-in TOU with an IHD offer, are cost effective, but the magnitude of net benefits vary by almost a factor of 60 between the plans with the lowest and highest positive net benefits. Of the 7 pricing plans tested in the SPO, if they were to be extended to SMUD's entire residential population, the net benefits over 10 years would range from a low of roughly -$5.5 million for the opt-in TOU plan with the IHD offer to more than $86 million for the default TOU-CPP plan with an IHD offer. Default plans are significantly more cost effective than opt-in plans and pricing plans that include the offer of an IHD are all much less cost effective than the equivalent plan that does not offer an IHD. For simulated default plans without an IHD offer, the TOU plan has the lowest net benefits but still exceeds $50 million. The TOU-CPP plan is estimated to deliver net benefits that are more than twice as large as the TOU plan. In general, all CPP plans deliver net benefits that are roughly twice as large as the equivalent TOU plan.

Table 1-4: NPV of Benefits and Costs by Pricing Plan ($ millions)

Scenario Type	Scenario	Benefit/Cost Ratio	10 Year NPV for SMUD Territory		
			Benefits	Costs	Net Benefits
Opt-in Tested	TOU, No IHD Offer	1.19	$12.1	$10.2	$2.0
	TOU, IHD Offer	0.74	$15.5	$21.0	-$5.5
	CPP, No IHD Offer	2.05	$29.7	$14.4	$15.2
	CPP, IHD Offer	1.30	$34.3	$26.3	$7.9
Default Tested	TOU, IHD Offer	2.04	$66.9	$32.8	$34.1
	CPP, IHD Offer	2.22	$142.1	$63.9	$78.2
	TOU-CPP, IHD Offer	2.49	$144.8	$58.1	$86.7
Default Simulated	TOU, no IHD Offer	4.48	$66.9	$15.0	$52.0
	CPP, no IHD Offer	4.28	$142.1	$33.2	$109.0
	TOU-CPP, no IHD Offer	4.53	$144.8	$32.0	$112.9

1.6 End-of-Pilot Survey Summary

A survey was conducted in the fall of 2013, after the end of the second summer period, to obtain input among pilot participants on the following topics:

- Customer satisfaction with SMUD and with the pricing plan customers were on;
- Awareness of the attributes of each pricing plan;
- Perceptions about the pricing plan;
- Reasons for staying on the pricing plan;
- Awareness of events for the CPP pricing plans; and
- IHD use.

The survey was sent to all customers who were enrolled on a pricing plan (including those who actively dropped out but not those who moved) as well as a sample of control group and deferred customers. The survey was conducted using both online and hard copy questionnaires. The overall response rate was 40%. Key survey findings include the following:

- Satisfaction ratings for respondents in all treatment cells, including the deferred treatment cell, were equal to or greater than satisfaction levels in the control group. Put another way, defaulting customers onto time-variant rates or using recruit and delay research methods in some cases did not negatively impact satisfaction with SMUD services.
- Customers on time variant pricing plans, including default plans, report greater agreement with the statement, “My current pricing plan is easy to understand” than do customers on the standard rate. Opt-in customers showed greater actual (not perceived) understanding of rate attributes than did customers on the standard rate and default customers showed about the same level of understanding as customers on the standard rate.
- Significantly more customers on time-variant pricing plans agreed with the statement, “My current pricing plan provides me with opportunities to save money” than did customers on the standard rate. More time-variant pricing plan customers also felt that their pricing plan was fair than did customers on the standard rate.
- Roughly 40% of customers on default time-variant pricing plans and about 57% of those on opt-in plans strongly or somewhat agreed with the statement, “My current pricing plan is better than my old pricing plan” and roughly half of all default respondents and three quarters of opt-in respondents strongly or somewhat agreed with the statement, “I want to stay on my pricing plan.”
- Almost half of default and roughly two thirds of opt-in respondents strongly or somewhat agreed with the statement, “I think the Sacramento community would be better off if everybody was on my pricing plan.”
- Almost 60% of default and 80% of opt-in respondents strongly or somewhat agreed with the statement, “I believe that I did something good for Sacramento by participating in my pricing plan.”

2 Introduction and Pilot Overview

SMUD is located in California's Central Valley where hot summer temperatures and a very high saturation of air conditioning equipment result in peak load requirements concentrated over a relatively short number of hours. SMUD has approximately 540,000 residential customers and a peak load of roughly 3,000 MW. The top 42 hours of system load each year account for approximately 400 MW of incremental load on the system.

The primary objective of SPO is to investigate the effectiveness of AMI-enabled, time-variant pricing and enhanced information to induce behavior change in electricity consumers. Of particular interest is reduction in peak-period electricity use. By implementing time-variant pricing, SMUD seeks to:

- Provide a clear high price signal to consumers during SMUD's summer peak period;
- Encourage customers to shift loads by lowering prices during non-peak periods; and
- Assure that customers who choose not to shift, or cannot shift load, are not penalized with bills that are significantly higher than they would be on SMUD's otherwise applicable rate.

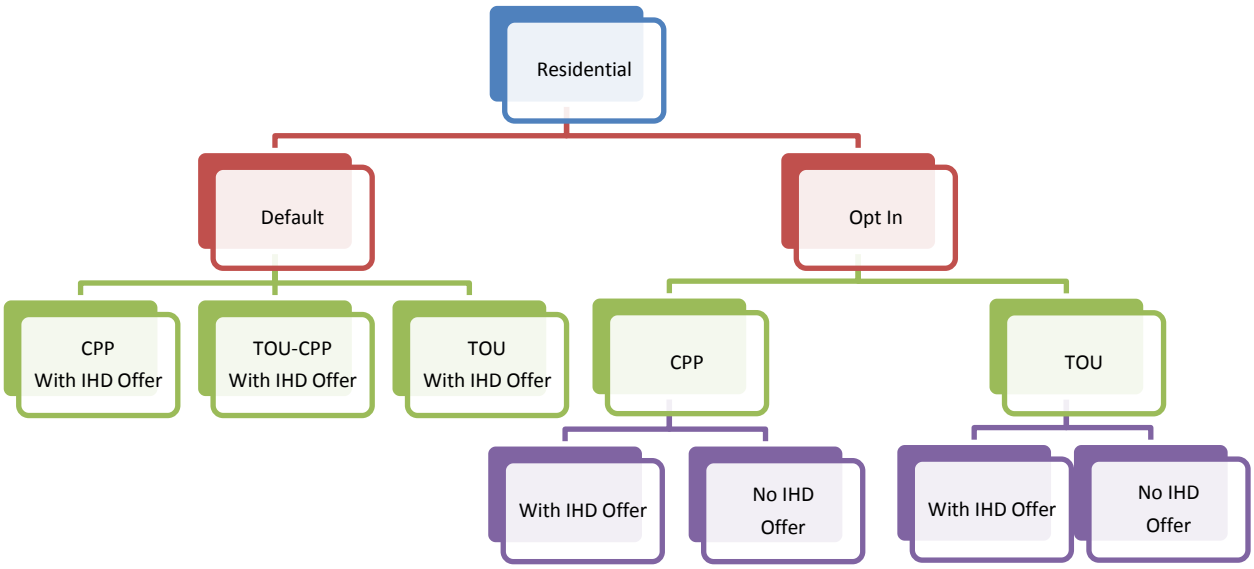
SMUD's SPO is 1 of 11 Consumer Behavior Studies funded by the U.S. Department of Energy (DOE) in an effort to assess customers' response to time-variant rates and increased access to information about electricity consumption. SPO is also one of the major components of SMUD's SmartSacramento®[5] project. The SmartSacramento smart grid project embodies SMUD's public spirit and mission to empower its customers with solutions and options that increase energy efficiency, protect the environment, reduce global warming and lower the cost to serve. When completed, SMUD's comprehensive smart grid will be a customer-centric system designed to enable informed participation by customers as well as the creation of new customer services and solutions. In addition, the project will improve the reliability and efficiency of utility operations, facilitate integration of distributed and intermittent forms of clean and renewable energy, and optimize asset utilization along the entire energy chain—from electricity generation to air conditioning units in customers' homes.

Figure 2-1 summarizes the key features of the SPO pilot, which include:

- Three rate options: time-of-use (TOU), critical peak pricing (CPP) and a TOU-CPP combination;
- Two recruitment strategies: opt-in and default (or opt-out);
- One technology offer: an In Home Display (IHD) that streams usage information to consumers in real time; and
- Three different experimental designs: randomized encouragement design (RED), randomized control trial (RCT) and within-subjects.

[5] A registered service mark of the Sacramento Municipal Utility District.

Figure 2-1: Overview of SPO Treatments



2.1 Pricing Plans

The SMUD Board of Directors approved SPO in August 2011. SPO pricing plans are applicable during the summer months of June through September. Participants revert to their otherwise applicable pricing plan schedule during non-summer months. Participating customers were first placed on the SPO pricing plans on June 1, 2012 and the pilot was scheduled to end on September 30, 2013. Given the success of the pilot and the additional learnings that can be obtained by allowing pilot participants to stay on the SPO pricing plans, SMUD has decided to allow them to do so for at least another year.

The three rate options offered through the SPO pilot include:

- **TOU Rate Option:** Participants were charged an on-peak price of $0.27/kWh between the hours of 4 PM and 7 PM on weekdays, excluding holidays. For all other hours, participants were charged $0.0846/kWh for the first 700 kWh in each billing period, with any additional usage billed at $0.1660/kWh.
- **CPP Rate Option:** Participants were charged a price of $0.75/kWh during CPP event hours, when temperatures and SMUD's system loads are expected to be unusually high. This rate option was designed under the assumption that 12 CPP events would be called each year, between the hours of 4 PM and 7 PM on weekdays, excluding holidays. Customers were notified 24 hours in advance of an event day. For all other hours, participants were charged $0.0851/kWh for the first 700 kWh in each billing period, with any additional usage billed at $0.1665/kWh.
- **TOU-CPP Rate Option:** The third and final SPO rate combines the pricing structures of the TOU and CPP rate options. The TOU-CPP off-peak electricity rate was $0.0721/kWh for the first 700 kWh in each billing period, with any additional off-peak usage billed at $0.1411/kWh. Participants were charged an on-peak price of $0.27/kWh between the hours of 4 PM and 7 PM on weekdays, excluding holidays. A CPP price of $0.75/kWh was charged to participants between the hours of 4 PM and 7 PM on CPP event days, which were planned to be called 12

times during the summer months. The 12 days are the same as those called for the CPP-only rate.

For all three SPO rate options, customers with domestic wells we given a base usage of 1,000 kWh per billing period (rather than 700 kWh). In addition, customers who were on the Energy Assistance Program Rate (EAPR) received about a 30% discount on the price they paid for all SPO rates, depending on how much energy they used. Table 2-1 summarizes the prices that were in effect by rate period during the two summers. Only the standard rate changed in 2013. All SPO pricing plans had the same prices in both summers.

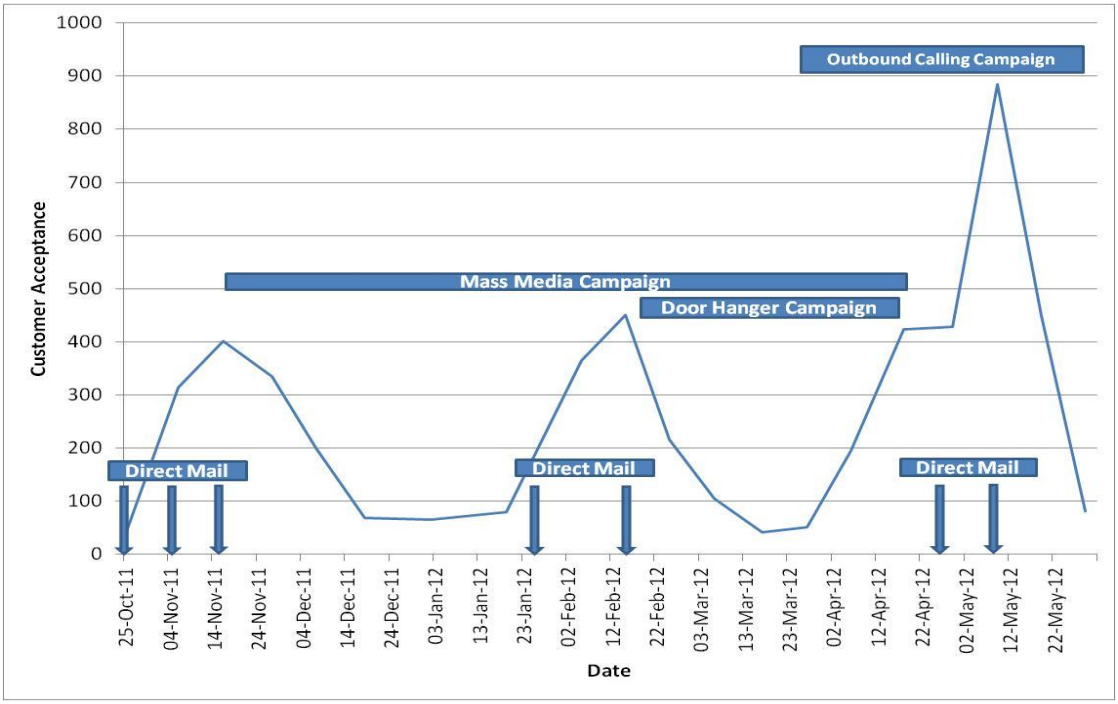
Table 2-1: Electricity Prices by Rate Period and Tariff

Category	Rate	Fixed Charge	Critical Peak	On-peak	Off-peak Base	Off-peak Base Plus	Off-peak Non-discounted Base Plus
2012							
Regular Pricing	Standard	$10.00	–	–	$0.1016	$0.1830	–
	EAPR	$3.50	–	–	$0.0660	$0.1281	$0.1830
SPO Pricing Standard	TOU	$10.00	–	$0.27	$0.0846	$0.1660	–
	CPP	$10.00	$0.75	–	$0.0851	$0.1660	–
	TOU-CPP	$10.00	$0.75	$0.27	$0.0721	$0.1411	–
SPO Pricing EAPR	TOU	$3.50	–	$0.20	$0.0550	$0.1162	$0.1660
	CPP	$3.50	$0.50	–	$0.0553	$0.1165	$0.1665
	TOU-CPP	$3.50	$0.50	$0.20	$0.0468	$0.0987	$0.1411
2013							
Regular Pricing	Standard	$14.00	--	--	$0.0955	$0.1771	--
	EAPR	$5.50	--	--	$0.05921	$0.109802	$0.1803
SPO Pricing	Same as in 2012						

2.2 Marketing and Recruitment Strategies

In the SPO pilot, SMUD examined two recruitment strategies: opt-in and default enrollment. Each customer chosen for inclusion in the pilot was randomly assigned to a treatment group and was then recruited for that specific rate/IHD offer/recruitment combination. Under the opt-in strategy, participants were invited to enroll in the pricing plan specific to their treatment group. Customers were solicited through a multi-faceted marketing campaign summarized in Figure 2-2.

Figure 2-2: Recruitment Timeline for Opt-in Treatment Cells



For opt-in treatments, the first direct mail solicitation occurred in October 2011. A second letter was sent in January to customers who had not yet enrolled. Because of concerns that some treatment cells might not reach their target enrollment rates through direct mail solicitation alone, starting in March 2012, SMUD implemented a door hanger and outbound calling campaign, which continued into May. Through these various efforts, SMUD exceeded target enrollment for all opt-in treatments prior to June 1, 2012, when customers were placed on the new rate.[6]

For default treatments, customers were placed on either the TOU, CPP or TOU-CPP pricing plan and were told to contact SMUD if they did not wish to participate. Customers were initially notified of the impending change in their pricing plan in early April 2012 and a follow-up notification occurred in early May. Welcome packets were sent to all customers on May 29, just prior to the new rates going into effect. SMUD had based the design and sampling for the SPO on the assumption that half of all default customers would drop out prior to going on the rate. In reality, the opt-out rate prior to June 1 when the default rates went into effect ranged from 3% to 7%.

The two opt-in TOU treatment groups utilized a *recruit and delay* RCT design. Two randomly selected groups of customers were chosen and recruited in the same manner. One group of volunteers was placed on the new rate on June 1 and the other group was told that their rate change would be deferred until summer 2014. The purpose of the deferred enrollment is to create a control group for each treatment group that allows for self-selection but avoids selection bias in the estimated impacts.

[6] A very small number of customers were enrolled after June 1.

Prior to soliciting participants, SMUD spent a significant amount of time and money understanding how to communicate the benefits of, and address concerns about, time-variant pricing programs and how to manage potential dissatisfaction stemming from the fact that some volunteers in selected opt-in treatment cells would have enrollment deferred for two years. From February through August 2011, SMUD conducted 25 focus groups and 4 surveys involving more than 2,000 customers to solicit input on marketing messages, naming conventions and other communication issues as input to development of the marketing and education plan.

Based in part on the above research, SMUD used the following names for the three pricing plans tested in the SPO:

- **Summer Weekday Value Plan** for the opt-in and default TOU treatments;
- **Off-peak Discount Plan** for the opt-in and default CPP treatments; and
- **Optimum Off-peak Plan** for the combination TOU-CPP treatment, which was implemented as a default rate only.

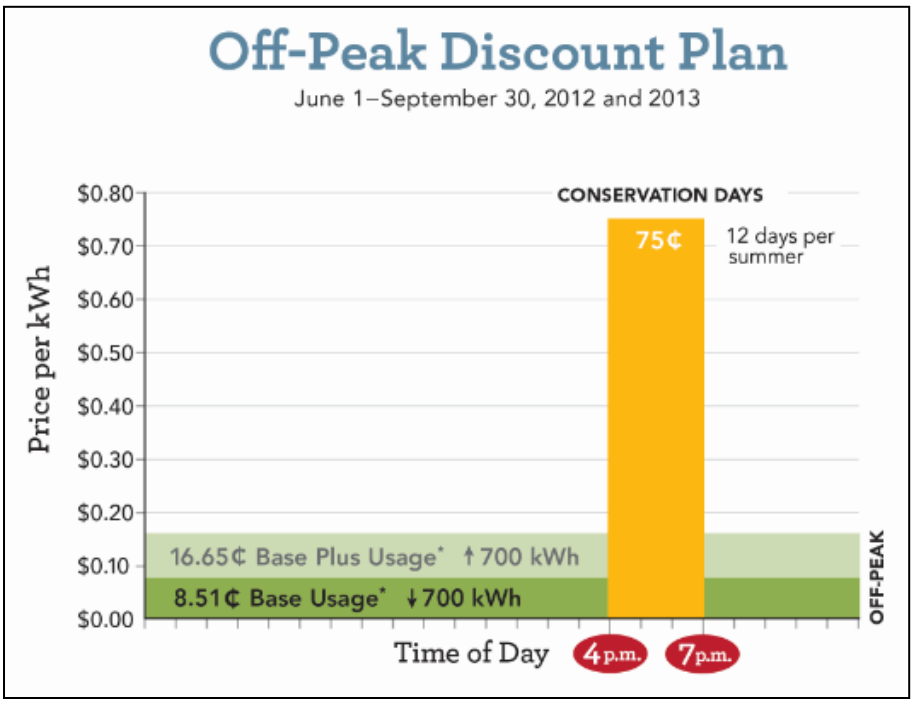
The primary messages and content used the initial solicitation letters included the following:

- The lead marketing message was that customers get a discount off the standard price during non-peak hours, which is most of the time (the amount of time varies across the three rates). The secondary message was that prices are higher for relatively few hours (e.g., only 1% of the time for the CPP rate).
- The primary message concerned "saving money on your summer electricity bills." Secondary messages included taking control and helping the environment.
- Using less electricity during peak hours, shifting usage to before 4 PM or after 7 PM and/or reducing use overall will save money.
- Additional perks include a free countertop electricity use display (for those treatment cells where IHDs are offered), access to an informational graph on My Account that shows hourly and daily usage, access to a website with energy saving tips, and discounts on activities, like movie tickets and water parks that can make using less electricity during peak hours easy and fun.

Many of these same themes were elaborated on in color brochures that were included with the solicitation letter. The cover letter itself did not provide any information about the actual prices but the brochure provided this information in the form of a graphical display. An example of the graph for the CPP Off-peak Discount Plan treatment is shown in Figure 2-3. Examples of selected marketing materials used for customer recruitment can be found in Appendix D of the interim SPO evaluation report submitted to DOE on.[7]

[7] See *SmartPricing Options Interim Evaluation*. Prepared for U.S. Department of Energy, Lawrence Berkeley National Laboratory. October 23, 2013. This report will hereafter be referenced in this document as the SPO Interim Evaluation.

Figure 2-3: Graphical Display of Off-peak Discount Plan Pricing



To help maintain the internal validity of the experiment, SMUD focused significant effort and attention on maintaining consistency in communication and educational content across treatment cells. Keeping messages and content as consistent as possible across treatment cells helps to ensure that differences in enrollment rates and electricity use across rate options and other treatment conditions are due to differences in the treatments themselves and not due to differences in messaging or communication. For example, the only differences in the initial letter sent to customers in the opt-in and default CPP treatment cells are summarized below.

The opening line in the opt-in and default letters is, respectively:

- Sign up today and you could save on your electric bills next summer!
- You're now on a new pricing plan that can help you save on your summer electricity bills!

The next sentence in the two letters, respectively, is as follows:

- You are invited to participate in a two-year SmartPricing Options pilot that can help you manage your energy bills.
- You're among the first SMUD customers to be randomly selected for a two-year SmartPricing Options pilot that can help you better manage your energy use during the summers of 2012 and 2013.

The final paragraph in the default letter indicates that customers who do not want to stay on the new plan can opt out by calling SMUD. Specifically, the letter says:

- If you would like to remain on your standard rate plan, call 1-855-736-7655. However, should you decide not to participate, you won't be able to enroll later and you will miss out on the cost savings and energy management benefits.

The final difference between the opt-in and default treatments concerned the IHD offer. The IHD was offered to some opt-in customers and not others and was offered to all default customers. Opt-in customers receiving the IHD offer could indicate their interest at the time of enrollment and nearly all customers said they would like to receive the IHD. Default customers needed to be more proactive since an enrollment transaction was not needed for the rate itself.

2.3 In Home Displays

As indicated above, IHDs were offered to selected opt-in treatment groups and to all default treatment groups. Figure 2-4 shows the IHD used in the SPO pilot. The purpose of the IHD offer was to examine its effect on customer acceptance and retention rates, program satisfaction and, where possible, electricity use.[8] For default customers, all of whom were offered an IHD, the intent was also to ensure that these customers were given tools to help them manage their energy use. Customers did not need to accept the IHD in order to participate in the pricing plan. The IHDs were preset to communicate with each customer's meter when they were turned on and were sent to customers through the mail.

Figure 2-4: In Home Display Used in SPO Pilot

Customers in the opt-in treatment cells were asked to indicate at the time of enrollment whether or not they wished to receive an IHD and almost everyone indicated they would. Customers in the default treatment cells were also asked to indicate their interest in receiving the IHD. However, default customers had to be more proactive than opt-in customers since they couldn't indicate their interest at the time of enrollment (because default customers didn't have to enroll). As a result, between 20% and 25% of default customers asked for and received an IHD.

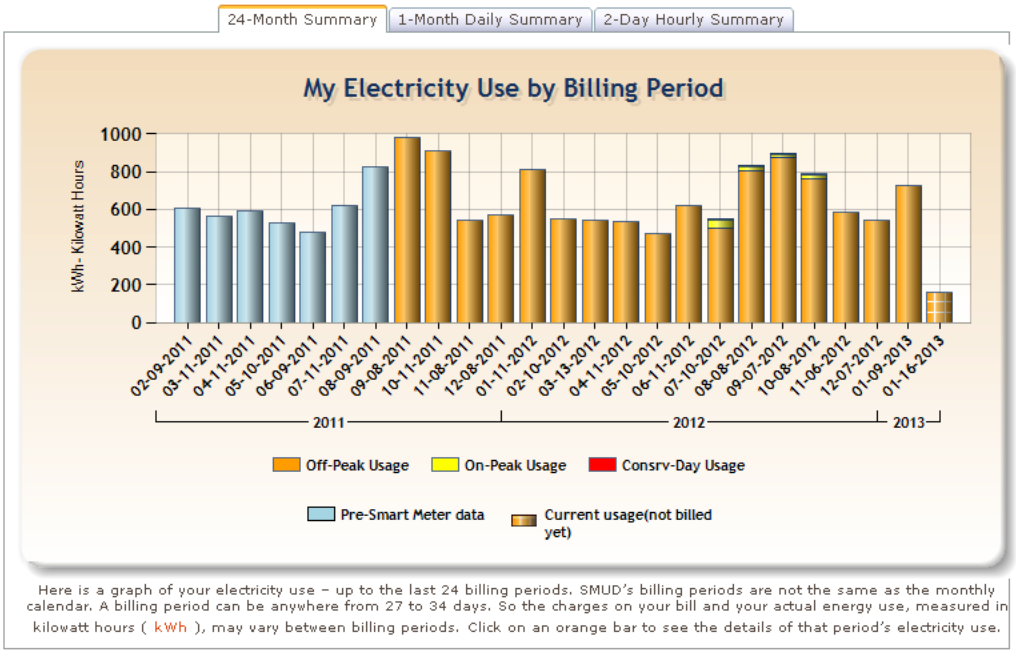
[8] As discussed in Section 1 and at greater length in subsequent sections, the SPO was designed to assess the impact of an IHD **offer** on electricity use, which is different from assessing the impact of an IHD on energy use.

Not all customers who received and successfully connected the IHD to their meter. In 2012, it was not possible to track IHD connection rates to individual customer accounts but this functionality became available in 2013. This allowed for a determination of the percent of customers who received an IHD in 2012 that were connected all, some or none of the time during summer 2013. Roughly one third of opt-in customers were connected at least some of the time in 2013 and between 40% and 60% of default customers that had requested an IHD were connected at least some of the time in 2013. When combined with the percent of all default customers who requested an IHD, roughly 10% to 15% of all default customers had their IHD connected at least some of the time.

2.4 Web Portal Information

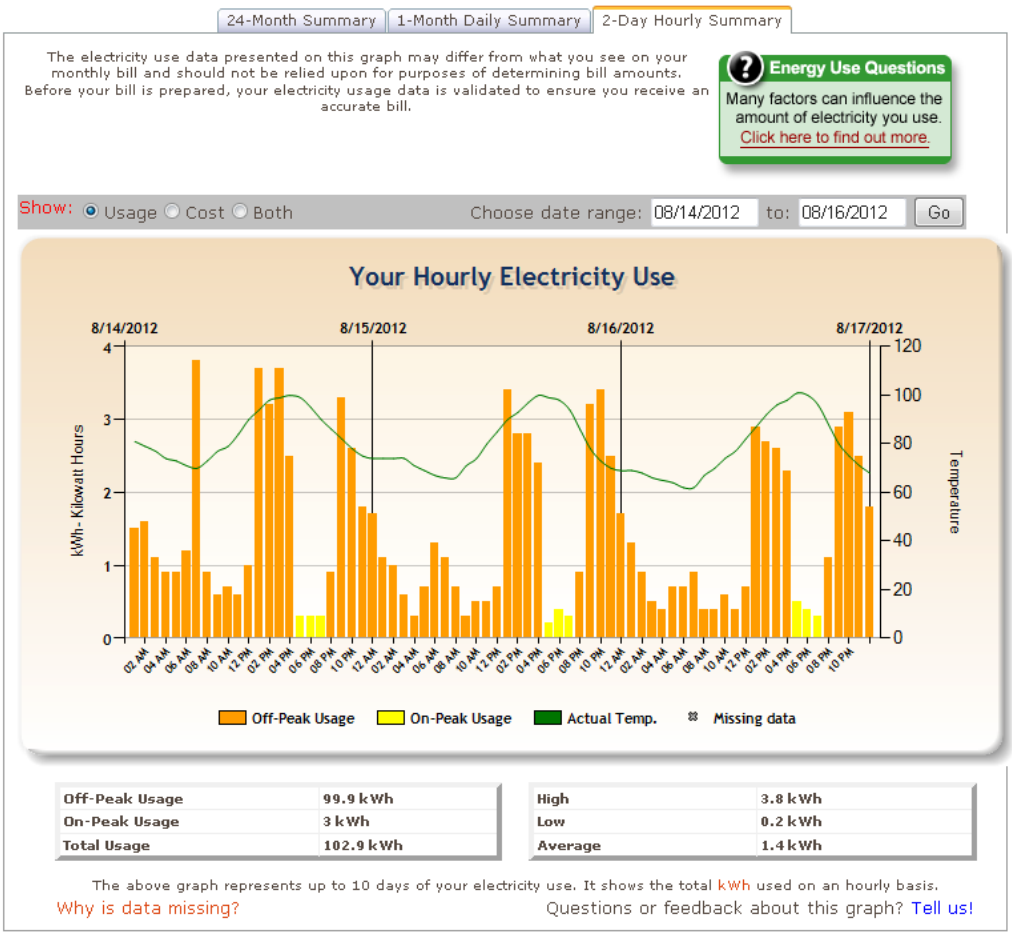
In addition to information provided in real-time through an IHD offered to some treatment groups, all pilot participants could access information about their usage profile through a web portal. Figures 2-5 and 2-6 show the landing page and the more detailed hourly information that are accessible to all pilot participants, respectively.

Figure 2-5: SPO Web Portal Landing Page on My Account[9]



[9] All SMUD residential customers have access to interval data through My Account. Data for customers on time-variant rates is formatted differently to show usage by rate period.

Figure 2-6: Hourly Usage Page for SPO Participants



2.5 Terminology

When evaluating the impact of a pricing pilot, it is important to precisely define the variables of interest. Too often, terminology can be misleading as the same term can mean different things to different people. For example, when examining marketing effectiveness, one could compare the enrollment rate at a point in time (say, on June 1 in this instance, when all customers were placed on the new rate) with the number of customers solicited. However, this ratio would under report marketing effectiveness because some customers may have moved, and therefore become ineligible for the new rate, between the time they responded affirmatively to the marketing solicitation and the time when the new rates went into effect. Similarly, someone might compare enrollment on a rate at the beginning and end of the summers and conclude (incorrectly), for example, that 10% of customers left the new rate because they didn't like it. In reality, many of those customers who left may have done so because they moved, not because they no longer wanted to be on the rate. These examples indicate why it's important to precisely define the impact measures that are reported so that reviewers do not misinterpret their meaning. Below, we define the key output variables that are reported in subsequent sections. A few additional definitions of terms are contained in the glossary in Appendix A.

- **Enrolled Customers**: Enrolled customers are customers who are on a new pricing plan at a given point in time. For opt-in rates, this group consists of customers who accepted the marketing offer, were assigned to the treatment group (rather than the control group), did not change their mind or move prior to the plan going into effect, and are still on the plan (e.g., have not dropped out or moved) at the time that the enrollment snap shot is taken. For default enrollment, enrolled customers at a point in time are customers who did not opt-out prior to or after going on the pricing plan, or did not move or leave the plan for any reason between when they were initially enrolled and when the enrollment is reported.
- **Enrollment Rate:** The enrollment rate consists of all customers who were ever actually on an SPO pricing plan for some period of time (meaning they enrolled at some point in time and did not de-enroll, opt-out or move before June 1, 2012) divided by the number of customers who were offered the plan. This is different from the customer acceptance rate, as defined below.
- **Customer Acceptance Rate:** The customer acceptance rate consists of all customers who agreed to go on a new pricing plan divided by the number of customers who were offered the plan. This value will typically be larger than the enrollment rate (and can't be less than it) as it includes everyone who signed up for a pricing plan even if they never went on the new plan.
    - For opt-in treatments, the *numerator* in the customer acceptance rate includes all customers who agreed to go on the pricing plan but who may have never done so because, for example, they moved before the plan went into effect. It would also include customers who went on the plan but later dropped out. The denominator would include all customers who received the marketing offer. This includes everyone chosen in the original sample less those who moved before the first marketing packets were sent. The customer acceptance rate is the best measure of the effectiveness of a marketing campaign.
    - For default treatments, the *numerator* of the customer acceptance rate consists of all customers who were defaulted onto the pricing plan and did not drop out prior to going on the new plan. If a customer goes on the plan and later drops out off, they would still be included in the numerator of this variable. Only customers who drop out prior to going on the plan are excluded from the numerator. The *denominator* of the customer acceptance rate for default pricing plans equals the number of customers who were defaulted onto the plan. It excludes customers who moved before June 1, 2012.
- **Decliners:** A decliner is a customer who was offered a pricing plan but declined to accept the offer. For opt-in plans, the number of decliners equals the total number of customers marketed to minus the total number of customers who accepted the offer. For default plans, the number of decliners equals the total number of customers defaulted onto the pricing plan minus those who dropped out prior to going on the plan. It does not include customers who were actually placed on the plan and then later drop out.
- **Drop outs:** Drop outs consist of customers who went on a pricing plan at some point in time, but who later requested to be taken off the plan. It does not include customers who drop out due to changing their location (e.g., moving). These are called movers. Customers who went on to MedRate or budget billing are also counted as drop outs although they may not have had a choice to stay in the SPO pilot. However, their numbers are so small that they are categorized with drop outs.
- **Movers:** Movers are customers who were either defaulted onto a new pricing plan or accepted an offer on an opt-in basis, but subsequently moved and, therefore, are no longer enrolled on

the plan. A mover may or may not have ever actually gone on the new pricing plan. For example, some customers may have accepted the new plan several months prior to the new plan going into effect and may have moved before they were placed on the pricing plan. Similarly, default customers may have not consciously declined the default option but may have moved between the time they were notified that a new pricing plan would be going into effect and when the plan actually went into effect.

2.6 Report Organization

The remainder of this report is organized as follows. Section 3 provides a summary of the analytical methods used to estimate load impacts for each pricing plan. Section 4 summarizes the load impact estimates for the four TOU pricing plans and Section 5 does the same for the CPP pricing plans. Section 6 examines the acceptance rate of IHDs for opt-in and default customers and the connection rate among those who accepted an IHD. It also examines the impact of the offer of an IHD on load reduction. The impact of the offer of IHD on acceptance of the rate plan is discussed in Section 8. Section 7 documents the estimation of demand models and price elasticities that can be used to predict the impact of changes in price levels on load reductions. Section 8 examines customer acceptance and retention rates for each pricing plan and summarizes models that were estimated that can be used to predict the likelihood of customers with various characteristics to accept and stay on each pricing plan. Section 9 summarizes the results of a conjoint survey that was conducted to determine how customer acceptance might change with variation in the attributes of opt-in pricing plans. Section 10 compares the relative cost-effectiveness of each pricing plan if it were to be rolled out to the broader SMUD population. Finally, Section 11 summarizes the findings from a detailed survey conducted among all participants after the end of the second summer to assess customer satisfaction with and perspectives on the various pricing plans and the use of IHDs.

3 Analytical Methodology for Load Impact Estimation

SMUD implemented an experimental design that encompasses multiple treatments and multiple methods of evaluation. This design enables a large number of useful analyses to be done that will help SMUD and the industry at large to make more informed decisions about time-variant pricing. Perhaps most importantly, the design allows for estimation of load impacts and acceptance rates without the risk of selection bias; this is quite rare and valuable in the realm of utility program evaluation. The discussion in this section focuses on the methods used to estimate the load impacts reported in Sections 4 and 5. The methods used to develop demand models and choice models for the various pricing plans are discussed in the report sections covering those topics.

3.1 General Approach

The fundamental step in estimating load impacts is to determine what loads would have been for treatment customers if they hadn't been exposed to the treatment; this is referred to as a reference load. SPO relied primarily on two experimental methods for developing reference loads—a randomized control trial (RCT) and a randomized encouragement design (RED). In addition, two treatments, opt-in CPP with and without an IHD offer, were designed to be analyzed using a within-subjects analysis, which constructs reference loads based on treatment customer loads during a time when the treatment is not in effect. The decision to rely on this design was based on an assumption that opt-in rates would be lower than they actually were. Because of the higher opt-in rates obtained in the study, it was possible to develop impact estimates using an RED analysis for these treatments that were originally planned to be analyzed using a within-subjects analysis. Section 9 of the SPO Interim Evaluation report compares load impact estimates developed using RED and within-subjects analysis methods, and also a third method involving the ex post development of control groups using statistical matching methods. This comparison strongly supports the use of RED/RCT methods for impact estimation whenever such methods are feasible.

An RCT refers to a research strategy in which customers who volunteer for a treatment are randomly assigned to treatment and control conditions. This method ensures that the only difference between treatment and control customers, other than small differences due to random sampling variation, is that one group receives the treatment and the other does not. An RCT design ensures that impact estimates are not affected by selection bias or other potential explanations for observed differences between the two groups of customers.

In practice, randomization can be achieved using either a *recruit and deny* process or a *recruit and delay* process. In the former, control customers are never given the treatment whereas in the latter, customers assigned to the control group are placed on the treatment after the end of the trial measurement period. Prior to that time, they act as the control group against which treatment effects are measured. SMUD used the recruit and delay method. Conceptually, the important issue is that because the groups were identical in expectation prior to the start of the experiment, the behavior of the group not on the treatment can be assumed to be an accurate representation of what the behavior of the group on the treatment would have been in the absence of the treatment. This study design was applied to two treatments: opt-in TOU and opt-in TOU plus IHD.

Load impacts can be estimated based on an RCT design by using what is called a difference-in-differences analysis. To estimate load reduction during the peak period, for example, the first difference calculation subtracts average load for the treatment group from the average load for the control group after the treatment goes into effect (in this instance, after June 1, 2012). A second difference value is calculated equal to the difference in peak period loads between treatment and control customers prior to the treatment going into effect (during the summer of 2011 in this instance). This second difference is subtracted from the first, which is why the analysis is called a difference-in-differences. The purpose of this second step is to adjust for any pretreatment differences between the control and treatment groups that might occur due to random variation in the assignment of customers to the treatment and control groups. This difference should be quite small if the treatment and control samples are large, since random error diminishes as sample sizes increase. If sample sizes are small, random error can be more impactful. Section 4 of the SPO Interim Evaluation report shows that adjustments due to random variation are small for all treatments in the SPO.

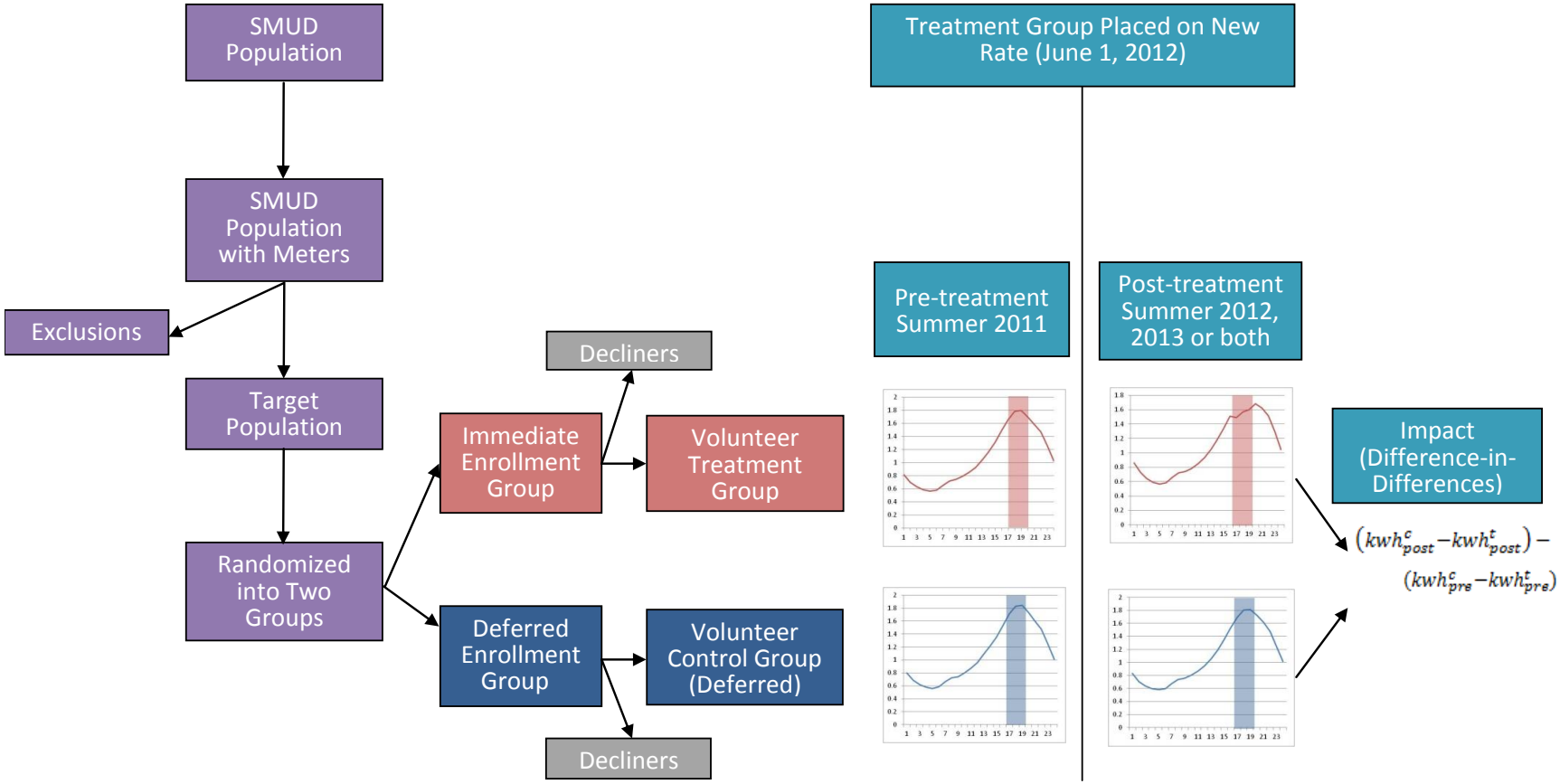
Figure 3-1 summarizes the design and evaluation of impacts using an RCT design. This approach was used for the two opt-in TOU treatments (with and without an IHD offer). Note that the randomization into either the immediate treatment or deferred treatment groups took place before customers were offered the pricing plan. Offers to customers, however, were exactly the same for both groups. Customers were blind to whether they had been pre-assigned to the immediate or deferred start as were customer service representatives (CSRs). Customers and CSRs only learned which group a customer was in after the customer accepted the plan offer.[10]

The experimental method used for the opt-out TOU treatments and for all CPP treatments is an RED. From the perspective of internal validity, an opt-in RCT and an RED are equivalent—both control equally well for selection bias and both allow one to estimate effects for those who accept the treatment, not just those that are offered the treatment. The analysis required to estimate the treatment effect on the treated using an RED requires an extra step as outlined later in this section.[11] Each requires the assumption that the offer of a treatment not taken or not received has no effect on energy consumption.

[10] The initial group of customers recruited for opt-in treatments were not told about the delay until after they agreed to participate. Some complaints from customers placed in the delayed group prompted SMUD to modify the recruitment material for all customers, both those pre-assigned to the treatment and delayed groups, to indicate that enrollment for some customers would be delayed. It is possible that a different set of customers would enroll in a program that only 50% of customers will be able to take part in immediately as compared to a program where all people who are interested are immediately enrolled. This could lead to an issue with external validity. However, this issue was unavoidable in designing an internally valid experiment.

[11] For further discussion of RCTs and REDs, see "Using Randomization in Development Economics Research: A Toolkit," by Duflo, Glennerster and Kremer. Handbook of Development Economics.

Figure 3-1: Overview of RCT Implementation and Analysis



In an RED, the behavior of two randomly-chosen groups of customers who were subjected to different levels of encouragement to take up a treatment is observed. For example, one group—the control group—could have received no offer to be on a new plan, while the treatment group could have received an invitation to enroll in a new plan. In a more complicated example, one group could have received an invitation to opt-in, while the other group could have received notification that they would be put on the rate by default unless they chose to opt-out. The key in both situations is that the two groups receive different levels of encouragement to be on the plan. The different levels of encouragement induce different participation rates between two groups that had the same expected characteristics prior to the experiment. This allows one to estimate the effect of the treatment on customers who were affected by the encouragement, as discussed below.

Using an RED design to estimate unbiased treatment effects requires the assumption that customers who are offered the treatment but decline are unaffected by the offer, and the only effect the treatment has is through the price signal (and the offer of the IHD, if applicable). Put another way, it is necessary to assume that customers who decline the offer—either on an opt-in or default basis—behave afterwards in the same way they would if they had never seen the offer. An RED analysis also assumes that customers who are placed on the rate through a default process, but would have opted in if the rate had been offered as voluntary, behave the same way no matter which way the offer was made. Some of the analyses also require the assumption that there are no customers who would accept the offer on an opt-in basis, but decline it on a default basis. Each of these assumptions seem quite reasonable. An RED was used for the following five treatments: default TOU plus IHD; default TOU-CPP plus IHD; opt-in CPP; opt-in CPP plus IHD; and default CPP plus IHD.

One fundamental difference between the analyses used for RCTs and for REDs is that with RCTs, all customers in the treatment group are enrolled and therefore assumed to be affected by the treatment and none in the control group are affected. In contrast, for REDs, the treatment group consists of all customers who received some form of encouragement toward a treatment and the control group consists of customers who received less encouragement or no encouragement. This means the RED treatment group contains many customers who are assumed to be unaffected by the treatment because they declined. This introduces a potential for confusion in terminology when discussing REDs because it is often convenient to consider the treatment group of an experiment to be the group of all customers who are directly affected by the treatment of interest (e.g., all customers who actually enroll).

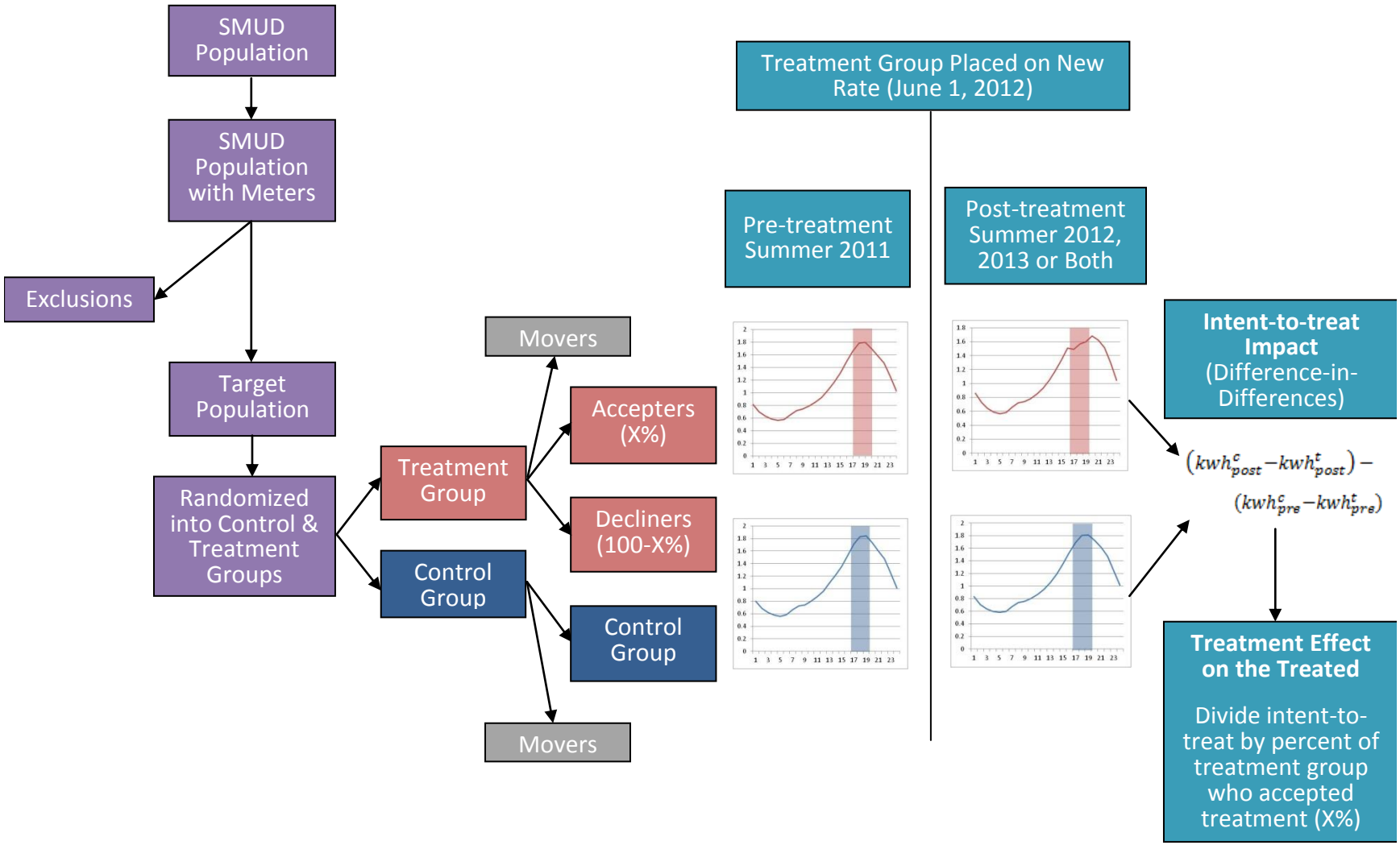
For an RED there are two treatments of interest, each vital to producing the final treatment impact estimate. First, there is the encouragement treatment, which gives an RED its name. In this case, that treatment consists of invitations to opt-in to the pricing plan (and for some the additional offer of an IHD) for opt-in cells and default assignment to a pricing plan (plus an IHD offer) for default cells. Second, there is the impact of the pricing plan itself, with or without an IHD offer. That is, the impact for those that enroll on the plan, not those that are offered the plan. In all discussions involving an RED, we adhere to the following terminology: the treatment group is synonymous with the encouraged group and refers to the group of customers who received a higher level of encouragement toward the treatment, including those who decline; takers and compliers are synonymous and refer to customers who accept the plan they are offered or defaulted onto, which does not necessarily mean they also took

the IHD offer.[12] Non-complier refers to a customer that has declined the offer, either by not opting in or by requesting not to be defaulted onto the plan. The control group refers to all customers receiving the lower level of encouragement—which typically is no encouragement.

Figure 3-2 summarizes the conceptual design and analysis of an experimental treatment using an RED. As discussed above, there are two load impacts of potential interest. One is the difference in load during, say, the peak period, between the encouraged (treatment) and non-encouraged (control) groups. As with the RCT, this analysis is based on a difference-in-differences calculation. This load impact is primarily of interest in this context because it is a necessary step to obtain the primary effect of interest, namely, the load reduction of compliers—that is, those customers in the encouraged group that actually take up the treatment. This impact is estimated by dividing the impact for the encouraged group by the percent of encouraged customers who accept the treatment offer. This is explained more fully in Section 3.2.

[12] Definitions of treatment group and control group are also included in the glossary in Appendix A.

Figure 3-2: Overview of RED Implementation and Analysis



3.2 Analysis of RCT and RED Treatment Groups

As discussed in Section 3.1, the logic underlying all RCT and RED analysis is that an unbiased reference load can be estimated by taking average loads among a group of customers with the same average pretreatment characteristics as customers who are subject to the treatment or encouragement of interest. The primary impact estimation process is referred to as a difference-in-differences analysis because the impact estimates equal the difference between loads in the treatment and control group at the time of interest (in this case, summer 2012, 2013 or both combined) minus the difference between loads in the treatment and control group during particular times prior to when the treatment goes into effect (e.g., summer 2011).

Difference-in-differences calculations can be done using regression analysis or simple averaging. Regression analysis is used here rather than simple averaging because regression allows each customer's mean usage to be modeled separately, which reduces the standard error of the impact estimates without changing their magnitude. Additionally, standard regression software allows for the calculation of standard errors for load impact estimates that correctly account for the correlation in customer loads over time.[13]

The pretreatment differences adjusted for by the regression should be as close as possible to the differences between the groups that would have been expected if the treatment had not been in place. Therefore, in all cases, the pretreatment loads included in each regression were chosen to be the loads most directly analogous to the loads during the period for which impacts were measured. For example, the pretreatment loads included in the analyses of TOU peak periods were the loads from the same groups during the peak period on weekdays from summer 2011. Similarly, the pretreatment loads used in the regressions for estimating CPP impacts were loads from the 4-7 PM peak period on weekdays with high temperatures above 90°F in summer 2011. Those days were chosen because CPP events are typically only called on hot days. It is important to note, however, that because the sample sizes are fairly large and because treatment and control group pretreatment loads are quite close in all cases, the adjustment for pretreatment differences generally has only a small impact on the results. Repeating all calculations as simple differences without pretreatment adjustments would lead to similar conclusions about the overall effect of each treatment.

The regression specification underlying all the treatment effect estimates reported from RCTs and REDs in this report is:

$$load_{it} = a_i + b_1 T_i I_1 + b_2 I_1 + u_{it} \qquad \text{3-1}$$

The dataset used and the exact definition of each variable and parameter differs across treatment cells, as discussed below.

3.2.1 Opt-in TOU With and Without IHD Offer (RCT)

Two treatment groups were analyzed using the RCT framework—TOU and TOU plus IHD offer—and the dataset and variable definitions are the same for both. The primary analysis of interest for each

[13] More accurately, they account for the correlation in regression errors within customers over time.

treatment provides estimates of the peak period demand impact from the TOU pricing plan (or the TOU rate plus IHD plan). In this case, the dataset includes all customers who enrolled in the pricing plan, including deferred customers. The enrolled customers are the treatment group and the deferred customers are the control group. The variable $load_{it}$ in equation 3-1 contains hourly load only during the weekday peak period from 4-7 PM for summer 2011 and either summer 2012, summer 2013 or both, depending on what impacts are of interest,[14] for both treatment and control customers. The index *i* refers to customers and the index *t* refers to the time period of interest (which could be a simple hour, the average across the peak period hours, or some other period of interest).

In this version of the regression, $a_i$is an estimated parameter equal to the mean peak period weekday usage for each customer. The primary parameter of interest is b_1, which provides the estimated demand impact of TOU during the peak period. The parameter is the estimated coefficient on $T_i I_1$. T_i is equal to 1 for the treatment group during the treatment period (e.g., after they are placed on the pricing plan) and 0 otherwise. Finally, I_1 is the variable equal to 1 during the treatment period for all customers and 0 otherwise; this is not a parameter of primary interest, but it allows the regression to estimate the primary parameter of interest without confounding differences between treatment and control customers with differences in usage across years.

Demand impacts have also been estimated for each weekday peak period hour separately for each summer month—meaning there is a separate estimate of the TOU impact for 4-5 PM in June, 5-6 PM in June and so forth, with each estimate providing an average value over that hour for all weekdays in the respective month. This is accomplished using an identical regression specification as above, with a more limited dataset. For example, to produce the estimate for 4-5 PM in June, the dataset is restricted to contain only the hour from 4-5 PM for each weekday during June 2011 and June 2012. All other aspects of the specification remain the same and the interpretation of the variables and estimated parameters are very similar to the case of estimating the overall average effect.

Additionally, demand impacts were estimated for all non-peak periods during the summer, as described in the results section. In these cases, again, the regression specification and interpretation are the same; the only difference is that different hours were included in the regression. These sets of hours can be directly inferred from the results given. For example, to estimate the effect of TOU on the hours immediately before the peak period, the regression only includes hours immediately before the 4-7 PM peak period.

Finally, energy conservation impacts were estimated in addition to demand impacts. Energy conservation is not the primary goal of the treatments, but the treatments could lead to measurable energy savings, which could provide additional value to SMUD. Alternatively, TOU rates could lead to overall increases in usage if customers primarily shift usage from peak to off-peak periods while simultaneously increasing overall usage in response to the lower off-peak prices, which are in effect

[14] If the analysis is being done to estimate impacts for summer 2012, the data set includes data from 2011 and 2012. If the analysis is being done to estimate impacts for summer 2013, the data set includes data from 2011 and 2013. If the analysis is being done to estimate the average impact across both summers, the data set would include data from 2011, 2012 and 2013.

many more hours than higher peak period prices. Determining whether the SPO pricing plans decrease or increase usage, or leave it largely unchanged, is important for cost-effectiveness analysis.

To estimate energy conservation effects, the same specification is used but the estimation is based on monthly usage data rather than hourly or rate-period usage. The dataset includes monthly usage for June-September 2011, 2012 and/or 2013 depending on the time period of interest for the same sets of customers as in the demand impact estimates. The impacts are calculated based on differences in usage between the treatment and control groups during the treatment period and were adjusted based on differences seen in the pretreatment data, the summer of 2011. In this version of the regression, a_i is an estimated parameter equal to the mean monthly usage over pre- and post-treatment periods for each customer. The primary parameter of interest is b_1, which is equal to the estimated monthly energy savings due to TOU during the treatment period. The definitions and interpretations of $T_i I_1$ and $b_2 I_1$ are identical to the demand impact case.

3.2.2 Default TOU Plus IHD Offer and TOU-CPP Plus IHD (RED)

The rest of the TOU analyses are based on REDs rather than RCTs. There are two rates analyzed in the RED framework: default TOU and default TOU-CPP. Both of these treatments included the offer of an IHD. For the TOU-CPP rate, the analysis method summarized in this section focuses on the impact on all summer weekdays. The analysis method used to estimate the incremental effect of the CPP price is discussed in Section 3.2.3.

For both TOU default treatments, the primary analysis of interest is estimation of the peak period demand impact from the TOU rate. The regression specification in equation 3-1 does not directly provide this estimate; instead it provides an estimate of the load impact for the average customer that received an offer, not the average for customers who accepted the offer. This initial load impact estimate is often referred to as the intent-to-treat estimate. Under the reasonable assumption that non-compliers were unaffected by the offer, the intent-to-treat estimate can be transformed into the effect of the treatment on compliers by dividing the intent-to-treat estimate by the fraction of the population enrolled on the pricing plan. This scaled up effect is often referred to as the local average treatment effect. The word “local” is used to indicate that the effect is only measured for customers who responded to the encouragement. In the case where a comparison is made between an encouraged group and a control group with no one on the treatment, it is also referred to as the treatment effect on the treated. If the comparison is made between two groups that are encouraged in different ways (e.g., opt-in encouragement versus default encouragement), the local effect represents the change in usage for customers who would not have enrolled if given that option and who did not opt out from the default enrollment.

It is important to understand how equation 3-1 is used in the RED analyses because it is the first step of each such analysis. In the case of the TOU and TOU-CPP treatments, the dataset includes all customers who were offered the respective treatment (either TOU plus IHD offer or TOU-CPP plus IHD offer) and all customers in the control group. The dataset contains hourly load only during the peak period hours of weekdays from 4-7 PM for summer 2011 and either summer 2012, 2013 or both for both groups. The interpretation of the variables and estimated parameters for these two groups is essentially the same as in the TOU RCT cases above, with the important difference being that all parameters include the effect

of non-compliers and are therefore intent-to-treat estimates rather than estimates of the local average treatment effect.

Also analogous to the TOU RCT case is that estimates are developed for individual hours or non-peak periods by altering the set of hours in the regression dataset. Similarly, energy savings impacts are estimated by substituting monthly data for hourly data, in the same way described above for the TOU RCTs. Again, this produces intent-to-treat estimates which must be scaled up.

In each case, intent-to-treat estimates are scaled up to local average treatment effects by dividing by the fraction of customers enrolled at the relevant time. This is complicated somewhat by the fact that customer enrollment changes over the summer as some customers drop out of the treatment. For monthly TOU impacts, the enrollment fraction used for scaling was the average enrollment during that month among the relevant treatment group. For overall TOU impacts, the fraction used was the average enrollment fraction over the period of interest, either 2012, 2013 or both.

For impact estimation, the TOU-CPP plus IHD group can be treated identically to the TOU-only groups. The interpretation of the results must take into account the fact that these customers face much higher prices on certain days. For this reason, we also examine the effect of TOU on this group of customers, excluding CPP days. The method for doing this is to use the same regression analysis, but to exclude CPP days from the dataset.

3.2.3 Opt-in CPP, Default CPP and Default TOU-CPP (RED)

The RED analysis of CPP rates is the same as the analysis described above for TOU rates, with equation 3-1 again being the regression specification and the dataset including the full treatment and control group for each rate. This method applies to opt-in CPP with and without the offer of an IHD and default CPP and TOU-CPP, both of which included the offer of an IHD. The only difference in the analysis of the CPP rates and the TOU rates is that the pretreatment data includes only weekdays with peak temperatures above 90°F in 2011.

Again, for REDs, equation 3-1 produces the intent-to-treat estimate, which must be scaled up by the fraction of customers within the treatment group that is enrolled to produce the local average treatment effect. Due to customers leaving the rate during the summer, this fraction differs across events, and so each CPP event impact is estimated using the fraction of enrolled customers at that point during the summer. Overall, average CPP effects are scaled by the average enrollment fraction over all CPP events.

For the TOU-CPP with IHD group, the effect of the CPP rate on CPP days is estimated in the same way as the effect of the CPP treatment for the other CPP cells.

3.3 Standard Errors

In order to interpret the results of each analysis, it is important to understand not just the point estimates for each variable, but also the variance of each estimate and the associated confidence interval. For RCT analyses, the regression software automatically produces standard error estimates,

and the only complication is that those estimates must be calculated using the cluster option, which assumes that the regression errors are correlated with each other within each customer's set of errors.

For RED analyses, the first step is to estimate the standard errors of the intent-to-treat estimates, as produced by the regression with the cluster option. Those standard error estimates are then scaled up using the same scaling factor used to scale the intent-to-treat estimates themselves—the difference in the fraction of compliers between the treatment and control groups. This produces correct standard error estimates for the estimates of the local average treatment effects.

With point estimates and standard errors, confidence bands and tests of statistically significant differences can be calculated. To calculate the p-value of the hypothesis that the point estimates arise from the same distribution, we first calculate the standard error of the difference, which is the square root of the sum of the standard errors from each point estimate. Next, the ratio of the difference to the standard error of the difference is calculated. Under standard assumptions and the central limit theorem, this ratio is distributed with a Gaussian (Normal) distribution with mean zero and variance equal to one. Therefore, the p-value is determined by finding the fraction of the Gaussian distribution that is more extreme (i.e., further from zero) than the calculated ratio.[15] Because two-sided hypothesis tests are performed in all cases, this fraction is doubled and that equals the p-value. The p-value indicates the probability of observing an estimated difference that large if the two estimates came from the same distribution. Therefore, a low p-value indicates that it is unlikely that a difference that large would be observed if the two estimates came from the same distribution. In that sense, a low p-value increases confidence that the observed differences are not due to chance alone and therefore are statistically significant.

[15] Technically, a t-distribution should be used for such a test, but the t-distribution and Gaussian distribution are virtually identical for large sample tests such as this.

4 TOU Pricing Plan Impacts

This section presents the demand and energy impact estimates for the TOU and TOU-CPP pricing plans included in the SPO. The SPO design was intended to provide adequate statistical power to measure treatment effects[16] averaged over each summer for the peak period for each rate option (for TOU, TOU-CPP and CPP options). These average impacts are the primary focus of this evaluation, although sample size calculations also focused on estimating conservation effects. Other impacts of interest can be obtained from the data, including estimates by month, estimates for individual hours of the peak period, individual CPP event day effects and non-peak period effects. When reviewing these additional estimates, it should be kept in mind that the experiment was not designed to estimate these effects. As such, standard error estimates for these parameters tend to be larger. When reviewing impact estimates in the remainder of this section and in Section 5, keep in mind that the convention used is that positive impact values indicate reductions in use and negative values indicate increases.

4.1 Peak Period Load Reductions by Pricing Plan

The TOU peak period covers 4 to 7 PM on all non-holiday weekdays from June through September. During the peak period, the price per kWh for non-EAPR customers is 1.6 to 3 times higher than the off-peak price, depending on whether a customer's energy use puts them in usage tier 1 or 2. For customers on the low-income EAPR rate, the peak period price is 1.2 to 3.6 times higher than the off-peak price.

Table 4-1 shows the average estimated absolute and percentage impacts for the TOU rate options across all summer peak hours. Impacts are shown for each summer and for the two summers combined. The p-values in the last column in the table show whether the difference in impacts across the two summers is statistically significant. Table 4-2 shows the p-values for the pairwise comparisons of load impacts across pricing plans to assess whether the impact for one pricing plan is significantly different from the impact for another plan.

Looking first at the impacts in Table 4-1 averaged across the two years, the largest absolute and percent reductions are from the opt-in TOU group that was offered the IHD. The average impact for this treatment group was 0.21 kW, which equals 11.9% of the whole house reference load. The lowest absolute and percent impact was for the default TOU group (which included an IHD offer, as did all default groups), where the absolute average reduction across the two summers equaled 0.11 kW, or 5.8% of the average customer's whole house reference load. Impacts for the remaining two groups, opt-in TOU with no IHD offer and default TOU-CPP with an IHD offer, were 0.16 kW (9.4%) and 0.17 kW (8.7%), respectively. As seen in Table 4-2, the differences in peak period load impacts across the various pricing plans were statistically significant for 3 pairwise comparisons:

- the default TOU with an IHD offer and default TOU-CPP with an IHD offer, with a p-value of 0.05 (statistically significant at the 90% confidence level);

[16] See CBS Power Analysis in Appendix F of the SPO Interim Report.

- opt-in TOU with an IHD offer and opt-in TOU without an IHD offer, with a p-value of 0.07 (statistically significant at the 90% confidence level); and
- the opt-in TOU with IHD offer and default TOU with IHD offer, which was statistically different at the 99% level of confidence.

Table 4-1: Average Peak Period Load Impacts for TOU Pricing Plans for the Average Weekday

Group	Year	Average Impact per Customer (kW)	95% CI Lower[17]	95% CI Upper	Reference Load (kW)	Impact as % of Reference Load	P Value (Difference Across Years)
Opt-in TOU, No IHD Offer	2012	0.17	0.13	0.22	1.71	10.0%	0.65
	2013	0.15	0.10	0.21	1.69	9.1%	
	Average	0.16	0.12	0.21	1.72	9.4%	n/a
Opt-in TOU, IHD Offer	2012	0.24	0.20	0.27	1.80	13.1%	0.15
	2013	0.20	0.15	0.24	1.79	10.9%	
	Average	0.21	0.18	0.25	1.79	11.9%	n/a
Default TOU, IHD Offer	2012	0.12	0.09	0.15	1.87	6.2%	0.52
	2013	0.10	0.07	0.14	1.80	5.7%	
	Average	0.11	0.08	0.14	1.86	5.8%	n/a
Default TOU-CPP, IHD Offer[18]	2012	0.16	0.11	0.21	1.90	8.2%	0.63
	2013	0.18	0.11	0.24	1.85	9.6%	
	Average	0.17	0.11	0.22	1.91	8.7%	n/a

Table 4-2: P-values for Pair Wise Comparisons of Average Load Impacts Across Two Years for TOU Pricing Plans

Group	Opt-in TOU, No IHD Offer	Opt-in TOU, IHD Offer	Default TOU, IHD Offer	Default TOU-CPP, IHD Offer
Opt-in TOU, No IHD Offer	n/a	n/a	n/a	n/a
Opt-in TOU, IHD Offer	0.07*	n/a	n/a	n/a
Default TOU, IHD Offer	0.05*	0.00**	n/a	n/a
Default TOU-CPP, IHD Offer	0.90	0.13	0.05*	n/a
*Statistically significant at the 90% level; ** Statistically significant at the 99% level				

[17] The 95% confidence bands are shown for load impacts in each table in this report. If the upper and lower values of the 95% confidence band bracket 0, it means that the estimated impact is not statistically significant with 95% confidence.

[18] Average weekday impacts for the TOU-CPP plan include impacts on both CPP and non-CPP days.

4.2 Impact Persistence

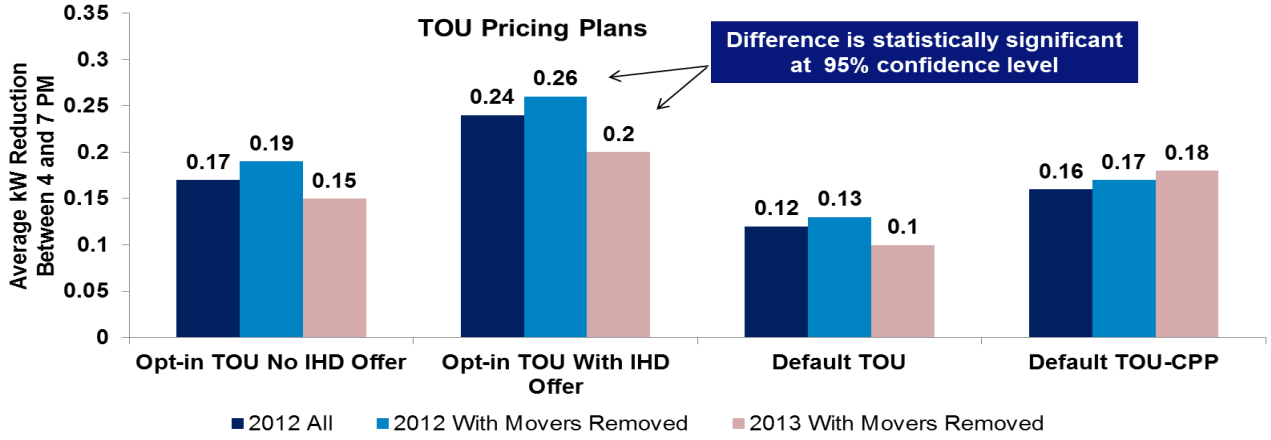
An important issue for resource planning purposes is whether load impacts from time-variant rates persist over time. As seen in Table 4-1, there are small decreases in the average impact from 2012 to 2013 for three of the four pricing plans and a small increase in the impact for the fourth pricing plan, default TOU-CPP. However, as indicated by the p-values in the last column in the table, none of these differences is statistically significant.

The above comparison of load impacts in 2012 with those in 2013, while interesting, is not the best measure of persistence because the population of participants changed across the two summers. As discussed at length in Section 8, customer attrition for most plans equaled roughly 25% over the course of the two summers, with the vast majority of this attrition resulting from customers who moved rather than from those who actively dropped out of the pricing plans. Customers who moved were dropped from their pricing plan and could not re-enroll. Since movers are more likely to live in multiple family dwellings and, therefore, be more likely to have smaller loads than those who don't move, a simple comparison of load impacts across the two summers based on the populations that are enrolled in each summer is not a valid measure of whether load impacts persist among customers who remain on a pricing plan over time, which is a more interesting question from a policy perspective. To make this comparison, load impacts were calculated for each summer based on the segment of customers who did not move over the course of the study.[19]

Figure 4-1 shows impacts for each summer for customers who did not move over the two summers. For comparison, it also shows the estimates based on the full 2012 population. As seen, the impacts for the stable population are larger for each pricing plan, which is consistent with the hypothesis that movers have smaller loads and load response than those who do not move. For three of the four pricing plans, the small differences across years for the non-mover population are not statistically significant – that is, impacts persisted across the two summers for those who were enrolled in both summers. For the opt-in TOU group with an IHD offer, there was a drop in load impacts in the second summer and the difference is statistically significant at the 95% confidence level.

[19] Active drop outs were kept in the database since dropping them would have led to a selection effect that could not be controlled for using the RED analysis methods applied in each case because there were no drop outs in the control group, just movers. Because the same percent of customers should move in both the treatment and control groups, the RED analysis is still valid when movers are dropped.

Figure 4-1: Load Impacts for Each Summer for Customers Who Did Not Move During the Study Period



4.3 Load Impacts by Month

In addition to knowing how average impacts vary across pricing plans, it is useful to observe how impacts vary across months for each plan. Table 4-3 shows the average load reductions by month for the two summers combined for each TOU pricing plan. For the three TOU only plans, September has the lowest absolute and percent load reductions across the four months, with June being the second lowest. The average impacts are highest in July for the two opt-in plans and highest in August for the default TOU plan, but the differences between July and August are not large for any of these plans. Impacts for the default TOU-CPP plan are influenced by the number of event days in each month, which is why the impacts in September are much higher than for the default TOU plan. Across the two years, there were more CPP event days in September (a total of 9) than in any other month.[20]

[20] There was 1 June event used in the analysis, 5 July events, 8 August events and 9 September events across the two years.

Table 4-3: 2012/2013 Average Load Impacts by Month for TOU Pricing Plans[21]

Month	Group	Average Impact per Customer (kW)	95% CI Lower	95% CI Upper	Reference Load (kW)	% Impact
June	Opt-in TOU, No IHD Offer	0.15	0.10	0.19	1.57	9.4%
	Opt-in TOU, IHD Offer	0.17	0.13	0.20	1.55	10.9%
	Default TOU, IHD Offer	0.10	0.07	0.12	1.75	5.5%
	Default TOU-CPP, IHD Offer	0.14	0.09	0.19	1.81	7.6%
July	Opt-in TOU, No IHD Offer	0.21	0.15	0.26	2.11	9.7%
	Opt-in TOU, IHD Offer	0.27	0.23	0.32	2.05	13.4%
	Default TOU, IHD Offer	0.12	0.08	0.15	2.17	5.5%
	Default TOU-CPP, IHD Offer	0.19	0.13	0.25	2.25	8.4%
August	Opt-in TOU, No IHD Offer	0.20	0.14	0.26	1.83	11.2%
	Opt-in TOU, IHD Offer	0.27	0.22	0.31	2.07	12.9%
	Default TOU, IHD Offer	0.14	0.10	0.18	2.15	6.5%
	Default TOU-CPP, IHD Offer	0.20	0.13	0.27	2.22	9.0%
September	Opt-in TOU, No IHD Offer	0.08	0.02	0.14	1.33	6.0%
	Opt-in TOU, IHD Offer	0.14	0.10	0.19	1.50	9.6%
	Default TOU, IHD Offer	0.07	0.04	0.11	1.61	4.5%
	Default TOU-CPP, IHD Offer	0.14	0.07	0.20	1.69	8.1%

4.4 Load Impacts by Customer Type

For opt-in pricing plans, it is useful to understand how load impacts vary across customers who might differ in selected ways such as EAPR status or overall usage. Such information can be used to develop targeted marketing strategies that can improve program cost effectiveness. Even for default plans, knowing the types of customers that produce the largest load reductions can be useful input to educational strategies that might help improve overall load reductions.

Table 4-4 shows how load impacts vary by EAPR status for the four TOU pricing plans. EAPR customers have both lower load impacts on an absolute basis and lower reference loads compared with non-EAPR customers for all four treatment groups. For the two default pricing plans, the difference in the absolute impacts between EAPR and non-EAPR customers is small and is explained completely by the difference in reference loads for the two groups since the percent reductions are almost identical. That is, EAPR customers show the same responsiveness to price as non-EAPR customers when defaulted onto a TOU pricing plan, but the absolute impacts are lower for EAPR customers because their usage is lower. For the two opt-in pricing plans, both the average absolute and percent reductions are lower for EAPR

[21] Hourly impacts by month during the peak period for the TOU pricing plans are presented in Appendix B.

customers than for non-EAPR customers. For the opt-in group with no IHD offer, the load reduction for EAPR customers is less than half as large as for non-EAPR customers even though the reference load for the two groups differed by less than 10%. For the opt-in group with the IHD offer, the absolute impacts differ by about 50% even though the reference loads differ once again by less than 10%.

Table 4-4: 2012/2013 Average Load Impacts by EAPR Status

Group	EAPR					Non-EAPR				
	Impact	95% CI Lower	95% CI Upper	Reference Load	% Impact	Impact	95% CI Lower	95% CI Upper	Reference Load	% Impact
Opt-in TOU, No IHD Offer	0.08	0.00	0.16	1.65	4.8%	0.20	0.15	0.25	1.76	11.3%
Opt-in TOU, IHD Offer	0.14	0.08	0.20	1.70	8.2%	0.24	0.20	0.29	1.84	13.2%
Default TOU, IHD Offer	0.09	0.04	0.15	1.64	5.7%	0.11	0.08	0.14	1.93	5.8%
Default TOU-CPP, IHD Offer	0.15	0.05	0.25	1.76	8.5%	0.17	0.11	0.22	1.96	8.5%

Another important customer characteristic of potential interest is usage. Table 4-5 shows how load impacts vary with usage. All customers on each pricing plan were stratified into quartiles based on average summer usage. Bins 1 through 4 in the table represent the lowest to the highest usage quartile. Absolute impacts increase significantly from the lowest to the highest usage bin for each treatment group, but the magnitude of the spread varies significantly across treatment groups. For example, for the default TOU plan, the difference in impacts is less than a factor of three between the lowest and the highest usage bin. However, for the default TOU-CPP group, the difference is more than a factor of 10. The variation in percent impacts is much different from the variation in absolute impacts, increasing from lowest to highest in some cases but falling in others. One thing that is clear is that for any opt-in pricing plan, targeting high usage customers will be much more cost effective than targeting low usage customers.

Table 4-5: 2012/2013 Average Load Impacts by Usage Quartile for TOU Pricing Plans (Bin 1 is the lowest usage quartile, Bin 4 is the highest usage quartile)

Group	Bins	Reference Load	Impact	95% CI Lower	95% CI Upper	Percent Impact
Opt In TOU, No IHD Offer	1	0.60	0.05	0.01	0.10	9.1%
	2	1.30	0.13	0.06	0.21	10.3%
	3	1.98	0.18	0.09	0.27	9.2%
	4	3.15	0.28	0.15	0.41	8.8%
Opt In TOU, IHD Offer	1	0.62	0.07	0.03	0.11	11.2%
	2	1.33	0.20	0.14	0.26	15.1%
	3	2.00	0.24	0.17	0.31	12.2%
	4	3.16	0.33	0.24	0.42	10.5%
Default TOU, IHD Offer	1	0.64	0.06	0.02	0.09	9.0%
	2	1.35	0.10	0.05	0.14	7.2%
	3	2.05	0.12	0.06	0.18	5.8%
	4	3.30	0.16	0.08	0.24	4.8%
Default TOU-CPP, IHD Offer	1	0.59	0.03	-0.03	0.09	4.6%
	2	1.36	0.07	-0.01	0.14	4.8%
	3	2.07	0.20	0.09	0.30	9.5%
	4	3.53	0.36	0.22	0.50	10.2%

4.5 Load Impacts Outside the Peak Period

Although the peak period hours are of primary interest, it is also useful to know what happens to electricity usage during non-peak hours for customers on the TOU pricing plans, especially those hours just before the peak period when pre-cooling might occur and right after the peak period, when a snapback effect might exist. Table 4-6 shows impacts for each of the four TOU groups for the two hours before the peak period (2 to 4 PM) and the two hours after the peak period (7 to 9 PM) across all summer weekdays for the two summers combined. The results in the table show that there are no statistically significant load reductions in the hours leading up to or following the peak period for any of the TOU pricing plans for the average weekday.

Table 4-6: 2012/2013 Average Load Impacts Before and After Peak Period for TOU Pricing Plans

Group	Average Impact Pre-Peak (2-4PM) (kW)	95% CI Lower	95% CI Upper	Average Impact Post-Peak (7-9 PM) (kW)	95% CI Lower	95% CI Upper
Opt-in TOU, No IHD Offer	-0.03	-0.07	0.00	0.00	-0.04	0.03
Opt-in TOU, IHD Offer	0.00	-0.03	0.03	0.02	-0.01	0.04
Default TOU, IHD Offer	0.00	-0.03	0.02	0.02	-0.01	0.04
Default TOU-CPP, IHD Offer	0.01	-0.03	0.06	0.02	-0.02	0.06

4.6 Energy Savings

In addition to calculating demand impacts during the TOU peak period, overall energy savings was estimated for each treatment. Table 4-7 summarizes this analysis. All four treatment groups showed energy savings of roughly 1% but only the impact estimate for the default TOU plan was statistically significant. Given the lack of load shifting seen in the prior section and the fact that the opt-in groups showed statistically significant load reductions during the peak period (as seen in Table 4-1), even the statistically insignificant impacts shown below may be taken as evidence of energy savings. With significant peak period reduction and no evidence of load shifting, the net result would need to be a modest reduction in overall energy use. Importantly, there is no evidence of an increase in overall electricity use in response to the lower off-peak prices that are in effect the majority of hours.

Table 4-7: Energy Savings for TOU Pricing Plans

Group	Design	Average Monthly Impact (kWh)	95% CI Lower	95% CI Upper	Monthly Reference Load (kWh)	Impact as % of Reference Load
Opt-in TOU, No IHD Offer	RCT	9.4	-6.8	21.6	818	1.1%
Opt-in TOU, IHD Offer		7.4	-7.9	26.7	843	0.9%
Default TOU, IHD Offer	RED	11.4	1.7	21.1	844	1.3%
Default TOU-CPP, IHD Offer		11.9	-8.6	32.4	885	1.3%

5 CPP Pricing Plan Impacts

This section summarizes the demand and energy impact estimates for the CPP pricing plans and for CPP days for the TOU-CPP pricing plan. As in Section 4, which covered the TOU treatments, the primary focus of this section is on average peak-period load impacts across all CPP events for the entire summer. We also examine how impacts vary across events and with fluctuations in temperature on event days. Impact comparisons are also made for customers who were and were not offered an IHD. As in the TOU section, additional estimates are developed for time periods that the experiment was not designed to produce, but that are nevertheless of interest.

5.1 Peak Period Load Reductions

The peak period for the CPP pricing plans is the same as for the TOU plans, 4 to 7 PM. In 2012, 12 CPP event days were called. However, on the first event day, June 20, 2012, customer notifications did not go out to everyone. As a result, the June 20 event day was not included in the analysis. For customers who did not receive notification for the June 20 event, an additional first event was called but not analyzed. This way, when the second event was called on July 10, it was the second event for all customers. In 2013, 12 events were called. Table 5-1 shows the dates, day of week and daily maximum temperature for each event day. Across the two summers, 2 events were called in June (although one was not included in the analysis for reasons stated above), 5 in July, 8 in August and 9 in September. The daily maximum temperature exceeded 90°F on all but 2 CPP days and was 95°F or greater on 16 out of the 24 event days. 5 of the 7 coolest event days occurred in September 2013.

Table 5-1: CPP Event Days for 2012 and 2013

2012 Events			2013 Events		
Date	Day of Week	Daily Maximum Temperature (°F)[22]	Date	Day of Week	Daily Maximum Temperature (°F)
20-Jun-12	Wednesday	Not Analyzed	28-Jun-13	Friday	104
10-Jul-12	Tuesday	101	2-Jul-13	Tuesday	103
12-Jul-12	Thursday	102	3-Jul-13	Wednesday	105
2-Aug-12	Thursday	99	19-Jul-13	Friday	99
8-Aug-12	Wednesday	100	15-Aug-13	Thursday	95
9-Aug-12	Thursday	103	19-Aug-13	Monday	104
10-Aug-12	Friday	103	6-Sep-13	Friday	94
14-Aug-12	Tuesday	96	9-Sep-13	Monday	101
15-Aug-12	Wednesday	95	10-Sep-13	Tuesday	87
12-Sep-12	Wednesday	92	13-Sep-13	Friday	91
13-Sep-12	Thursday	97	19-Sep-13	Thursday	91
14-Sep-12	Friday	91	30-Sep-13	Monday	78

[22] The maximum temperature reported here comes from a maximum temperature file provided by SMUD. In some cases it is slightly higher than the maximum hourly temperature in the hourly temperature file used for analysis purposes. In the comparable table in the interim report, the hourly maximum temperature was reported and it differs slightly on some days from the values reported here which is based on the data contained in the maximum temperature file provided by SMUD.

Table 5-2 shows the average impact across all CPP event hours for 2012, 2013 and the two years combined. Table 5-3 shows the p-values for each pairwise comparison of load impacts by pricing plan based on the two year average. Focusing first on the opt-in plans, the average load reductions for the opt-in CPP plan with no IHD offer was 0.49 kW, or roughly 20.9% of whole house load, and the average for the opt-in CPP plan with an IHD offer was 0.64 kW, or 25.1%. The difference in the two estimates is not statistically significant although this may primarily be due to the relatively large confidence bands around the average value for the opt-in group with no IHD offer. The sample size for this treatment group was small to begin with, with enrollment of only 212 at the start of summer 2012. By the end of summer 2013, the sample size had fallen to less than 150, which is why the confidence bands for the 2013 estimate are so large and also why they are larger for the two year average than for any of the other treatment cells. Indeed, as seen in Table 5-3, the average impact estimate across two years for the CPP plan with no IHD offer is not statistically different from any of the other three plans even though the absolute differences are roughly 50% in two cases.

Table 5-2: Load Impacts for CPP Pricing Plans

Group	Year	Average Impact per Customer (kW)	95% CI Lower	95% CI Upper	Reference Load (kW)	Impact as % of Reference Load	P Value (Difference Across Years)
Opt-in CPP, No IHD Offer	2012	0.52	0.26	0.78	2.38	21.9%	0.78
	2013	0.46	0.16	0.77	2.25	20.6%	
	Average	0.49	0.24	0.73	2.33	20.9%	n/a
Opt-in CPP, IHD Offer	2012	0.69	0.58	0.79	2.62	26.2%	0.27
	2013	0.60	0.48	0.72	2.48	24.1%	
	Average	0.64	0.54	0.73	2.53	25.1%	n/a
Default CPP, IHD Offer	2012	0.32	0.24	0.40	2.64	12.1%	0.16
	2013	0.41	0.32	0.50	2.47	16.5%	
	Average	0.36	0.28	0.44	2.56	14.0%	n/a
Default TOU-CPP, IHD Offer	2012	0.33	0.25	0.41	2.61	12.8%	0.48
	2013	0.29	0.20	0.38	2.43	11.9%	
	Average	0.31	0.24	0.39	2.54	12.3%	n/a

The default CPP plan had an average load reduction of 0.36 kW, or 14.0% of whole house load. This is roughly half as large as for the opt-in CPP plan with an IHD offer and the difference is statistically significant at the 99% confidence level. The default TOU-CPP plan produced an average reduction of 0.31 kW, or 12.3% of whole house load. The difference in impacts between the two default options is not statistically significant.

Table 5-3: P-values for Pair Wise Comparisons of Load Impacts Across CPP Pricing Plans (Based on Averages for 2012/2013 Combined)

Group	Opt-in CPP, No IHD Offer	Opt-in CPP, IHD Offer	Default CPP, IHD Offer	Default TOU-CPP, IHD Offer
Opt-in CPP, No IHD Offer	n/a	n/a	n/a	n/a
Opt-in CPP, IHD Offer	0.27	n/a	n/a	n/a
Default CPP, IHD Offer	0.33	0.00**	n/a	n/a
Default TOU-CPP, IHD Offer	0.18	0.00**	0.39	n/a

** Statistically significant at the 99% confidence level

The last column in Table 5-2 shows the results of tests for statistically significant differences across the two summers. As seen, although there were small decreases in the estimated impacts for three of the four plans, none of the differences across years are statistically significant. Section 5.2 compares impacts across years after controlling for changes in the population of participants due to customers that moved over the two summers.

Although the sample sizes used in SPO were not designed to estimate individual event day load impacts, it is still possible to do so, while recognizing that the confidence intervals around these estimates will be larger than for the average event day. Table 5-4 shows the estimated load impacts for each event day for one of the four treatments, the opt-in CPP rate with IHD offer.[23] As seen, the load impacts vary significantly across event days, from a low of 0.23 kW on the coolest day (September 30, 2013) when the maximum temperature was only 78°F, to a high of 1.0 kW on the hottest day (July 12, 2012), when the maximum temperature was 102°F. In general, load impacts are higher on hotter days than on cooler ones, although other factors such as day of week and random variation in loads mean that the relationship between temperature and load reductions is not perfectly correlated. Figures 5-1 and 5-2 show the relationship between weather and absolute and percentage load reductions, respectively. As seen, the slope of the line is much steeper when based on absolute load reductions than it is when based on percentage load reductions. Indeed, given that the reference load increases significantly with temperature, even if the percentage load reduction was constant across days, a graph of weather versus absolute load reductions would still have a positive slope. As seen in Figure 5-2, however, there is also a positive relationship between temperature and percent reduction, meaning that the average consumer on this rate reduces load more on both a percentage and absolute basis as the daily maximum temperature increases.

Another issue of interest is whether impacts drop off on the second and third day of multi-day events. In other words, do consumers tire of reducing load when it is hot several days in a row? There were two three-day event sequences across the 23 event days, both during the 2012 summer, and three two-day events, with one occurring in 2012 and two in 2013. Differences in impacts were small in four out of five multi-day sequences. The only one where the difference was relatively large was for the two-day event sequence on September 9 and 10 in 2013. However, this difference is due entirely to the drop off in

[23] Appendix C contains impact estimates for each hour of each event day for all four treatments.

temperature on the second event day, when the maximum temperature was only 87°F, compared with 101°F on the prior day. Indeed, the percentage reduction across those two days was nearly identical.

Table 5-4: Event Day Load Impacts for Opt-in CPP with IHD Offer

Date	Day of Week	Daily Maximum Temp (°F)	Load Reduction	95% CI Lower	95% CI Upper	Reference Load	% Impact
10-Jul-12	Tuesday	101	0.84	0.66	1.02	2.70	30.9%
12-Jul-12	Thursday	102	1.00	0.80	1.20	3.13	32.1%
2-Aug-12	Thursday	99	0.59	0.41	0.77	2.61	22.6%
8-Aug-12	Wednesday	100	0.69	0.52	0.86	2.63	26.4%
9-Aug-12	Thursday	103	0.84	0.65	1.03	2.97	28.2%
10-Aug-12	Friday	103	0.90	0.70	1.10	3.16	28.4%
14-Aug-12	Tuesday	96	0.70	0.53	0.87	2.66	26.3%
15-Aug-12	Wednesday	95	0.65	0.48	0.82	2.60	25.1%
12-Sep-12	Wednesday	92	0.48	0.32	0.64	2.00	23.9%
13-Sep-12	Thursday	97	0.45	0.28	0.62	2.16	20.7%
14-Sep-12	Friday	91	0.41	0.24	0.58	2.14	19.0%
2012 Average	n/a	n/a	**0.69**	**0.58**	**0.80**	**2.62**	**26.3%**
28-Jun-13	Friday	104	0.68	0.45	0.91	3.14	21.5%
2-Jul-13	Tuesday	103	0.95	0.73	1.17	3.31	28.6%
3-Jul-13	Wednesday	105	0.94	0.71	1.17	3.49	27.0%
19-Jul-13	Friday	99	0.68	0.47	0.89	2.72	25.1%
15-Aug-13	Thursday	95	0.53	0.33	0.73	2.46	21.7%
19-Aug-13	Monday	104	0.72	0.50	0.94	3.10	23.1%
6-Sep-13	Friday	94	0.46	0.27	0.65	1.90	24.4%
9-Sep-13	Monday	101	0.73	0.52	0.94	2.79	26.3%
10-Sep-13	Tuesday	87	0.55	0.36	0.74	2.04	26.9%
13-Sep-13	Friday	91	0.35	0.15	0.55	1.93	17.9%
19-Sep-13	Thursday	91	0.34	0.14	0.54	1.59	21.2%
30-Sep-13	Monday	78	0.23	0.03	0.43	1.22	18.8%
2013 Average	n/a	n/a	**0.60**	**0.48**	**0.72**	**2.48**	**24.1%**

Figure 5-1: Maximum Temperature and Absolute Load Reduction for Opt-in CPP with IHD Offer

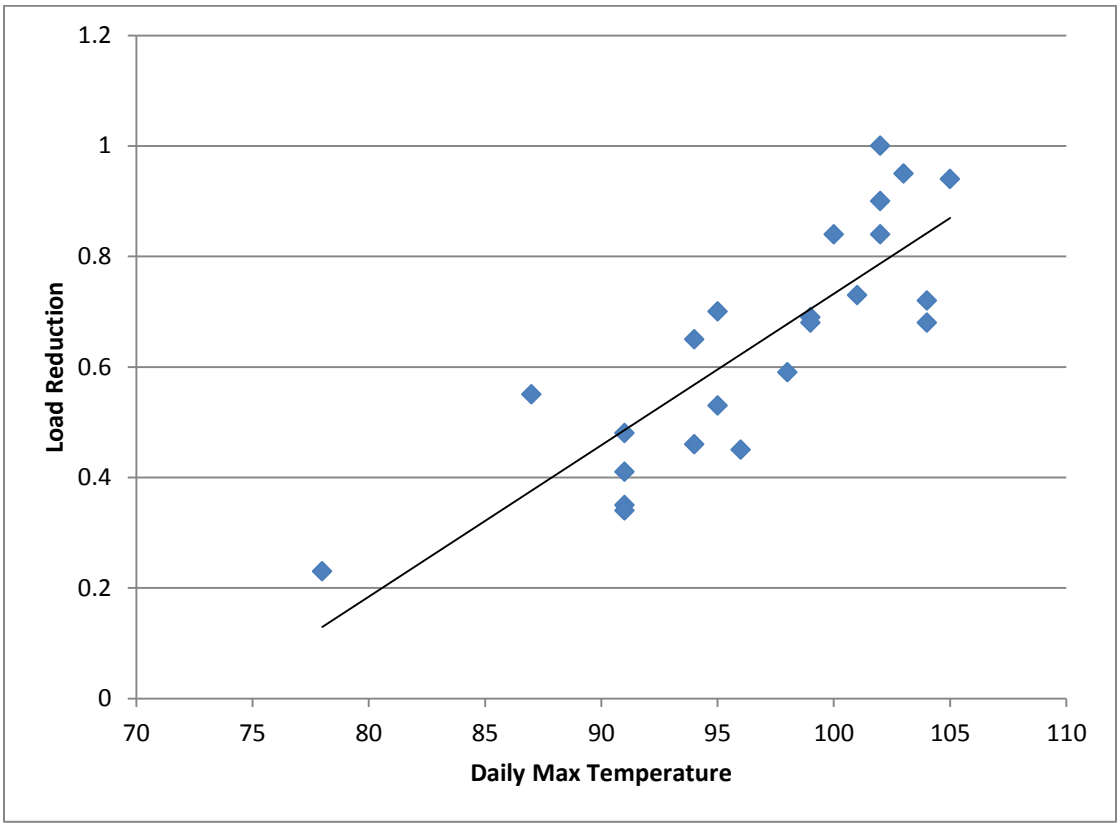
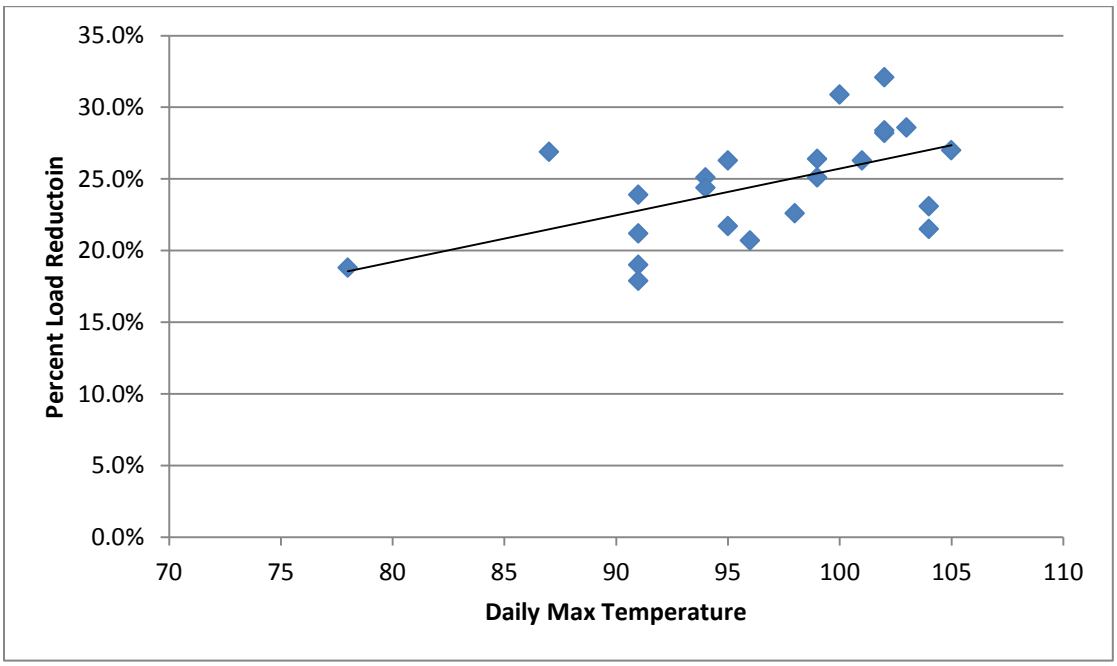


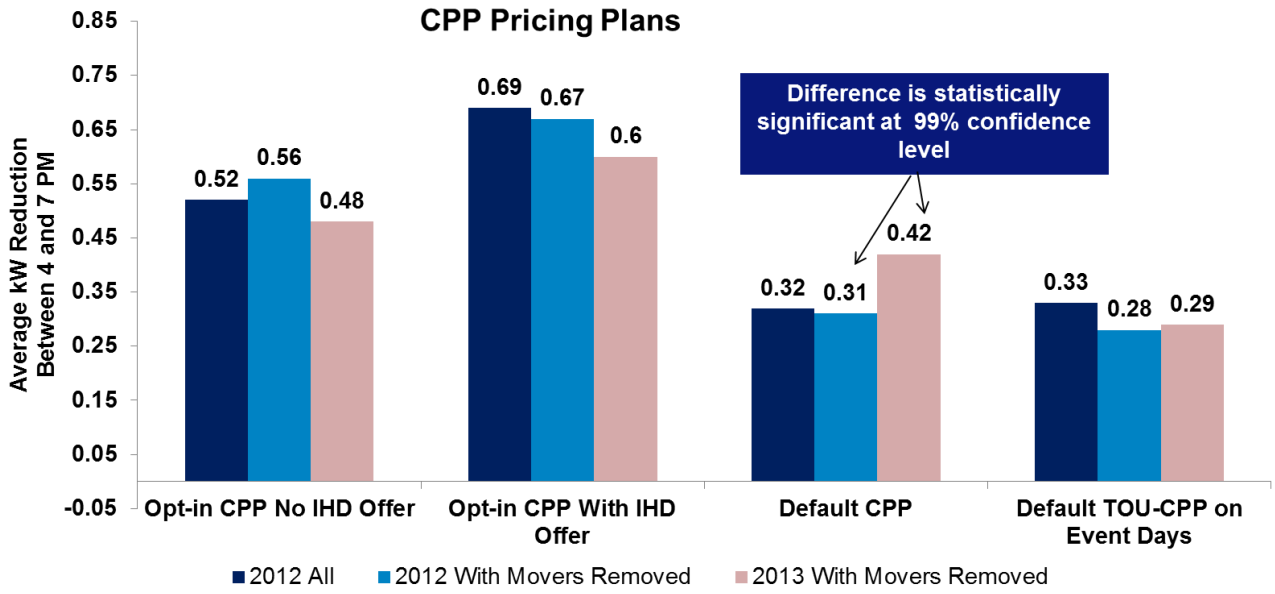
Figure 5-2: Maximum Temperature and Percentage Load Reduction for Opt-in CPP with IHD Offer



5.2 Impact Persistence

Figure 5-3 shows the load impacts for 2012 and 2013 for the population of customers who did not move over that time period. As was seen in Section 4.2 for the TOU pricing plans, after controlling for movers, differences across years were statistically significant for only one of the four pricing plans, in this case for the default CPP plan. It should be noted that the significant difference shows an increase in impacts in the second summer, not a decrease. It would appear that default customers who stayed on the pricing plan became more adept at responding to CPP event notifications than they were in the first summer.

Figure 5-3: Load Impacts for Each Summer for CPP Customers Who Did Not Move During the Study Period



5.3 Load Impacts by Customer Type

Table 5-5 shows the average load impact across event days in both years by pricing plan and EAPR status. In all cases, the impact estimates for non-EAPR customers are larger than for EAPR customers, although for the default TOU-CPP plan, the difference is relatively small. The load impact for EAPR customers for the opt-in CPP plan with no IHD offer is negative and not statistically significant. However, the sample size for this group is quite small, with 65 customers on average in summer 2012 and only 51 customers on average in summer 2013. As such, it may be inappropriate to conclude from this evidence that EAPR customers on this pricing plan are unresponsive to the CPP price signal. It may simply be that the magnitude of their price responsiveness is too small to detect given the small sample size for this group. When comparing impacts between EAPR and non-EAPR customers, it is important to note the percentage impact as well as the absolute impact. Depending on the pricing plan, there is a 10% to 35% difference in reference loads between EAPR and non-EAPR customers and this difference explains some of the difference in absolute impacts.

Table 5-5: 2012/2013 Average Load Impacts by EAPR Status for CPP Pricing Plans

Group	EAPR					Non-EAPR				
	Impact	95% CI Lower	95% CI Upper	Reference Load	% Impact	Impact	95% CI Lower	95% CI Upper	Reference Load	% Impact
Opt in CPP, No IHD	-0.03	-0.38	0.32	1.84	-1.7%	0.69	0.38	1.00	2.51	27.6%
Opt in CPP, IHD Offer	0.30	0.16	0.44	2.18	13.7%	0.76	0.63	0.88	2.65	28.6%
Default CPP-TOU	0.26	0.13	0.40	2.23	11.9%	0.32	0.23	0.40	2.60	12.3%
Default CPP	0.22	0.10	0.35	2.35	9.5%	0.40	0.31	0.49	2.61	15.2%

Table 5-6 shows the average load impacts by pricing plan and usage quartile based on average summer usage. Estimated load impacts are between 4 and 7 times larger for customers in the highest usage quartile compared to those in the lowest. Much of this variation is due to differences in the reference loads, which are between 5 and 6 times larger for high quartile customers compared to the lowest quartile group. The percentage impacts are relatively constant across usage quartiles. Once again, when comparing impacts across pricing plans, it is important to keep in mind that the opt-in sample sizes for the CPP group with no IHD is small, with only about 50 customers in each of the four usage bins. The samples sizes for all of the other plans are reasonably large, with between 150 and 350 in each bin for each pricing plan. The significant increase in the magnitude of the absolute load reductions as usage increase suggests that any opt-in program will likely be more cost effective it if targets high users unless such users are significantly less likely to enroll in the program.

Table 5-6: 2012/2013 Average Load Impacts by Usage Quartile for CPP Pricing Plans (Bin 1 is the lowest usage quartile, Bin 4 is the highest usage quartile)

Group	Bins	Reference Load	Impact	Percent Impact	95% CI Lower	95% CI Upper
Opt in CPP, No IHD Offer	1	0.72	0.16	21.9%	-0.07	0.38
	2	1.65	0.40	24.0%	-0.02	0.81
	3	2.63	0.58	22.2%	0.11	1.06
	4	4.27	1.04	24.3%	0.08	1.99
Opt in CPP, IHD Offer	1	0.83	0.26	31.3%	0.14	0.38
	2	1.76	0.53	29.8%	0.38	0.67
	3	2.68	0.72	26.9%	0.52	0.92
	4	4.06	1.05	25.7%	0.76	1.34
Default TOU-CPP, IHD Offer	1	0.68	0.11	16.3%	0.03	0.19
	2	1.45	0.16	11.2%	0.05	0.27
	3	2.22	0.35	15.8%	0.20	0.50
	4	3.75	0.59	15.6%	0.39	0.79
Default CPP, IHD Offer	1	0.73	0.15	20.6%	0.07	0.23
	2	1.50	0.23	15.3%	0.12	0.34
	3	2.42	0.41	16.7%	0.25	0.56
	4	3.90	0.62	16.0%	0.41	0.84

5.4 Load Impacts Outside the Peak Period

Table 5-7 shows the estimated impacts for the two hours immediately before and after the event period for the average event day. This analysis focuses on determining if pre-cooling behavior occurs before the event period and if a snapback effect can be observed after the event period when customers might adjust their thermostat to a cooler temperature or conduct activities that they avoided doing during the high priced event period. The values in the table for the pre-peak period represent the hours from 2 to 4 PM and the post event hours are from 7 to 9 PM. For two of the four groups, opt-in CPP with no IHD offer and default TOU-CPP, there are no statistically significant impacts in the pre-event period. In the post event period, the impacts are not statistically significant for three of the four pricing plans. Impacts in both the pre- and post-event periods are statistically significant for the opt-in CPP plan with the IHD offer. Notably, the post-treatment effect shows that the peak period reductions continue beyond the event period rather than translate into a snapback effect as is sometimes seen with load control and other demand response programs. The impact in the pre-treatment period is also statistically significant for the default CPP group. For the opt-in group with the IHD offer, the pre- and post-period load reductions, roughly 0.12 kW in both periods, are equal to about 20% of the estimated load reduction during the peak period. Similarly, the pre-event load reduction for default CPP is almost 20% of the peak period load reduction.

Table 5-7: 2012/2013 Impacts Before and After Peak Period on Event Days for CPP Pricing Plans

Group	Average Impact Pre-Peak (kW)	95% CI Lower	95% CI Upper	Average Impact Post-Peak (kW)	95% CI Lower	95% CI Upper
Opt-in CPP, No IHD Offer	0.01	-0.20	0.21	-0.11	-0.30	0.07
Opt-in CPP, IHD Offer	0.12	0.04	0.21	0.12	0.05	0.20
Default CPP, IHD Offer	0.07	0.02	0.12	0.04	-0.01	0.10
Default TOU-CPP, IHD Offer	0.04	-0.01	0.10	0.04	-0.02	0.09

From the perspective of cost-effectiveness, it is useful to know if there are spillover effects from event based tariffs on non-event days. Put another way, is there evidence that customers make behavioral adjustments that carryover to days on which the time-variant rate is not in effect. Table 5-8 shows the estimated load impacts during the peak period on nonevent days. The estimated peak period reduction on nonevent days is statistically significant for three of the four pricing plans, and is positive but insignificant for the opt-in CPP plan with no IHD offer. For two of the pricing plans, opt-in and default CPP with an IHD offer, the nonevent day impacts are roughly one quarter as large as the impacts on event days summarized in Table 5-2. For the default TOU-CPP plan, the nonevent day impacts are almost half as large as the event day impacts. The fact that the TOU-CPP impacts are as large as they are is logical since peak-period pricing is in effect on those days. However, there is no price signal in effect to drive demand reductions on nonevent days for the other two pricing plans. These results are consistent with the hypothesis that CPP customers may adjust their thermostat settings on all weekdays in order to avoid the higher event day prices and/or permanently adjust their behavioral patterns for other end uses on all weekdays.

Table 5-8: 2012/2013 Average Peak Period Impacts on Non-Event Days for CPP Pricing Plans

Group	Average Impact During Peak Hours on Nonevent Weekdays (kW)	95% CI Lower	95% CI Upper	% of Event Day Impact
Opt-in CPP, No IHD Offer	0.04	-0.13	0.21	8%
Opt-in CPP, IHD Offer	0.15	0.08	0.21	23%
Default CPP, IHD Offer	0.10	0.06	0.15	28%
Default TOU-CPP, IHD Offer	0.14	0.09	0.19	45%

An important corollary of the above findings regarding statistically significant load reductions on nonevent days is that within-subjects analysis of load impacts based only on post treatment period data would significantly understate the load impacts on event days. Such analysis, which is often used to estimate impacts for CPP programs or pilots where randomly selected control groups are not available, relies on loads on hot-nonevent days to estimate reference loads. The evidence presented here showing significant reductions on these nonevent days means that this type of analysis will produce impact estimates that are downward biased. An alternative approach to impact estimation when randomly chosen control groups are not available is to develop a control group using statistical matching methods. If the matching is based on proxy days from the post treatment period, the bias would be the same as for a within-subjects analysis. On the other hand, if pretreatment data is used for matching, no such bias would exist. A comparison of load impacts based on the RCT/RED designs used in the SPO, within-subjects analysis and statistical matching can be found in Section 9 of the SPO Interim Report.

5.5 Overall Energy Savings

Table 5-9 contains estimates of overall energy savings for customers on CPP rates. In this analysis, the monthly usage of each treatment and control group was compared for each month across the two summers. Pretreatment data from the summer of 2011 was also included to account for any differences between the groups before the treatment began. For opt-in CPP with no IHD offer and default TOU-CPP, energy savings were small and were not statistically significant. However, for both the opt-in and default CPP groups that included an IHD offer, energy savings were equal to between 2.7% and 3.6% of average monthly electricity use. This result is consistent with the prior finding that these participants had large reductions during the peak period and also showed statistically significant reductions in the pre-event period. The opt-in group also showed statistically significant reductions in the post event period.

Table 5-9: 2012/2013 Average Energy Savings for CPP Pricing Plans

Group	Design	Average Summer Energy Savings (kWh)	95% CI Lower	95% CI Upper	Monthly Reference Load (kWh)	Impact as % of Reference Load
Opt-in CPP, No IHD Offer	RED	-7.7	-68.7	53.3	758	-1.0%
Opt-in CPP, IHD Offer		30.1	3.3	56.9	856	3.5%
Default CPP, IHD Offer		22.8	6.2	39.4	864	2.6%
Default TOU-CPP, IHD Offer		11.9	-8.6	32.4	885	1.3%

5.6 TOU Impacts on CPP Event Days

When comparing load impacts and cost-effectiveness for TOU and CPP pricing plans, it is useful to examine the load reductions from TOU rates under the same weather conditions as those that occur on CPP days since load impacts for TOU rates increase with temperature. Table 5-10 shows the average impact for both CPP and TOU rates across the 23 historical event days used in the analysis. For convenience, it also shows the average impacts for TOU plans on the average weekday, which were previously shown in Table 4-1. Table 5-11 shows the results from the tests to determine whether differences across pricing plans are statistically significant. Of particular interest is whether there are statistically significant differences in peak period reductions under CPP event-like weather conditions for CPP and TOU pricing plans.

Table 5-10: Peak Period Load Reductions for All Pricing Plans

Group	CPP Day Impacts			Average Weekday Impacts		
	Impact	Reference Load	% Impact	Impact	Reference Load	% Impact
Opt in TOU, IHD Offer	0.32	2.38	13.3%	0.21	1.79	11.9%
Opt in TOU, No IHD Offer	0.23	2.24	10.1%	0.16	1.72	9.4%
Opt-in CPP, IHD Offer	0.64	2.53	25.1%	n/a	n/a	n/a
Opt-in CPP, No IHD Offer	0.49	2.33	20.9%	n/a	n/a	n/a
Default TOU, IHD Offer	0.15	2.47	5.9%	0.11	1.86	5.8%
Default CPP, IHD Offer	0.36	2.56	14.0%	n/a	n/a	n/a
Default TOU-CPP, IHD Offer	0.31	2.54	12.3%	0.17	1.91	8.7%

As seen in Table 5-10, impacts for TOU pricing plans are significantly higher on CPP days than on the average summer weekday. The ratio of load reductions on CPP days to non-CPP days ranges from a low of 1.25 for default TOU to a high of 1.91 for the opt-in TOU plan with no IHD offer. The ratios for the default TOU-CPP plan and the opt-in TOU plan with the IHD offer are 1.82 and 1.52, respectively. For three of the four pricing plans, these differences are largely due to differences in the reference loads between CPP and non-CPP days, as indicated by little change in the percentage load reductions on the two day types. For the default TOU-CPP plan, the percentage load reduction is higher on CPP days than on non-CPP days. This is logical since prices are also higher on CPP days for this pricing plan.

Table 5-11 shows the results of statistical tests to determine whether the load impacts are significantly different between TOU and CPP rates on CPP days for the relevant comparisons. As seen, CPP pricing plans produce significantly greater impacts on CPP days than TOU plans in all cases, which is to be expected since prices are significantly higher under CPP plans compared with comparable TOU plans. In each relevant comparison, the load reductions are roughly twice as large under the CPP plan compared with the comparable TOU plan.

Table 5-11: Pairwise Comparison of Load Reductions for CPP and TOU Pricing Plans on CPP Days

Group	Opt-in TOU, IHD Offer	Opt-in TOU, No IHD Offer	Default TOU, IHD Offer
Opt-in CPP, IHD Offer	0.00**	n/a	n/a
Opt-in CPP, No IHD Offer	n/a	0.05*	n/a
Default CPP, IHD Offer	n/a	n/a	0.00**

*Statistically significant at the 90% level; ** Statistically significant at the 99% level

6 The Influence of In Home Displays

SMUD's SPO was designed to assess the impact of the offer of an IHD on customer acceptance of opt-in time-variant pricing plans by marketing TOU and CPP rates with and without the offer of an IHD. This issue is analyzed in Section 8. As discussed there, the offer of a free IHD does not increase customer acceptance rates for the time-variant pricing plans included in the SPO.

Another useful investigation concerns the acceptance of and connection rates for IHDs among treatment groups that received an IHD offer. What percent of customers who received an IHD offer accepted it and what percent of those customers receiving an IHD connected the device with their meter? These issues are discussed below in Section 6.1. A related issue concerns the characteristics of customers who do and don't request an IHD when given the option and who do and don't connect the device once it is received. These issues are discussed in Section 6.2.

A third important issue is whether IHDs influence consumer electricity use. The SPO was designed to determine if there are differences in load impacts for customers who were *offered* an IHD as part of the rate offer, and those who were *not offered* an IHD as part of the rate offer. As seen in Sections 4 and 5, there is some difference in load impacts across treatment cells that did and did not include an IHD offer. However, testing the load impact of an IHD *offer* is different from testing the load impact of an IHD, because many people who were offered an IHD did not accept one and many who accepted an IHD did not use it. Given the general interest in whether or not IHDs influence usage behavior, it is likely that some readers will draw conclusions about the influence of IHDs by observing these differences. To reduce the likelihood that readers will draw incorrect conclusions about the influence of IHDs on energy use and demand response, we examine this issue in Section 6.3.

6.1 IHD Acceptance and Use

As previously discussed, two of the opt-in treatment groups were also offered a free IHD if they enrolled on the rate. Acceptance of the IHD was not a condition of going on the pricing plan. Opt-in customers could indicate at the time of enrollment whether or not they wanted the IHD. If they did, the IHD was mailed to them pre-commissioned, so that when they unpacked it and turned it on, it was supposed to automatically connect with their meter and start displaying information.

All customers selected for the default pricing plans were offered a free IHD. Because customers were automatically enrolled unless they opted-out, there was not the same opportunity to simply "check a box" at the time of enrollment to indicate whether or not they wanted an IHD. Instead, those who wanted an IHD had to take a proactive step to request it. Put another way, the transaction costs associated with requesting an IHD were higher for default customers compared with opt-in customers. In addition, customer inertia may reduce acceptance rates for default customers compared with opt-in customers who were already engaged in a transaction when asked to indicate their interest in receiving an IHD. Once requested, as with the opt-in treatment groups, a pre-commissioned IHD was mailed to customers and all that was needed to use it was to unpack it and turn it on.

In summer 2012, SMUD was able to determine from the meter data management system the number of IHD devices that were connected to meters at any point in time but was not able to link those devices to

individual customer accounts. However, in summer 2013, data became available that provided a daily log for each customer indicating whether or not their IHD was connected to their meter.[24] As such, for the second year of the pilot, it was possible to identify customers who had their IHDs connected during the entire summer, those who never had it connected during summer 2013, and those who were connected on some days and not on others.

For each treatment group, Table 6-1 shows the number of customers who requested an IHD at the beginning of the pilot, the IHD acceptance rate (the number accepting divided by the number offered), the number of customers who accepted an IHD that were still enrolled at the beginning of the summer period in 2013 and, of those, the percent that had their device connected with their meter during the entire summer, the percent that were connected at some point in time during summer 2013 and the percent that were never connected in 2013.

Table 6-1: IHD Acceptance and Connection Rates

Group	Enrolled 6/1/12	# That Accept IHD	Acceptance Rate	# of Customers With IHDs Still Enrolled as of 6/1/13	% Connected All the Time	% Connected Some of the Time	% Never Connected
Opt-in CPP, IHD Offer	1,569	1,498	95%	1,195	11.6%	27.4%	61.0%
Opt-in TOU, IHD Offer	2,092	2,017	96%	1,597	11.6%	22.8%	65.6%
Default TOU-CPP, IHD Offer	588	136	23%	112	18.8%	39.3%	42.0%
Default CPP, IHD Offer	701	167	24%	140	14.3%	42.9%	42.9%
Default TOU, IHD Offer	2,018	418	21%	363	18.2%	23.1%	58.7%

As seen in the table, roughly 96% of opt-in customers requested an IHD whereas fewer than 25% of default customers did so. As seen in the last three columns in the table, roughly two thirds of opt-in customers who accepted an IHD and who were still enrolled at the beginning of the 2013 summer never had their device connected in 2013. This "never connected rate" was much lower for two of the three default groups, equal to roughly 42% for the default TOU-CPP and CPP groups. The higher connection rate for default customers compared with opt-in customers is consistent with a hypothesis that, since default customers had to take a proactive step to request the device compared with the passive "check the box" approach for opt-in customers, they were more invested in using the device once it arrived. As

[24] Reporting functionality from the HAN Communication Manager (HCM) had not been established prior to the launch of the technology and took approximately a year after go-live to established automated reporting out of HCM. However, it should be noted that the functionality was available in HCM, but SMUD had not created business requirements to set-up that functionality before the program launch, primarily because reporting on IHD connectivity had not been part of the critical path for program launch or reporting to the DOE.

seen in Section 6.2, default customers who requested the device were much more engaged customers in that they had a higher propensity to participate in other SMUD programs. Why the "never connected rate" for default TOU customers is closer to that of opt-in customers than it is to that of the other default groups is unclear.

Although not shown in Table 6-1, it should be noted that roughly 70% of those who were connected some of the time had their devices communicating with their meters more than 50% of all summer days. Put another way, most of the customers that were connected some of the time were connected most of the time.

6.2 Customer Characteristics of IHD Users

For planning purposes, it is useful to examine the characteristics of customers who did and did not request an IHD and also the characteristics of those who had their IHD connected during the summer of 2013. Since nearly all opt-in participants requested an IHD, it was not possible to distinguish between those who did and did not request the technology for opt-in pricing plans. For default pricing plans, a binary outcome model (logit)[25] was estimated relating the likelihood of requesting an IHD to customer characteristics such as EAPR status, participation in other SMUD programs and other variables. Because the logit model is nonlinear, the estimated coefficients do not represent changes in the expected probabilities that would result from changes in the explanatory variables.[26] Such "marginal effects" provide meaningful interpretations of how different variables affect the likelihood of a given choice controlling for all other variables. For a logit model specification, marginal effects are calculated using a transformation of the parameter estimates that involves the logistic cumulative density function. Throughout the remainder of this report, the marginal effects (and not the estimated logit coefficients) are reported for all choice models.[27] The marginal effects show the change in the likelihood of the outcome variable given the presence of a particular characteristic for binary variables (e.g., participants in another SMUD program) or given a 1% change in the magnitude of a continuous variable (e.g., share of summer usage on peak).

Table 6-2 shows the marginal effects for a model relating the likelihood of requesting an IHD to customer characteristics. As seen in the first row of the table, the likelihood of requesting an IHD is 6% higher for EAPR pricing plan participants than for non-EAPR participants. There is no difference in the likelihood of requesting an IHD for CPP or TOU-CPP participants compared with TOU participants (as seen by the second and third rows in the table). The greater the share of summer electricity use that occurs during the peak hours from 4 to 7 PM, the greater the likelihood of requesting and IHD, but the magnitude of the influence is relatively small. A 10% increase in peak period usage as a percent of summer usage increases the likelihood of requesting an IHD by 1.6%. Participation in SMUD's EE

[25] Logit, probit and linear probability models were estimated and the alternative specifications produced results quite similar to those associated with the logit model.

[26] The specification of the logit model is Pr(accepting/connecting IHD) = $\exp(x'\beta)\,/(1+\exp(x'\beta))$, where the β terms are the coefficients to be estimated. This nonlinear specification ensures that the predicted probabilities will be between zero and one.

[27] All reported marginal effects are average marginal effects (AME) as opposed to marginal effects at the mean (MEM) or marginal effects at representative values (MER).

loan/rebate, EnergyHelp, Green Energy and MyAccount programs increases the likelihood of requesting an IHD by 6 to 9%.

Table 6-2: Likelihood of Requesting an IHD for Default Pricing Plans

Variable	Marginal Effect	Interpretation
EAPR status	0.059**	EAPR customers are 6% more likely to request an IHD than non-EAPR customers
CPP pricing plan	0.026	Participants on the default CPP pricing plan are not more or less likely to request an IHD than those on the TOU pricing plan
TOU-CPP pricing plan	0.017	Participants on the default TOU-CPP pricing plan are not more or less likely to request an IHD than those on the TOU pricing plan
Share of summer 2011 kWh consumed on peak	0.159+	Participants that use more of their total summer usage during the peak period are more likely to request an IHD
Carbon Offsets program	0.050	Participation in the Carbon Offsets program is not correlated with the likelihood of requesting an IHD
Received EE loan or rebate	0.058**	Participants in the EE load/rebate program are 6% more likely to request an IHD
EnergyHelp program	0.079**	Participants in the EnergyHelp program are 8% more likely to request an IHD
Green Energy program	0.059**	Participants in the Green Energy program are 6% more likely to request an IHD
Customer enrolled in MyAccount	0.087**	MyAccount customers are 9% more likely to request an IHD

**p<0.01; *p<0.05; +p<0.1

As was seen in Table 6-1, many customers who requested and received IHDs did not have the device connected during the summer of 2013 when connection rate data became available. Tables 6-3 and 6-4 show the marginal effects from a logit model that relates the likelihood of having the IHD connected during the summer of 2013 to customer and rate characteristics. The dependent variable equals 1 if the device was connected at any point in time during summer 2013, and 0 if it was never connected during that summer. Table 6-3 shows results for the opt-in pricing plans and Table 6-4 shows the same results for default pricing plans.

As seen in Table 6-3, EAPR customers on the opt-in pricing plans who requested an IHD were less likely to have had it connected in 2013 than non-EAPR customers. Customers on the opt-in TOU pricing plan were less likely than those on the CPP plan to have their IHD connected. Opt-in customers in the Carbon Offsets and EE loan/rebate programs were more likely to have had their IHD connected, but participants in the EnergyHelp program were significantly less likely to have had their device connected.

Participation in the Green Energy program is not correlated with the likelihood of having the IHD connected. MyAccount customers were 12% more likely to have had their IHD connected than non-MyAccount customers.

Table 6-3: IHD Connection Likelihood for Opt-in Pricing Plans (Among those requesting and receiving an IHD, the likelihood of the IHD being connected at some time during summer of 2013)

Variable	Marginal Effect	Interpretation
EAPR status	-0.103**	EAPR customers are 10% less likely to have had their IHD connected
TOU pricing plan	-0.041*	Participants on the opt-in TOU pricing plan are 4% less likely to have had their IHD connected than participants on the opt0in CPP pricing plan
Share of summer 2011 kWh consumed on peak	0.003**	Participants that use more of their total summer usage during the peak period are slightly more likely to have their IHD connected
Carbon Offsets program	0.153+	Carbon Offset customers are 15% more likely to have their IHDs connected (with confidence interval of 90%)
Received EE loan or rebate	0.066**	Participants in the EE loan or rebate program are 7% more likely to have their IHDs connected
EnergyHelp program	-0.102*	EnergyHelp participants are 10% less likely to have their IHDs connected
Green Energy program	0.022	Participation in the Green Energy program is not correlated with the likelihood of having an IHD connected
Customer enrolled in MyAccount	0.121**	MyAccount customers are 12% more likely to have their IHDs' connected

**p<0.01; *p<0.05; +p<0.1

Table 6-4 shows the marginal effects from the connection model for the default pricing plans. As with the opt-in plans, EAPR customers were less likely to have had their device connected in 2013 than non-EAPR customers. Participants in the CPP and TOU-CPP pricing plans were 15% more likely than TOU customers to have had the device connected, indicating that participants on dynamic rates may see greater value in using the IHD than those on static time-variant rate options. Customers that have higher usage on peak were slightly more likely to have had their device connected. Unlike with the opt-in plans, participation in other SMUD programs, except for MyAccount, was not correlated with the likelihood of having the IHD connected.

Table 6-4: IHD Connection Likelihood for Default Pricing Plans (Among those requesting and receiving an IHD, the likelihood of the IHD being connected at some time during summer of 2013)

Variable	Marginal Effect	Interpretation
EAPR status	-0.081+	EAPR customers are 8% less likely to have had their IHD connected
CPP pricing plan	0.147**	Participants on the default CPP pricing plan are 15% more likely to have had their IHD connected than participants on the default TOU pricing plan
TOU-CPP pricing plan	0.148**	Participants on the default TOU-CPP pricing plan are 15% more likely to have had their IHD connected than participants on the default TOU pricing plan
Share of summer 2011 kWh consumed on peak	0.005*	Participants that use more of their total summer usage during the peak period are slightly more likely to have their IHD connected
Carbon Offsets program	-0.078	Participation in the Carbon Offsets program is not correlated with the likelihood of having the IHD connected
Received EE loan or rebate	-0.014	Participation in the EE load/rebate program is not correlated with the likelihood of having the IHD connected
EnergyHelp program	-0.114	Participation in the EnergyHelp program is not correlated with the likelihood of having the IHD connected
Green Energy program	0.058	Participation in the Green Energy program is not correlated with the likelihood of having the IHD connected
Customer enrolled in MyAccount	0.163**	MyAccount customers are 16% more likely to have their IHDs' connected

**p<0.01; *p<0.05; +p<0.1

6.3 Load Impacts for Treatments With and Without an IHD Offer

As indicated previously, the SPO was designed primarily to examine the impact of the offer of an IHD on customer acceptance of time-variant rate options. The empirical evidence summarized in Section 8 shows that an IHD offer does not influence customer acceptance of the pricing plans. However, it is possible that those who accept an IHD respond more than those who do not. A comparison of load impacts for TOU and CPP plans with and without an IHD offer is a measure of the incremental effect of the offer, not necessarily the incremental impact of use of the IHD.

One estimate of the effect of the offer of an IHD on energy use can be developed by comparing the load reduction for opt-in TOU with and without an IHD offer and opt-in CPP with and without an IHD offer in

Tables 4-1 and 5-2. For the TOU case, the estimated load reduction for the opt-in TOU group receiving an IHD offer is 0.21 kW (for the two summers combined). Without an IHD offer, the impact is 0.16 kW. For the opt-in CPP plan, the estimated impacts with and without an IHD offer are 0.64 kW and 0.49 kW respectively. As seen in Table 4-2, the 0.05 kW difference for the TOU plan is statistically significant at the 90% confidence level. As seen in Table 5-3, although the 0.15 kW difference between the two groups for the CPP pricing plan is larger than the difference for the TOU plan, it is not statistically significant at the 90% confidence level, perhaps due to the small sample size for the opt-in CPP treatment with no IHD offer, which was roughly 200 in 2012 and had dwindled to roughly 150 by the end of the 2013 summer.

While it is tempting to consider these differences to equal the impact of the IHD offer on demand, and even more tempting to attribute the difference to the impact of the IHD, not just the offer, both conclusions are incorrect. The first is incorrect because the estimate does not take into account pretreatment differences between the groups that were and were not offered the IHD. Each estimate itself is internally valid and is based on a difference-in-differences regression, but the difference between the two estimates does not factor in pretreatment differences between the groups. As seen in Figures 6-1 and 6-2, there are small but meaningful differences in usage between the two groups during the pretreatment period. The difference during the peak period on the average weekday for the TOU groups is 0.06 kW and the difference for the CPP groups is 0.20 kW. When these pretreatment differences are subtracted from the observed difference during the treatment period, the estimated impact of the IHD is essentially 0 in the case of the TOU plan and is actually negative for the CPP plan. Put another way, after correcting for pretreatment differences, the offer of the IHD does not influence demand response for opt-in pricing plans.

Figure 6-1: Usage by TOU Opt-in Customers With and Without an IHD Offer

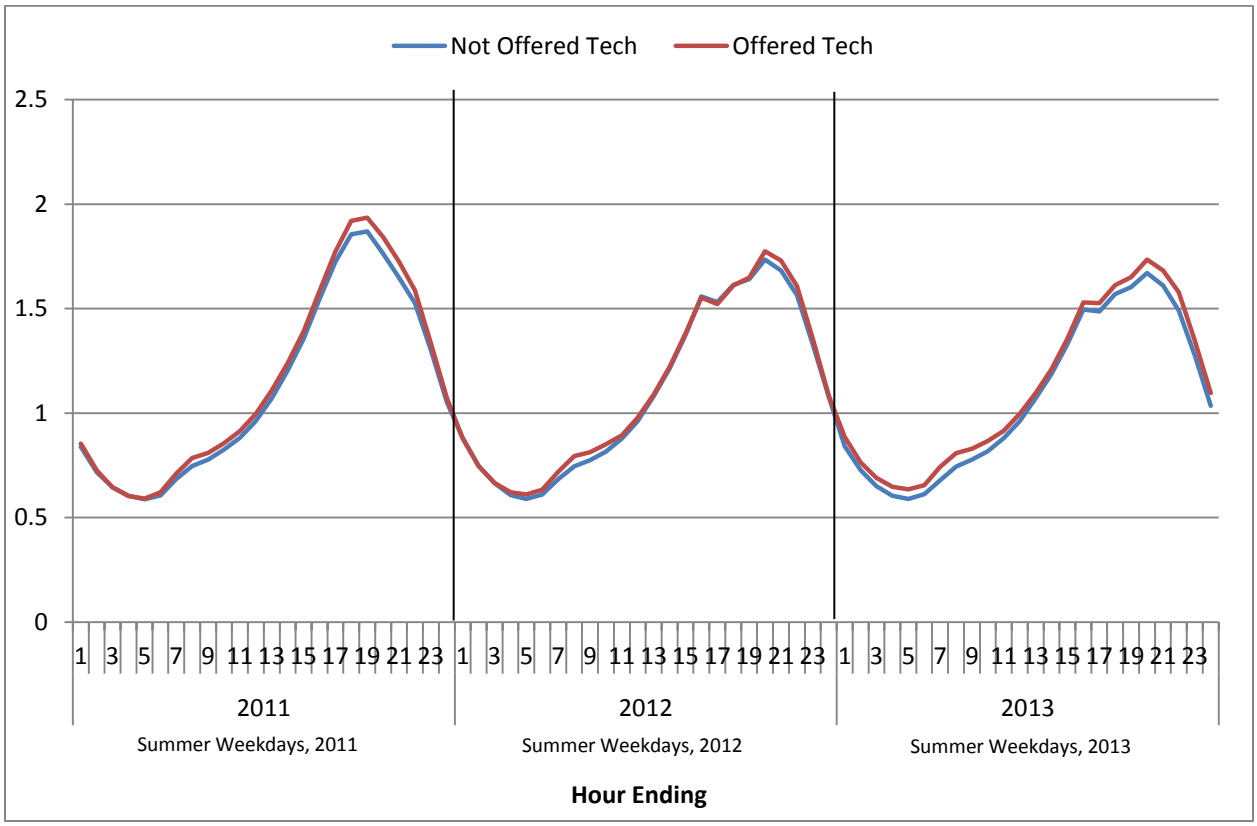
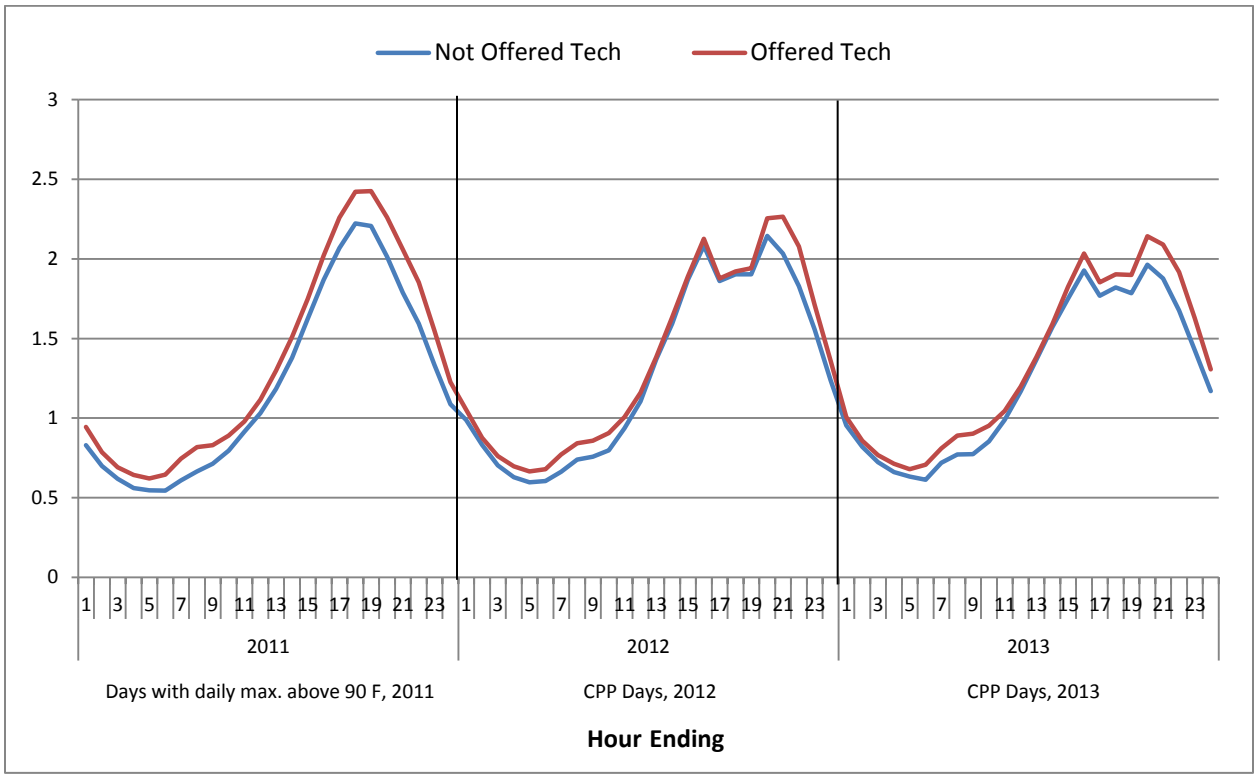


Figure 6-2: Usage by CPP Opt-in Customers With and Without IHD Offer



As previously discussed, nearly everyone in the opt-in pricing plans accepted an IHD although many did not connect it. A relevant question is whether those who did connect the device were more responsive to the price signals than those who did not. Figures 6-3 and 6-4 show hourly usage for opt-in TOU and opt-in CPP customers, respectively, during the pretreatment and treatment periods for customers that had their devices connected at least some of the time during the summer of 2013 and those that did not. Also included in the figures are loads for customers in the treatment groups who were not offered an IHD.[28]

Looking first at the opt-in TOU pricing plan (Figure 6-3), several things are noteworthy. Those who had their IHDs connected some or all of the time in 2013 had higher pretreatment peak period loads than those who did not. Those who were not connected (the largest share by far) had pretreatment loads nearly identical to TOU customers that were never offered an IHD. Connected customers were much more responsive than those who were not connected and also more responsive than those who were never offered an IHD. As evidenced by the pretreatment difference in loads, there is a strong selection effect among those who were connected. These customers are "peakier" and much more responsive than those that were not connected, but this greater responsiveness cannot be attributed to use of the IHD. While it is possible that some of this difference is attributable to the IHD, it is also possible that the entire difference is due to selection effects and that these customers are simply much more engaged in

[28] It should be noted that the pretreatment period loads for TOU customers are for the average weekday but the pretreatment loads for CPP customers are for days in which the average temperature during the peak period exceeded 90°F as these hot days are more representative of CPP event days.

managing their energy use than non-connected customers and that this engagement effect explains why they kept the IHD connected during this period and also why they responded more to the price signal.

Figure 6-3: Usage by Opt-in TOU Customers With Devices Connected and Not Connected in Summer 2013

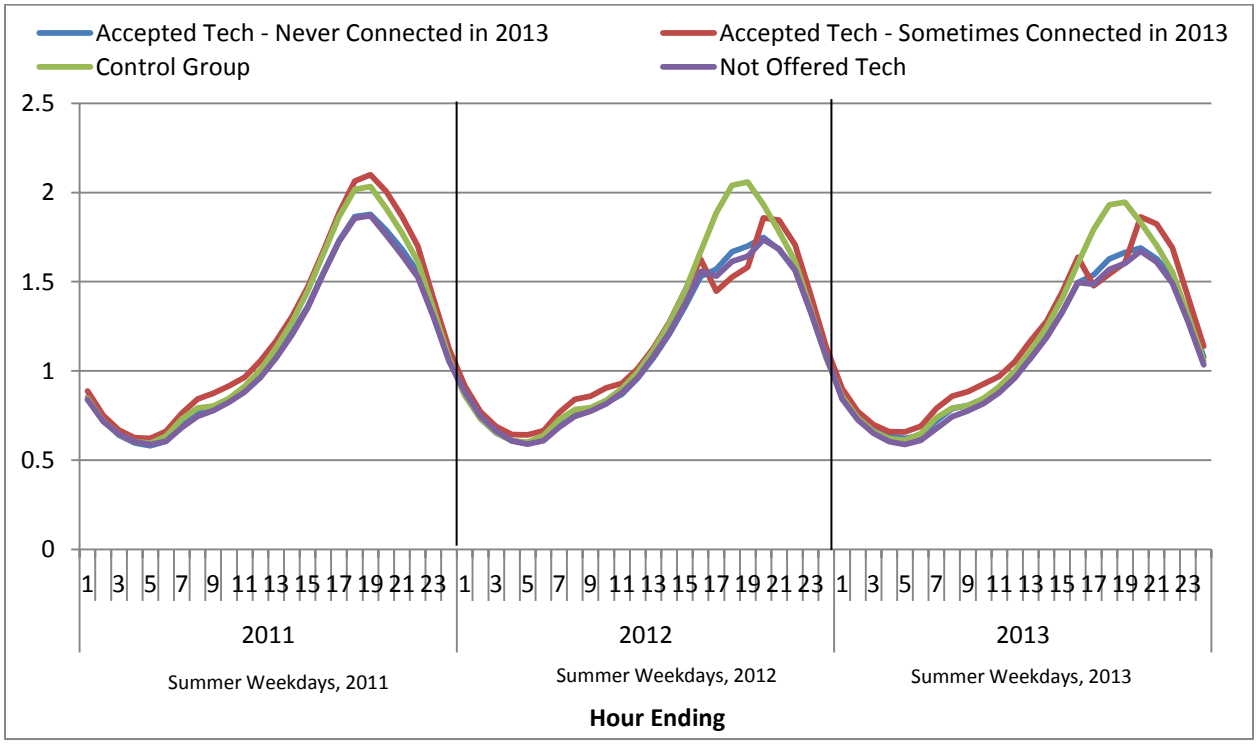
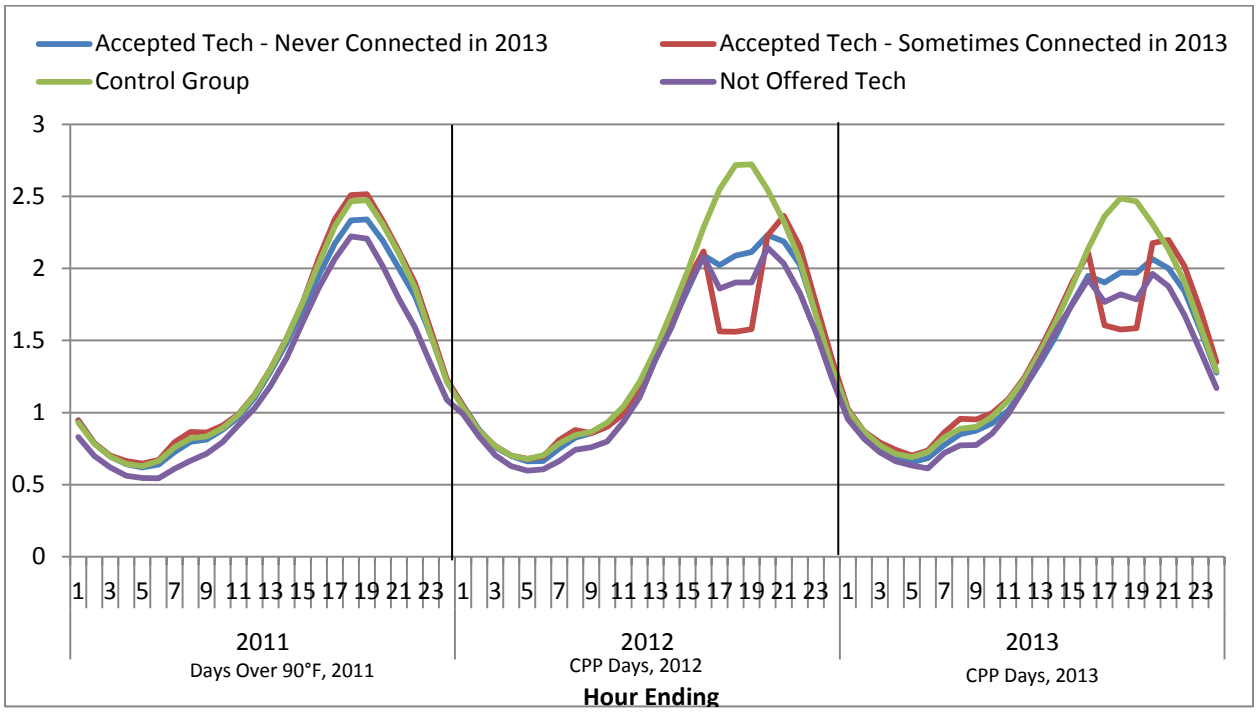


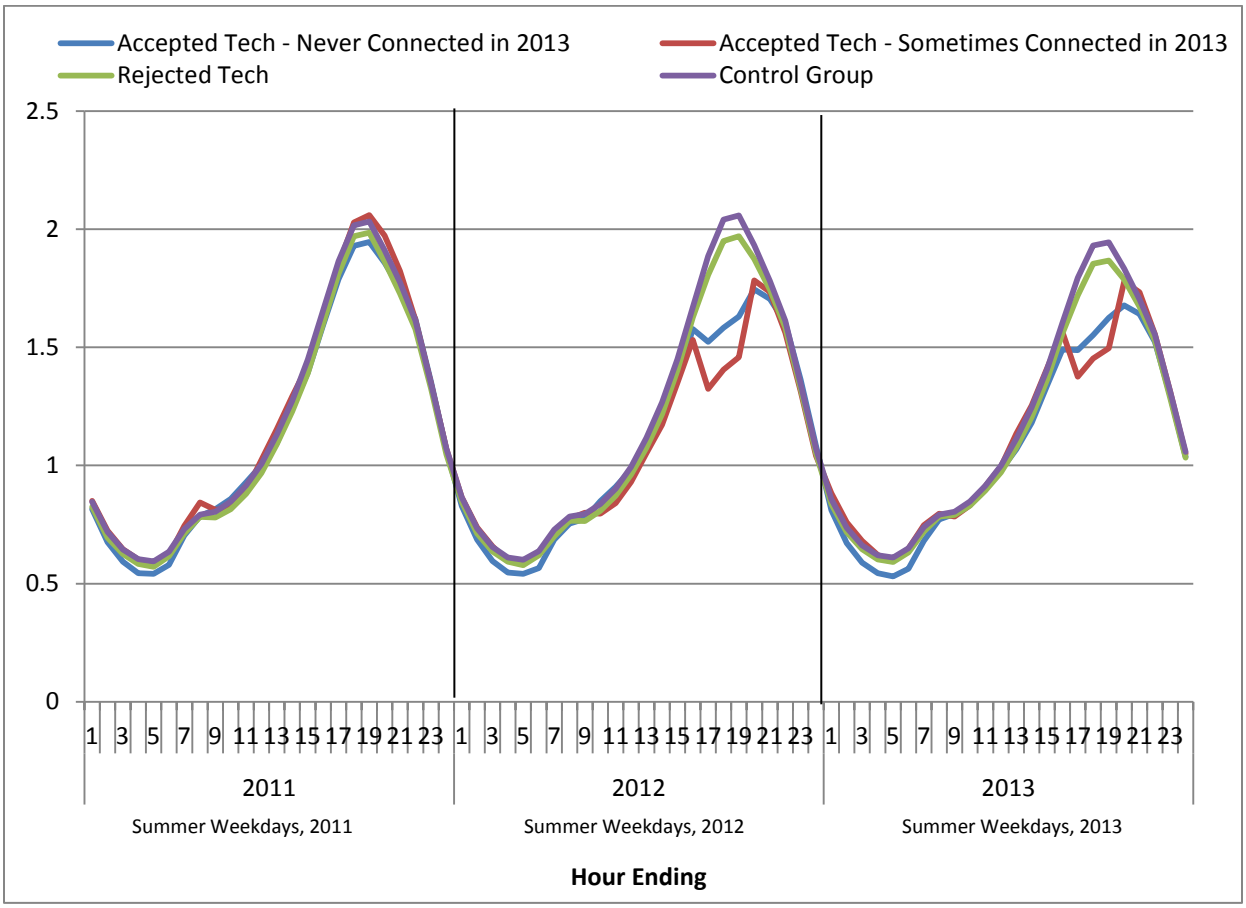
Figure 6-4: Usage by Opt-in CPP Customers With Devices Connected and Not Connected in Summer 2013



The same basic patterns observed for the opt-in TOU plan are seen for the opt-in CPP plan. Those who kept their devices connected during the summer of 2013 were much more responsive than those who did not. In this instance, however, there is a difference in the pretreatment period between those who accepted the IHD but were not connected in 2013 and those who were not offered the IHD.

Figures 6-5 through 6-8 show load shapes on the default pricing plans that were and were not connected. They also show loads for customers who rejected the offer of an IHD and for the control group for each pricing plan. As seen in Figure 6-5, customers who accepted an IHD offer were much more price responsive than those who did not. Indeed, the average response for those who did not appears to be minimal, although there is some reduction in usage during the peak period over the two years compared with the control group, but not enough to show the notch during the peak period that depicts a strong load reduction as is seen for the IHD accepting group.

Figure 6-5: Usage by Default TOU Customers who Did and Did Not Accept an IHD



Figures 6-6 and 6-7 both pertain to the default TOU-CPP plan. The first figure shows loads for the average weekday while the second represents loads on CPP days (and hot days during the pretreatment period). Figure 6-8 is for default CPP customers. In all cases, the same basic patterns are observed, the most notable being the strong selection effects at work for those who accepted an IHD and, among that group, those who were and were not connected in 2013.

Figure 6-6: Usage by Default TOU-CPP Customers who Did and Did Not Accept an IHD (Average Summer Weekday)

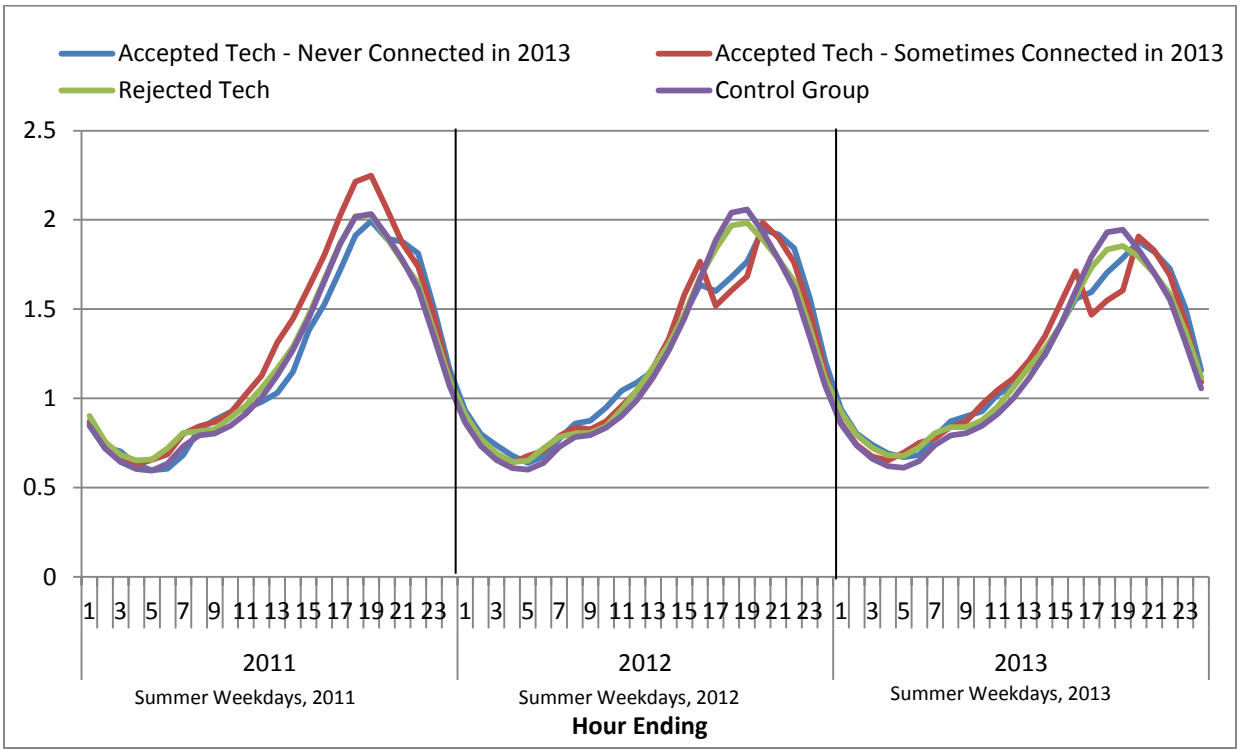


Figure 6-7: Usage by Default TOU-CPP Customers who Did and Did Not Accept An IHD (Hot, Non-event Days for Pretreatment Period)

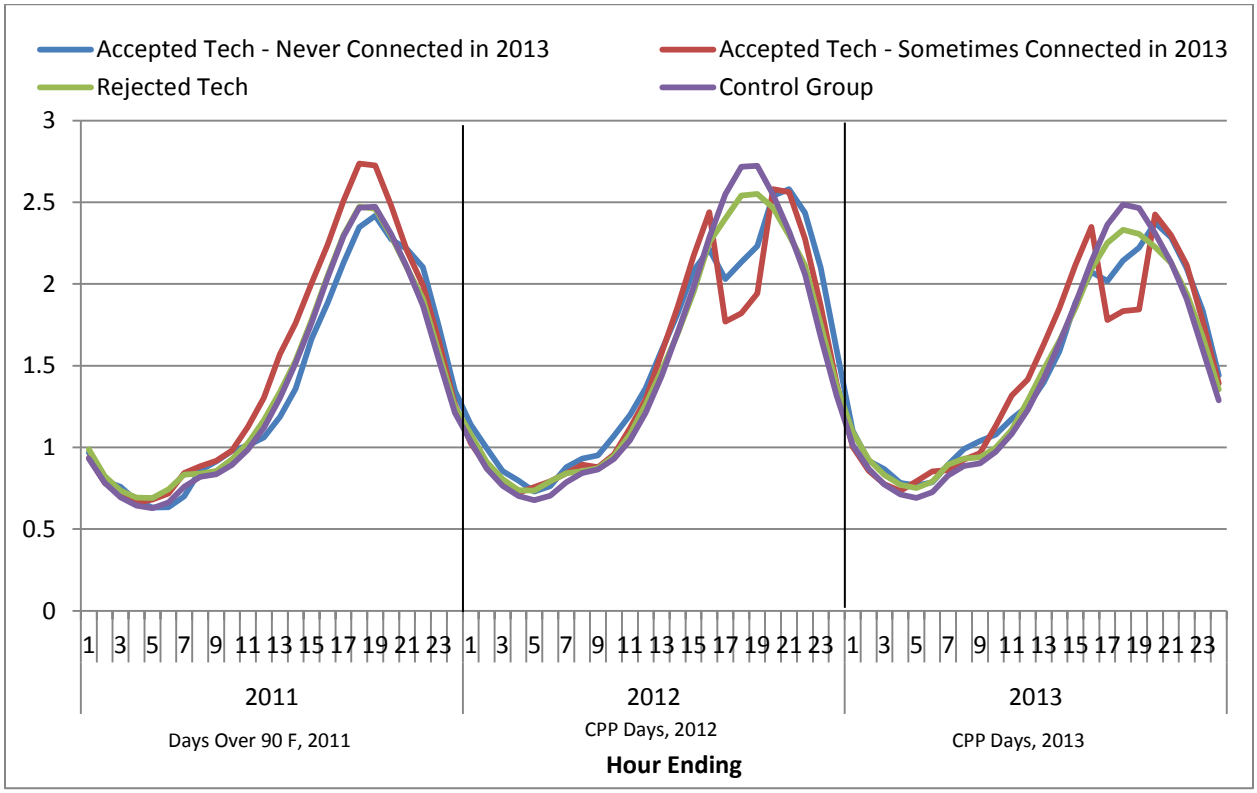
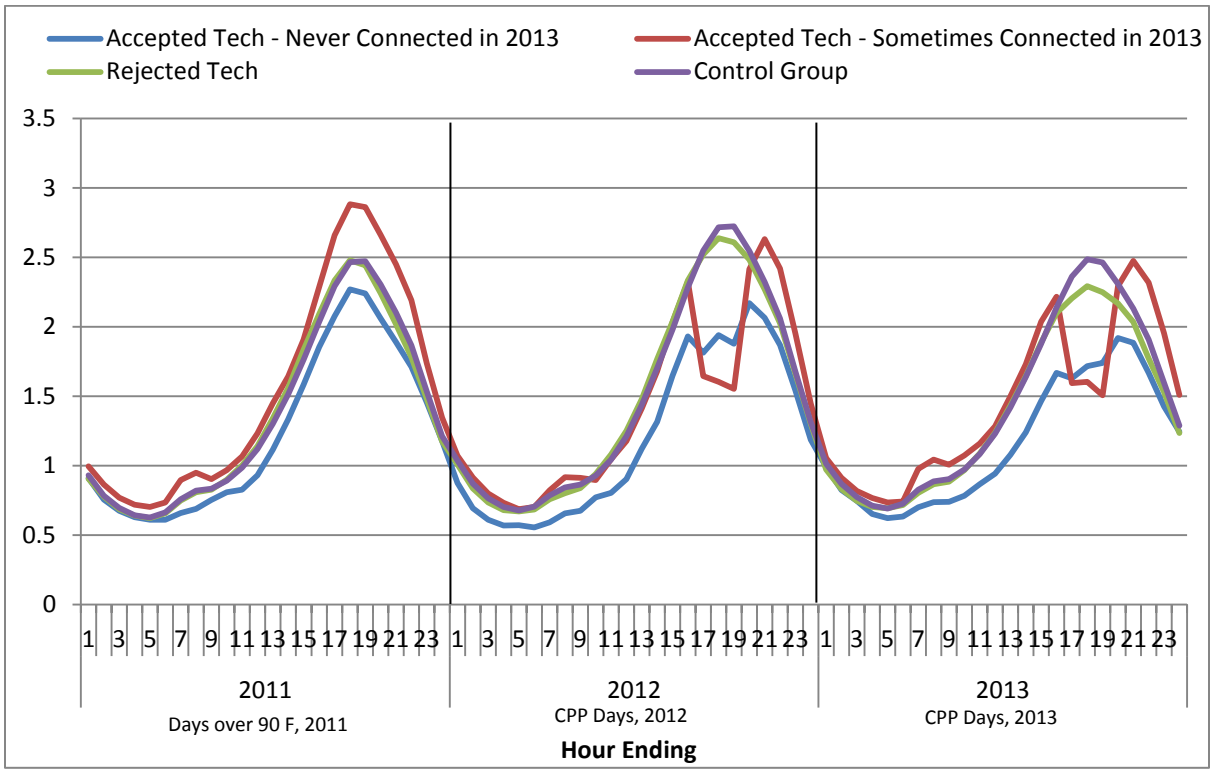


Figure 6-8: Usage by Default CPP Customers who Did and Did Not Accept An IHD



7 Price Elasticity Estimation

One of the primary goals of the SPO pilot was to determine the degree to which residential customers in SMUD's service territory respond to the price signals associated with time-varying rates. The impact estimates summarized in Sections 4 and 5 show that the average participant reduced load in response to the specific price signals tested in the SPO pilot. There is also interest in predicting how demand response might change if SMUD were to offer similar pricing plans but with different price ratios and levels than were tested in the SPO pilot. Price elasticities are a simple metric that quantifies the relationship between changes in price and changes in energy use. This section documents the development of price elasticity estimates based on the SPO results and shows how they can be used to predict changes in energy use as a function of changes in peak and off-peak prices.

7.1 Analysis Methodology

The SPO pilot was not designed specifically to estimate price elasticities for each pricing plan. A pilot designed to estimate price elasticities for a specific pricing plan would ideally involve multiple test cells, each with a different set of peak and off-peak prices.[29] This was not done in the SPO. However, by pooling customers across pricing plans, additional variation in prices can be included in the estimating database. As evidenced by the impact estimates summarized in Sections 4 and 5, price responsiveness appears to vary between customers who enroll through opt-in and default recruitment strategies. Elasticities may also vary between EAPR and non-EAPR customers. As such, the demand modeling summarized below that produces price elasticity estimates was done separately for opt-in and default plans and for EAPR and non-EAPR customers within the default and opt-in pricing plans. That is, the analysis produces four sets of price elasticities.

A structural economic model of demand is used to estimate price elasticities. The model is consistent with the neoclassical theory of utility maximization in which customers are assumed to consume the amount of electricity that maximizes their well-being subject to a budget constraint that is influenced by prices. Estimating a structural model requires the specification of a functional form for the demand equations that represent consumer preferences. In this study, the constant elasticity of substitution (CES) functional form is used. This function has been widely used in the analysis of electricity pricing experiments, including California's Statewide Pricing Pilot.[30] The CES model is comprised of two equations. The first equation expresses the ratio of peak and off-peak energy use as a function of an intercept term and the ratio of peak and off-peak prices.

$$ln\left(\frac{Q_1}{Q_2}\right) = a_{12} + b_{12} * ln\left(\frac{P_1}{P_2}\right) \tag{7-1}$$

[29] For an example of a pilot that included multiple prices for each rate option, see George and Faruqui, *Impact Evaluation of California's Statewide Pricing Pilot*. Final Report, March 16, 2005. http://www.energyarchive.ca.gov/demandresponse/documents/group3_final_reports/2005-03-24_SPP_FINAL_REP.PDF

[30] *Ibid*

where Q_i is electricity use (kWh/hour) in period *i* in and P_i is the price of electricity in period *i*. The term a_{12} is the intercept and b_{12} is the elasticity of substitution, which measures the degree of substitutability between the peak and off-peak periods for a given set of prices. Equation 7-1 captures tradeoffs in electricity consumption that occur between rate periods in the same day.

The second equation in the CES model pertains to daily electricity consumption and has the following specification:

$$ln(Q_d) = c + d * ln(P_d) \quad (7\text{-}2)$$

In this equation, Q_d is the total electricity consumed in a day and P_d is the average price for that day, which is a weighted average of the peak and off-peak prices. Equation 7-2 is often called the daily equation since it captures changes in electricity consumption at the daily level that result from changes in prices and the term *d* is the daily price elasticity.

Taken together, Equations 7-1 and 7-2 form a system of equations that can be estimated using a dataset consisting of electricity consumption for a large number of customers at the daily level in the post-treatment period (summer 2012 and summer 2013). Such a dataset was constructed using customer load data and information on each customer's experimental pricing plan. Econometric estimation adds idiosyncratic error terms to both equations and the resulting equations were then estimated jointly using seemingly unrelated regression (SUR) in Stata. As mentioned earlier, separate models were estimated for four combinations of pricing plans that vary based on whether customers were enrolled on a default or opt-in basis and whether or not they faced EAPR or non-EAPR prices.

Because of the tiered nature of the SPO rates, there is a simultaneity problem that must be addressed during the estimation process. In order to properly estimate the parameters of the model, the relationship between prices and quantities must flow in only one direction – namely the prices are allowed to influence the amount of electricity consumed in each period, but the amount of electricity consumption cannot influence the prices. With a tiered rate structure in which the price of electricity increases after a certain amount of electricity has been consumed each month, this condition is violated since the amount of electricity consumption determines the price in each period and also affects the weights that are used to calculate the average daily price.

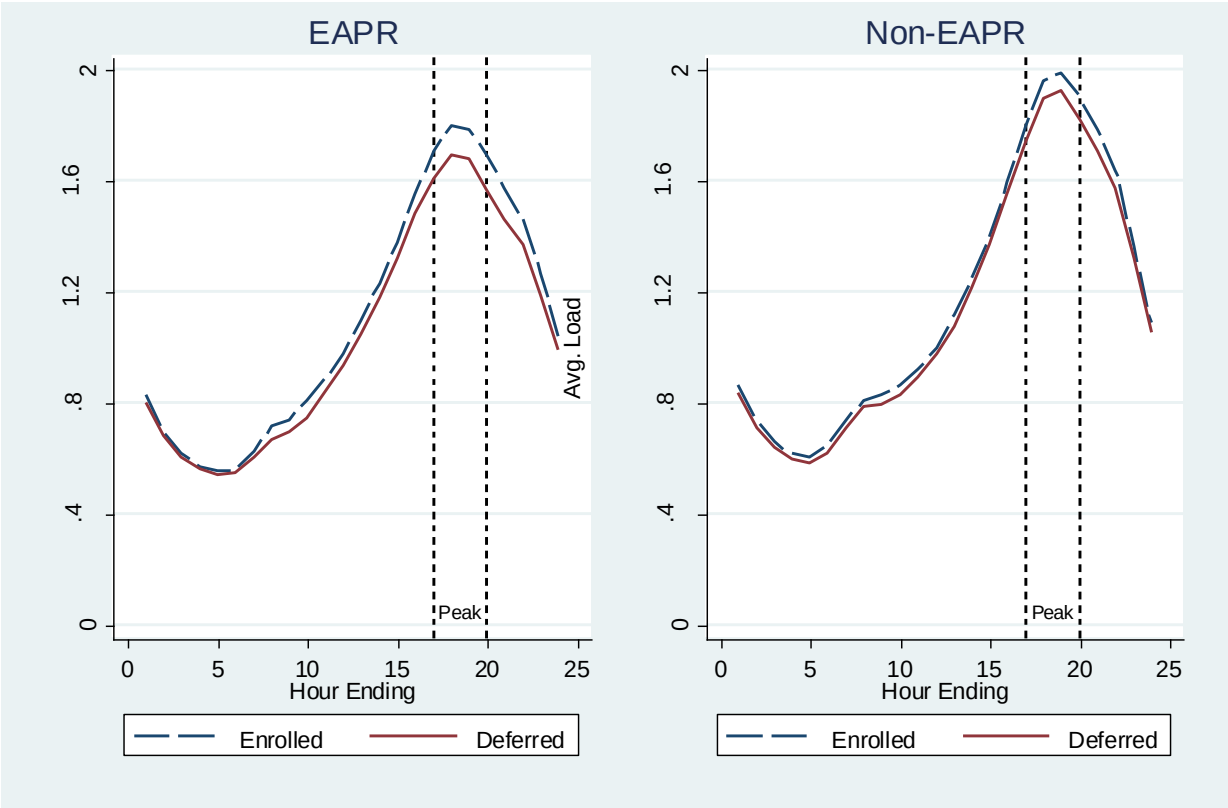
To avoid the simultaneity problem, the average electricity consumption of the relevant control group was used to determine the applicable tier for the average customer and also to weight the peak and off-peak prices used to calculate the average daily price.[31] The practical result of this solution is that all customers face only the base usage prices since the average consumption of the control groups is below the base usage threshold.

During the course of the analysis, it was discovered that pre-treatment load differences existed between customers who chose to enroll in the opt-in TOU rate and those who accepted the rate offer but were deferred (the de-facto control group). These pre-treatment loads are shown in Figure 7-1. For both

[31] These average values were calculated both on CPP and non-CPP days to allow for some difference between very hot days and more mild days.

EAPR and Non-EAPR customers, the enrolled group has noticeably higher average loads, particularly during the peak period (hours ending 17-20). The result of this pre-treatment difference in the CES model that utilizes only post-treatment data is that reductions in peak period consumption due to the increase in the peak period price appear smaller than they are in reality, which causes the model to underestimate the peak period elasticities.[32] In a similar fashion, any increases in off-peak consumption that are caused by the price change will appear larger than the change that actually occurred, which will again result in biased elasticity estimates. To correct for these problems, only the deferred control group and the opt-in CPP group were used to estimate elasticities for opt-in customers.

Figure 7-1: Pre-treatment Summer Loads for Enrolled and Deferred TOU Customers



7.2 Price Elasticity Estimates

Parameter estimates from the CES model are shown in Table 7-1. Values for the elasticities vary substantially across default and opt-in pricing plans and EAPR and non-EAPR customers. Specifically, non-EAPR customers appear more willing to shift consumption from the peak to off-peak period than EAPR customers and customers on default rates are less willing to shift than opt-in customers. These findings are consistent with those reported elsewhere. For example, in the impact evaluation of California's Statewide Pricing Pilot, CARE customers, which, like EAPR customers, qualify based on income and receive significant price discounts, showed very little price responsiveness. Similarly,

[32] This pretreatment difference was corrected for when estimating the impacts reported in Section 4 through the use of the difference-in-differences regression methodology.

numerous evaluations of PG&E's SmartRate critical peak pricing program have shown that CARE customers provide significantly smaller demand reductions than do non-CARE customers.

Table 7-1: CES Parameter Estimates

Elasticity	Default Non-EAPR	Default EAPR	Opt-in non-EAPR	Opt-in EAPR
Elasticity of Substitution	-.069**	-.024**	-.183**	-.089**
Daily Elasticity	-.030**	.019	-.035**	-.011

Note: ** = significant at 99% level, * = significant at 95% level

The elasticity of substitution and daily price elasticity estimates found here are comparable to those found in California's Statewide Pricing Pilot. The elasticity of substitution during the hotter summer months found in that study for the CPP rate for customers in the hottest climate zone (comparable to SMUD's service territory) was -0.127 and the daily price elasticity was -0.033.[33] These values represent the combined population of CARE and non-CARE customers. Roughly one third of SMUD's pilot participants are EAPR customers. If we calculate a weighted average elasticity from Table 7-1 for the opt-in pricing plans, for example, based on a split of 30% EAPR and 70% non-EAPR customers, the elasticity of substitution would equal -0.155 and the daily price elasticity would equal -0.028. Thus, the value found here for the elasticity of substitution is about 20% higher than in the Statewide Pricing Pilot and the daily price elasticity is about 15% lower. Since the change in demand given a change in price is a function of both values, it appears the SMUD's customers show responsiveness to price similar to the most comparable segment of customers that were tested in the Statewide Pricing Pilot roughly ten years ago.

Once the parameters of the CES were estimated, it is relatively straightforward to calculate point elasticities (own and cross-price) for the different customer segments and simulate the impacts of other TOU and CPP rates that were not included in the pilot.[34] Four different point elasticities are shown in

[33] *Ibid*, Table 4-6.

[34] For detailed derivations of the elasticities, refer to Appendices 7, 8, and 9 of the Impact Evaluation of the California Statewide Pricing Pilot (CRA 2005). http://www.energyarchive.ca.gov/demandresponse/documents/group3_final_reports/2005-03-24_SPP_APPENDICES.PDF. At a high level, the model is estimated using all of the rate groups for each combination of EAPR and default to produce estimates of the elasticity of substitution (EOS) and daily (DAILY) price elasticities. These estimates are converted into own and cross price elasticities using the average percentage of electricity used during each rate period and the average expenditure ($) during each period for each of the groups as follows:

Define perc_p as % usage during peak hours and share_p as % of electricity expenditure during peak period). Then,

E(p,p) = perc_op*EOS + share_p*DAILY

E(p,op) = (-1)*perc_op*EOS + share_op*DAILY

E(op,p) = (-1)*perc_p* EOS + share_p*DAILY

E(op,op) = perc_p*EOS + share_op*DAILY

Table 7-2: the own-price elasticity for the peak period ($E_{p,p}$), the cross-price elasticity of peak consumption with respect to off-peak price ($E_{p,op}$), the cross-price elasticity of off-peak consumption with respect to the peak price ($E_{op,p}$) and the own-price elasticity for the off-peak period ($E_{op,op}$).

Table 7-2: Own and Cross Price Elasticities

EAPR Status	Rate Type	Rate	$E_{p,p}$	$E_{p,op}$	$E_{op,p}$	$E_{op,op}$
EAPR	Opt-in	TOU	-0.078	0.067	0.011	-0.022
		CPP	-0.076	0.064	0.014	-0.025
	Default	TOU	-0.011	0.030	0.013	0.006
		CPP	-0.015	0.033	0.009	0.009
		TOU-CPP	-0.010	0.029	0.014	0.005
Non-EAPR	Opt-in	TOU	-0.166	0.131	0.017	-0.053
		CPP	-0.159	0.124	0.024	-0.059
	Default	TOU	-0.069	0.038	0.001	-0.031
		CPP	-0.064	0.033	0.005	-0.036
		TOU-CPP	-0.071	0.040	-0.002	-0.029

The elasticities represent the percentage change in electricity consumption that would result from a 1% increase in a particular price. For example, an own-price elasticity of -0.166 for the peak period means that increasing the peak period price by 1% would reduce peak consumption by 0.166%, or that a 10% price increase would reduce consumption by about 1.7%. Own-price elasticities for both the peak and off-peak periods are negative, reflecting that increases in the price during either period would reduce electricity usage during that period. Cross-price elasticities are positive, indicating that the peak and off-peak periods are substitutable goods.

Similar to the elasticity of substitution estimates, there are also patterns across EAPR status and rate types in the point elasticities. EAPR customers are generally less responsive to price than non-EAPR customers (about 50% less responsive), while customers who enrolled in an opt-in plan are significantly more price responsive than default customers on average. The latter is expected since one reason opt-in customers likely chose the rate was because they have loads that can be more readily shifted (or they are more willing to shift those loads). Opt-in customers are also more likely to have a better understanding of the rates since they made an active choice to enroll as opposed to being enrolled without any required action. Despite the large differences in average price responsiveness, default rates provide a much larger aggregate impact due to the larger number of people for whom the rate applies. Lastly, on a percentage basis, customers respond more to changes in the peak price than to changes in the off-peak price.

As a check on the reliability of the model, load impacts during the peak period were calculated for each pricing plan and compared to the load impacts reported in Sections 4 and 5 based on the RCT/RED impact analysis. This comparison is shown in Table 7-3. Impact estimates from the model match up almost exactly with the measured impacts for CPP rates and are also very close for TOU rates. The close match between the results provides confidence that the CES model is doing a good job of capturing the

underlying preferences of customers. It also suggests that the simplifying assumptions made regarding the price signals used in the estimation database in order to eliminate the simultaneity problem associated with increasing block pricing accurately capture whatever heuristics consumers use to make usage decisions when faced with such complex rate structures.

Table 7-3: Comparison of Load Impacts from CES Model with Measured Load Impacts

Rate	Group	% Measured Peak Load Reduction (2012-2013 avg)	% Peak Load Reduction Using CES Model
CPP	Opt-in, IHD Offer	26%	26%
	Default TOU-CPP, IHD Offer	13%	13%
	Default CPP, IHD Offer	12%	12%
TOU	Opt-in, IHD Offer	13%	15%
	Default TOU-CPP with IHD Offer	6%	6%
	Default TOU with IHD Offer	8%	7%

7.3 Simulating the Impact of Changes in Prices

The primary benefit of estimating a structural demand model is that it allows for predictions of what load impacts would be under alternative rates of interest that were not offered as part of the SPO pilot. Combined with the conjoint analysis and choice analysis, using elasticities from the CES model can help to estimate important counterfactual outcomes that would result from changing many characteristics of the time-varying rates. The only components of the rates that can be explored with the CES elasticities are the prices in each rate period. Because these elasticities are point elasticities, they are most valid for examining small price changes in the neighborhood of the original rates as opposed to larger price changes.

Predicted load impacts for several TOU and CPP rates that differ based on the non-EAPR price[35] in the peak period are presented in Table 7-4. The rates that were included in SPO are also shown in the table (in bold) for comparison purposes. For the default CPP rate, the model predicts that reducing the peak period price from $0.75/kWh to $0.60/kWh would reduce the peak period load reduction for enrolled customers by 1.3 percentage points on CPP days, from 11.7% to 10.4%. Increasing the price to $0.90/kWh would increase load reduction by 1.1 percentage points, from 11.7% to 12.8%. For opt-in CPP customers, the same price increase would produce a larger change in load reduction, 2 percentage points, from 26.4% to 28.4%. Similar interpretations apply for changing the peak price for a TOU rate.

[35] For the purposes of this exercise, EAPR prices are also adjusted so that they are 65% of the Non-EAPR price.

Table 7-4: Predicted Load Impacts for Non-SPO Prices

Rate	Enrollment	Peak Price	Off-Peak Price	Peak Load Reduction on Applicable Days
CPP	Default	$1.20	$0.09	14.4%
		$1.05	$0.09	13.7%
		$0.90	$0.09	12.8%
		$0.75	***$0.09***	***11.7%***
		$0.60	$0.09	10.4%
		$0.45	$0.09	8.8%
		$0.30	$0.09	6.5%
	Opt-in	$1.20	$0.09	31.5%
		$1.05	$0.09	30.1%
		$0.90	$0.09	28.4%
		$0.75	***$0.09***	***26.4%***
		$0.60	$0.09	23.8%
		$0.45	$0.09	20.5%
		$0.30	$0.09	15.6%
TOU	Default	$0.42	$0.08	8.4%
		$0.37	$0.08	7.7%
		$0.32	$0.08	6.9%
		$0.27	***$0.08***	***5.9%***
		$0.22	$0.08	4.8%
		$0.17	$0.08	3.3%
		$0.12	$0.08	1.5%
	Opt-in	$0.42	$0.08	19.9%
		$0.37	$0.08	18.4%
		$0.32	$0.08	16.7%
		$0.27	***$0.08***	***14.6%***
		$0.22	$0.08	12.0%
		$0.17	$0.08	8.8%
		$0.12	$0.08	4.3%

8 Program Marketing, Customer Acceptance and Retention

SMUD's SPO is one of the few pricing pilots that have been done in the industry that systematically examined the issue of customer acceptance of time-variant rates. Specifically, SPO allows for a comparison of:

- Acceptance rates for CPP and TOU rates based on opt-in and default enrollment, and for the TOU-CPP rate based on default enrollment; and
- The impact of offering enabling technology, in the form of a free IHD, on customer acceptance of CPP and TOU rates.

Understanding if there are significant differences in acceptance rates for various forms of time-variant rates, how acceptance rates differ between default and opt-in enrollment, and whether offering an IHD to customers affects acceptance rates, are all critical issues in developing an effective pricing strategy. Findings from the SPO pilot provide some of the best empirical evidence to help settle debates about these issues that have been waged for more than a decade based largely on assumptions, assertions and, at best, qualitative evidence from focus groups.

Table 8-1 summarizes the customer acceptance rates for each SPO pricing plan. Among the most important findings are:

- SMUD's multi-faceted marketing strategy for opt-in pricing plans led to acceptance rates that ranged from 16.4% to 18.8%. These high acceptance rates contradict the often cited claim that very few customers will voluntarily enroll on time-variant rates.
- The offer of enabling technology in the form of a free IHD did not materially increase customer acceptance of either the CPP or TOU plan.
- The default treatment groups display extremely high enrollment rates, ranging from a low of almost 93% for the TOU-CPP plan to a high of almost 98% for the TOU plan.
- Once enrolled, the dropout rate across the two summers ranged from a low of 4.0% for default TOU to a high of 9.3% for opt-in CPP with no IHD offer. The percent of customers who moved, and therefore dropped off the pricing plan, ranged from roughly 18% to 22% over the two SPO summer periods. Since many customers who move relocate within the SMUD service territory, this high move rate suggests that, if SMUD were to offer time-variant pricing plans in the future, allowing customers to default onto the same plan when they relocate would retain many more customers on each plan and would significantly reduce marketing costs by avoiding solicitations to customers that were previously on the plan.

Table 8-1: Customer Acceptance Rates for SPO Pricing Plans[36]

Recruitment Approach	Rate	IHD Offer	Acceptance Rate	Drop Out Rate Over 2 Summers (6/1/12 – 9/30/13)	Move Out Rate Over 2 Summers (6/1/12 – 9/30/13)	Overall Attrition (drop outs + Movers)
Opt-in	CPP	No	18.8%	9.3%	22.4%	31.8%
		Yes	18.2%	7.3%	19.0%	26.3%
	TOU	No	16.4%	5.9%	20.8%	26.7%
		Yes	17.5%	5.2%	21.4%	26.6%
Default	CPP	Yes	95.9%	5.7%	18.0%	23.7%
	TOU	Yes	97.6%	4.0%	21.3%	25.3%
	TOU-CPP	Yes	92.9%	7.7%	19.4%	27.0%

The remainder of this section is divided into two primary subsections. Section 8.1 focuses on customer acceptance, enrollment, retention and attrition for the opt-in rates while Section 8.2 covers the same topics for default rates. Each section contains both descriptive statistics as well as analysis to determine key drivers of customer acceptance and attrition for each pricing plan. Customer acceptance of and connectivity for IHDs was covered in Section 6.

8.1 Opt-in Pricing Plans

The SPO pilot included two opt-in pricing plans, CPP and TOU. Each plan was offered to two randomly chosen groups of customers, with one offer including a free IHD while the other did not. Thus, there were four treatment cells for opt-in plans. Comparing acceptance rates for CPP with and without an IHD, and TOU with and without an IHD, is a direct measure of whether the offer of a free IHD materially increases acceptance rates for the two rates. Comparing acceptance rates for the CPP and TOU pricing plans will indicate whether customers generally have a stronger preference for one plan over the other when comparing it to the standard tariff. Importantly, this comparison is not the same as asking a group of customers to choose between CPP and TOU plans, which would be a more direct measure of customer preferences among time-variant rate options. Even if the same percent of customers took the two pricing plans, it could be that customers who accept the CPP rate might prefer the TOU rate over CPP if they had a choice, and vice versa. This issue is explored in Section 9 through analysis of a conjoint survey in which customers were given the option of choosing among multiple pricing plans. As will be seen, there does appear to be a relatively strong preference for TOU over CPP rates when both are offered simultaneously.

Before summarizing the acceptance rates and other outcomes associated with marketing and enrollment, it is worth noting that there is a difference between the number of customers drawn

[36] For opt-in pricing plans, the acceptance rate was calculated by taking the number of customers who enrolled at any point prior to or during the summer of 2012 and dividing it by the number of customers who received marketing materials. For default plans, the acceptance rate was calculated by taking the number of customers who did not opt out of the rate as of June 1, 2012 and dividing it by the number of customers who received marketing materials.

into the various treatment samples and the number who received treatment offers. SMUD pulled the treatment samples in late August 2011. Between the time when the sample was pulled and when the marketing materials were first sent, some customers moved, in which case they were dropped from the research sample since they no longer qualified to participate in the study. Table 8-2 reports the number of customers in the original sample and the number of customers who received marketing offers. These differences are small for the opt-in treatments because the time between when the sample was drawn and when the first solicitations were sent was relatively brief. As shown in Section 8.2, more customers were lost between the sample draw and the initial offer for default customers because default notifications were not sent until April 2012, more than seven months after the sample was drawn. In the remainder of this section, the basis for all estimates of customer acceptance and enrollment rates is the number of customers receiving the offer, not the number in the initial sample.

Table 8-2: Number of Customers Sampled and Number of Customers Receiving Opt-in Offers

Group	Total in Sample	Total Offered	% Offered
Control Group	45,863	45,183	99%
Opt-In CPP, No IHD Offer	1,214	1,187	98%
Opt-In CPP, IHD Offer	9,198	9,060	98%
Opt-In TOU, No IHD Offer, Control (Deferred)	7,630	7,513	98%
Opt-In TOU, No IHD Offer, Enrolled	7,634	7,500	98%
Opt-In TOU, IHD Offer, Control (Deferred)	12,707	12,553	99%
Opt-In TOU, IHD Offer, Enrolled	12,743	12,554	99%

8.1.1 Customer Acceptance of Opt-in Pricing Plans

Table 8-3 summarizes the main findings concerning customer acceptance of the opt-in pricing plans. Overall, acceptance rates were quite high relative to participation in most other opt-in, time-variant rate programs, especially when considering the relatively short period over which marketing occurred. By comparison, PG&E's SmartRate tariff, a CPP rate first marketed in 2008 that is structurally similar to the SPO CPP rate, had an acceptance rate of roughly 8% in its first two years of offering the rate.[37] With two exceptions (Salt River Project and Arizona Public Service), most other utility programs have acceptance rates of 5% or less, often much less.[38] The fact that SPO obtained acceptance rates approaching 20%

[37] See "2009 Load Impact Evaluation for Pacific Gas and Electric Company's Residential SmartRate—Peak Day Pricing and TOU Tariffs and SmartAC Program, Volume 2: Ex Ante Load Impacts" by S. George, J. Bode, M. Perry & A. Goett. Prepared for PG&E.

[38] Based on personal correspondence between Stephen George and representatives from APS and SRP conducted for a confidential client, as of late 2010, Arizona Public Service had roughly 51% of residential customers, and 65% of residential kWh served, enrolled on one of five TOU rates. Around the same time, Salt River Project had 28% of its residential accounts on one of two TOU rates and estimated that it had nearly 50% of its target market of high use customers on these rates.

from the general population in a single campaign suggests that other utilities can achieve similar acceptance rates using a well-researched and concerted marketing effort.

Table 8-3: Acceptance Rates for Opt-in Pricing Plans

Group	Total Offered	Total Accepted	Acceptance Rate
Opt-in CPP, No IHD Offer	1,187	223	18.8%
Opt-in CPP, IHD Offer	9,060	1,651	18.2%
Opt-in TOU, No IHD Offer	7,500	1,229	16.4%
Opt-in TOU, IHD Offer	12,554	2,199	17.5%

The differences in acceptance rates across the various pricing plans are small, although some are statistically significant. Table 8-4 shows the p-statistic associated with the pairwise comparisons of acceptance rates across the various pricing plans. A p-value of 0.05 indicates that the difference is statistically significant at the 95% confidence level. The acceptance rate for the CPP pricing plan with no IHD offer, 18.8%, is more than 2 percentage points higher than the 16.4% acceptance rate for the TOU plan, and this difference is significant at the 95% confidence level, with a p-value of 0.04. The acceptance rates for the same two pricing plans with the IHD included are 18.2% and 17.5%, respectively. This difference is not statistically significant at the 95% confidence level. As discussed in the introduction to this section, and in more detail in Section 9, the slightly higher acceptance rates for the CPP plans over the TOU plans should not be interpreted as a preference by consumers for CPP over TOU rates. Indeed, when offered simultaneously in the conjoint survey discussed in Section 9, there is a strong preference for TOU rates over CPP rates.

Table 8-4: P-values for Pairwise Comparisons of Customer Acceptance Rates for Opt-in Pricing Plans

Group	Opt-in CPP, No IHD Offer	Opt-in CPP, IHD Offer	Opt-in TOU, No IHD Offer	Opt-in TOU, IHD Offer
Opt-in CPP, No IHD Offer	n/a	n/a	n/a	n/a
Opt-in CPP, IHD Offer	0.64	n/a	n/a	n/a
Opt-in TOU, No IHD Offer	0.04	0.00	n/a	n/a
Opt-in TOU, IHD Offer	0.27	0.18	0.04	n/a

8.1.2 Choice Analysis

An important consideration in developing pricing strategies going forward is whether customers who enroll on time-variant rates differ from those who do not. Knowing the characteristics of customers who are more likely to enroll on time-variant rates is useful for future targeting and for estimating the likely penetration of such rates among customers that were not included in the SPO pilot population. To

investigate these issues, a binary outcome model (logit)[39] was estimated for each rate option. The logit model relates the likelihood of accepting a rate offer to customer characteristics such as EAPR status, bill impacts and participation in other SMUD programs.

Models were initially estimated using two datasets – one containing the billing and load data for every SPO participant (N=47,076) and the second containing billing data plus survey responses to a residential appliance saturation survey (RASS) that was completed (N=2,509) to gather detailed information on customer characteristics. A comparison of results from models estimated on the two datasets showed that the signs and magnitudes of several key variables were considerably different. If the RASS sample was representative of the SPO population, we would expect the same model to yield the same results using both datasets. We believe that this problem is symptomatic of a selection effect associated with survey response. Further investigation showed that survey respondents are more "engaged" with their energy consumption than the general population of SMUD customers as evidenced by participation in other SMUD programs, including MyAccount. This higher level of engagement caused these customers not only to respond at higher rates to the RASS but to also be more likely to accept one of the pricing plans. Attempts to correct for this response bias using a Heckman two-step estimator were unsuccessful. As such, all of the analysis presented below is based on the full SPO population and relies on variables that are available for all customers, not just survey respondents. This approach has the advantage that SMUD can use these models for targeting and for extrapolation to the full SMUD population.

Table 8-5 shows the marginal effects[40] from the choice model that can be used to predict enrollment for the opt-in TOU pricing plans offered in the SPO. The table also provides examples of how the likelihood of enrollment would change given a change in the magnitude of the explanatory variables in the model. The explanatory variables include EAPR status, whether or not an IHD was included in the pricing plan marketing offer, bill savings associated with going on the rate in the absence of a change in behavior (e.g., a measure of the degree of structural win from selecting the rate) and binary variables representing participation in other SMUD programs, including enrollment in MyAccount. The bill savings variable equals a customer's bill based on usage during the summer of 2011 and the time-variant pricing plan that they eventually enrolled in divided by the bill based on the same summer 2011 usage and the otherwise applicable SMUD tariff, multiplied by 100 to turn the variable into a percentage value. It represents the bill savings they would achieve on the new pricing plan if they didn't change their usage.

As seen in the table, EAPR customers are about 10% more likely to enroll on the TOU plan than are non-EAPR customers. The likelihood of enrollment is also positively correlated with participation in the Carbon Offsets, EnergyHelp, Green Energy and My Account programs, but participation in the EE loan/rebate program is not a driver of enrollment on TOU rates. The higher the bill savings that would result from enrolling on the TOU plan in the absence of changing usage behavior, the greater the likelihood of enrollment. The offer of an IHD has no statistically significant impact on enrollment.

[39] Logit, probit and linear probability models were estimated and the alternative specifications produced results quite similar to those associated with the logit model.

[40] See the discussion at the beginning of Section 6.2 concerning choice modeling and marginal effects.

Table 8-5: TOU Pricing Plan Customer Choice Model Summary

Variable	Marginal Effect	Interpretation
EAPR status	0.106**	EAPR customers are 10% more likely to enroll in TOU than non-EAPR customers
IHD offer included	0.004	Offer of IHD has no statistically significant impact on enrollment
2011 summer savings as % of summer bill compared with standard tariff	0.237**	Bill savings of 10% increases the likelihood of enrollment by 2.4%
Carbon Offsets program	0.102**	Carbon Offset customers are 10% more likely to enroll in TOU pricing plan
Received EE loan or rebate	0.008	Having received an EE loan or rebate has no statistically significant impact on enrollment
EnergyHelp program	0.088**	EnergyHelp participants are 9% more likely to enroll in the TOU pricing plan
Green Energy program	0.061**	Green Energy participants are 6% more likely to enroll in the TOU pricing plan
Customer enrolled in MyAccount	0.075**	MyAccount customers are 7.5% more likely to enroll in the TOU pricing plan

**p<0.01; *p<0.05; +p<0.1

Table 8-6 shows the marginal effects from the logit model for the opt-in CPP pricing plans. Results for the CPP plans are quite similar to those for the TOU plans, with one significant exception. In this case, the bill impact from enrolling on the rate has a negative sign and is not statistically significant.

Table 8-6: CPP Pricing Plan Customer Choice Model Summary

Variable	Marginal Effect	Interpretation
EAPR status	0.105**	EAPR customers are 10% more likely to enroll in CPP pricing plan than non-EAPR customers
IHD offer included	0.000	Offer of IHD does not increase enrollment in CPP
2011 summer savings as % of summer bill compared with standard tariff	-0.047	Bill savings compared with standard rate is not statistically significant and has opposite sign compared with the TOU choice model
Carbon Offsets program	0.126**	Carbon Offset customers are 13% more likely to enroll in CPP pricing plan
Received EE loan or rebate	0.006	Having received an EE loan or rebate has no statistically significant impact on enrollment
EnergyHelp program	0.087**	EnergyHelp participants are 9% more likely to enroll in the CPP pricing plan
Green Energy program	0.052**	Green Energy participants are 5% more likely to enroll in the CPP pricing plan
Customer enrolled in MyAccount	0.097**	MyAccount customers are 10% more likely to enroll in the CPP pricing plan

**p<0.01; *p<0.05; +p<0.1

8.1.3 Customer Retention and Attrition for Opt-in Pricing Plans

Tables 8-7 through 8-9 summarize the retention, churn and dropout rates for each opt-in pricing plan for three time periods: summer 2012, the period in between the two SPO summers, and summer 2013. Although the intention was to cease enrollment after June 1, 2012, a few customers were enrolled during the first summer and 2 customers were actually enrolled in between the two summer periods. These new enrollees must be factored into the calculation of the retention and dropout rates. The retention rate for each period is equal to the enrollment at the end of the period divided by the sum of enrollment at the start of the period plus enrollment during the period. The dropout rate equals the number of drop outs during the period divided by the number of participants enrolled at the start of the period plus enrollment during the period.

As discussed at the beginning of this section, the number of movers is much larger than the number of people who leave each pricing plan because they prefer an alternative plan. The overall dropout rate is quite low, as shown previously in Table 8-1.[41] As seen in Tables 8-7 through 8-9, the dropout rate is relatively constant throughout the period, although it is slightly higher in the first summer than in the

[41] It should be noted that the dropout rates shown in Table 8-1 do not equal the sum of the dropout rates in Tables 8-7 through 8-9, because the dropout rates in the latter tables apply to each of the three periods and the denominator in each period is different from the denominator used to calculate the values in Table 8-1.

second summer for all four pricing plans. Due to the relatively constant move rate, the retention rate is also lower in between the two summers than it is during either summer period. As mentioned previously, given the high move rate, a pricing strategy that allows customers who move within the SMUD service territory to default onto the rate they had previously been on would significantly reduce marketing costs associated with maintaining or increasing program enrollment over a long time period.

Table 8-7: Customer Retention for Opt-in Pricing Plans for Summer 2012

Group	Total Enrolled June 1, 2012	Total Enrolled Sept 30, 2012	Enrolled After June 1	Movers	Dropouts	Summer 2012 Retention Rate[42]	Summer 2012 Dropout Rate[43]
Opt-in CPP, No IHD Offer	212	193	2	15	7	90.2%	3.3%
Opt-in CPP, IHD Offer	1,569	1,454	19	87	48	91.6%	3.0%
Opt-in TOU, No IHD Offer	1,157	1,074	35	83	37	90.1%	3.1%
Opt-in TOU, IHD Offer	2,092	1,936	24	131	49	91.5%	2.3%

Table 8-8: Customer Retention in Between Summer Periods

Group	Total Enrolled Sept 30, 2012	Total Enrolled June 1, 2013	Enrolled During Period	Movers	Dropouts	Interim Period Retention Rate	Interim Period Dropout Rate
Opt-in CPP, No IHD Offer	193	161	0	23	9	83.4%	4.7%
Opt-in CPP, IHD Offer	1,454	1,265	1	149	41	86.9%	2.8%
Opt-in TOU, No IHD Offer	1,074	941	1	113	21	86.6%	2.0%
Opt-in TOU, IHD Offer	1,936	1,664	0	232	40	85.6%	2.1%

[42] The retention rate equals the number of customers enrolled at the beginning of the period, plus enrollments during the period, divided by the number of customers enrolled at the end of the period.

[43] The dropout rate equals the number of drop outs divided by the number of enrolled customers at the beginning of the period plus enrollees during the period.

Table 8-9: Customer Retention for Opt-in Pricing Plans for Summer 2013

Group	Total Enrolled June 1, 2013	Total Enrolled Sept 30, 2013	Enrolled During Period	Movers	Dropouts	Summer 2013 Retention Rate	Summer 2013 Dropout Rate
Opt-in CPP, No IHD Offer	161	147	0	10	4	91.3%	2.5%
Opt-in CPP, IHD Offer	1,265	1,172	0	66	27	92.6%	2.1%
Opt-in TOU, No IHD Offer	941	877	0	52	12	93.2%	1.3%
Opt-in TOU, IHD Offer	1,664	1,554	0	90	20	93.4%	1.2%

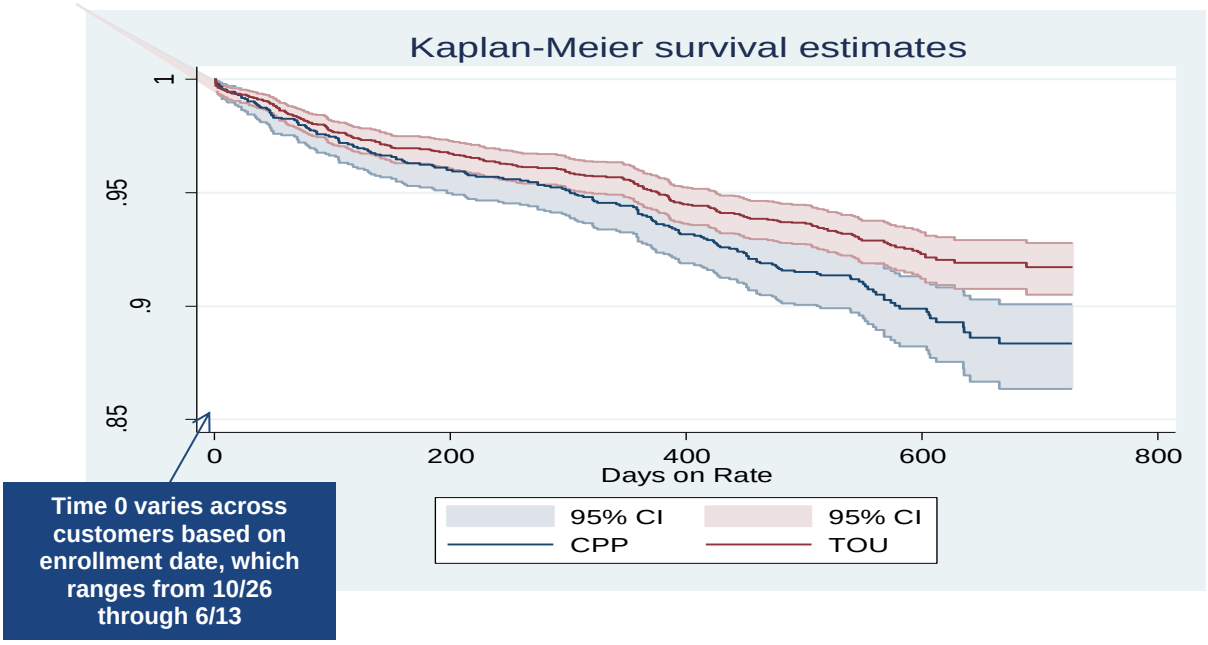
8.1.4 Modeling Opt-Out Decisions for Opt-in Pricing Plans

The prior section provided summary statistics on customer retention, move rates and dropout rates for the opt-in pricing plans. This section examines dropout rates using two different approaches.

The first approach involves a Kaplan-Meier survival function for the opt-in TOU and CPP pricing plans (combining the treatment cells with and without the IHD offer for each plan). This function displays the likelihood of staying on a pricing plan as a function of time, which in this instance is measured as the number of days since accepting the plan offer, not since enrolling on the plan. The Kaplan-Meier curve is graphed in Figure 9-1. Note that this function depicts active de-enrollment, not customers who left the plan because they moved. Given that marketing began in the fall of 2011 and customers were not actually enrolled on an opt-in pricing plan until June 1, 2012, some customers may have dropped out before even going on the plan. Note also that the starting point (0 in the graph) varies across customers. The first customer acceptances occurred on October 26, 2011 and the last one included in this database occurred on June 13, 2012.

As seen in the figure, opt-out rates are slightly greater for the CPP pricing plans than for the TOU plans. The Kaplan-Meyer function is relatively smooth over the entire historical period. However, this may be due, in part, to the fact that each customer has a different start date so that specific events, such as the lead up to each summer when customers were reminded that they were being placed on the rate or following multiple CPP event periods, are blurred in terms of when they occur for the average customer. As will be seen in Section 8.2, for default treatments, nearly everyone was marketed to at the same time so the time since acceptance is nearly the same for everyone and it is easier to see how attrition correlates with certain events.

Figure 8-1: Kaplan-Meyer Survival Function for Opt-in Pricing Plans



As seen in the figure, the retention rates are slightly higher for the TOU plans than for the CPP plans or, put differently, at any point in time, customers are slightly more likely to opt-out of the CPP plans than the TOU plans. For a customer who accepted the pricing plan offer in the spring of 2012 (say around April 1, 2012), the probability that they were still on the plan near the end of the second summer (around September 30, 2013, which is roughly 500 days after acceptance) is roughly 94% for TOU customers and about 91% for CPP customers. After about 500 days following acceptance, there is a sharper drop off in the Kaplan-Meyer curve for the CPP plans than for the TOU plans, so a customer that enrolled in the fall of 2011 (more than 600 days prior to the end of summer 2013), has about a 92% probability of still being on a TOU plan but a CPP customer has only about an 87% probability of still being enrolled.

To better understand how the likelihood of dropping off each plan varies with customer characteristics, a Cox Proportional Hazard (Cox PH) model was estimated. A Cox PH model provides estimates of the hazard ratio, which is defined as the instantaneous probability of a customer dropping off a plan at time *t* given that they have not dropped prior to that time:

$$\textbf{HR} = \frac{\textit{Probability that customers with characteristic X drop out}}{\textit{Baseline probability of dropping out that depends only on time}}$$

The hazard ratio is interpreted as follows:

- A HR equal to 1 means that the characteristic of interest has no impact on the likelihood of dropping out;

- A HR > 1 means that a characteristic increases the likelihood of dropping out (e.g., a HR of 1.1 on the EAPR variable, for example, means that EAPR customers are 10% more likely to drop out at any given time than non-EAPR customers);
- A HR < 1 means that a characteristic decreases the likelihood of dropping out (e.g., a HR of 0.9 for the EAPR variable would mean EAPR customers are 10% less likely to drop out than non-EAPR customers).

Table 8-10 summarizes the results of the Cox PH model estimation for opt-in pricing plans. When interpreting these results, it is very important to keep in mind that dropout rates are quite low overall, so that even variables that significantly change the probability of dropping out may not be significant from a practical standpoint. For example, the fact that CPP customers are 80% more likely to drop out than TOU customers means that the dropout rate is around 9% rather than 5%. This difference may not be material in terms of its impact on program cost effectiveness or overall demand response achieved. As seen below, most variables tested are not statistically significant. Being on the CPP plan increases the likelihood of dropping out relative to being on the TOU plan as does having received an EE load or rebate, whereas higher bill savings reduces the likelihood of dropping out.

Table 8-10: Cox PH Model Results for Opt-in Pricing Plans

Variable	Hazard Ratio Estimates	Interpretation
EAPR status	0.84	EAPR customers are less likely to drop out than non-EAPR customers but the impact is not statistically significant
CPP	1.79**	Customers who opt-in to the CPP pricing plan are 80% more likely to drop out than those who opt-in to the TOU pricing plan (but opt-out rates are low for both plans)
2011 Summer Savings as a % of Summer Bill	0.03**	A 10% savings on summer bills reduces the likelihood of an opt-in customer dropping out by 30%.
Carbon Offsets program	0.21	Enrollment in the Carbon Offsets program reduces the likelihood of dropping out, but is not statistically significant
Received EE loan or rebate	1.30*	Customers who received an EE loan or rebate are 30% more likely to drop out
EnergyHelp program	0.64	Customers enrolled in the EnergyHelp program are more likely to drop out, but the impact is not statistically significant
Green Energy program	0.99	Enrollment in the Green Energy program has essentially no impact on dropout rates
Customer enrolled in MyAccount	1.01	MyAccount has no impact on dropout rates for opt-in customers

**p<0.01; *p<0.05; +p<0.1

Note: The interpretation of the summer savings coefficient differs from the others due to the structure of the Cox PH model. The initial estimate of 0.03 represents the impact of saving 100% of summer bills and was converted to a more easily interpretable impact of 10% savings.

8.2 Default Treatments

The SPO pilot included three default treatments—CPP, TOU and a combination TOU-CPP plan. In addition to being defaulted onto the new rate, all groups were offered a free IHD. As mentioned previously, it is worth noting the difference between the number of customers drawn into the various treatment samples and the number who were defaulted onto the new pricing plans. SMUD pulled the treatment samples in late August 2011. Between the time when the samples were pulled and when the default notifications were sent, some customers moved, in which case these customers were dropped from the research sample as they no longer qualified to participate in the study. Table 8-11 reports the number of customers in the original sample and the number of customers who received marketing offers. These differences are larger for the default treatments than for the opt-in treatments because the time between when the sample was drawn and when the first solicitations were sent was longer for default treatments. Notifications were not sent until April 2012, which was more than seven months after the sample was drawn. In the remainder of this section, the basis for all estimates of customer acceptance and enrollment rates is the number of customers receiving the offer, not the number in the initial sample.

Table 8-11: Number of Customers Sampled and Number of Customers Defaulted Onto New Pricing Plans

Group	Total in Sample	Total Offered	% Offered
Default TOU-CPP, IHD Offer	729	680	93%
Default CPP, IHD Offer	846	780	92%
Default TOU, IHD Offer	2,410	2,219	92%

8.2.1 Customer Acceptance of Default Pricing Plans

Table 8-12 summarizes the main findings concerning customer acceptance of the default pricing plans. For default plans, acceptance is defined by customers who did not dropout prior to going on the plan, but the acceptance rate excludes those who moved between receiving a default notification and going on the plan. In this way, the acceptance rate reflects only customers who proactively chose not to be defaulted onto the new plan, not those who never went on the plan because of other factors such as moving. Overall, acceptance rates were extremely high, ranging from 93% to over 97%. This far exceeded SMUD's pilot design assumptions, which were that 50% of customers would opt out prior to being placed on the default pricing plan.

Table 8-12: Acceptance Rates for Default Pricing Plans

Group	Total Offered	Movers Prior to 6/1/12	Dropouts Prior to 6/1/12	Total Accepted	Total Offered Less Movers	Acceptance Rate
Default TOU-CPP, IHD Offer	680	47	45	588	633	92.9%
Default CPP, IHD Offer	780	49	30	701	731	95.9%
Default TOU, IHD Offer	2,219	152	49	2,018	2,067	97.6%

Although the range of acceptance rates across the three default plans is less than five percentage points, each is statistically different from the other two at the 95% confidence level. Table 8-13 shows the p-statistics for the pairwise comparisons of acceptance rates for the default pricing plans. The acceptance rate for the TOU-CPP plan, 92.9%, is more than 3 percentage points lower than the acceptance rate for the CPP plan which, in turn, is two percentage points lower than for the TOU plan. Although these differences are statistically significant, they may not be material from a policy or program planning perspective, given how high the acceptance rates were for all default plans.

Table 8-13: P-statistics for Pairwise Comparisons of Customer Acceptance Rates for Default Pricing Plans

Group	Default TOU-CPP, IHD Offer	Default CPP, IHD Offer	Default TOU, IHD Offer
Default TOU-CPP, IHD Offer	n/a	n/a	n/a
Default CPP, IHD Offer	0.02	n/a	n/a
Default TOU, IHD Offer	0.00	0.01	n/a

8.2.2 Customer Retention and Attrition for Default Pricing Plans

Table 8-14 shows retention rates for each default pricing plan. As discussed previously, when examining retention rates, it is important to distinguish between movers and dropouts. As with the opt-in plans, the overall attrition/retention rate is influenced much more by movers than by customers dropping out of the plans. The pattern of dropouts for default plans is similar to that for the opt-in plans in that the dropout rate for default customers was higher in the first summer than during the period in between summers and lowest in the second summer. Dropout rates for the TOU plan were quite low in all periods. By the second summer period, additional dropouts were lower than in either of the other two time periods for all three pricing plans. A close comparison of the overall dropout rate for default customers in Tables 8-14 through 8-16 with the dropout rates for the opt-in pricing plans shows that the dropout rate was higher for opt-in plans than for default plans. This seemingly counterintuitive finding actually has a logic to it in that the average opt-in customer is much more aware of and engaged in the rate choice than the average default customer, which includes a sub-segment of customers who were not even aware that they were on the new pricing plan as indicated in the results from the end of pilot survey summarized in Section 11.

Table 8-14: Customer Retention for Default Pricing Plans for Summer 2012

Group	Total Enrolled June 1, 2012	Total Enrolled Sept 30, 2012	Movers	Dropouts	Summer 2012 Retention Rate[44]	Summer 2012 Dropout Rate[45]
TOU-CPP	588	527	37	26	89.6%	4.4%
CPP	701	645	38	44	92.0%	2.7%
TOU	2,018	1,839	135	19	91.1%	2.2%

Table 8-15: Customer Retention in Between Summer Periods for Default Pricing Plans

Group	Total Enrolled Sept 30, 2012	Total Enrolled June 1, 2013	Movers	Dropouts	Interim Period Retention Rate	Interim Period Dropout Rate
TOU-CPP	527	465	50	12	88.2%	2.3%
CPP	645	566	64	15	87.8%	2.3%
TOU	1,839	1,628	187	24	88.5%	1.3%

Table 8-16: Customer Retention for Default Pricing Plans for Summer 2013

Group	Total Enrolled June 1, 2013	Total Enrolled Sept 30, 2013	Movers	Dropouts	Summer 2013 Retention Rate	Summer 2013 Dropout Rate
TOU-CPP	465	431	27	7	92.7%	1.5%
CPP	566	536	24	6	94.7%	1.1%
TOU	1,628	1,508	108	12	92.6%	0.7%

8.2.3 Modeling Opt-Out Decisions for Default Pricing Plans

Figure 8-2 shows the Kaplan-Meier survival functions for the three default pricing plans combined and Figure 8-3 shows the functions for each plan separately. As seen in Figure 8-2, dropout rates were highest between when notifications of being defaulted onto the pricing plan were sent out and when enrollment occurred, although as seen above, the dropout rate even during this period was quite low. The relatively high rate continued in the first few weeks after enrollment and then flattened out

[44] The retention rate equals the number of customers enrolled at the beginning of the period, plus enrollments during the period, divided by the number of customers enrolled at the end of the period.

[45] The dropout rate equals the number of drop outs divided by the number of enrolled customers at the beginning of the period.

significantly during the first summer and between summers until the notifications went out in spring 2013 telling customers they would be going back on the pricing plan in June 2013, when there was a small uptick in the number of dropouts. While this pattern of de-enrollment is logical and might be relevant from a policy perspective if dropout rates were higher, the fact that they are so low in general minimizes the relevance of these findings from a practical perspective.

Figure 8-3 shows the Kaplan-Meier survival functions for each default pricing plan separately. It shows that the probability of dropping out is higher for the CPP plan relative to the TOU plan and highest for the TOU-CPP plan relative to the other two options. The relatively steep decline during the summer period for the two CPP options relative to the TOU plan is likely a function of the CPP events that occur during the summer period.

Figure 8-2: Kaplan-Meier Survival Function for All Default Rates Combined

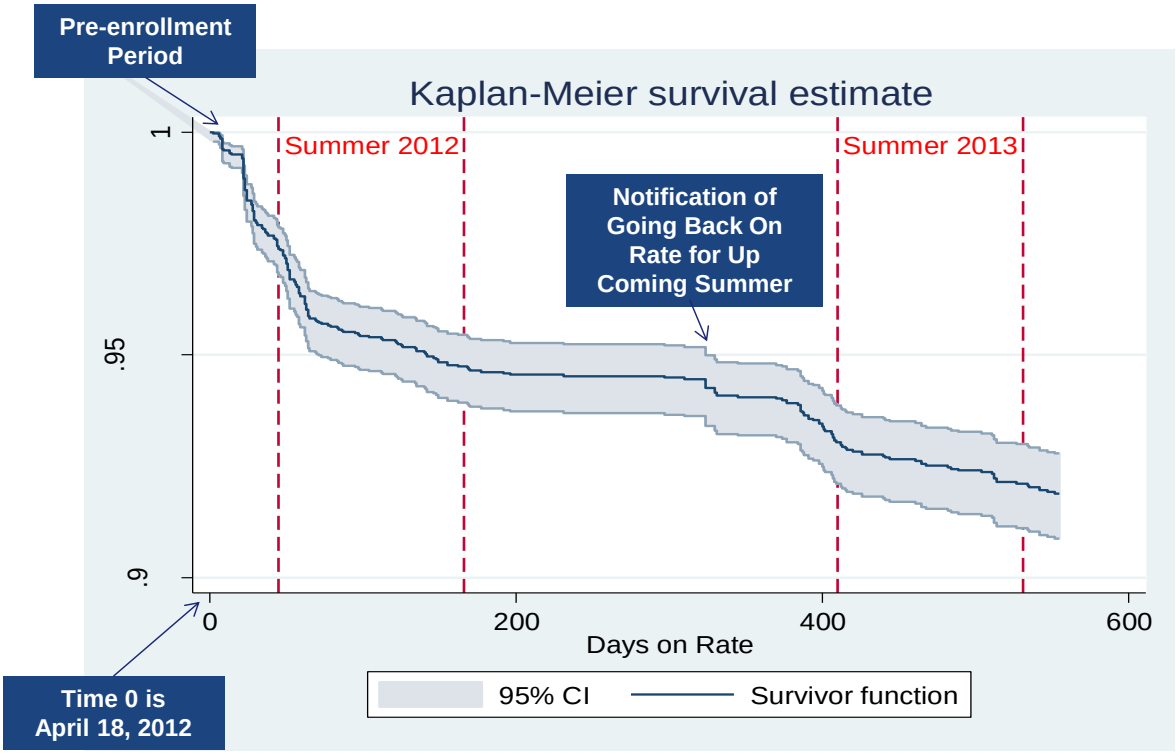
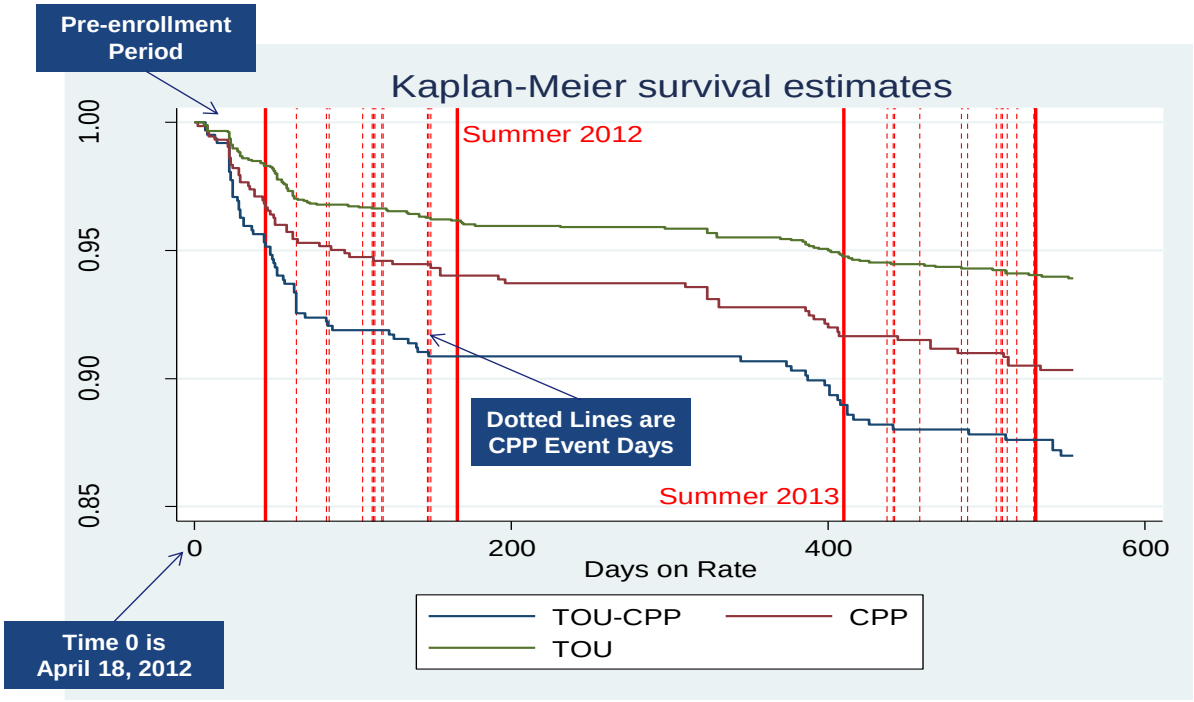


Figure 8-3: Kaplan-Meier Survival Functions by Default Option



As was done for the opt-in treatment options, a Cox PH model was estimated for each default pricing plan. Table 8-17 summarizes the results from the modeling exercise. The results indicate that customers who were defaulted onto the TOU-CPP plan were more than two times as likely to opt out at any given point in time compared with customers who were defaulted onto the TOU plan and CPP customers were roughly 2 times more likely to opt-out compared with TOU customers. Customers who save 10% of their bill on the time-varying rate are 24% less likely to opt out. Several variables representing enrollment in other SMUD programs were also included in the model. These show that EAPR customers are about 32% less likely to opt-out at any given time, while customers who either received an EE loan/rebate or were enrolled in MyAccount are about 1.4 times more likely to opt out.

When interpreting the above findings, the reader is once again cautioned that the relatively large size of some of the coefficients, indicating a substantial difference in dropout rates across customers with different characteristics, doesn't mean that dropout rates are high for any group. For example, given the two-year dropout rate of 4% for the average TOU participant, if one segment is 50% more likely to dropout than another, it means that if the dropout rate for one segment is 4%, the dropout for the other would be 6%. Neither dropout rate is very high from a practical perspective.

Table 8-17: Cox PH Model Results for Default Pricing Plans

Variable	Hazard Ratio Estimates	Interpretation
EAPR status	0.68**	EAPR customers are 32% less likely to drop out than non-EAPR customers
CPP	2.07*	Customers defaulted onto CPP are two times more likely to drop out than those defaulted onto TOU
TOU-CPP	2.52**	Customers defaulted onto TOU-CPP are two and a half times more likely to drop out than those defaulted onto TOU
2011 Summer Savings as a % of Summer Bill	0.07**	A 10% savings on summer bills reduces the likelihood of dropping out by 24%
Carbon Offsets program	0.51	Enrollment in the Carbon Offsets program reduces the likelihood of dropping out, but is not statistically significant
Received EE loan or rebate	1.44*	Customers who received an EE loan or rebate are 44% more likely to drop out
EnergyHelp program	1.61	Customers enrolled in the EnergyHelp program are more likely to drop out, but the impact is not statistically significant
Green Energy program	0.90	Enrollment in the Green Energy program reduces the likelihood of dropping out, but is not statistically significant
Customer enrolled in MyAccount	1.37*	MyAccount customers are 37% more likely to drop out

**p<0.01; *p<0.05; +p<0.1

Note: The interpretation of the summer savings coefficient differs from the others due to the structure of the Cox PH model. The initial estimate of 0.07 represents the impact of saving 100% of summer bills and was converted to a more easily interpretable impact of 10% savings

9 Analysis of the Impact of Changes in Rate Characteristics on Customer Acceptance

The analysis in Section 8 discussed acceptance rates for SPO participants for the specific pricing plans that were included in the pilot. SMUD has interest in knowing the impact on customer acceptance of potential changes in the characteristics of pricing plans, including peak-to-off-peak price ratios, the extent and timing of the peak period, the number of event days for CPP prices, and others. This section summarizes the analysis of and findings from a conjoint survey that was conducted to explore these important planning issues.

During development of the survey strategy, an important consideration was the risk of over surveying the SPO participant population. Two issues are relevant. One is to avoid risking the validity of the load impact estimates obtained from the SPO by reminding, through frequent surveys, that customers were being studied, which can influence behavior. This is referred to as a Hawthorne effect, where the knowledge that one is being studied causes a change in behavior that wouldn't necessarily occur if the intervention were offered without the subject's knowledge that they were being studied. The second issue is the risk of survey fatigue, which can reduce response rates and potentially bias results. Since there were many other issues of interest to SMUD that could only be explored through a survey among SPO participants at the end of the pilot (summarized in Section 10), a decision was made to conduct the conjoint survey among customers who did not participate in the SPO (other than as control group customers as discussed below). With this in mind, the following three customer segments were surveyed:

- **SPO control group** – Customers who were used for evaluation purposes as part of the SPO pilot, but were not offered any of the SPO rates. This segment is most representative of the SPO participants;
- **Ineligible group** – Customers who were ineligible for the SPO pilot, including customers in SMUD's balanced billing and direct load control programs; and
- **Eligible group** – Customers who were eligible for the SPO pilot, but either were not sampled or did not have a smart meter at the time of the SPO sampling (and therefore could not participate).

These last two segments were included so that the results could be extrapolated to SMUD's entire customer population, not just those that were included in the SPO.

Table 9-1 summarizes the sample design and response rate by study group. To gauge response rates and test the viability of the conjoint survey instrument, a pre-test was conducted among 500 customers. Based on this pre-test, the number of records to release for the full launch was determined, with the goal of meeting the target number of completed surveys for each study group. Across the pre-test and full launch, 3,031 total surveys were sent and 1,142 surveys were completed, equaling an overall response rate of 38%.

Table 9-1: Sample Design and Response Rate by Study Group

Study Group	Target Completes	Records Released			Completed Surveys	Response Rate
		Pre-test	Full Launch	Overall		
SPO Control Group	500	250	1,265	1,515	590	39%
Ineligible Group	250	125	633	758	313	41%
Eligible Group	250	125	633	758	239	32%
Total	**1,000**	**500**	**2,531**	**3,031**	**1,142**	**38%**

Even though SPO participants were not surveyed, the actual choices they made as part of the pilot were factored into the survey analysis and modeling by "anchoring" the survey results to the choices made by SPO participants during the pilot. Conjoint surveys are a good way to examine the trade-offs customers make among products and services that differ according to various attribute combinations and to determine the relative importance of each attribute on customer choice. However, it is well known that such surveys significantly overstate acceptance rates for new product or service offerings relative to the status quo.[46] This is due, at least in part, to the fact that customers typically don't factor in the transaction costs associated with proactively making a purchase or changing pricing plans, for example, when responding to such surveys. Another big reason for differences in acceptance rates from conjoint surveys and actual market choices is that survey acceptance rates typically are reported for those who respond to the survey whereas market acceptance rates are calculated as the number accepting an offer divided by the number who were sent an offer. As such, these acceptance rates include in the denominator people who were marketed to but who do not make a choice after considering the offer (e.g., because they didn't open the envelope or pick up the phone in response to a marketing solicitation). As a result of these and perhaps other factors, it is not uncommon to find that acceptance rates in conjoint surveys are 3 or 4 (or more) times larger than those seen when choices are actually made by consumers. Consequently, whenever possible, it is very important to anchor a conjoint survey to actual choice data. This was done here by having the first set of choices made by survey respondents be equal to the pricing plans that were offered in the SPO. The ratio of the actual acceptance rate to the survey acceptance rate was then used to adjust all acceptance rates determined from survey-based simulations of alternative pricing plans.

The remainder of this section is organized as follows. Section 9.1 summarizes the survey instrument and process. Section 9.2 discusses the model that was estimated using the survey data and Section 9.3 presents the results from a simulation exercise that predicts the change in customer acceptance rates based on changes in rate attributes. Appendix D summarizes results from the survey showing how customer characteristics vary across the three customer segments that were included in the survey sample.

[46] See Breidert, Hahsler and Reutterer. "A Review of Methods for Measuring Willingness to Pay." Innovative Marketing, Volume 2, Issue 4, 2006.

9.1 Survey Instrument Design

The survey instrument included three sections:

- Preferences for SPO rates as a single alternative to the standard rate;
- Conjoint exercise, including nine choice sets with three rate options in each set; and
- Customer behavior and characteristics.

The first section described the current standard rate that the customer was on and then described the rate types (TOU, CPP and CPP-TOU) and technology options (IHD) included in some of the SPO pricing plans. All of these descriptions closely replicated the marketing materials from the SPO, including the specific prices that were used for the TOU, CPP and CPP-TOU pricing plans. After reading each pricing plan description, respondents were asked to indicate whether they preferred each plan over the standard rate, totaling three choices. Section 9.2 discusses the results from this section of the survey.

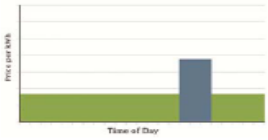
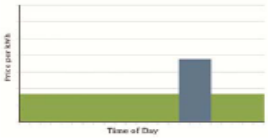
In the conjoint section of the survey, each respondent viewed 27 randomly selected choice options (9 sets of 3) and made 9 choices in total. The choice options included variations of the following rate components:

- Plan type – Standard, TOU, CPP or CPP-TOU
- Tier structure – with or without
- Tier 1 price for each plan
- Tier 2 price for each plan
- TOU on-peak price for each plan – 0.5x to 2x SPO price ratios
- CPP on-peak price for each plan – 0.5x to 2x SPO price ratios
- On-peak time period – 1-7 PM, 3-7 PM or 4-7 PM
- Number of CPP days – 6, 12, 18 or 24
- Technology option – none, IHD or PCT

Figure 9-1 provides an example choice set. Appendix E provides more details on the steps that were taken to randomly assign all of the pricing plan components across the choice sets that were shown to survey participants.

Finally, it is important to note that there were two different versions of the survey, depending on whether or not a customer was on the EAPR tariff. A non-EAPR customer would receive the version describing SMUD's non-EAPR rates and an EAPR customer would receive the version describing SMUD's EAPR rates, including the time-varying options.

Figure 9-1: Example Choice Set

Case 8 of 9	Plan A	Plan B	Plan C
Plan Type	Summer Weekday Value Plan 	Summer Weekday Value Plan 	Off-Peak Discount Plan
Electricity Prices	**Off-Peak:** $0.10/kWh first 700 kWh $0.10/kWh in excess of 700 kWh **On-Peak:** $0.17/kWh	**Off-Peak:** $0.07/kWh first 700 kWh $0.07/kWh in excess of 700 kWh **On-Peak:** $0.28/kWh	**Off-Peak:** $0.09/kWh first 700 kWh $0.15/kWh in excess of 700 kWh **On-Peak:** $1.54/kWh on Conservation Days Otherwise, same as Off-Peak
On-Peak ( ) & Off-Peak ( ) Periods			
Conservation Days	None	None	6 Days
Free Technology			None
Which plan do you prefer?	A	B	C

A survey pre-test was implemented according to the following schedule:

- 3/19/2013: SMUD sent initial letter
- 3/25/2013 (+4 business days): Direct mail letter with survey URL and incentive ($5 bill)
- 3/27/2013 (+2 business days): Email with survey URL (if available)
- 4/01/2013 (+3 business days): Reminder postcard
- 4/03/2013 (+2 business days): Reminder email (if available)
- 4/11/2013 (+6 business days): Reminder letter with hard copy survey.

The full launch was implemented according to the following schedule:

- 4/09/2013: SMUD sent initial letter
- 4/15/2013 (+4 business days): Direct mail letter with survey URL and incentive ($5 bill)
- 4/17/2013 (+2 business days): Email with survey URL (if available)
- 4/22/2013 (+3 business days): Reminder postcard
- 4/24/2013 (+2 business days): Reminder email (if available)
- 5/02/2013 (+6 business days): Reminder letter with hard copy survey

As seen above, the full launch followed the same implementation procedures as the pre-test, including the same days of the week for delivering each communication. As such, the final survey dataset was able to combine information from both phases of the study.

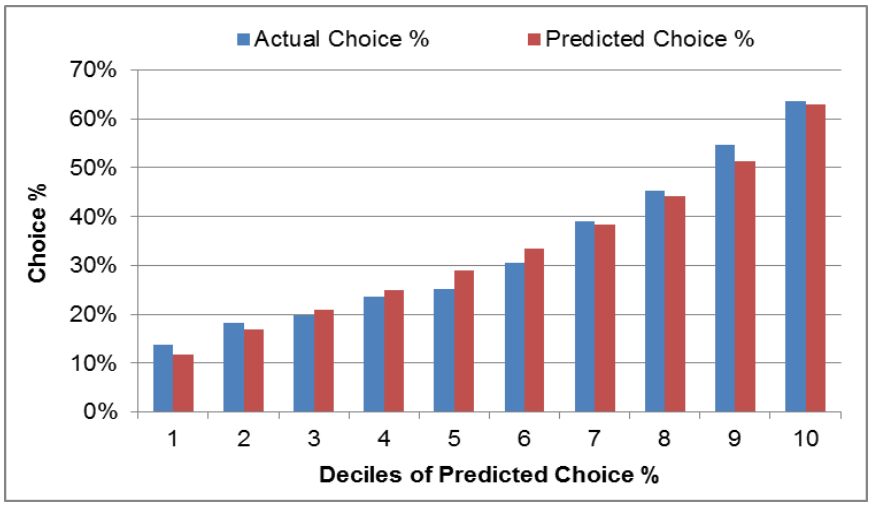
9.2 Survey Analysis and Model Estimation

Data from the conjoint survey was used to estimate a conditional logit model that can be used to predict the likelihood of enrolling in a pricing plan as a function of attributes of the rate structure and other features of the plan such as whether or not enabling technology is included in the offer. The magnitude and significance of the model coefficients also indicate the relative influence of various attributes on customer choice.

As discussed in the prior section, each survey respondent was asked to complete nine choice exercises. When a survey respondent chose one of the three options, that option was coded as a 1 in the estimation dataset and the options that were not chosen were coded as 0s. Thus, when estimating the conditional logit model, the analysis dataset included 27 observations per respondent, with nine 1s for the options that were chosen and 18 0s for the options that were not chosen. The final analysis dataset included 30,834 observations (1,142 respondents x 27 observations for each respondent), which provides a large amount of information for estimating electricity rate preferences.

The choice likelihoods based on the model and the actual choices made in the survey, sorted by deciles of likelihoods[47] estimated by the model, are shown in Figure 9-2. The figure shows that there is a very strong correlation between predicted likelihoods and the options chosen by survey respondents (depicted in the figure as "actual"). In other words, the model captures important variation that determines why some rates are chosen by respondents and others are not.

Figure 9-2: Predicted and Actual Choice Percentages



[47]The logit model was used to predict the likelihood of each pricing plan being selected. For example, one plan might have a 5% likelihood of being selected and another might have a 15% likelihood of being selected and so on, Once all of the likelihood predictions were made, they were sorted by deciles and then compared with the percentage choices that were made in the survey (e.g., the "actual choice percentages). The figure shows the match between actual and predicted likelihoods by decile.

Table 9-2 shows the estimated coefficients for the conditional logit model developed from the conjoint survey data. Most of the variables in the model are highly statistically significant and the signs and relative magnitudes appear reasonable. For example, holding all else equal, an increase in any of the prices leads to a decrease in the likelihood that a given pricing plan is chosen. In addition, it makes sense that respondents are most sensitive to changes in the tier 1 price because the largest amount of electricity usage is charged at this price for most customers.[48] Similarly, it makes sense that respondents are least sensitive to changes in the CPP price because the smallest amount of electricity usage is exposed to that price given that it is in effect for only 3 hours a day for a limited number of days.

As for technology, both the IHD and PCT lead to a small increase in enrollment. Recall from the discussion in Section 8, there was no difference in acceptance rates for those who were and were not offered an IHD in the SPO. An increase in the number of CPP event days or in the length of the peak period leads to a decrease in the likelihood that a given pricing plan is chosen. A pricing plan with tiers is less desirable than one without tiers, all else equal, but this difference was not statistically significant at the 90% level of confidence. The "Ineligible X Time-varying" coefficient shows that customers in the ineligible group were significantly more likely to choose the time-varying rate options. This is most likely due to the fact that many of these ineligible customers were participants in SMUD's direct load control program and, as such, would be more likely to also participate in a time-varying rate program. Finally, the model included binary variables for the pricing plan types. The signs and magnitudes of the coefficients indicate that respondents have a substantially higher preference for TOU than any other pricing plan type, especially relative to CPP. This finding would appear to contradict what was found in the SPO, where enrollment in TOU and CPP rates was very similar. This apparent contradiction is explored more fully in Section 9.3.

With perfect information, one would expect to see customers who are structural winners enroll on time-varying pricing plans at higher rates than those who are not structural winners. A structural winner is a customer whose bill will go down by enrolling on a time-varying pricing plan even if they don't change their usage behavior. Bills would go down even more for structural winners if they adjusted their behavior to use less electricity during the peak period. Furthermore, if one time-varying rate reduced bills more than the other, one would expect the likelihood of enrollment to be higher for the rate with the greatest bill reduction. Of course, customers do not have perfect information and rates are complex so they may use heuristics (e.g., I don't use much air conditioning so this might be a good rate for me) that are imperfectly correlated with the amount of potential bill reduction for each rate choice.

[48] On average, around 85% of summer usage is in the first tier (under 700 kWh per month).

Table 9-2: Conditional Logit Model Output for All Customers
(* p<0.05, ** p<0.01, *** p<0.001)

Variable	Definition	Coefficient	T-Statistic
Tier 1 Price	The price in $/kWh in tier 1	-0.089***	-5.8
Tier 2 Price	The price in $/kWh in tier 2	-0.028**	-3.1
Peak Period Price	The price in $/kWh during the peak period as defined in the pricing plan	-0.024***	-7.8
CPP Price	The price in $/kWh during the peak period on CPP days	-0.010***	-10.9
IHD	1 if offer includes an IHD, 0 otherwise	0.086*	2.3
PCT	1 if offer includes a PCT, 0 otherwise	0.112**	3.0
CPP Event Days	The maximum # of CPP events that can be called for each plan offer	-0.029***	-7.9
TOU Length	# of hours in the peak period for the TOU rate	-0.233***	-10.2
CPP Length	# of hours in the peak period for the CPP rate	-0.176***	-6.9
CPP-TOU Length	# of hours in the peak period for the CPP-TOU rate	-0.213***	-8.0
Tiers	1 if the offer is a tiered rate, 0 otherwise	-0.124	-1.8
Ineligible X Time-varying	1 if a customer was in the ineligible group and the given option in the survey was a time-varying rate	0.700***	6.4
TOU	1 if the offer is a TOU rate, 0 otherwise	0.618***	5.3
CPP	1 if the offer is a CPP rate, 0 otherwise	-0.098	-0.7
CPP-TOU	1 if the offer is a CPP-TOU rate, 0 otherwise	0.431**	2.8
Observations			30,834
Pseudo R-squared			0.098

To determine the extent to which being a structural winner influences rate choice, we used interval data to calculate 2012 summer bills for each customer on each pricing plan offered in the survey and also for the standard rate. These calculations could only be done for the 569 SPO pilot control group customers for whom interval data was available. Since customers received the survey in May 2013, the prior year's summer usage was most pertinent. Prices during non-summer months are the same for all pricing plans so only differences in summer bills were relevant. After testing various specifications of this variable in the conjoint model, we found that percent wins/losses relative to the standard rate had the highest predictive power. To understand how the percent wins/losses variable was calculated, consider this example:

- Using 2012 interval data for a given survey respondent, assume the bill for the summer was $900 for one of the time-varying pricing plans.
- Assume the bill under the standard rate for the same survey respondent equaled $1,000.
- Therefore, the percent wins/losses variable would equal 10% (=($1000-$900)/$1000).

Considering that summer bills ranged from less than $100 to over $1,000, specifying this variable on a percentage basis was the best way to normalize the variable in the model.

Table 9-3 shows the results from adding this variable to the model shown in Table 9-2. Table 9-3 contains two columns, one that includes only the variables in Table 9-2 but estimated on the subpopulation of 569 customers for which interval data is available (e.g., the control group from the SPO). A comparison of the coefficients in Tables 9-2 and 9-3 suggests that there are differences between the control group population and the other two customer segments that were included in the estimation of the model in Table 9-2, although these differences are small and do not change any of the conclusions from the basic model. The second column in Table 9-3 adds the structural wins/losses variable to the model. As seen, the coefficient on this variable is large relative to the other coefficients and is statistically significant. The positive sign means that larger structural winners are more likely than smaller winners to enroll and both are more likely than structural losers to enroll on a time varying rate.

Table 9-3: Conditional Logit Model Output with % Wins/Losses Variable (Control Group Only)
(* p<0.05, ** p<0.01, *** p<0.001, T-statistics Shown Below Coefficients)

Variable	Model From Table 9-2	Alternative Specification
% Wins/Losses		0.8998** 2.9
Tier 1 Price	-0.0754*** -3.5	-0.0097 -0.3
Tier 2 Price	-0.0340** -2.6	-0.0441** -3.3
TOU Peak Price	-0.0266*** -5.9	-0.0189*** -3.7
CPP Price	-0.0103*** -7.6	-0.0082*** -5.4
IHD	0.0397 0.7	0.0369 0.7
PCT	0.0866 1.7	0.0885 1.7
CPP Event Days	-0.0328*** -6.4	-0.0262*** -4.8
TOU Length	-0.2748*** -8.4	-0.2475*** -7.4
CPP Length	-0.1894*** -5.1	-0.1663*** -4.4
CPP-TOU Length	-0.1796*** -5.0	-0.1381*** -3.6
Tiers	-0.0801 -0.9	-0.0281 -0.3
TOU	0.8576*** 5.5	0.8493*** 5.4
CPP	-0.0316 -0.2	-0.1637 -0.8
CPP-TOU	0.3125 1.5	0.1452 0.7
Observations	15,903	15,903
Pseudo R-squared	0.122	0.123

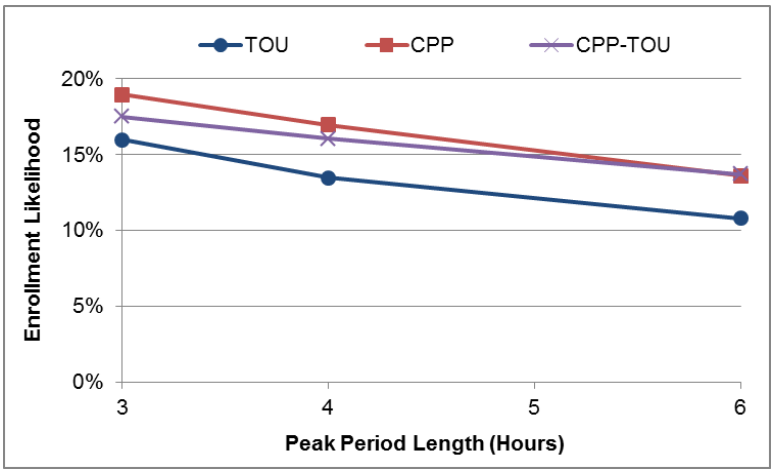
9.3 Predicted Enrollment Likelihoods

After finalizing the conditional logit model, it was used to simulate enrollment for 1,358 different pricing plans that vary with respect to attribute combinations. Whereas the survey data is based on choice sets with three alternatives, this simulation is based on choice sets with two alternatives (default standard

rate and each time-varying plan separately). These results were based on the model in Table 9-2[49] rather than Table 9-3 because the model in Table 9-2 is based on the full SMUD population, not just those that were eligible for SPO or had smart meters at the time of the pilot. The simulation results show how predicted enrollment likelihoods change as each pricing plan attribute changes (unless otherwise specified, other attributes are held at the SPO specifications). Prices are not held constant as other attributes vary – rather, peak and off-peak prices change in order to reflect how prices would be developed by SMUD in the future. For example, a CPP pricing plan that can be called up to 24 times in a year will have lower peak and off-peak prices than one that can only be called up to 12 times a year because these simultaneous changes in the number of event days and prices is consistent with prices that might ultimately be offered or comparisons that SMUD will want to simulate to determine pricing strategy moving forward. The remainder of this section summarizes the results from these simulation exercises for non-EAPR customers. EAPR results are similar.

Figure 9-3 shows how the likelihood of enrollment varies with changes in peak period length. As the peak period length increases for each pricing plan, the enrollment likelihood decreases. Even though these longer peak periods correspond with a decrease in prices (for reasons discussed above), survey respondents clearly preferred the shorter peak period. From an enrollment perspective, a three-hour peak period (the SPO design) is optimal. Basically, customers prefer fewer peak period hours with slightly higher prices over longer peak periods with lower prices.

Figure 9-3: Predicted Enrollment Likelihood by Peak Period Length



For the CPP plans, Figure 9-4 shows how the predicted enrollment likelihood changes as the number of CPP days vary. The enrollment likelihood is roughly the same for 6 and 12 event days but as the number of event days increases beyond 12, the enrollment likelihood decreases even though the peak and off-

[49] As discussed previously, the conjoint survey results were calibrated to reproduce the actual choices seen in the SPO by comparing the stated preference acceptance rates with the revealed preference rates (from the SPO). This calibration was accomplished by inserting three constants into the enrollment model shown in Table 9-2 equal to -1.77 for the TOU rate, -0.42 for the CPP rate and -0.94 for the CPP-TOU rate. With these adjustment factors in the model, when the SPO rate attributes are input to the model, the estimate likelihood equals the observed enrollment rates for each pricing plan reported in Section 8.

peak prices decrease in order to offset the greater number of CPP days. From an enrollment perspective, 6 to 12 CPP event days is optimal. Basically, customers prefer fewer event hours with slightly higher prices. As with peak period length, the optimal number of CPP event days is consistent with the design of the SPO rates, which were designed around 12 event days each summer.

Figure 9-4: Predicted Enrollment Likelihood by Number of CPP Days

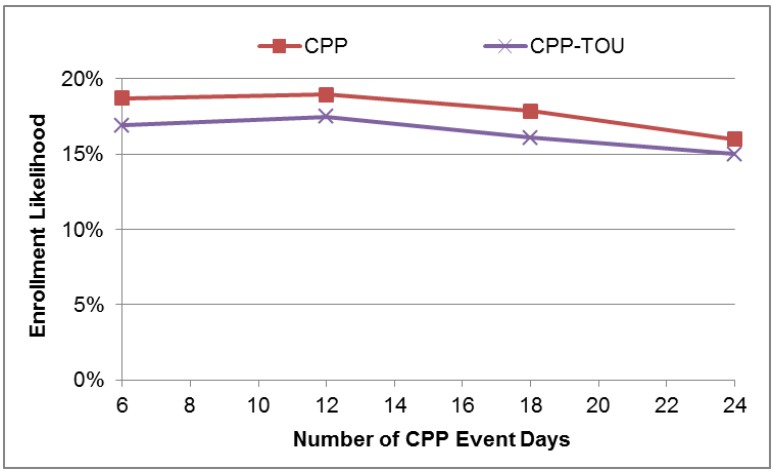


Figure 9-5 shows the enrollment likelihood by TOU price signal and Table 9-4 shows the prices that were included in the survey. The price signal is expressed as a multiple of the SPO rate designs. Contrary to what many policymakers assert, price signal has a minimal impact on enrollment likelihood. As shown in Table 9-4, the TOU peak price increases from $0.22/kWh at 0.75x to $0.39/kWh at 2x, but given that tier 1 and tier 2 prices decrease by around 33% as a result, this increase in the TOU peak price leads to a small change in the enrollment likelihood, from around 16% to 14%. A similar result is found for CPP-TOU, for which the enrollment likelihoods range from 15.5% to 17.5% across the TOU price signals.

Figure 9-5: Predicted Enrollment Likelihood by TOU Price Signal

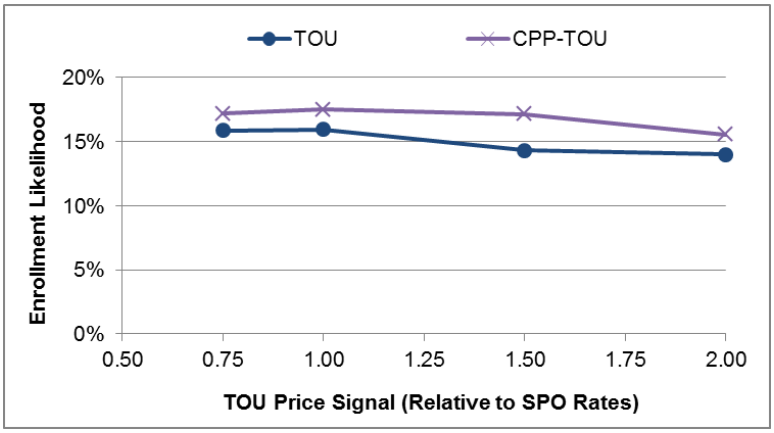


Table 9-4: Associated Prices by TOU Price Signal for Figure 5-3

Rate Type	TOU Price Signal	Tier 1 Price ($/kWh)	Tier 2 Price ($/kWh)	TOU Peak Price ($/kWh)	CPP Price ($/kWh)
TOU	0.75	$0.09	$0.18	$0.22	--
	1.00	$0.08	$0.16	$0.26	--
	1.50	$0.07	$0.14	$0.34	--
	2.00	$0.06	$0.12	$0.39	--
CPP-TOU	0.75	$0.08	$0.15	$0.19	$0.72
	1.00	$0.07	$0.14	$0.23	$0.72
	1.50	$0.06	$0.12	$0.30	$0.72
	2.00	$0.06	$0.11	$0.36	$0.72

Figure 9-6 shows the enrollment likelihood by CPP price signal and Table 9-5 shows the associated prices for each CPP price signal (relative to SPO rates). Unlike for the TOU price signal, an increase in the CPP price signal leads to a steady decrease in the enrollment likelihood. As shown in Table 9-5, the CPP peak price increases from $0.40/kWh at 0.5x to $1.24/kWh at 2x, which leads to a 22% decrease in tier 1 and tier 2 prices. Nonetheless, this decrease in off-peak prices is insufficient to offset the decrease in enrollment that results from CPP prices that rise above $1.00/kWh, even though those CPP prices are in effect for only 1.2% of summer hours (36 of 2,904 hours). A similar result is found for CPP-TOU, for which the enrollment likelihoods also steadily decrease as the CPP price signal increases. As such, these results suggest that customers may experience a “sticker shock” effect for CPP prices of around $1.00/kWh or higher.

Figure 9-6: Predicted Enrollment Likelihood by CPP Price Signal

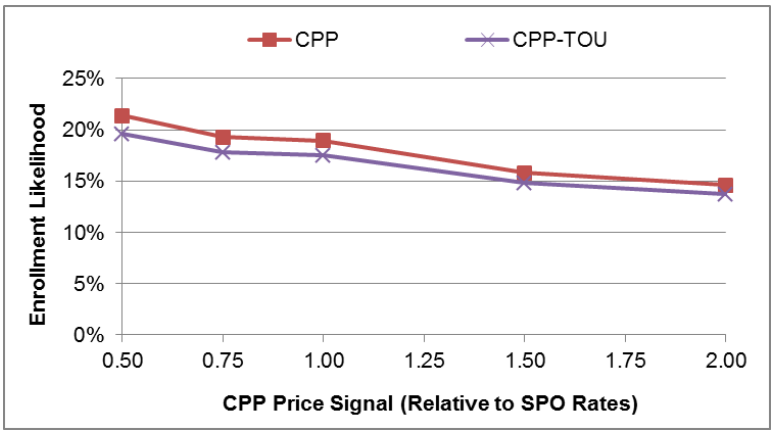
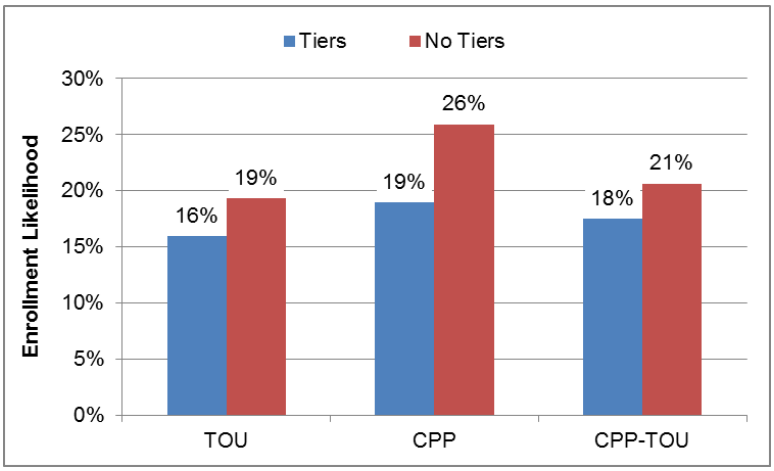


Table 9-5: Associated Prices by CPP Price Signal for Figure 5-4

Rate Type	CPP Price Signal	Tier 1 Price ($/kWh)	Tier 2 Price ($/kWh)	TOU Peak Price ($/kWh)	CPP Price ($/kWh)
CPP	0.50	$0.09	$0.18	--	$0.40
	0.75	$0.09	$0.17	--	$0.58
	1.00	$0.08	$0.16	--	$0.74
	1.50	$0.08	$0.15	--	$1.01
	2.00	$0.07	$0.14	--	$1.24
CPP-TOU	0.50	$0.08	$0.16	$0.25	$0.39
	0.75	$0.08	$0.15	$0.24	$0.56
	1.00	$0.07	$0.14	$0.23	$0.72
	1.50	$0.07	$0.13	$0.21	$0.99
	2.00	$0.06	$0.12	$0.20	$1.22

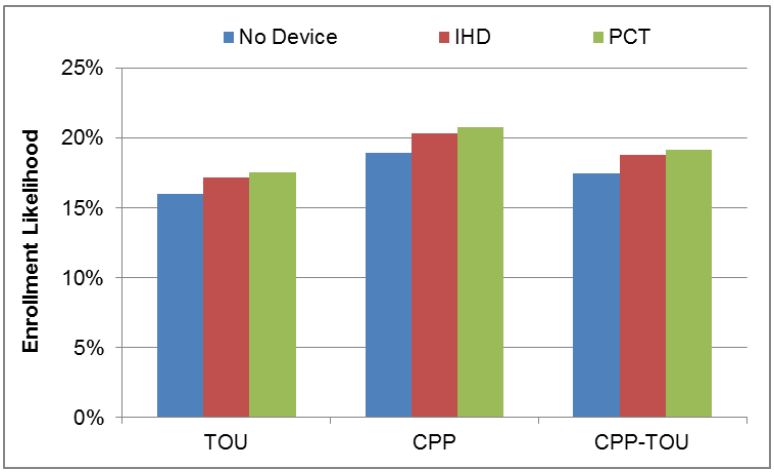
Figure 9-7 shows the predicted enrollment likelihood by rate tier structure. Time-varying rates without tiers are clearly preferred. In addition, although it is not shown in the figure, the analysis shows that nearly 62% of respondents prefer the standard rate without tiers relative to the current standard rate. As discussed above, customers are most sensitive to changes in the tier 1 price because the largest amount of electricity usage is charged at this price for most customers (around 85% on average). However, a rate without tiers is preferred not only because of its simplicity, but also because the tier 2 price in the model decreases substantially in order to equal the tier 1 price. Even though this decrease in price for usage above 700 kWh only applies to around 15% of usage on average, it leads to a substantial increase in enrollment likelihood.

Figure 9-7: Predicted Enrollment Likelihood by Tier Structure



Finally, the model estimated the enrollment likelihood by technology option. These results are illustrated in Figure 9-8. As in the SPO pilot, the technology offer has a minimal impact on enrollment.

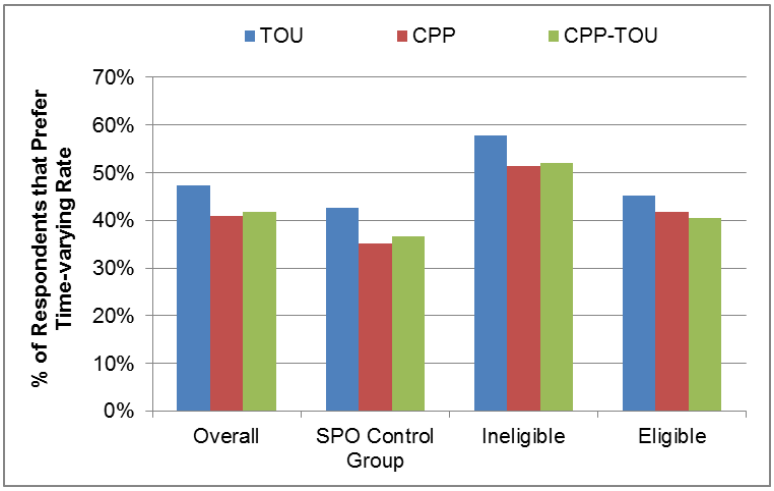
Figure 9-8: Enrollment Likelihood by Technology Option



As discussed in Section 9.2, the conditional logit model includes additional constants for each time-varying rate in order to calibrate the model to SPO opt-in enrollment rates. Without these adjustments, the model suggests that respondents have a substantially higher preference for TOU than any other pricing plan type, especially relative to CPP. This result is somewhat unexpected given the nearly equal TOU and CPP enrollment rates from the SPO pilot and is explained more fully below.

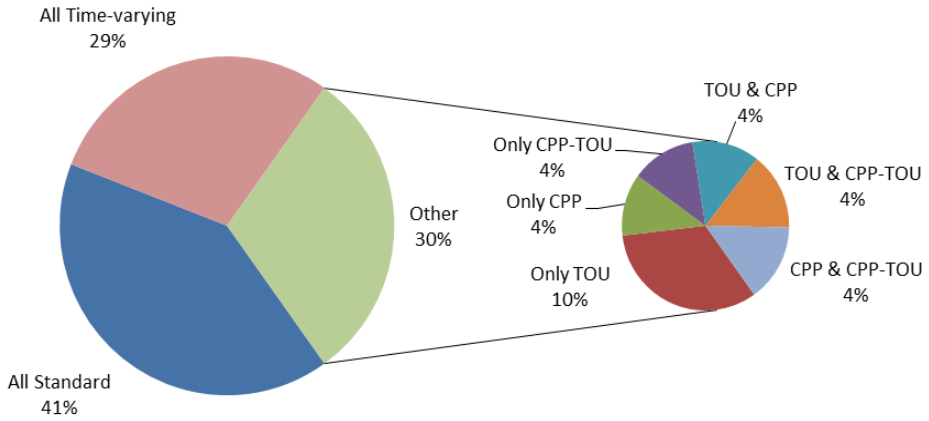
To begin, we first analyzed responses from the first section in the questionnaire where each time-varying rate from the SPO was presented as a single alternative to the standard rate. Figure 9-9 summarizes those results. When the SPO rates were presented separately as a single alternative to the standard rate, respondents had a slightly higher preference for TOU but, in general, the results were similar to the pilot, which showed that preferences for opt-in TOU and CPP were roughly the same. This finding further motivates the question as to why respondents strongly preferred TOU in the conjoint exercise (when multiple rates were offered simultaneously).

Figure 9-9: Preferences for Time-varying Rates as a Single Alternative to the Standard Rate



To explore this issue further, we analyzed the distribution of preferences for the bivariate choice set (e.g., current versus one other choice). As seen in Figure 9-10, most respondents fall into the two "all-or-nothing" categories – they either prefer all time-varying rate options or none. As a result, there is a lot of overlap between customers who prefer TOU and those who prefer CPP, which can potentially lead to unexpected results when both rates are offered simultaneously, as in the conjoint exercise.

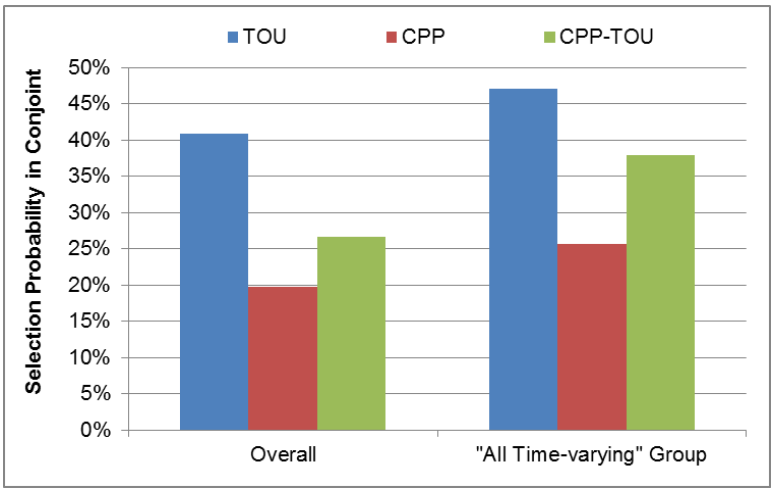
Figure 9-10: Distribution of Preferences for Time-varying Rates as a Single Alternative



Finally, to assess the impact of this overlap between customers who prefer TOU and those who prefer CPP, we further analyzed the unadjusted[50] conjoint exercise responses, focusing on respondents that prefer all of the time-varying rates as a single alternative to the standard rate. For this "All Time-varying" group and all customers (as a comparison), Figure 9-11 summarizes preferences for each type of time-varying rate in the conjoint exercise. When the conjoint exercise presents a TOU rate to respondents in the "All Time-varying" group, of the three choice options, the TOU rate was chosen around 47% of the time. Even though these customers also prefer CPP over the standard rate, with a 25% selection probability, the CPP rate is much less likely than the TOU rate to be chosen when it is presented in the conjoint exercise. Therefore, when multiple rates are offered simultaneously as in the conjoint exercise, while both TOU and CPP are preferable to the standard rate for these customers, TOU is clearly the most preferred option.

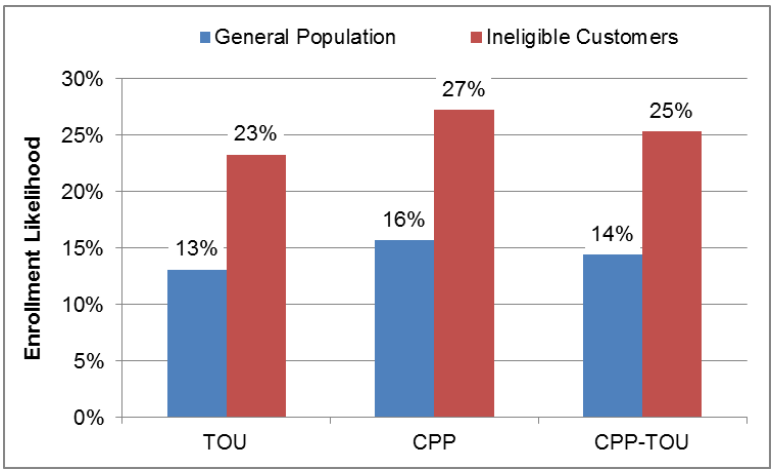
[50] The results in Figure 9-11 are raw responses that are not adjusted by the TOU, CPP and CPP-TOU constants in the conditional logit model.

Figure 9-11: Time-varying Rate Preferences in the Conjoint Exercise (Unadjusted[2])



As mentioned at the outset of this report section, in addition to predicting how enrollment rates vary with changes in pricing plan attributes, SMUD was also interested in determining whether customers who were not eligible for the SPO would have different enrollment likelihoods than those who did participate. This is why the survey plan targeted not just the SPO control group but also those who were not eligible due to participation in other SMUD programs. To determine whether ineligible customers might behave differently, a variable equal to 1 if a customer was in the ineligible group and the given option in the survey was a time-varying rate. We call this variable "Ineligible X Time-varying." As shown in Figure 9-12, customers that were ineligible for the pilot (mostly due to being in SMUD's AC load control program) are significantly more likely to enroll in time-varying rates. This finding is consistent with those of other utilities and also with the SPO choice analysis summarized in Section 8. Customers that have shown a willingness to enroll in one utility program (in this case, SMUD's AC load control program) are significantly more likely to enroll in another program.

Figure 9-12: Predicted Enrollment Likelihood by Population Segment



10 Cost Effectiveness Analysis

The primary objective of time-variant rates is to improve economic efficiency by reducing demand during periods when generation, transmission and distribution costs are high and/or shifting load to periods when costs are lower. As seen in prior sections, each pricing plan examined in the SPO resulted in different per customer and aggregate changes in energy use by rate period. Default pricing plans had lower average demand reductions than opt-in plans but had much higher participation rates. When the lower average reductions are combined with the much higher participation rates, default plans will produce higher aggregate demand reductions compared with opt-in plans. Similarly, CPP pricing plans produce greater reductions during peak periods on event days compared with TOU pricing plans but TOU plans deliver demand reductions every weekday while CPP plans only reduce demand on event days. Opt-in and default plans are likely to have very different costs as well. Recruitment costs per enrolled customer were significantly higher for opt-in plans compared with default plans. CPP pricing plans were somewhat more costly to implement due to more complex billing and notification requirements, but also delivered larger demand reductions per customer. Given all of these differences, it is useful to compare the relative benefits and costs associated with each pricing plan as input to future pricing strategy. This section summarizes the cost effectiveness methodology and results for each SPO pricing plan and for variations on default plans that exclude the offer of IHDs, which add significantly to the cost of the default programs.

Cost-effectiveness analysis is a forward looking exercise. It can be used to address three important questions concerning time-variant pricing plans or other demand response resources:

- Is it cost effective to continue to operate the pricing plan without expansion? This scenario accounts for the fact that, in many instances, equipment and recruitment costs are sunk. However, if operating costs are high and benefits low, it might make sense to terminate the program rather than continue to operate it.
- Is it cost effective to recruit additional participants onto a pricing plan? This scenario addresses the question of whether increased enrollment will increase or decrease overall cost-effectiveness. Under this scenario, start-up costs are treated as sunk and the focus is on marginal cost-effectiveness of new enrollees given initial recruitment, enrollment and equipment costs as well as ongoing costs of keeping customers enrolled and engaged.
- Is an option cost-effective taking into consideration all costs, including sunk costs?

The analysis presented in this section focuses on the second and third questions. The analysis examines the 7 pricing plans included in the SPO plus three additional scenarios that simulate the three SPO default plans but without the offer of an IHD. Table 10-1 summarizes the ten scenarios that are examined.

Table 10-1: Summary of Cost Effectiveness Scenarios Analyzed

Rate	Opt-in Enrollment		Default Enrollment	
	No IHD offer	IHD offer	No IHD offer	IHD offer
TOU	X	X	Δ	X
CPP	X	X	Δ	X
TOU-CPP			Δ	X

The analysis summarized here is based on the two-year average enrollment rates and load impacts from the SPO under the assumption that these values would hold if the pricing plans were offered to SMUD's entire residential population. The costs, summarized below, also use SPO values as the starting point. Cost effectiveness analysis is often done based on impact estimates derived under normal and extreme weather conditions since demand response impacts can vary significantly with differences in weather. The load impacts, and therefore the net benefits, are larger under extreme weather conditions than under normal weather conditions. 2012 and 2013 were actually cooler than normal weather conditions on both average weekdays and on event days, and much cooler than extreme weather conditions (typically characterized by conditions that occur once every 10 years). As such, the net benefits summarized here understate the values that would result under a more typical ex ante analysis, especially one based on extreme weather conditions.

The remainder of this section is organized as follows. Section 10.1 presents a conceptual overview of the cost effectiveness framework that was used to estimate net benefits, and the benefit-cost ratio, for each scenario. Section 10.2 summarizes the inputs that were used for the analysis. Section 10.3 summarizes the results, including sensitivity analysis that shows which variables most impact net benefits.

10.1 Cost Effectiveness Framework

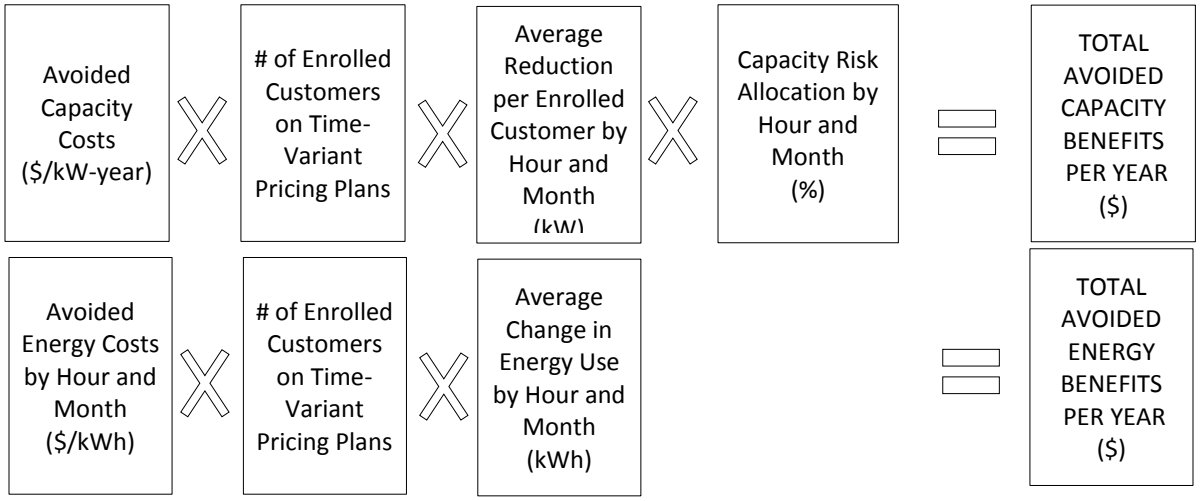
The primary benefits associated with time-variant pricing stem from a reduction in the need for new capacity additions and avoided wholesale energy costs due to reduced loads during high cost periods or shifting usage from higher to lower cost periods. Such pricing can also reduce the need for transmission and/or distribution investments but these benefits have not been included in the analysis conducted here.[51]

At the simplest level, avoided capacity and energy benefits are calculated as depicted in Figure 10-1. For capacity benefits, average load impacts by hour are multiplied by the number of enrolled customers to produce aggregate load reductions by time of day. The capacity risk allocation factor shown in the fourth box in the diagram is explained below but, in short, it is a way of recognizing that the risk of not having enough generation to meet demand is highly concentrated in relatively few hours of each year and few hours across multiple years. Put differently, it is a way of time-differentiating the capacity value

[51] As was true from the fact that we are relying on relatively cool, historical weather conditions rather than ex ante, extreme conditions, leaving out transmission and distribution benefits means that the values estimated here may understate the net benefits that can be realized from time-variant pricing. Including T&D benefits could increase net benefits by as much as 25%.

of demand reductions from time-variant rates so they can be compared with other capacity options. The benefits associated with avoided energy costs are calculated by multiplying the aggregate change in energy use in each hour by the avoided cost of energy production in each hour.

Figure 10-1: Cost-Effectiveness Calculations for Avoided Capacity and Energy Benefits



As mentioned above, a key factor in the capacity equation is the capacity risk allocation factor shown in the first equation. Time variant rates and other demand response (DR) resources, like peaking power plants, can be thought of as insurance against the rare situations in which demand would otherwise exceed the generation capacity of a utility. Continuing this insurance analogy, comparing the capacity benefits of time-variant rates to another resource (such as a single cycle gas turbine) is like comparing two car insurance quotes when the policies are different. When the car policy characteristics such as the deductible, bodily insurance limit, property damage limit and/or roadside assistance differ, the insurance quotes are not directly comparable. Similarly, different generators provide different types of insurance and different pricing plans and other types of DR provide different types of insurance. For example, the hours of the day and months of the year when high prices are in effect, and the maximum number of hours when they are in effect, are typically limited. Also, there are differences in the amount of resources that can be delivered by time-variant rates or other DR resources across specific hours and months. In SMUD's service territory, load reductions from time-variant rates are higher on high demand days when the value of the reductions are greatest. In order to make adequate comparisons, it is necessary to quantify how the insurance value varies by hour and month and factor in the extent to which resource availability coincides with the capacity value.

The capacity insurance value of a resource is directly linked to how it affects the risk of shortages in balancing demand and supply. All other factors being equal, a resource that can deliver when the risk of supply shortages is greatest should provide more insurance value than a resource that cannot. In most systems, extreme weather drives up the system demand, the likelihood of resource shortages and the need for additional capacity. Although unforeseen system shocks such as forced outages can occur during hours without extreme loads, the system is designed with sufficiently large operating reserves to absorb such contingencies and allow other installed resources to come online, ramp up, and meet

demand.[52] At high system demand levels, it is more difficult to operate the system in general, and there is greater risk that unplanned outages will result in insufficient installed capacity. Put simply, the primary driver of additional capacity needs is demand.[53] This generally means that resources available in the summer mid-afternoon hours, when systems typically peak, have higher insurance value than resources available in shoulder or off-peak hours.

Figure 10-2 shows the load duration curves for the top 500 hours for SMUD for the years 2004-2013. The graph illustrates the fact that the top 10, 50 and 100 hours have substantially higher loads than all other hours. It also illustrates the fact that high system loads do not occur in each calendar year and, in the case of an extreme weather year, the risk of a resource shortage is increased. Nevertheless, the planning criteria for the supply system ensure that the likelihood of a resource shortage occurring on any given day is extremely low.[54] This equates to a very low likelihood that there are more than a few hours in a year in which resource shortages can occur.

Figure 10-3 shows a consolidated load duration curve for the same years, with the demand shown as the percentage of the highest peak demand from 2004-2013, 3,280 MW. Over 10 years there were only 12 hours in which demand was higher than 95% of the all-time system peak and only 71 total hours in which demand exceeded 90% of the all-time peak. This illustrates that reducing demand for a few hours, if targeted correctly, can significantly reduce the likelihood that system demand will come within 5% of the all-time system peak and will help avoid the need to procure additional generation capacity. Despite a relatively narrow, three-hour peak period and a limited number of event days (12), the SPO rates produce reductions for 36 hours per year (or 360 hours over 10 years), which is sufficient to reduce system peak loads and avoid the need for capacity additions.

[52] Installed capacity shortages are altogether different than the ability to recover from system shocks, such as transmission or generation forced outages. Installed capacity includes operating reserves, generation online and generation off line. The system operator has separate criteria for adequate amounts of quick response operating and back-up reserves (ancillary services) to help balance the system and recover from any shocks.

[53] In some systems, scheduled outages for generator maintenance during shoulder months can also affect the likelihood of supply shortages. In incorporating scheduled outages, it is important to distinguish risk due to scheduling error from risk due to insufficient installed resources. In many systems, scheduling maintenance is a challenge, but it is also the case that, when done properly, the risk of a shortage in supply is relatively low in shoulder months compared to in the peaking months, which are usually during the summer.

[54] In other words, the Loss of Load Expectation (LOLE) is highly unlikely to exceed 20 or 50 hours, much less 100 hours, given the existing planning criteria.

Figure 10-2: SMUD Load Duration Curves for 2004 through 2013

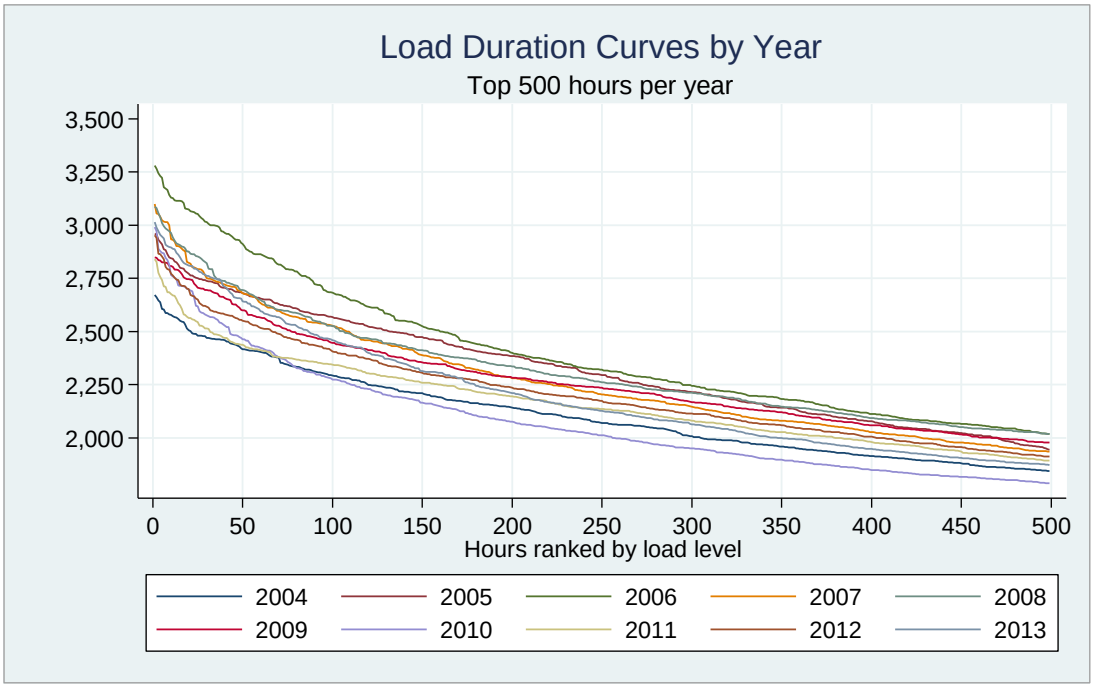
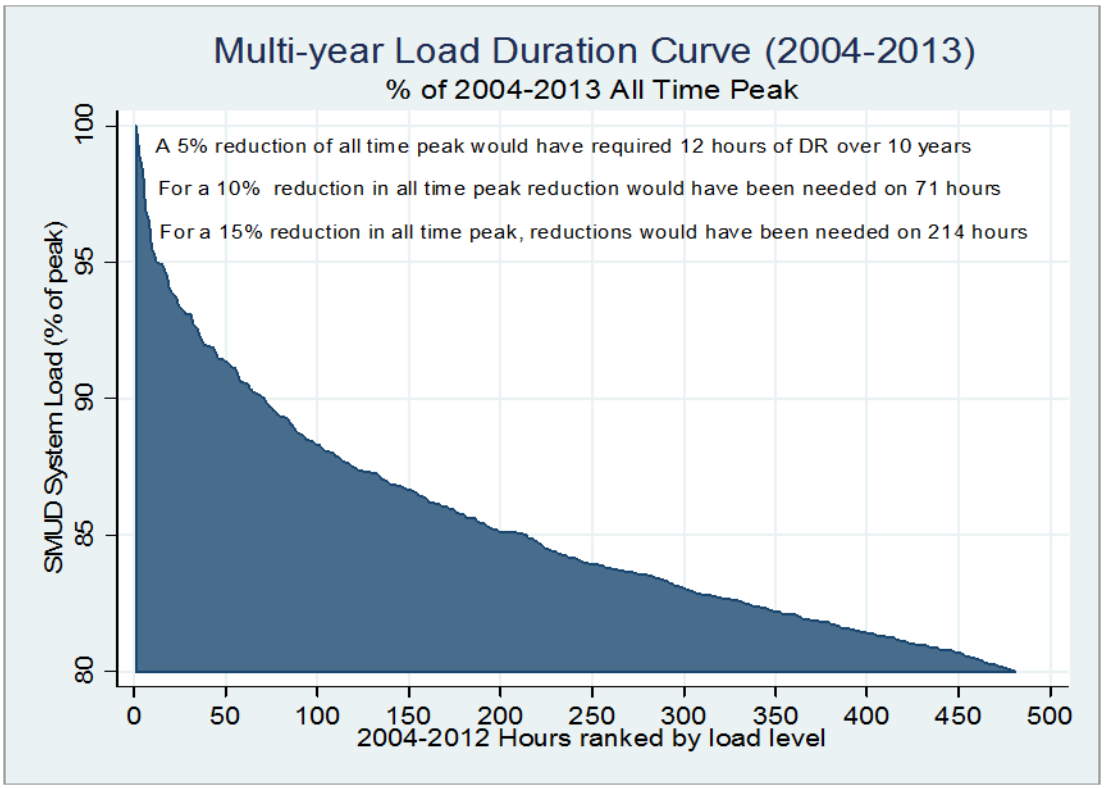


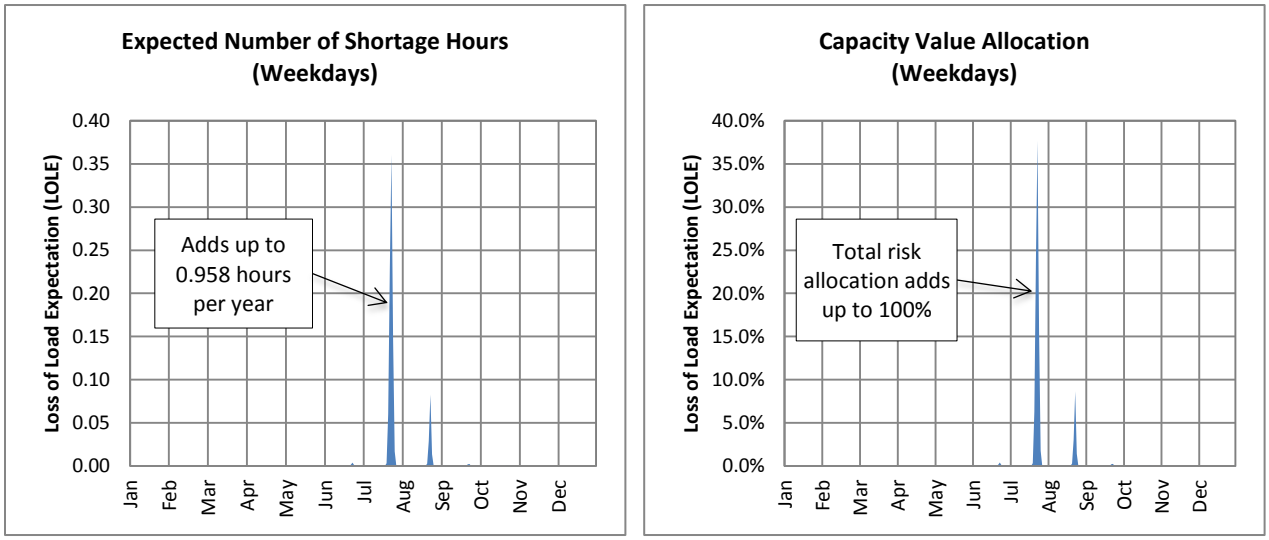
Figure 10-3: Number of Hours in Which Demand is Within X% of SMUD's All Time System Peak



Shortages in installed capacity typically occur when system loads are high or when multiple generators experience unforeseen outages at the same time. SMUD simulated the risk of shortages, taking into account the likelihood of extreme system loads and the probability of generator forced outages. The process is repeated thousands of times because loads for any given year are not known in advance and because there was a random component to forced outages. The goal is to estimate how many shortage hours can be expected on average – known as the Loss of Load Expectation (LOLE) – and when shortages are most likely to occur. This data on the concentration of risk can be used to calculate the concentration of the need for capacity and to time differentiate capacity value.

Figure 10-4 shows how the allocation of capacity value is developed. The left hand side of the figure shows the expected number of shortage hours (LOLE) by month and hour of day. The right hand side of the figure is identical except for the scale, which reflects the share of expected shortages in each combination of month and hour of day. Note that the total for the allocation of capacity need across all months and hours of the day adds up to 100%. As shown, the risk of high system loads is highly concentrated in summer months and in afternoon hours. The need for installed resource capacity to meet extreme system loads is similarly concentrated. Based on the risk allocation, one can say, for example, that 4.8% of the risk is concentrated in the hours from 3 PM to 4 PM in July.

Figure 10-4: Illustrative Example of Time Differentiated Risk Allocation for Capacity Need



This type of risk allocation of capacity need can be used to time-differentiate capacity value. For illustration, assume that the avoided cost of capacity is $120 per kW-year. If 4.8% of the overall risk allocation is concentrated in the 3 PM to 4 PM hour of the month of July, $5.76 of the total capacity value (4.8% x $120 = $5.76) is allocated to that time period. Load reductions that result from time-variant pricing during those hours would then be valued at an avoided cost of $5.76. Load reductions that occur during different hours, for example in September when the risk allocation is roughly 0.5%, would have a much lower value (e.g., (0.5)x$120 = $0.60).

Once the avoided capacity and energy costs have been calculated using the conceptual framework outlined above, the net benefits over time must be compared with the cost of achieving those benefit

streams to determine net benefits (or the benefit-cost ratio) for each pricing plan. For modeling cost-effectiveness in this instance, costs have been estimated for the following four cost categories:

- *One-time costs not tied to enrollment.* These are mainly program set up costs incurred when a program is developed and initially launched. They are not recurring and are not tied to the number of enrollments. They include components such as developing IT systems for settlement, initial market research to inform program design and other similar components.
- *Recurring costs or incentives not tied to enrollment*. These costs are incurred annually and do not change materially with program expansion or contraction. They are often referred to as overhead costs. They typically include the personnel costs required to administer the program.
- *One-time costs or incentives tied to enrollment*. These are costs that are incurred when a customer is initially enrolled. They can be in the form of equipment and installation costs, acquisition costs, sign-up incentives or other costs. Their defining characteristic is that they do not recur annually.
- *Recurring costs or incentives tied to enrollment*. These costs are incurred annually but grow or decrease as enrollment changes. They can be in the form of recurring customer engagement costs, equipment monitoring or annual incentive payments.

The input values used to calculate costs and benefits are summarized in Section 10.2.

10.2 Overview of Input Values

This section contains a brief summary of the key inputs to the cost effectiveness model. Each of the scenarios summarized in Table 10-1 is assumed to go into effect starting in 2018. The net present value (NPV) of benefits and costs are compared over 10 years based on a nominal discount rate of 7.1%.

The load impact estimates used in the analysis are based on the two-year, ex post average impacts for each SPO pricing plan. As discussed in the introduction to this section, it would be better to use ex ante impact estimates for normal and extreme weather conditions. However, development of those estimates was not part of the work scope for this project. Thus, the analysis is based on the ex post values, which will understate the net benefits that would exist under normal and extreme weather since both 2012 and 2013 were below normal weather years. For simplicity, we have used only the changes in load during the peak period from 4 to 7 PM for all pricing plans. Changes in off-peak loads and energy conservation effects have not been factored into the analysis. For TOU pricing plans, estimated load reductions differ for CPP and non-CPP days, which produces a more accurate estimate of net benefits since so much of the capacity value is concentrated in a few hours on the hottest days. Using the average weekday values only would understate the benefits for TOU plans. For CPP plans, load impacts on non-CPP days are assumed to be zero, whereas load impacts for TOU rates equal the average impact on non-CPP day weekdays. The hourly impacts by month that are used in the analysis are contained in Appendices B and C and are consistent with the average impacts reported in Sections 4 and 5.

Load impacts for the three default scenarios that did not include an offer of an IHD were assumed to be the same as the SPO pricing plans that included the IHD offer. As discussed in Section 6.3, although there are statistically significant differences in load impacts between the opt-in TOU groups with and without the offer of an IHD, there is also a pretreatment difference between these two groups as was seen in Figure 6-1. This difference, when netted out, more than offsets the observed post treatment

difference. Put another way, it is invalid to attribute the difference in impacts between the two groups to the presence of the IHD. As such, we are comfortable assuming that the load impacts are the same with and without an IHD.

As also discussed in Section 6.3, although there are very large differences in observed load shapes between default customers who requested an IHD and those who did not, and also between those who requested an IHD and had it connected all or some of the time during the 2013 summer and those who did not (see Figures 6-3 through 6-10), it is impossible to know whether any of these differences are due to selection effects or due to the influence of the IHD. The analysis in Section 6.2 shows clearly that customers who requested an IHD are much more engaged than those who did not, which is a clear indication of a strong selection effect.

The customer enrollment and attrition values used for the cost effectiveness analysis are taken directly from Tables 8-7 through 8-9 and 8-14 through 8-16. Each scenario assumes that the pricing plans are offered to SMUD's entire residential population and the acceptance and attrition rates found in the SPO apply to the entire residential class. The analysis also assumes that, for opt-in programs, customers who move from one location to another within SMUD's service territory will be defaulted onto the same rate that they had before moving. Given the high move rate in SMUD's service territory, any opt-in program that did not implement this business policy would have much higher recruitment costs, and much lower net benefits, than are shown in Section 10.3. Based on input from SMUD, we have assumed that 80% of customers who move each year relocate somewhere within SMUD's service territory and, therefore, remain on the same time-variant rate they were on before moving. Also based on input from SMUD, we assume that there is still a cost associated with setting these movers up on the same pricing plan after they relocate but this cost is much lower than the cost of recruiting a new customer to replace them. For default pricing plans, these setup costs are assumed to be 0.

The avoided capacity cost estimates were provided by SMUD. The estimated values for each year are confidential. Generally, they range from roughly $50 to $80/kW-year in the first few forecast years and increase to around $125/kW-year by the end of the forecast period. As discussed in Section 10.1, the avoided capacity costs are time differentiated using estimates of the loss of load probability provided by SMUD. LOLP on SMUD's system is highly concentrated in a few hours. The peak period hours from 4 to 7 PM in July and August capture 75% of the annual LOLP. As such, load reductions during these hours are much more highly valued than those at any other time of the year.

Avoided energy prices were also provided by SMUD and, like capacity values, are confidential. As discussed previously, for simplicity, we have only examined the load impacts during the peak period and, therefore, only energy prices for the hours from 4 to 7 PM are factored into the benefit calculation. Furthermore, only summer months are relevant since time-variant rates examined here are only in effect during the summer months. Generally, prices during the peak period range from $0.035 to $0.045/kWh on the average weekday and are 5 to 10% higher on the typical event day.

Table 10-2 summarizes the costs for each of the four primary cost categories that are used as input to the analysis. These are based on costs that were incurred for a variety of activities as part of the SPO and assumptions about how various costs would change if the pricing plans were offered to the entire

residential population. As seen in the table, the biggest cost difference across pricing plans has to do with one-time equipment and acquisition costs for customers. Plans that do not offer an IHD have much lower costs than those that do and default plans have much lower acquisition costs than opt-in plans. Fixed costs vary somewhat across plans based primarily on differences in management costs for projects with and without IHDs and differences in notification costs for CPP versus TOU plans. One time fixed costs are higher for default CPP programs compared with opt-in programs because of required upgrades to the billing system to handle the larger volume of billing for CPP customers.

Table 10-3: Cost Inputs

Option	Fixed Costs (Non-volumetric)		Variable Costs (Per Enrollee)	
	One Time Costs ($000)	Recurring Annual Costs ($000)	One Time Costs	Recurring Annual Costs
Opt in TOU No IHD	$748	$245	Acquisition: $62.84	$4.60
Opt in TOU with IHD	$778	$245	Equipment: $131.20 Acquisition: $60.70	$4.66
Opt in CPP No IHD	$1,322	$335	Acquisition: $58.53	$7.88
Opt in CPP with IHD	$1,352	$445	Equipment: $131.20 Acquisition: $60.46	$7.47
Default TOU with IHD	$778	$245	Equipment: $131.20 Acquisition: $3.99	$2.18
Default CPP with IHD	$1,352	$445	Equipment: $131.20 Acquisition: $5.02	$5.33
Default TOU-CPP with IHD	$778	$445	Equipment: $131.20 Acquisition: $6.29	$5.33
Default TOU no IHD	$748	$155	Acquisition: $3.99	$2.18
Default CPP no IHD	$1,322	$335	Acquisition: $5.02	$5.33
Default TOU-CPP no IHD	$748	$335	Acquisition: $6.29	$5.33

10.3 Cost-Effectiveness Estimates and Sensitivity Analysis

Table 10-3 shows the NPV of benefits and costs over a ten year period for each pricing plan, as well as the benefit-cost ratio for each plan, based on the inputs and methods described above. Figure 10-5 displays the benefit-cost ratios visually so it is easy to compare the values across pricing plans. The values in the table and figure are for overall cost-effectiveness which includes both start-up and ongoing costs and address the policy question of which plan would be most cost effective if it were to be implemented from scratch. The marginal cost effectiveness values are shown in Table 10-4 and Figure 10-9. These estimates address the policy question of whether it is cost effective to continue to enroll more customers onto a plan once it is up and running.

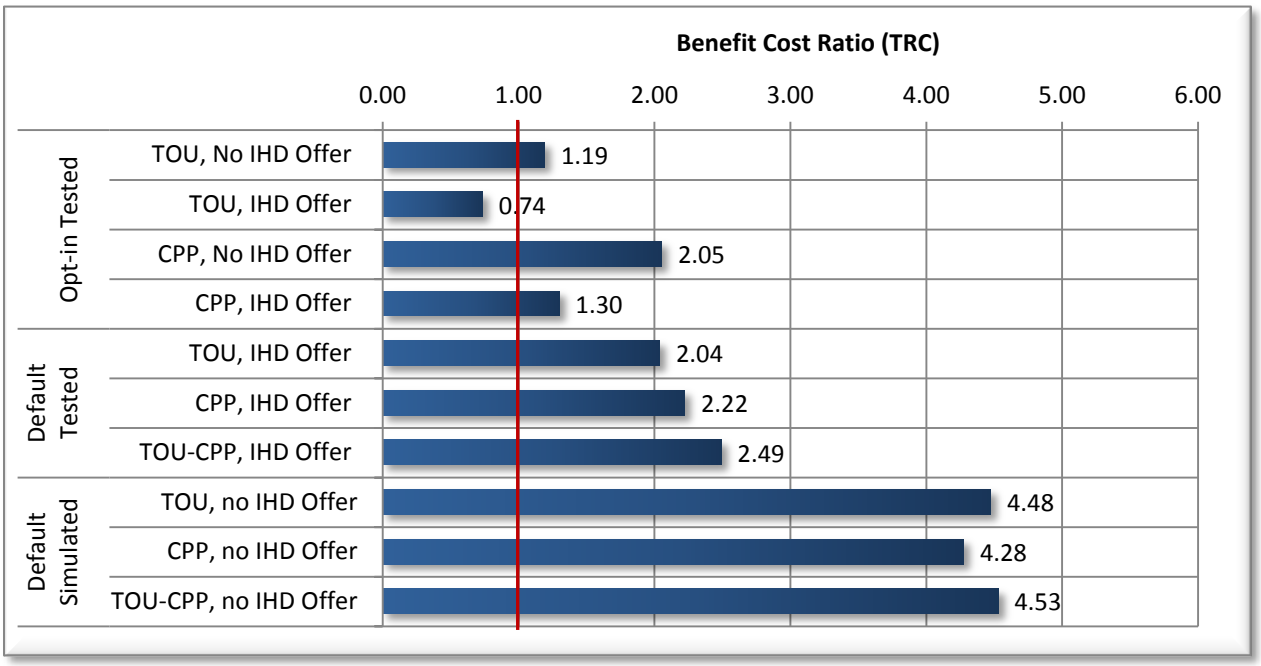
As seen in the table, all but one of the pricing plans, opt-in TOU with an IHD offer, are cost effective, but the magnitude of net benefits vary by almost a factor of 60 from the plans with the lowest and highest

positive net benefits. Of the 7 pricing plans tested in the SPO, if they were to be extended to SMUD's entire residential population, the net benefits over 10 years would range from a low of roughly -$5.5 million for the opt-in TOU plan with the IHD offer to more than $86 million for the default TOU-CPP plan with an IHD offer.

Table 10-5: NPV of Benefits and Costs by Pricing Plan ($ millions)

Scenario Type	Scenario	Benefit/Cost Ratio	10 Year NPV for SMUD Territory		
			Benefits	Costs	Net Benefits
Opt-in Tested	TOU, No IHD Offer	1.19	$12.1	$10.2	$2.0
	TOU, IHD Offer	0.74	$15.5	$21.0	-$5.5
	CPP, No IHD Offer	2.05	$29.7	$14.4	$15.2
	CPP, IHD Offer	1.30	$34.3	$26.3	$7.9
Default Tested	TOU, IHD Offer	2.04	$66.9	$32.8	$34.1
	CPP, IHD Offer	2.22	$142.1	$63.9	$78.2
	TOU-CPP, IHD Offer	2.49	$144.8	$58.1	$86.7
Default Simulated	TOU, no IHD Offer	4.48	$66.9	$15.0	$52.0
	CPP, no IHD Offer	4.28	$142.1	$33.2	$109.0

Figure 10-5: Benefit Cost Ratios by Pricing Plan



Under the assumption that the IHD adds significantly to costs but provides no additional benefits (an assumption that is consistent with the empirical evidence from the SPO), pricing plans that include the offer of an IHD are all much less cost effective than the equivalent plan that does not offer an IHD. For the default plans without an IHD offer, the TOU plan has the lowest net benefits but still exceeds $50 million. The TOU-CPP plan is estimated to deliver net benefits that are more than twice as large as the TOU plan. In general, all CPP plans deliver net benefits that are roughly twice as large as the equivalent TOU plan. This stems from the fact that the LOLP and therefore the time-differentiated value of avoided capacity, is highly concentrated in relatively few hours, and the average load reductions for CPP plans are roughly twice what they are for the TOU plans during those hours.

The benefit cost ratios for the 10 scenarios examined range from 0.74 for the opt-in TOU plan with IHD offer, to 4.53 for the TOU-CPP plan with no IHD offer. For the same reasons discussed above, the ratios are much lower for opt-in plans than default plans, lower for default plans with an IHD offer than for those without, and lower for CPP plans compared with TOU plans.

Figures 10-6 through 10-8 show the results of sensitivity analysis that was done for three of the pricing plans: opt-in and default CPP and default TOU, all without an IHD offer. This analysis shows how the benefit-cost ratio varies with changes in input values. Each row in the figures, labeled on the Y axis, shows the change in the benefit-cost ratio given a change of plus or minus 20% in the base value used in the analysis. For example, for the opt-in CPP plan shown in Figure 10-6, the benefit-cost ratio of 1.67 was based on the load impact estimates discussed in Section 10-2. If the peak period load reduction for this pricing plan was 20% less than what was observed in the SPO, the benefit-cost ratio would fall to 1.31. If it was 20% larger than what was scene in the SPO, it would increase to 1.95. The variables shown at the top end of the vertical axis are much more significant drivers of net benefits than those at the bottom.

These figures show not only which variables are the most significant drivers of net benefits, but also illustrate how robust each pricing plan is to changes in input values and assumptions. If the benefit-cost ratio is above 1 in all cases, as it is for these three plans, or the value varies little when inputs vary, it is quite robust. If the ratio dips below 1 given changes in some input values, and if these values have a fair amount of uncertainty associated with them, pricing strategies based on those plans may or may not be sound depending on how things materialize over time.

For all three pricing plan scenarios, load impacts and avoided capacity costs are the most significant drivers of net benefits. Indeed, for the CPP plans, the variation in the benefit-cost ratio is identical given a plus or minus 20% change in either load reductions or avoided capacity costs. This is logical since the product of these two variables, weighted by the time-differentiated capacity value, produce about 99% of the benefit. For TOU rates, avoided energy costs outside the peak period also contribute to the benefit calculation so the variation in net benefits given changes in peak period load impacts and avoided capacity costs differ.

Looking at the other variables in each figure, recurring costs tied to enrollment are the third most important driver of net benefits for the default plans whereas for the opt-in plan, one-time costs tied to recruitment are more important.

Figure 10-6: Sensitivity Analysis for Opt-in CPP Pricing Plan (No IHD Offer)

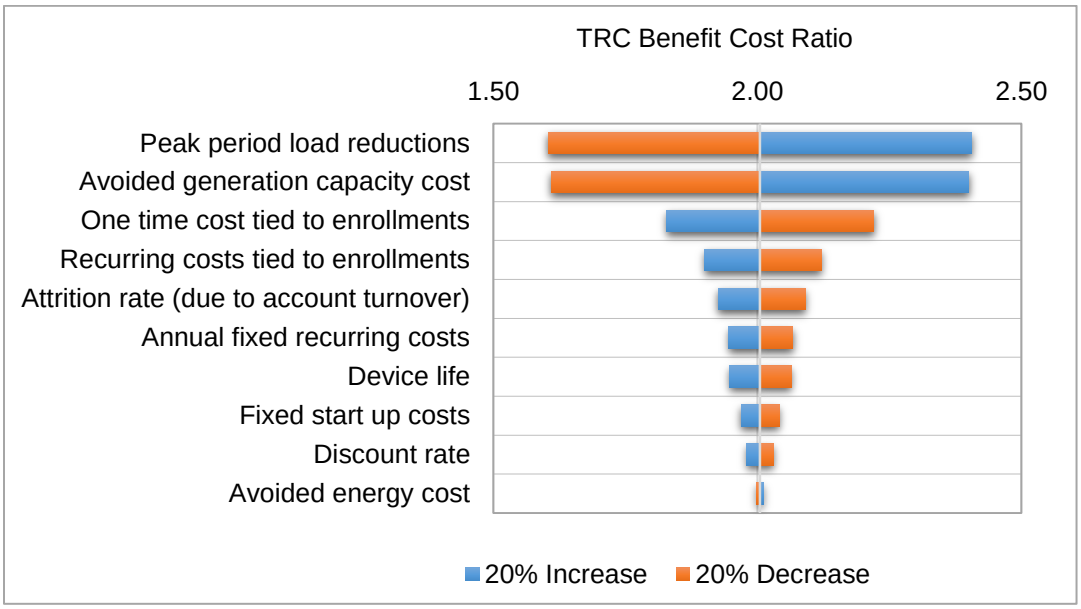


Figure 10-7: Sensitivity Analysis for Default TOU Pricing Plan (No IHD Offer)

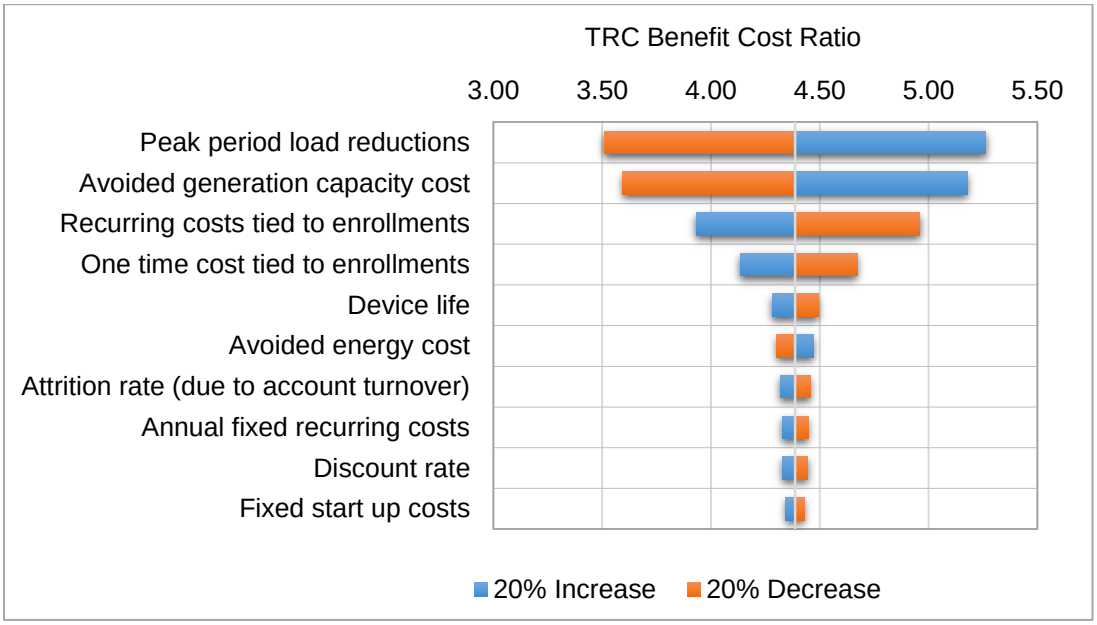


Figure 10-8: Sensitivity Analysis for Default CPP Pricing Plan (No IHD Offer)

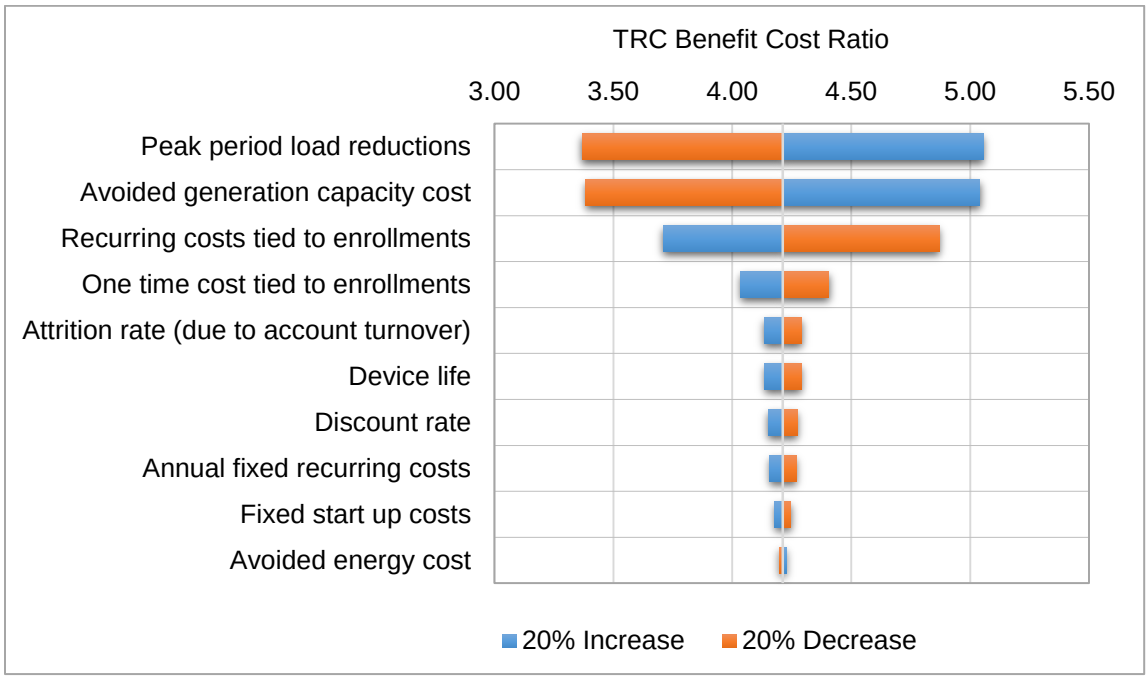
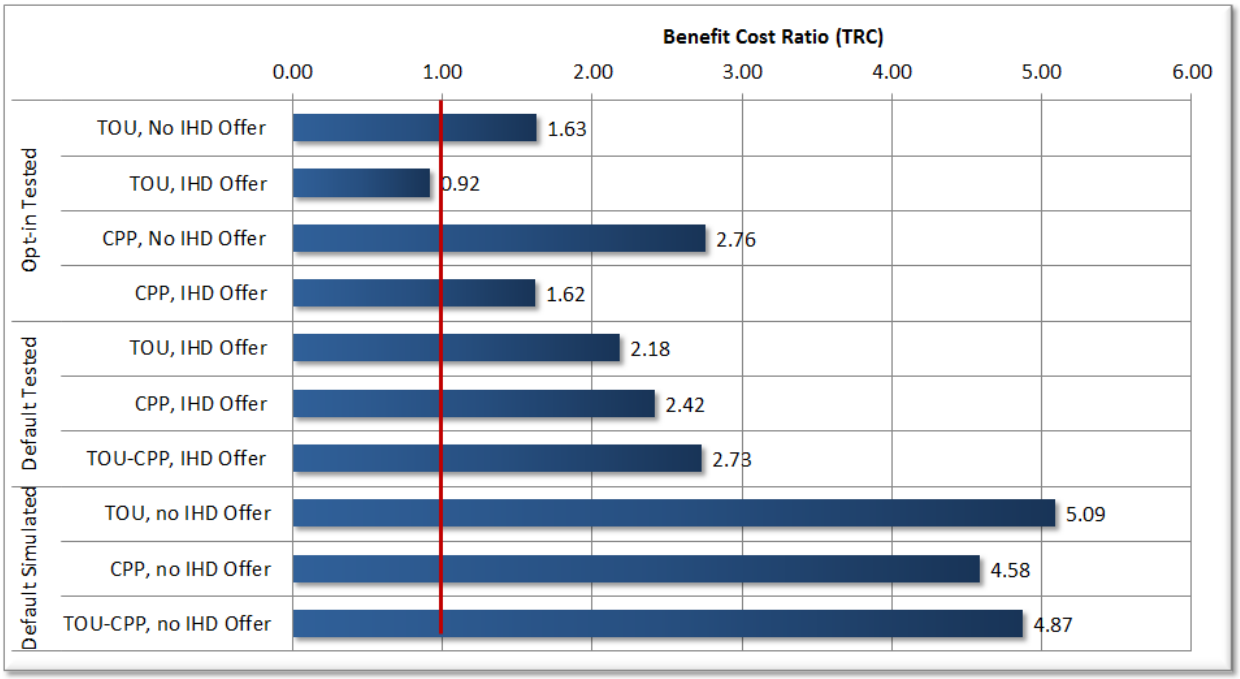


Table 10-4 and Figure 10-9 summarize the results of the marginal cost-effectiveness analysis for each pricing plan for the marginal customer, that is, the next customer to be enrolled. This analysis excludes the startup costs associated with each program and addresses the question of whether or not it is cost effective to expand an existing program, based largely on a comparison of incremental costs and benefits per customer. The analysis indicates that it would be cost effective to expand all of the pricing plans except the opt-in TOU rate with IHD offer, where the incremental costs exceed the incremental benefits because of the relatively low load impacts and the high cost of the IHD.

Table 10-4: NPV of Marginal Benefits and Costs by Pricing Plan for the Average Customer ($)

Scenario Type	Scenario	Benefit/Cost Ratio	10 Year NPV for SMUD Territory		
			Benefits	Costs	Net Benefits
Opt-in Tested	TOU, No IHD Offer	1.63	$142	$87	$55
	TOU, IHD Offer	0.92	$188	$206	-$17
	CPP, No IHD Offer	2.76	$268	$97	$171
	CPP, IHD Offer	1.62	$355	$219	$136
Default Tested	TOU, IHD Offer	2.18	$100	$46	$54
	CPP, IHD Offer	2.42	$153	$63	$90
	TOU-CPP, IHD Offer	2.73	$178	$65	$113
Default Simulated	TOU, no IHD Offer	5.09	$100	$20	$80
	CPP, no IHD Offer	4.58	$153	$34	$120
	TOU-CPP, no IHD Offer	4.87	$178	$37	$142

Figure 10-9: Marginal Benefit-Cost Ratios by Pricing Plan



11 End of Pilot Survey

This final report section summarizes the results from a survey that was done in the fall of 2013, after the end of the summer period, to obtain input among pilot participants on the following topics:

- Customer satisfaction with SMUD and with the pricing plan customers were on;
- Awareness of the attributes of each pricing plan;
- Perceptions about the pricing plan;
- Reasons for staying on the pricing plan;
- Awareness of events for the CPP pricing plans; and
- IHD use.

The survey questionnaire is contained in Appendix F. The survey was sent to all customers who were enrolled on a pricing plan (including those who actively dropped out but not those who moved) as well as a sample of control group and deferred customers. The survey was conducted using both online and hard copy questionnaires. The field work included the following multi-step process:

- Pre-announcement letter on SMUD letterhead;
- $2 with a letter sent by Nexant's market research group, Population Research Systems (PRS), on PRS letterhead with a URL link to where the survey could be completed;
- In addition to the above letter, customers for whom SMUD had email addresses were also sent a link via email for convenience;
- An email reminder was sent to non-respondents, with a URL link;
- A reminder letter with a hardcopy survey was sent to those who still had not responded to prior solicitations – this letter also contained a URL link to the questionnaire; and
- One more reminder email with a link; and
- Reminder postcard with URL link included.

The survey was in the field from November 13, 2013 through January 2, 2014. Table 11-1 shows the number of customers solicited by segment and the response rates for each group. As seen, there were 20 different customer groups included in the survey and the response rates varied across cells, with a low of 26% for those in the default, CPP-TOU treatment group who did not ask to receive an IHD to a high of 62% for the same default treatment group who did ask to receive an IHD. The overall response rate was 40%. Table 11-2 shows the survey topics covered for each survey cell.

Table 11-1: Number of Surveys Sent and Returned by Customer Segment

Group	Outcome	Group #	Population	Mailings	Completed Surveys	% Completed
Control Group		1	31,149	800	300	38%
Default CPP	No IHD Delivered	2	398	393	100	25%
	IHD Delivered	3	129	126	63	50%
	Actively Dropped Out	4	66	66	20	30%
Default TOU	No IHD Delivered	5	1,164	1,157	285	25%
	IHD Delivered	6	326	325	132	41%
	Actively Dropped Out	7	121	120	45	38%
Default CPP-TOU	No IHD Delivered	8	323	319	84	26%
	IHD Delivered	9	95	92	57	62%
	Actively Dropped Out	10	81	79	23	29%
Opt-in CPP	IHD Offered and Delivered	11	1,101	1,094	490	45%
	IHD Offered and Not Delivered	12	59	59	26	44%
	IHD Not Offered	13	145	143	60	42%
	Actively Dropped Out	14	142	140	57	41%
Opt-in TOU	IHD Offered and Delivered	15	1,476	1,475	660	45%
	IHD Offered and Not Delivered	16	59	59	25	42%
	IHD Not Offered	17	866	857	332	39%
	Actively Dropped Out	18	187	186	97	52%
Opt-in TOU - Deferred	IHD Offered	19	1,649	800	370	46%
	IHD Not Offered	20	984	800	366	46%
Total			**40,520**	**9,090**	**3,592**	**40%**

Table 11-2: Survey Topics Covered by Customer Segment

Set #	Set of Questions	Group #																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	General satisfaction with SMUD	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
2	Awareness and understanding of pricing plan features	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
3	Pricing plan expectations, Were expectations met?, Perception of savings, control and comfort impacts		X	X		X	X		X	X		X	X	X		X	X	X			
4	Behavioral changes and perceived difficulty		X	X		X	X		X	X		X	X	X		X	X	X			
5	Questions regarding opt outs at the beginning of 2013 summer				X			X			X				X				X		
6	Use, connectivity and perceived impact of IHDs (also as it relates the pricing plan and knowledge of appliance			X			X			X		X				X					
7	Reasons for Staying on the Pricing Plan		X	X		X	X		X	X		X	X	X		X	X	X			
8	Selected demographic questions	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

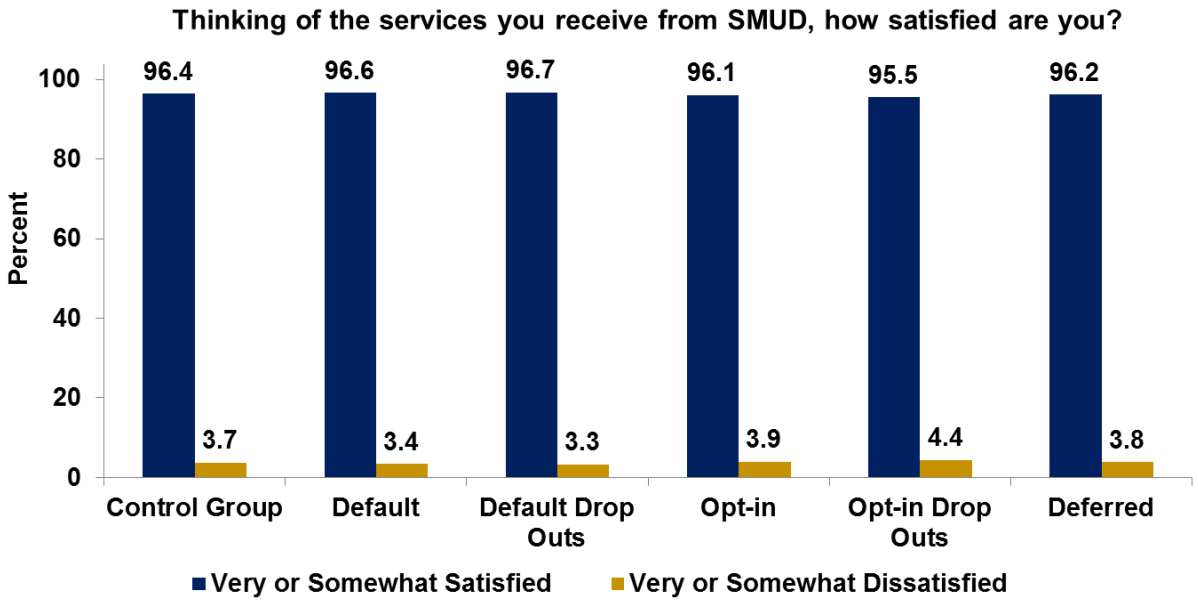
The differential response rates across customer segments shown in Table 11-1 mean that comparing survey responses across cells must be done carefully. For example, if we were to observe a significant difference in the response to a question between default CPP-TOU participants who did and did not ask for and receive an IHD, it would be difficult to know if this difference was due to differences in the responses of those two customer segments or due to differences in customers from the two segments who responded to the survey (e.g., differential response bias). Further investigation showed a relatively strong correlation between survey response and participation in selected treatment cells. For example, default customers (across all treatment groups) who responded to the survey were more than twice as likely to request an IHD (35%) compared with default customers who did not respond to the survey. Similarly, twice as many (20%) default customers who responded to the survey were enrolled in two or more other SMUD programs (e.g., Green Energy, EE Loan or Rebate, etc.) than customers who did not respond to the survey (9%). If those who requested an IHD and who participated in other SMUD programs are collectively defined as "engaged customers", it is clear these engaged customers are more likely to respond to the survey, more likely to enroll on opt-in pricing plans (as was seen in Section 8) and more likely to request an IHD. As such, comparing responses between those who did and did not request an IHD among default customers is probably not appropriate. Similarly, it may not be appropriate to extrapolate from those who responded to the survey to all default customers since those who did not respond are much less likely to be engaged customers and may have different perceptions than those who do respond. On the other hand, it is less certain whether there is much differential response bias between opt-in customers who responded to the survey and default customers who responded to the survey, since both groups have higher concentrations of engaged customers. While these responses may not represent well the non-respondent population for opt-in or default segments, they may represent well the engaged default and engaged opt-in customers who are likely to produce most of the demand response associated with these pricing plans.

With these cautions in mind, the remainder of this discussion summarizes the key findings from the end of pilot survey. The summary touches most of the questions included in the survey. Those not covered in this section are summarized in Appendix G.

11.1 Customer Satisfaction with SMUD Services

Figure 11-1 summarizes survey responses to the question, "Thinking of all of the services you receive from SMUD, how satisfied are you?" A four point scale was used, where 1 = very satisfied, 2 = somewhat satisfied, 3 = somewhat dissatisfied and 4 = very dissatisfied. As seen in the figure, SMUD's overall satisfaction ratings are extremely high and vary very little across treatment groups. Not shown in the figure, but important to note, is that within the top-two scores shown, on average, 70% of respondents gave the highest rating of 4 and 30% gave a rating of 3. Very importantly, satisfaction ratings were nearly identical for survey respondents in the control group, the default pricing plans and the opt-in pricing plans. That is, defaulting customers onto a new pricing plan did not reduce customer satisfaction relative to those in the control group or in the opt-in pricing plans. Also important is that the group of opt-in customers who were deferred for two years in order to provide a valid control group for opt-in treatments also provided nearly identical satisfaction ratings as those who were not deferred. Finally, drop outs who responded to the survey also had nearly identical satisfaction ratings as those who stayed on the rate for both default and opt-in pricing plans. While it is always possible that only the most satisfied customers are willing to respond to surveys and, therefore, these ratings may have an upward bias, given the amazingly high and consistent ratings across all groups, it would be hard to imagine that the magnitude of any response bias would be large enough to change the general conclusion that all groups are highly satisfied with SMUD's services overall and that satisfaction ratings are very similar across the very diverse segments included in the survey.

Figure 11-1: Customer Satisfaction with SMUD Services



11.2 Customer Satisfaction with and Perceptions of Pricing Plans

The survey included a number of questions designed to determine customer satisfaction with, understanding of, and perceptions about the pricing plans they were on. Table 11-3 summarizes the findings related to satisfaction with the pricing plan. The most common response across all plans,

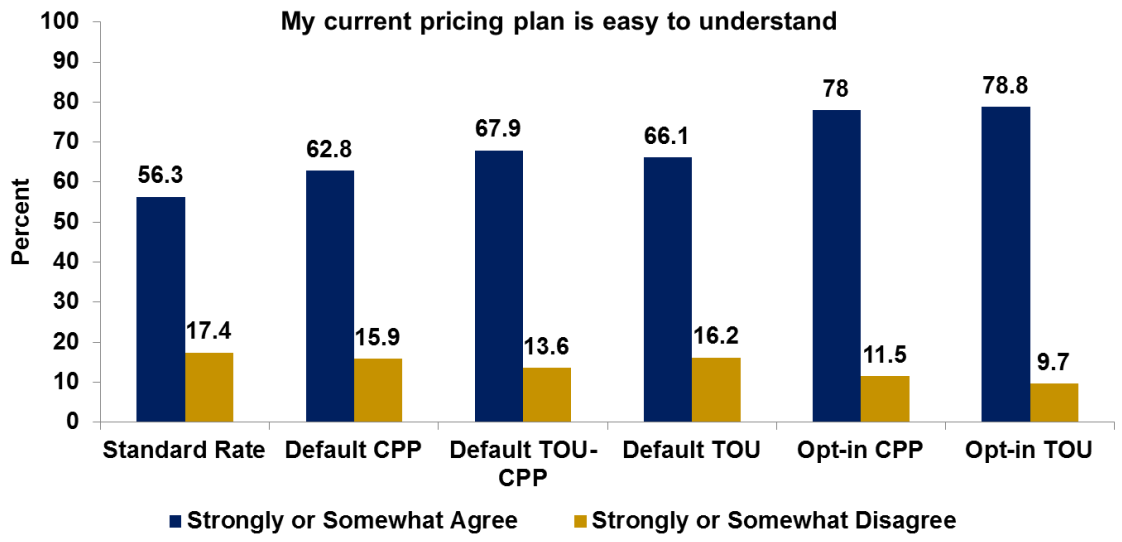
including the standard rate, was "somewhat satisfied", with a percent ranging from a low of 54% for the opt-in TOU plan to a high of 64% for the default CPP-TOU plan. Interestingly, the standard rate plan received more dissatisfied ratings than any of the other plans (with more than 20% of respondents rating the plan somewhat or very dissatisfied) and the lowest top-two-box scores among all the plans (with 80.3% scoring the standard plan either a 1 or a 2). Some of the additional survey results summarized below provide clues regarding why customers may rate time-variant pricing more highly than standard, tiered pricing in terms of overall satisfaction.

Table 11-3: Customer Satisfaction with Pricing Plans (%)
(1 = very satisfied; 2 = somewhat satisfied; 3 = somewhat dissatisfied; 4 = very dissatisfied)

Category	N	1	2	3	4
Control (standard rate)	300	20.3	60.0	15.0	4.7
Default CPP	163	30.1	57.0	10.6	2.3
Default CPP-TOU	141	22.1	63.9	10.4	3.6
Default TOU	417	22.9	61.5	13.6	2.1
Opt-in CPP	576	33.1	56.3	9.2	1.4
Opt-in TOU	1017	32.8	54.3	10.6	2.3

One reason why customers may be less satisfied with the standard rate than with time-variant pricing plans is that they feel the standard rate is more difficult to understand. Figure 11-2 shows the top-two and bottom-two box scores, on a five-point scale, to the question, "Please indicate whether you agree or disagree with the statement – my current pricing plan is easy to understand." The scale for this question is 1 = strongly agree; 2 = somewhat agree; 3 = no opinion; 4 = somewhat disagree; 5 = strongly disagree. On average, the "no opinion" response was given by about 20% of customers although only about 10% of opt-in customers gave this response. The difference between the sum of the two columns for each plan in Figure 11-2 and 100 is the percent of respondents indicating no opinion. As indicated in the figure, the standard pricing plan has the lowest agreement rating for this statement and the highest disagreement rating. The opt-in plans have higher agreement ratings than the default plans.

Figure 11-2: Perceived Ease of Understanding of Pricing Plans



Perception and reality are often different, especially for electricity tariffs with their fixed and variable components, different pricing tiers, and multi-part charges for distribution services, generation services and other cost components. While it may not be true that customers on time-variant rates actually understand the details better than those on the standard rate (especially time-variant rates that are an overlay on the standard tiered rate as was the case here), it is possible that customers feel like they do because of the educational material provided to them as part of the pilot, especially the graphical materials showing the low and high priced periods by time of day.

To explore this further, the survey asked customers a question designed to test their knowledge about the rate they were on. The question was as follows:

- Thinking only of the way you are charged for electricity in summer, which of the following best describes your household pricing plan? ***Check only one***
  1. Pay the same price for electricity no matter when you use it
  2. Pay a higher price for electricity used between 4:00 and 7:00 PM on all days
  3. Pay a higher price for electricity used between 4:00 and 7:00 PM on weekdays only
  4. Pay a much higher price for electricity used between 4:00 and 7:00 PM on 12 Conservation Days
  5. Pay a higher price for electricity used between 4:00 and 7:00 PM on weekdays **with** an even higher price on 12 days during the summer called Conservation Days
  6. Don't know

Table 11-4 summarizes the responses to this question. As seen, by far the greatest number of "don't' know" responses came from control customers on the standard rate plan, with 56% of respondents answering "don't know." Opt-in participants had by far the lowest number of "don't know" responses and the highest number of accurate responses. The accuracy of responses was similar for default and standard rate customers, although fewer default customers responded "don't know" than standard rate

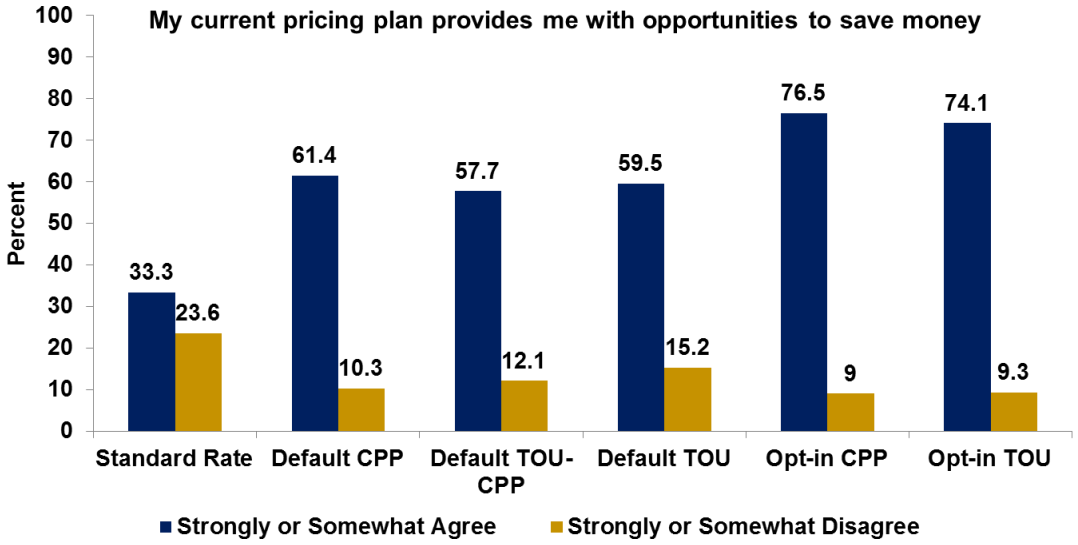
customers, indicating that they thought they knew the right answer. This finding is consistent with the higher perceived understanding by default customers compared with standard rate customers shown in Figure 11-2.

Table 11-4: Actual Understanding of Pricing Plans
(Correct answer circled in red)

Category	N	1	2	3	4	5	6
Control (standard rate)	300	25.7	8.7	4.7	0.3	4.7	56.0
Default CPP	163	15.9	7.2	4.9	19.6	13.7	38.6
Default CPP-TOU	141	9.9	12.8	10.4	7.9	21.4	37.6
Default TOU	417	13.2	16.1	29.9	1.6	5.9	33.1
Opt-in CPP	576	10.4	9.4	6.1	42.2	13.9	18.0
Opt-in TOU	1017	10.1	16.5	47.7	1.1	4.6	20.0

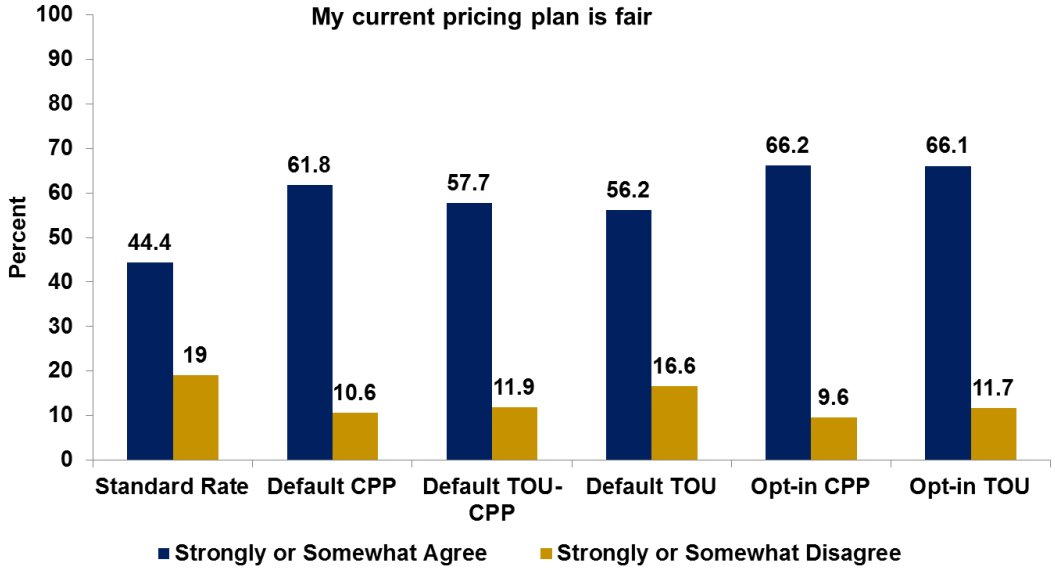
Another possible reason why respondents may be less satisfied with the standard rate than with time-variant pricing plans is that they don't feel the standard rate gives them as much opportunity to save money as do time-variant rates. Figure 11-3 shows the top and bottom two box scores, using the same five point agreement scale as in Figure 11-2, in response to the statement "My current pricing plan provides me with opportunities to save money." As seen, only about one third of standard rate plan respondents strongly or somewhat agreed with the statement whereas between one half and three quarters of respondents on time-variant pricing plans strongly or somewhat agreed with the statement. Roughly twice as many standard rate plan respondents somewhat or strongly disagreed with the statement compared with the other pricing plans. Not surprisingly, respondents on the opt-in pricing plans had the strongest agreement with the statement while respondents on default plans had agreement ratings in between those on the standard and opt-in plans. In a separate question, respondents were asked if they felt like they had more control over their energy costs on the time-variant plan compared with their prior tariff. Almost two thirds of default respondents and 80% of opt-in respondents answered yes.

Figure 11-3: Perceived Ability to Save Money by Pricing Plan



More survey respondents on time variant plans indicated that they thought their plan was fair than those on the standard rate, as indicated in Figure 11-4. Roughly 45% of control group customers on the standard rate strongly or somewhat agreed with the statement, "My current pricing plan is fair." Between 56% and 67% of respondents on time-variant pricing plans strongly or somewhat agreed with the statement. Default customers had slightly lower agreement than opt-in customers but the difference was not large.

Figure 11-4: Percent of Respondents Indicating They Think Their Pricing Plan is Fair



Other findings[55] from this portion of the survey include:

- Roughly 40% of customers on default time-variant pricing plans and about 57% of those on opt-in plans strongly or somewhat agreed with the statement, "My current pricing plan is better than my old pricing plan."
- About 47% of customers on default plans, including the standard SMUD rate, strongly or somewhat agreed with the statement, "My current pricing plan fits my lifestyle." Roughly 60% of opt-in customers strongly or somewhat agreed with that statement.
- Roughly the same percentages as in the prior statement apply to the question, "My current pricing plan is convenient."
- Approximately 57% of respondents on all pricing plans strongly or somewhat agreed with the statement, "I sometimes feel uncomfortable inside my home on summer afternoons and evenings because it is too expensive to run my air conditioner." Importantly, this same percentage was found for the standard rate so this is not a statement about high peak-period prices as much as it is about the perceived high cost of electricity regardless of the pricing plan. Roughly 25% of all respondents strongly or somewhat disagreed with the statement with the remaining respondents replying "no opinion."
- Approximately two thirds of default customers and roughly 85% of opt-in customers strongly or somewhat agreed with the statement, "I understand why SMUD is offering the pricing plan I am on."
- Almost half of default and roughly two thirds of opt-in respondents strongly or somewhat agreed with the statement, "I think the Sacramento community would be better off if everybody was on my pricing plan."
- Almost 60% of default and 80% of opt-in respondents strongly or somewhat agreed with the statement, "I believe that I did something good for Sacramento by participating in my pricing plan."
- Finally, roughly half of all default respondents and three quarters of opt-in respondents strongly or somewhat agreed with the statement, "I want to stay on my pricing plan."

In summary, these survey results show strongly that, contrary to opinion held by many stakeholders in the debate about time-variant pricing, the majority of customers who experience these rates, including those defaulted onto them, feel the rates are fair, provide more opportunity to manage energy costs, are easier to understand than standard rates, feel they are doing something good for the community by enrolling on these rates and want to stay on the pricing plan. Importantly, reported discomfort from reducing air conditioning use in order to keep costs down in what is a very hot climate region is the same for customers on the standard rate as for those on time-variant rates.

11.3 Reported Behavioral Changes

As is evident from the estimated load impacts reported in Sections 4 and 5, on average, customers on all pricing plans reduced electricity usage during peak periods. Evidence of increased load during other time periods is less clear. The end of pilot survey asked customers whether they reduced or shifted load

[55] Tables showing the details underlying this high level summary are contained in Appendix G.

and, if so, the specific types of action taken. Figure 11-5 summarizes these responses using the same five-point agreement scale employed for many of the questions already discussed.

As seen in the figure, roughly 75% of default respondents and nearly 90% of opt-in respondents strongly or somewhat agreed with the statement, "I make sure I use as little electricity as possible between 4 and 7 PM." Interestingly, roughly half of standard rate customers also agreed with that statement. California has had, for many years, an advertising campaign called Flex Your Power that encourages consumers to "give their appliances the afternoon off" on hot days when peak demand is high. Given this, it is not surprising to learn that customers on non-time variant rates are also conscious of keeping usage low in late afternoons and early evenings. It may also be the case that customers realize that air conditioning loads are significant contributors to electricity bills and have developed habits to reduce usage during the afternoon in order to keep bills down. Importantly, even if most control group customers reduce usage in the afternoon in response to advertising campaigns or overall daily price response, given the design of this pilot, the load impacts reported in Sections 4 and 5 are incremental to any load reductions that might be driven by these other factors.

Figure 11-5: Customer Perceptions about Peak Period Load Reductions

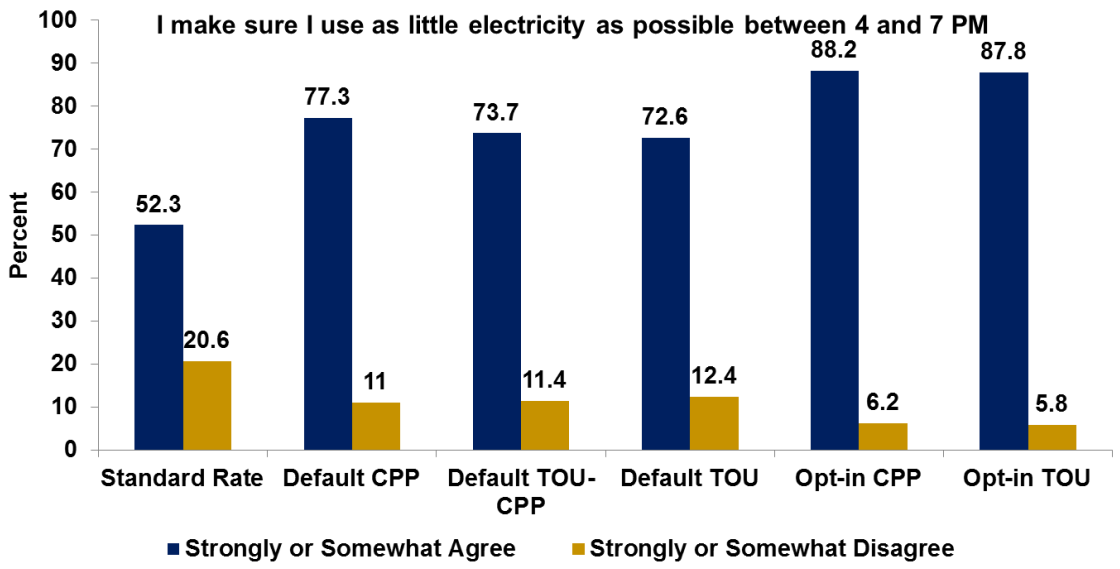
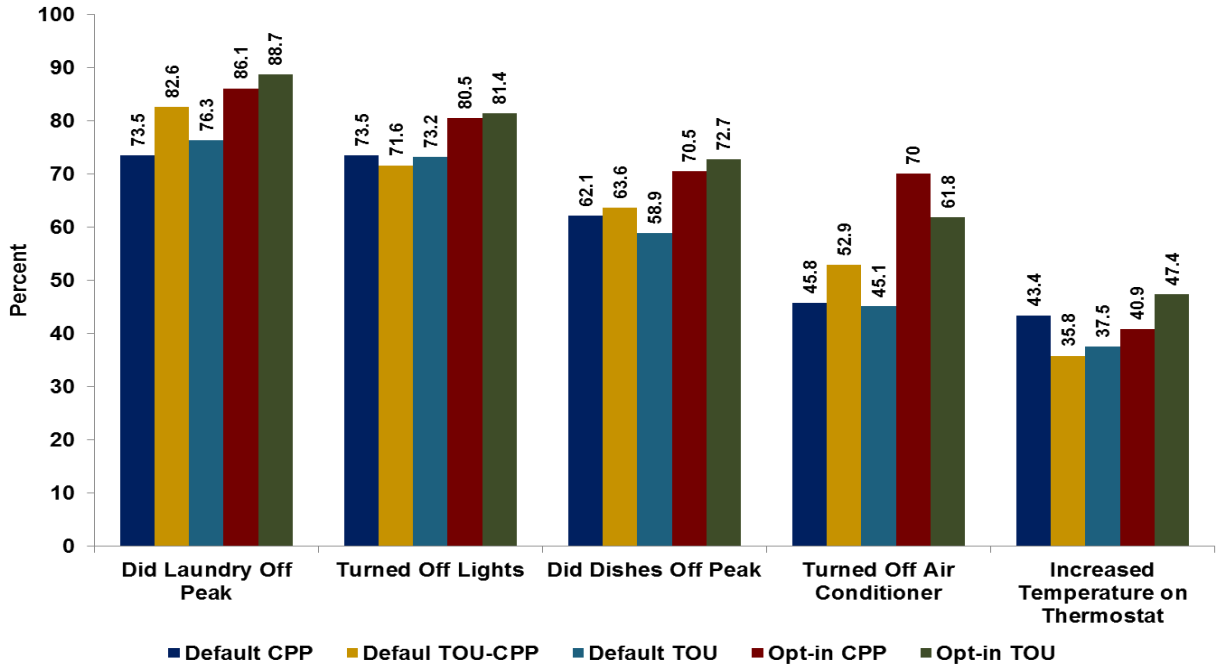


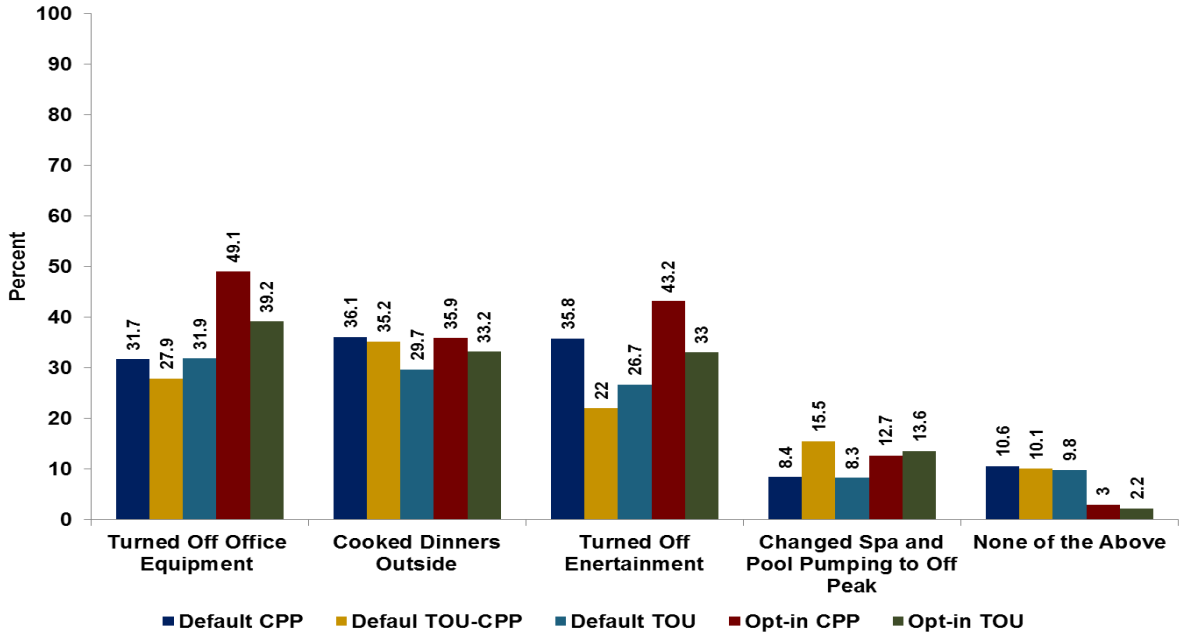
Figure 11-6 summarizes the actions that respondents reported taking to reduce load between 4 and 7 PM. In general, a higher percentage of respondents on opt-in pricing plans (the last two bars in each sequence) indicated that they took actions compared with those on default pricing plans but the differences are not large in most cases. Two of the top three actions reported, doing laundry and dishes during off-peak periods, suggest load shifting rather than conservation. The third and fourth most common action, turning off air conditioners and increasing thermostat settings, may or may not lead to overall energy savings depending on how much snap back electricity use occurs. As discussed in Sections 3 and 4, there does not appear to be much snapback effect observed for the pricing plans examined in the SPO. Turning off office and entertainment equipment during peak periods and cooking outside suggest some conservation impacts whereas shifting spa and pool pumping to the off-peak

period is a load shifting action. Roughly 10% of default respondents and 2 to 3% of opt-in respondents indicated that they hadn't taken any of the specific actions listed in the survey.

The survey also asked respondents to the above question how difficult it was to make the changes identified above. Roughly two thirds responded that it "was not difficult at all" while nearly all of the remaining respondents indicated it was "somewhat difficult." On average, fewer than 3% of respondents said it was "very difficult" to make the changes.

Figure 11-6: Behavioral Actions Taken to Reduce Load Between 4 and 7 PM





11.4 Reasons for Staying on the Pricing Plan

Default customers were asked about why they did not opt-out prior to enrolling on the plan and also why they stayed on the plan after enrollment. Recall from Section 2 that those in the default treatment groups were notified in April 2012 that they would be placed on a new pricing plan as of June 1 if they did not notify SMUD that they wished to remain on their current plan. Recall from Section 8 that only between 3 and 8% of notified customers dropped out prior to enrollment and that a similarly small percent of those who enrolled actively dropped out over the course of the two summers of the SPO pilot. Understanding the reasons why such a high percent of customers did not opt-out prior to being enrolled on the default pricing plans is important for determining pricing strategy going forward.

Table 11-5 summarizes the reasons given for not opting out of the default pricing plans prior to being enrolled in June 2012. Respondents were asked to check only one option that "best describes the most important reason for staying on the new plan." As seen, very few customers indicated that they planned to opt-out but never got around to it, so transaction costs do not appear to have much to do with the low dropout rate, at least for those who responded to the survey. Lack of awareness was identified as the primary reason by roughly one quarter of respondents although that seems to be a more important issue for CPP-TOU respondents than for the other pricing plans. It is not obvious why this would differ across pricing plans. Roughly 20% of respondents said that they did not know they could opt out. Roughly half of all respondents indicated that they either liked the plan when it was presented to them or wanted to try it before deciding whether it was the right plan for them.

Table 11-5: Reasons Why Default Customers Did Not Opt Out Prior to Going on the New Pricing Plan

Category	CPP	CPP-TOU	TOU
# of Respondents	163	141	417
Not aware that you had been assigned to the new plan	22.7%	35.5%	29.0%
Did not know that you could opt out	22.7%	17.5%	22.4%
Aware of the plan and felt that it was a good plan for you	25.7%	17.6%	20.8%
Not sure whether it was a good plan and wanted to try it before deciding to stay or revert to the original pricing plan	27.4%	28.5%	26.2%
Planned to opt out but never got around to it	1.5%	0.9%	1.6%

Default (and opt in) customers were also asked to indicate why they continued to stay on the new pricing plan after enrollment. This question consisted of a series of statements and respondents were asked to indicate how important each reason was in their decision to stay on the pricing plan. The question employed a four point scale where 1 = very important, 2 = somewhat important, 3 = somewhat unimportant and 4 = completely unimportant. Customers could also respond "don't' know." Table 11-6 summarizes the percent of respondents who indicated that a reason was very or somewhat important for each default pricing plan and Table 11-7 summarizes the responses for the opt-in pricing plans.

Table 11-6: Percent of Default Plan Respondents Who Indicate the Reason Was Very or Somewhat Important to Their Decision to Stay on the Pricing Plan[56]

Category	CPP	CPP-TOU	TOU
# of Respondents	163	141	417
I like the pricing plan SMUD assigned me to	59.5%	54.1%	57.2%
I didn't know I was assigned to the new pricing plan	35.3%	39.4%	35.8%
I didn't know I was able to drop out of the new pricing plan	38.0%	43.3%	45.4%
I assume the default pricing plan SMUD selected for me is best for me	52.5%	49.2%	51.0%
I intended to drop out but never got around to it	12.1%	17.4%	13.2%
I'm not sure I would be any better off on the standard rate	44.7%	37.9%	38.4%
The more I got used to the pricing plan, the more I like it	45.8%	41.2%	38.6%

As seen in Table 11-6, for default customers, the most important reason for staying enrolled for all pricing plans was that respondents liked the pricing plan, with between 54% and 60% of respondents indicating that this reason was very or somewhat important to their decision. Nearly as many (49% to 53%) of respondents indicated that their belief that SMUD had selected the best plan for them was very or somewhat important. Between 38% and 45% of respondents indicated that "the more I got used to the pricing plan, the more I liked it" was somewhat or very important. About one third of respondents indicated that lack of awareness of being on the plan or not thinking they could drop off the plan were very or somewhat important reasons for staying on the pricing plan. Between 10 and 20% of respondents said that they intended to drop out but never got around to it. This measure of inertia is significantly higher than the percent of customers who identified this as the most important reason for not dropping out prior to enrolling on the rate as indicated in Table 11-5. Between 35% and 45% of respondents indicated that they stayed in part because they weren't certain they would be better off on the standard rate.

Table 11-7: Percent of Opt In Respondents Who Indicate the Reason Was Very or Somewhat Important to Their Decision to Stay on the Pricing Plan[57]

Category	CPP	TOU
# of Respondents	576	1,017
I like the pricing plan	80.8%	78.1%
I didn't know I was able to drop out of the pricing plan	32.4%	35.6%
I intended to drop out but never got around to it	15.8%	12.7%
I don't think I would be any better off on the standard rate	47.8%	41.6%
The more I got used to the pricing plan, the more I like it	63.5%	64.4%

[56] By far, the majority of respondents who did not indicate that a particular reason was somewhat or very important checked the "no opinion" option. Between 3 and 18% of respondents indicated that any of the reasons were somewhat or very unimportant.

[57] See prior footnote.

Table 11-7 summarizes the survey responses for opt in participants. A much larger share of respondents, roughly 80%, indicated that liking the pricing plan was very or somewhat important in deciding to stay on the plan. The second highest importance rating was for similar reasons, "the more I got used to the pricing plan, the more I liked it." The percent of respondents who indicated that they intended to drop off but never got around to it was very similar to that for the default treatments. Roughly one third of respondents indicated that not knowing they could drop off the rate was somewhat or very important, and between 40% and 50% of respondents said that not knowing if they would be better off under the standard rate plan influenced their decision to stay.

11.5 In Home Displays

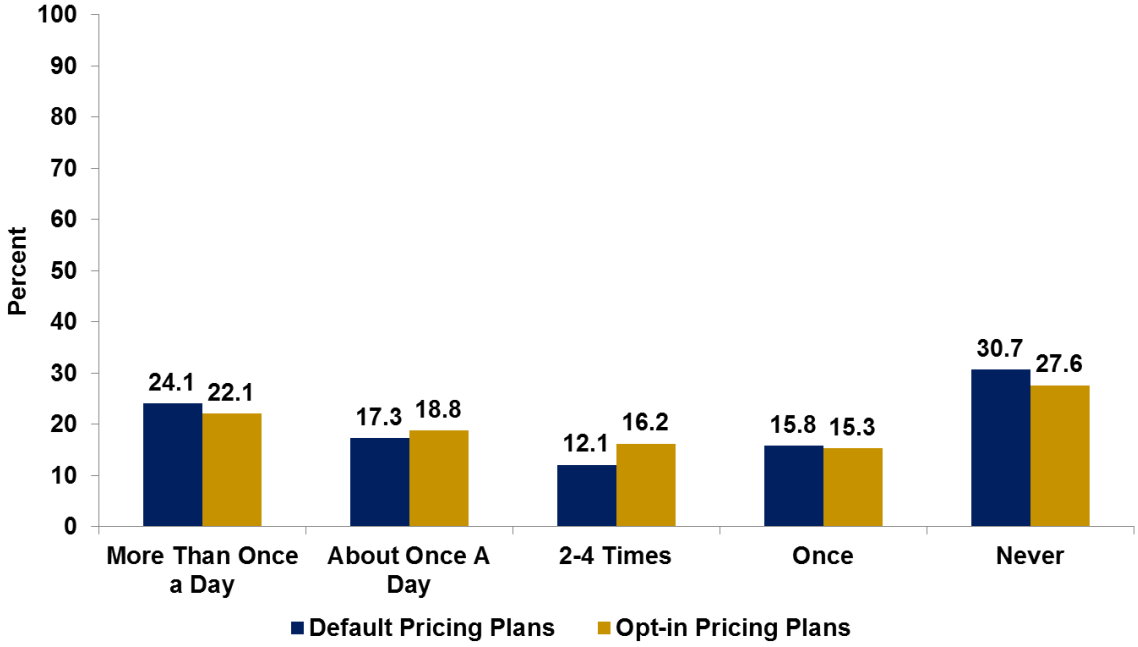
The survey also asked participants several questions about their use of IHDs. These questions were only asked of customers who were in treatment groups that had asked for and received an IHD (groups 3, 6, 9, 11 and 15 in Table 11-1). The first question asked respondents whether they remembered receiving an IHD. Between 80 and 90% of respondents said yes. The remaining questions pertain to this subset of customers who remembered receiving an IHD.

Respondents were asked whether they tried using the IHD once it was received. Recall from Section 6 that roughly twice as many default customers who asked for and received IHDs connected them to the meter compared with opt in participants. In response to this question about attempting to hook up the IHD to the meter, 90% of default respondents and almost 60% of opt in respondents said they had tried and succeeded in connecting the device. About 20% of default respondents and 30% of opt in respondents said they tried to connect the device but failed to do so. Roughly 8% of both groups said they did not try connecting the device and the remaining 2 to 3% of respondents said they couldn't remember. When asked if the IHD was still working, almost 80% said it was and about 10% said it wasn't. The remaining 10% weren't sure or didn't know.

Respondents were asked how often they had looked at the IHD in the last week prior to the survey. Figure 11-7 summarizes those responses. As seen, roughly 40% of both default and opt in respondents indicated they looked at the device more than once a day or about once a day. Recall that the survey was conducted in late fall 2013, which is 16 to 18 months after they would have received the IHD. About 30% of respondents said they had looked at the device between one and four times in the prior week, and the remaining 30% or so said they did not look at it at all. It should be noted that these estimates of use may be biased upward by the survey response bias discussed at the outset of this section. Default customers who requested IHDs and both default and opt-in customers that connected the devices are much more engaged in managing their energy use than those who did not, and these engaged customers are also more likely to respond to this survey.

Respondents were also asked if they had made any changes in their usage behavior based on information provided through the IHD. 60% of opt in and 67% of default respondents said yes, 12% of opt in and 15% of default respondents said no, and about 6% of each said they weren't sure. In response to this question, nearly 23% of opt in respondents said that they never got the device to work whereas less than half that total (11%) of default respondents said they couldn't get the device to work.

Figure 11-7: Frequency With Which Respondents Looked at Their IHD in the Prior Month



Appendix A Glossary of Terms for SPO Study Design

Control Group

The control group consists of customers who are identical to treatment customers except that they are not on the new rate. For treatments implemented using RED, control group customers are not offered the rate, but are randomly chosen from the same population as the treatment group. For the RCT design, control customers consist of customers who volunteered to go on the new rate but were assigned to the deferred group (and will go on the rate in 2014).

Customer Acceptance Rate

The customer acceptance rate consists of all customers who agreed to go on the rate divided by the number of customers who were offered the rate. This value will typically be larger than the enrollment rate (and can't be less than it) as it includes everyone who signed up for a rate even if they never went on the rate. For opt-in treatments, the numerator in the customer acceptance rate would include all customers who agreed to accept the rate, even if they were assigned to a control group leading to deferred enrollment. It would also include all customers who agreed to go on the rate but who may have never gone on it because, for example, they moved before the rate went into effect. It would also include customers who went on the rate but later dropped out. The denominator includes all customers in the original sample minus customers who moved before they received an offer. The customer acceptance rate is the best measure of the effectiveness of a marketing campaign. For default treatments, the numerator of the customer acceptance rate consists of all customers who were defaulted onto the rate and did not drop out prior to going on the rate. If a customer goes on the rate and later drops out of the program, they would still be included in the numerator of this rate. Only customers who drop out prior to going on the rate are excluded from the numerator. The denominator of the customer acceptance rate for default programs equals the number of customers who were defaulted onto the rate.

Decliners

A decliner is a customer that was offered a rate option but declined to accept the offer.
For opt-in treatments, the number of decliners equals the total number of customers marketed to minus the total number of customers who accepted the offer. For default treatments, the number of decliners equals the total number of customers defaulted onto the rate minus those who drop out prior to going on the rate. It does not include customers who actually are placed on the rate and then later dropped out.

Deferred RCT Customers

Customers recruited into the opt-in RCT treatments who are assigned to the control group, and therefore whose enrollment on the rate is deferred until after the end of the pilot in 2014.

Drop outs

Drop outs consist of customers who went on a rate at some point in time, but who later requested to be taken off the rate. It does not include customers who drop out due to changing their location (e.g., moving). These are called movers.

Enrolled Customers

Enrolled customers are customers who are on a new rate at a given point in time. For opt-in rates, this group consists of customers who accepted the marketing offer, were assigned to the treatment group (rather than the control group), did not change their mind or move prior to the rate going into effect, and are still on the rate (e.g., have not dropped out or moved) at the time that the enrollment snap shot is taken. For default enrollment, enrolled customers at a point in time are customers who did not opt-out prior to or after going on the rate, or did not move or leave the rate for any reason between when they were initially enrolled and when the enrollment is reported.

Enrollment Rate

The enrollment rate consists of all customers who were ever actually on a rate for some period of time divided by the number of customers who were offered the rate. This is different from the customer acceptance rate, as defined below.

General Population

All residential customers in SMUD's service territory (approximately 530,000 customers). This differs from the SPO eligible population, as defined below.

Movers

Movers are customers who were either defaulted onto a new rate or accepted a rate offer on an opt-in basis, but subsequently moved and, therefore, are no longer enrolled on the rate. A mover may or may not have ever actually gone on the new rate. For example, some customers may have accepted the new rate offer several months prior to the new rate going into effect and may have moved before they were placed on the rate. Similarly, default customers may have not consciously declined the default option but may have moved between the time they were notified that a rate change would be going into effect and when the rate actually went into effect.

Randomized Control Trial (RCT)

RCT refers to a research strategy in which customers who volunteer for a treatment are randomly assigned to treatment and control conditions. This method ensures that the only difference between treatment and control customers, other than differences due to random sampling variation, is that one group receives the treatment and the other does not. An RCT design ensures that impact estimates are not affected by selection bias or other potential explanations for observed differences between the two groups of customers. In practice, randomization can be achieved using either a *recruit and deny* process, or a *recruit and delay* process. In the former, control customers are never given the treatment whereas in the latter, customers assigned to the control group are placed on the treatment after the end of the trial measurement period. Prior to that time, they act as the control group against which treatment effects are measured. SMUD used the recruit and delay method. Deferred customers will be placed on the new rate in 2014.

Randomized Encouragement Design (RED)

RED refers to a research design in which two groups of customers are selected from the same population at random and one is offered a treatment while the other is not. Not all customers offered the treatment are expected to take it but, for analysis purposes, all those who are offered the

treatment are considered to be in the treatment group. Treatment impacts are estimated initially by comparing the change in usage between the treatment and control groups before and after the treatment goes into effect. This first stage impact estimate—referred to as an intent-to-treat estimate—reflects a weighted average of those who were offered the treatment and took it and those who were offered the treatment and declined. A second stage calculation can be done to determine the impact only for those customers who accepted the treatment offer. This estimate—referred to as the treatment effect on the treated—will be unbiased by selection effects.

In another variation on RED, two groups may be subject to differing levels of encouragement to take a treatment, such as in a comparison of a group offered a rate on an opt-in basis to a group offered a rate on a default basis. In this case, intent-to-treat and treatment effect on the treated estimates are developed in the same way, with the treatment effect on the treated being equal to the effect of the treatment on customers who would respond to the higher level of encouragement (e.g., rate by default) but who would not respond to the lower level of encouragement (e.g., an opt-in offer).

SPO Eligible Population

The SPO treatments were offered to a subset of SMUD's general population, consisting of the approximately 260,000 customers who had interval meters installed prior to June 2011, but excluding customers who were participating in SMUD's Air Conditioning Load Management (ACLM) program, Summer Solutions study (a separate dynamic pricing study), medical assistance program, master metered accounts, budget billing and PV solar programs. After these exclusions, there were approximately 176,000 customers eligible for inclusion in the pilot.

Treatment Group

The treatment group consists of customers who were either offered the new rate option (under RED) or who took it and were assigned to the treatment group rather than the control group (under an RCT design). Under RED, not every treatment customer is actually on the new rate. Under the RCT design, all treatment customers are on the new rate.

Within-subjects Design

A within-subjects design does not rely on an external control group to estimate impacts. Instead, it compares usage for customers who accept a treatment under treatment and non-treatment conditions. A within-subjects design is not as strong as RCT or RED in terms of clearly establishing causality between usage changes and treatments because other factors may affect usage (e.g., weather conditions) and be the cause of the observed change. As such, analysis based on a within-subjects design typically must use statistical models to control for the potential influence of other factors. Estimates based on a within-subjects design typically are best when impacts are expected to be reasonably large and when differences in other exogenous factors are small under treatment and non-treatment conditions. For these reasons, a within-subjects design is better suited to estimating impacts for a CPP for which the treatment is in effect on one day and not the next and for which impacts are expected to be relatively large, for a TOU rate, for which the pretreatment period consists of an entire summer of usage and occurs 12 months prior to the treatment summer, and where impacts are expected to be relatively small.

Appendix B Hourly Load Impacts by Month for TOU Pricing Plans

Table B-1: Average Hourly Impacts by Month for Opt-in TOU Groups

Treatment	Month	Hour	Estimated Impact	SE	95% CI Lower	95% CI Upper
Opt-in TOU, Without IHD Offer	June	4-5 PM	0.12	0.02	0.08	0.17
		5-6 PM	0.16	0.03	0.11	0.21
		6-7 PM	0.16	0.03	0.11	0.21
	July	4-5 PM	0.16	0.03	0.10	0.22
		5-6 PM	0.22	0.03	0.16	0.29
		6-7 PM	0.23	0.03	0.17	0.29
	August	4-5 PM	0.17	0.03	0.11	0.23
		5-6 PM	0.23	0.03	0.17	0.30
		6-7 PM	0.21	0.03	0.15	0.27
	September	4-5 PM	0.07	0.03	0.00	0.13
		5-6 PM	0.10	0.03	0.03	0.16
		6-7 PM	0.07	0.03	0.02	0.13
	Overall		**0.16**	**0.02**	**0.12**	**0.21**
Opt-in TOU, with IHD Offer	June	4-5 PM	0.14	0.02	0.11	0.18
		5-6 PM	0.18	0.02	0.15	0.22
		6-7 PM	0.18	0.02	0.14	0.22
	July	4-5 PM	0.26	0.02	0.21	0.30
		5-6 PM	0.30	0.02	0.25	0.35
		6-7 PM	0.27	0.02	0.22	0.31
	August	4-5 PM	0.24	0.02	0.19	0.29
		5-6 PM	0.29	0.03	0.24	0.34
		6-7 PM	0.27	0.02	0.22	0.32
	September	4-5 PM	0.13	0.02	0.08	0.18
		5-6 PM	0.16	0.03	0.11	0.21
		6-7 PM	0.14	0.02	0.10	0.19
	Overall		**0.21**	**0.02**	**0.18**	**0.25**

Table B-2: Average Hourly Impacts by Month for Default TOU Groups

Treatment	Month	Hour	Estimated Impact	SE	95% CI Lower	95% CI Upper
Default TOU with IHD Offer	June	4-5 PM	0.08	0.02	0.05	0.11
		5-6 PM	0.11	0.02	0.07	0.14
		6-7 PM	0.11	0.02	0.07	0.14
	July	4-5 PM	0.10	0.02	0.07	0.14
		5-6 PM	0.13	0.02	0.10	0.17
		6-7 PM	0.12	0.02	0.08	0.16
	August	4-5 PM	0.13	0.02	0.09	0.17
		5-6 PM	0.15	0.02	0.11	0.19
		6-7 PM	0.14	0.02	0.10	0.18
	September	4-5 PM	0.06	0.02	0.02	0.10
		5-6 PM	0.09	0.02	0.05	0.13
		6-7 PM	0.07	0.02	0.03	0.11
	Overall		**0.11**	**0.01**	**0.08**	**0.14**
Default TOU & CPP with IHD Offer	June	4-5 PM	0.10	0.03	0.05	0.15
		5-6 PM	0.15	0.03	0.10	0.21
		6-7 PM	0.16	0.03	0.10	0.21
	July	4-5 PM	0.17	0.03	0.10	0.23
		5-6 PM	0.20	0.04	0.13	0.28
		6-7 PM	0.20	0.04	0.13	0.27
	August	4-5 PM	0.16	0.04	0.08	0.23
		5-6 PM	0.22	0.04	0.15	0.30
		6-7 PM	0.22	0.04	0.15	0.29
	September	4-5 PM	0.12	0.04	0.05	0.19
		5-6 PM	0.17	0.04	0.09	0.24
		6-7 PM	0.13	0.04	0.06	0.20
	Overall		**0.17**	**0.03**	**0.11**	**0.22**

Appendix C Hourly Load Impacts for Each Event for CPP Pricing Plans

Table C-1: Average Hourly Impacts by CPP Day for Opt-in CPP without IHD Offer

Date	Hour	Estimated Impact	SE	95% CI Lower	95% CI Upper
6/28/2013	4-5 PM	0.55	0.30	-0.03	1.13
	5-6 PM	0.69	0.31	0.08	1.30
	6-7 PM	0.45	0.30	-0.13	1.04
7/2/2013	4-5 PM	0.75	0.30	0.17	1.34
	5-6 PM	0.91	0.29	0.33	1.48
	6-7 PM	0.82	0.28	0.27	1.37
7/3/2013	4-5 PM	0.48	0.31	-0.12	1.08
	5-6 PM	0.84	0.31	0.22	1.45
	6-7 PM	0.84	0.31	0.24	1.44
7/19/2013	4-5 PM	0.43	0.28	-0.12	0.99
	5-6 PM	0.86	0.28	0.32	1.40
	6-7 PM	0.83	0.27	0.31	1.35
8/15/2013	4-5 PM	0.11	0.26	-0.40	0.61
	5-6 PM	0.35	0.26	-0.16	0.85
	6-7 PM	0.28	0.25	-0.22	0.77
8/19/2013	4-5 PM	1.00	0.29	0.43	1.58
	5-6 PM	0.99	0.29	0.41	1.56
	6-7 PM	0.76	0.28	0.21	1.32
9/6/2013	4-5 PM	0.07	0.25	-0.41	0.56
	5-6 PM	-0.03	0.26	-0.53	0.48
	6-7 PM	0.07	0.26	-0.43	0.57
9/9/2013	4-5 PM	0.65	0.27	0.13	1.18
	5-6 PM	0.63	0.28	0.08	1.18
	6-7 PM	0.60	0.28	0.06	1.15
9/10/2013	4-5 PM	0.06	0.25	-0.44	0.55
	5-6 PM	0.40	0.26	-0.10	0.90
	6-7 PM	0.29	0.25	-0.20	0.77
9/13/2013	4-5 PM	0.17	0.27	-0.36	0.70
	5-6 PM	0.08	0.29	-0.48	0.65
	6-7 PM	-0.03	0.27	-0.55	0.50
9/19/2013	4-5 PM	0.30	0.26	-0.21	0.80
	5-6 PM	0.66	0.28	0.11	1.20
	6-7 PM	0.20	0.25	-0.29	0.70
9/30/2013	4-5 PM	0.31	0.27	-0.21	0.84
	5-6 PM	0.35	0.27	-0.19	0.89
	6-7 PM	0.02	0.26	-0.48	0.53
Overall		**0.46**	**0.15**	**0.16**	**0.77**

Table C-2: Average Hourly Impacts by CPP Day for Opt-in CPP with IHD Offer

Date	Hour	Estimated Impact	SE	95% CI Lower	95% CI Upper
6/28/2013	4-5 PM	0.57	0.12	0.34	0.80
	5-6 PM	0.73	0.12	0.50	0.96
	6-7 PM	0.73	0.12	0.51	0.96
7/2/2013	4-5 PM	0.95	0.12	0.72	1.18
	5-6 PM	1.01	0.11	0.79	1.24
	6-7 PM	0.87	0.11	0.66	1.08
7/3/2013	4-5 PM	0.87	0.12	0.63	1.10
	5-6 PM	0.89	0.12	0.65	1.13
	6-7 PM	1.06	0.12	0.84	1.29
7/19/2013	4-5 PM	0.57	0.11	0.36	0.79
	5-6 PM	0.75	0.11	0.54	0.96
	6-7 PM	0.72	0.11	0.51	0.93
8/15/2013	4-5 PM	0.47	0.10	0.27	0.67
	5-6 PM	0.53	0.10	0.33	0.74
	6-7 PM	0.60	0.10	0.40	0.80
8/19/2013	4-5 PM	0.57	0.11	0.35	0.79
	5-6 PM	0.79	0.11	0.56	1.01
	6-7 PM	0.79	0.11	0.57	1.02
9/6/2013	4-5 PM	0.48	0.10	0.29	0.67
	5-6 PM	0.49	0.10	0.29	0.68
	6-7 PM	0.43	0.10	0.23	0.62
9/9/2013	4-5 PM	0.69	0.11	0.48	0.90
	5-6 PM	0.81	0.11	0.59	1.02
	6-7 PM	0.71	0.11	0.50	0.92
9/10/2013	4-5 PM	0.62	0.10	0.44	0.81
	5-6 PM	0.55	0.10	0.36	0.74
	6-7 PM	0.46	0.09	0.28	0.65
9/13/2013	4-5 PM	0.33	0.10	0.13	0.53
	5-6 PM	0.34	0.10	0.14	0.54
	6-7 PM	0.37	0.10	0.17	0.56
9/19/2013	4-5 PM	0.26	0.10	0.07	0.45
	5-6 PM	0.36	0.10	0.17	0.56
	6-7 PM	0.39	0.10	0.19	0.58
9/30/2013	4-5 PM	0.25	0.10	0.05	0.44
	5-6 PM	0.25	0.10	0.05	0.45
	6-7 PM	0.19	0.10	0.00	0.39
Overall		**0.60**	**0.06**	**0.48**	**0.72**

Table C-3: Average Hourly Impacts by CPP Day for Default CPP with IHD Offer

Date	Hour	Estimated Impact	SE	95% CI Lower	95% CI Upper
6/28/2013	4-5 PM	0.40	0.08	0.25	0.55
	5-6 PM	0.43	0.08	0.28	0.59
	6-7 PM	0.49	0.08	0.34	0.64
7/2/2013	4-5 PM	0.43	0.08	0.28	0.58
	5-6 PM	0.45	0.07	0.30	0.59
	6-7 PM	0.46	0.07	0.32	0.60
7/3/2013	4-5 PM	0.49	0.08	0.33	0.65
	5-6 PM	0.50	0.08	0.34	0.67
	6-7 PM	0.50	0.08	0.35	0.66
7/19/2013	4-5 PM	0.37	0.07	0.24	0.51
	5-6 PM	0.36	0.07	0.22	0.49
	6-7 PM	0.32	0.07	0.18	0.46
8/15/2013	4-5 PM	0.39	0.07	0.25	0.52
	5-6 PM	0.41	0.07	0.27	0.55
	6-7 PM	0.44	0.07	0.30	0.58
8/19/2013	4-5 PM	0.49	0.08	0.34	0.64
	5-6 PM	0.64	0.08	0.48	0.79
	6-7 PM	0.68	0.08	0.53	0.83
9/6/2013	4-5 PM	0.35	0.07	0.22	0.48
	5-6 PM	0.40	0.06	0.27	0.53
	6-7 PM	0.34	0.06	0.21	0.47
9/9/2013	4-5 PM	0.40	0.07	0.26	0.54
	5-6 PM	0.49	0.07	0.34	0.63
	6-7 PM	0.47	0.07	0.32	0.61
9/10/2013	4-5 PM	0.43	0.07	0.30	0.56
	5-6 PM	0.46	0.07	0.33	0.59
	6-7 PM	0.34	0.07	0.21	0.47
9/13/2013	4-5 PM	0.35	0.07	0.22	0.48
	5-6 PM	0.43	0.07	0.30	0.57
	6-7 PM	0.37	0.07	0.24	0.50
9/19/2013	4-5 PM	0.29	0.06	0.16	0.42
	5-6 PM	0.35	0.07	0.22	0.48
	6-7 PM	0.27	0.07	0.14	0.40
9/30/2013	4-5 PM	0.18	0.07	0.05	0.32
	5-6 PM	0.20	0.07	0.08	0.33
	6-7 PM	0.17	0.07	0.04	0.30
Overall		**0.41**	**0.05**	**0.32**	**0.50**

Table C-4: Average Hourly Impacts by CPP Day for Default TOU-CPP with IHD Offer

Date	Hour	Estimated Impact	SE	95% CI Lower	95% CI Upper
6/28/2013	4-5 PM	0.41	0.08	0.26	0.57
	5-6 PM	0.46	0.08	0.29	0.63
	6-7 PM	0.43	0.09	0.25	0.60
7/2/2013	4-5 PM	0.33	0.08	0.16	0.49
	5-6 PM	0.50	0.08	0.34	0.66
	6-7 PM	0.42	0.08	0.27	0.57
7/3/2013	4-5 PM	0.35	0.09	0.17	0.53
	5-6 PM	0.35	0.09	0.17	0.53
	6-7 PM	0.40	0.09	0.23	0.56
7/19/2013	4-5 PM	0.36	0.08	0.21	0.52
	5-6 PM	0.42	0.08	0.26	0.57
	6-7 PM	0.42	0.08	0.26	0.58
8/15/2013	4-5 PM	0.27	0.07	0.12	0.42
	5-6 PM	0.34	0.08	0.18	0.49
	6-7 PM	0.18	0.08	0.02	0.33
8/19/2013	4-5 PM	0.35	0.08	0.19	0.52
	5-6 PM	0.38	0.08	0.23	0.54
	6-7 PM	0.40	0.08	0.24	0.56
9/6/2013	4-5 PM	0.19	0.07	0.05	0.33
	5-6 PM	0.30	0.07	0.16	0.45
	6-7 PM	0.27	0.07	0.12	0.42
9/9/2013	4-5 PM	0.24	0.07	0.10	0.39
	5-6 PM	0.31	0.08	0.15	0.46
	6-7 PM	0.31	0.08	0.16	0.46
9/10/2013	4-5 PM	0.23	0.07	0.10	0.36
	5-6 PM	0.32	0.07	0.17	0.46
	6-7 PM	0.19	0.07	0.05	0.34
9/13/2013	4-5 PM	0.18	0.08	0.03	0.34
	5-6 PM	0.12	0.08	-0.04	0.27
	6-7 PM	0.15	0.07	0.01	0.30
9/19/2013	4-5 PM	0.12	0.07	-0.02	0.25
	5-6 PM	0.19	0.07	0.05	0.34
	6-7 PM	0.15	0.08	0.01	0.30
9/30/2013	4-5 PM	0.06	0.07	-0.08	0.20
	5-6 PM	0.11	0.08	-0.04	0.26
	6-7 PM	0.08	0.07	-0.06	0.22
Overall		**0.29**	**0.05**	**0.20**	**0.38**

Appendix D Customer Behavior and Characteristics for Study Populations in the Conjoint Survey

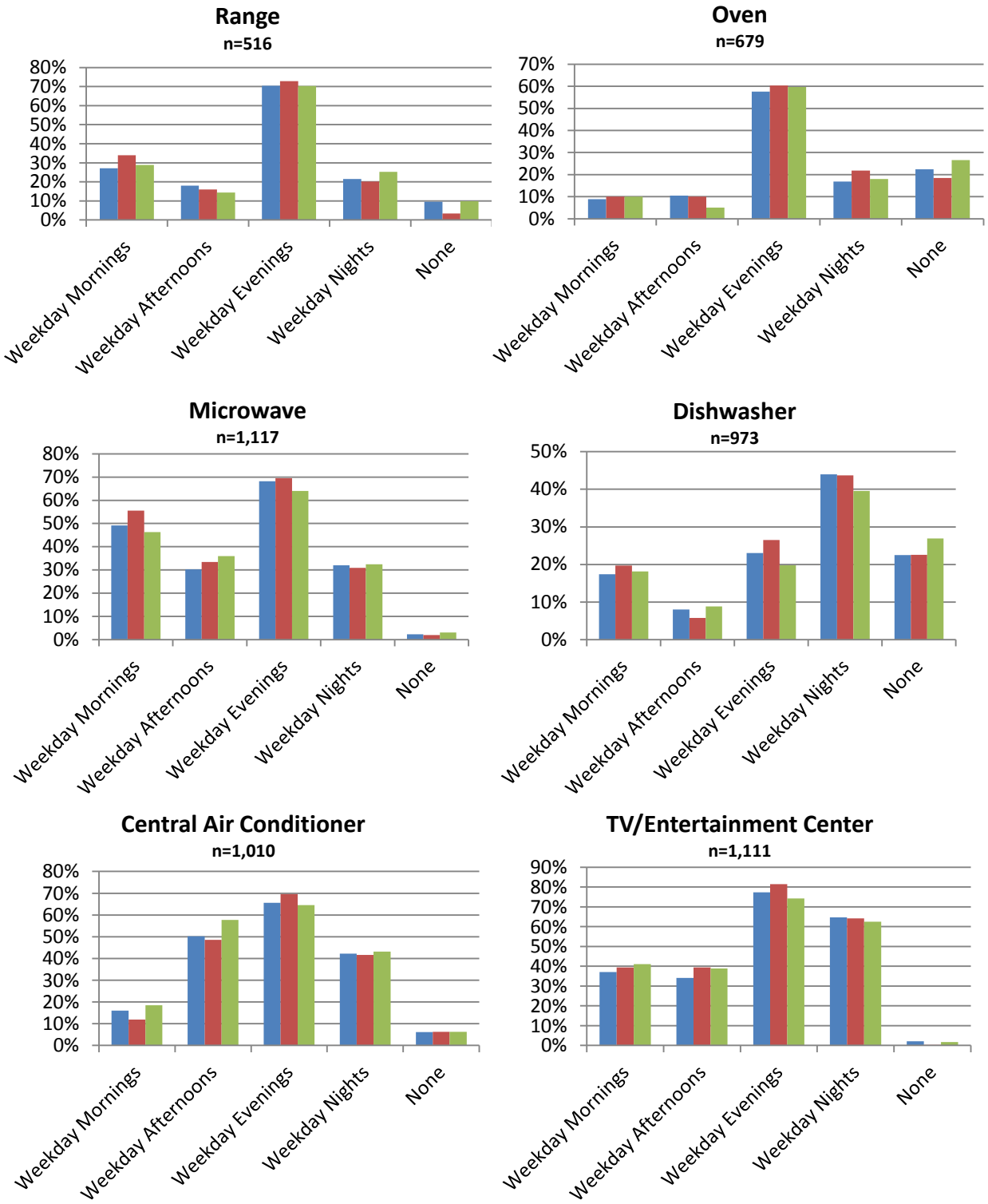
This appendix compares the characteristics of the three different study populations that were included in the conjoint survey discussed in Section 9.

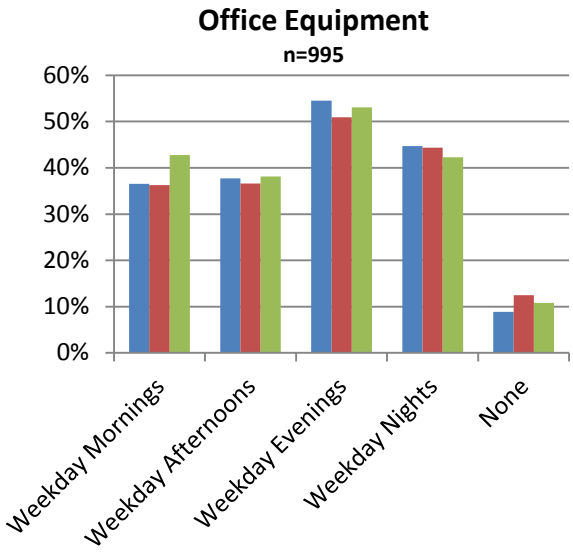
Customers first reported whether their appliances were exclusively powered by electricity. The results are summarized in Table D-1. The microwave was most commonly described as exclusively electric while the range was the least common. Customers then checked what time of day they use these exclusively electric products, choosing amongst "Weekday Mornings", "Weekday Afternoons", "Weekday Evenings", and "Weekday Nights". Participants were able to select more than one time for each appliance and these percentages are represented graphically in Figure D-1. The results are very similar across all three study groups.

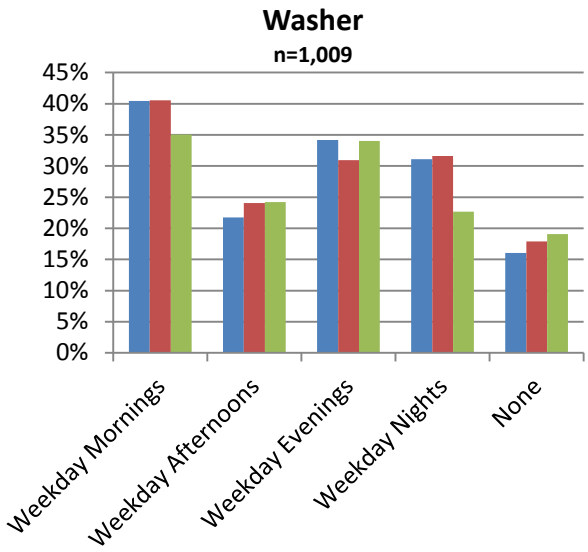
Table D-1: Percent of Appliances Reported as Powered Exclusively By Electricity (n=1,152)

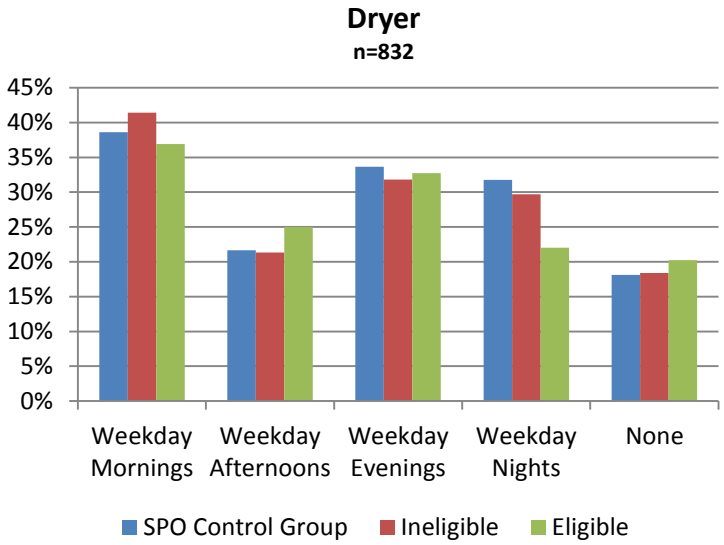
Appliances	SPO Control Group n=590	Ineligible n=313	Eligible n=239
Range	44%	46%	46%
Oven	61%	57%	58%
Microwave	98%	98%	97%
Dishwasher	87%	89%	76%
Central Air Conditioner	88%	91%	86%
TV/Entertainment Center	97%	98%	96%
Office Equipment	89%	87%	81%
Washer	89%	93%	81%
Dryer	72%	76%	70%

Figure D-1: Typical Time of Use of Exclusively Electrically Powered Appliances




Office Equipment
n=995
60%
50%
40%
30%
20%
10%
0%
Weekday Mornings
Weekday Afternoons
Weekday Evenings
Weekday Nights
None


Washer
n=1,009
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
Weekday Mornings
Weekday Afternoons
Weekday Evenings
Weekday Nights
None


Dryer
n=832
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
Weekday Mornings
Weekday Afternoons
Weekday Evenings
Weekday Nights
None
SPO Control Group
Ineligible
Eligible

As seen in Figure D-2, the most common number of thermostats in each household was one. Answers were very similar between groups, with the average number of thermostats being 1.2 for all three groups. The majority of these thermostats are programmable, shown in Figure D-3. Again there was no real difference between those in the SPO control group, ineligible group, and eligible group.

Figure D-2: Number of Thermostats (n=1,142)

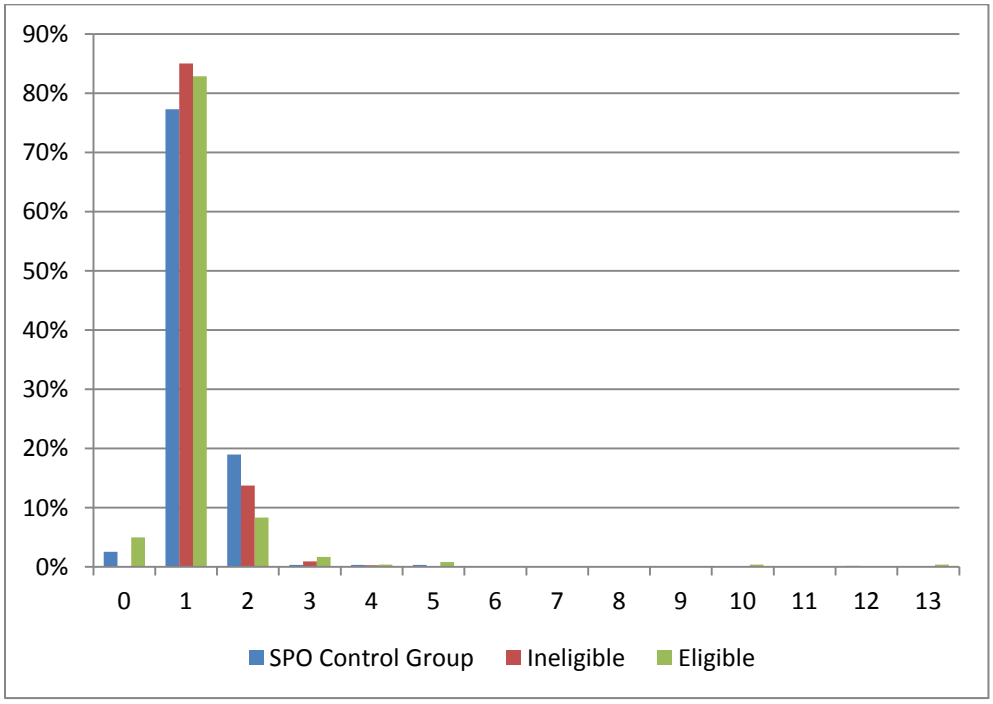


Figure D-3: Percent of Thermostats that are Programmable (n=1,115)

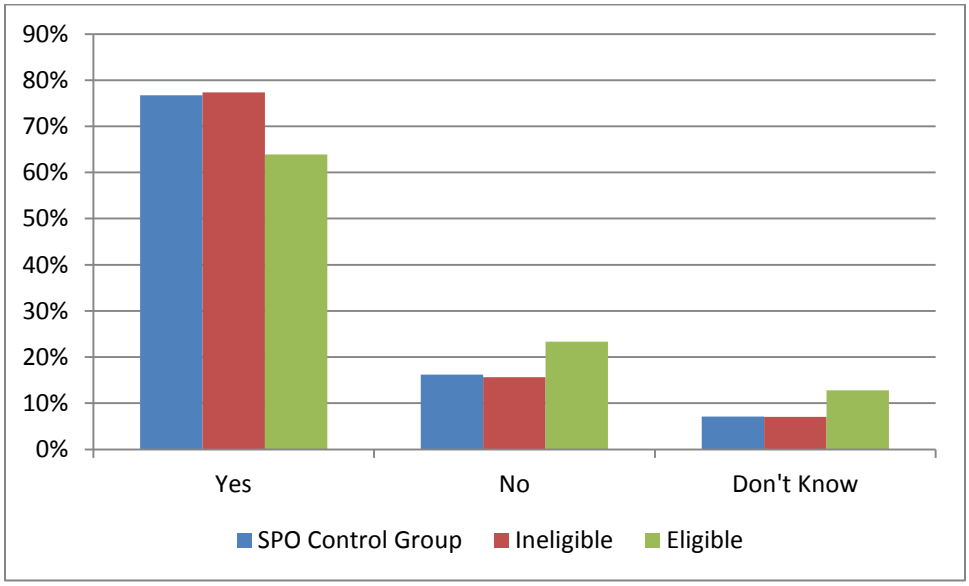


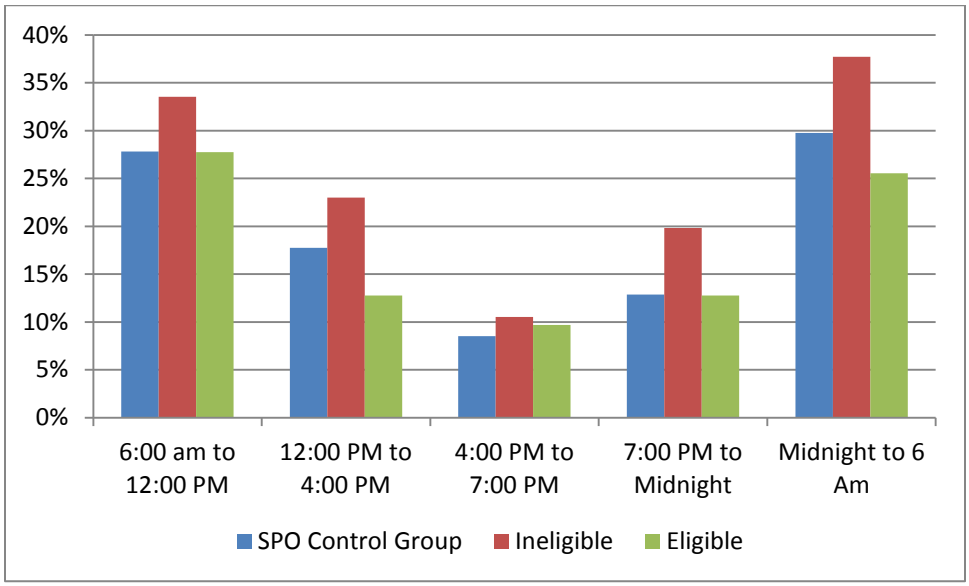
Table D-2 includes the average set temperature for the thermostats for different times of day. The numbers don't vary much between the groups, hovering between 73°F and 75°F for all times of day.

Participants also had the option in the survey to write that their thermostat was off at a given time, instead of set to a particular temperature. Figure D-4 summarizes the percentages of the thermostats set to off during each time period within each group.

Table D-2: Average Set Temperature of Programmable Thermostat at Varying Times of Day

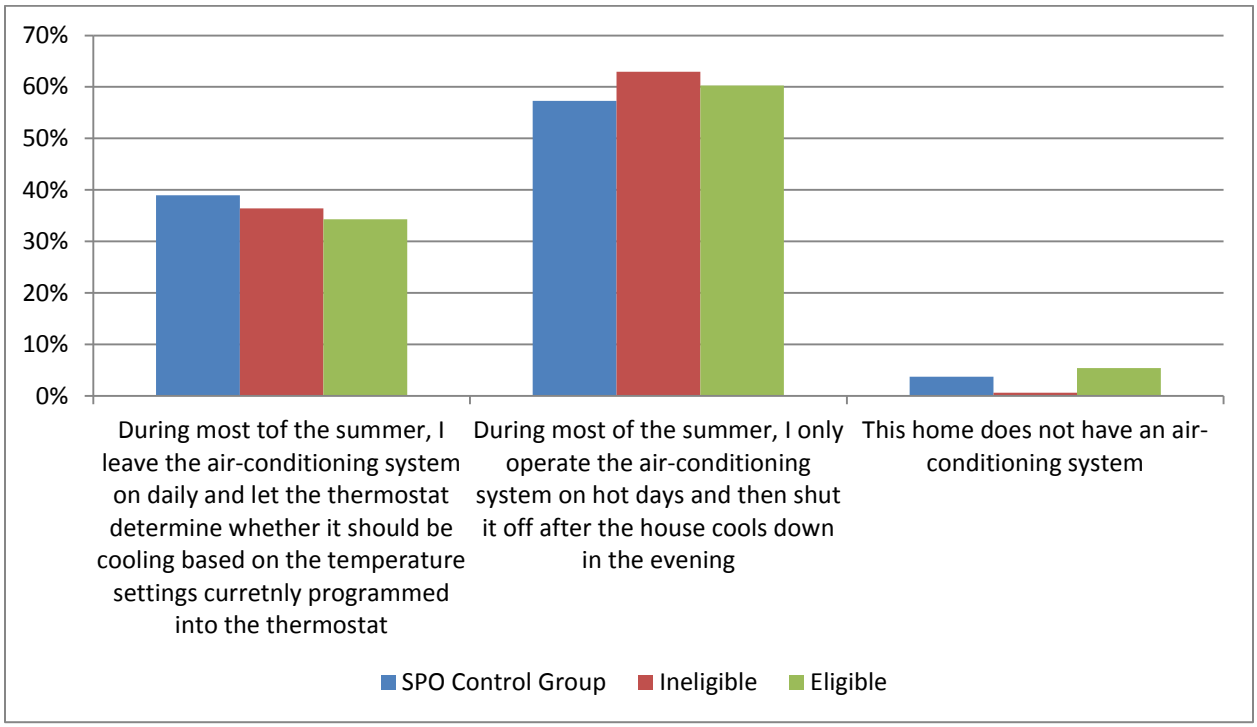
Study Group	6:00 am to 12:00 PM	12:00 PM to 4:00 PM	4:00 PM to 7:00 PM	7:00 PM to Midnight	Midnight to 6 Am
SPO Control Group	75.4	75.2	74.3	74.3	74.8
Ineligible	75.5	75.5	74.6	74.6	75.3
Eligible	74.3	74.2	74.0	73.5	73.3

Figure D-4: Percent of Thermostats Set to Off at a Given Time of Day (n=1,115)



The survey next presented the consumers with three choices of how they use their air conditioning, asking that they select one. The most popular answer involved turning off the air conditioner when it was not hot and thus not necessary for cooling. These results can be found in Figure D-5.

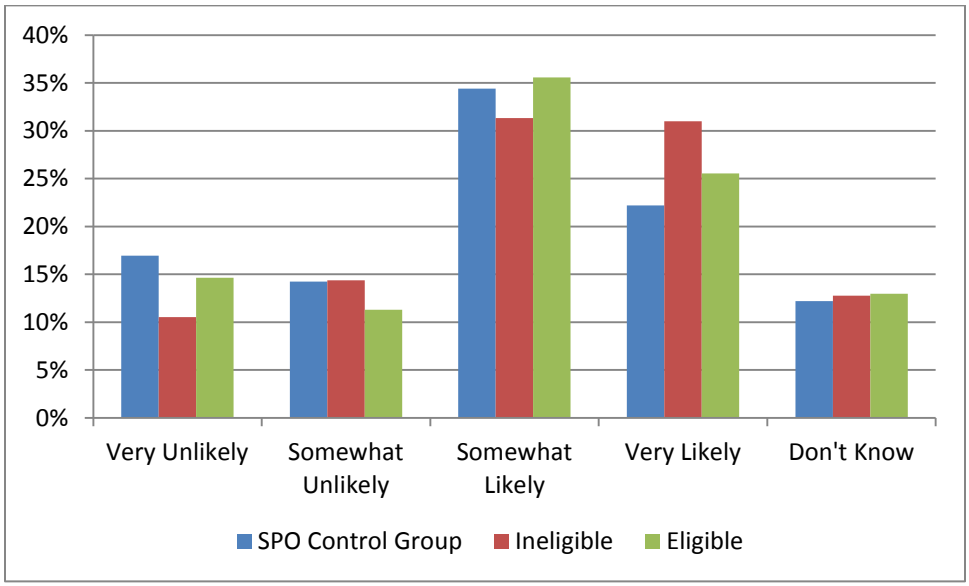
Figure D-5: Description of How Consumers Use Their Air Conditioners (n=1,142)



Again there was not much difference between the groups when it came to the likelihood of taking advantage of SMUD-sponsored energy efficiency programs. The plurality of consumers indicated that they were somewhat likely to take advantage of these programs, as seen in Figure D-6.

Figure

D-6: Likelihood of Customers to Take Advantage of SMUD-Sponsored Energy Efficiency Programs (Such as Rebates or Home Energy Audit Services) (n=1,142)



The majority of consumers rated their satisfaction with SMUD at a minimum of 8, shown in Figure D-7. Very few customers selected the lower spectrum, below 4. Figure D-8 indicates how much importance customers place on reducing home energy use in general. The majority find it to be at least somewhat important, if not very important. The vast majority of consumers chose saving money as their primary motivator in saving energy use, represented in Figure D-9.

Figure D-7: Overall Satisfaction with SMUD
(1 ="Completely Dissatisfied" and 10 ="Completely Satisfied") (n=1,141)

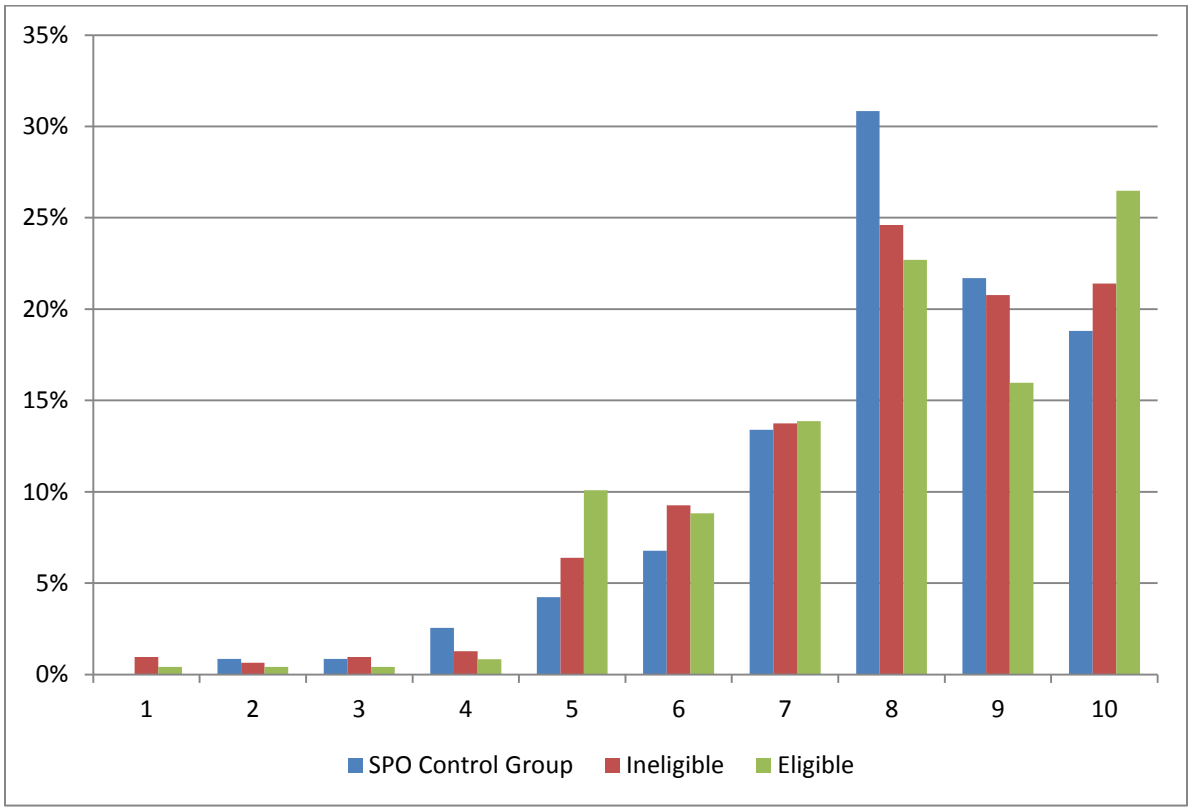


Figure D-8: Importance of Reducing Home Energy Use (n=1,142)

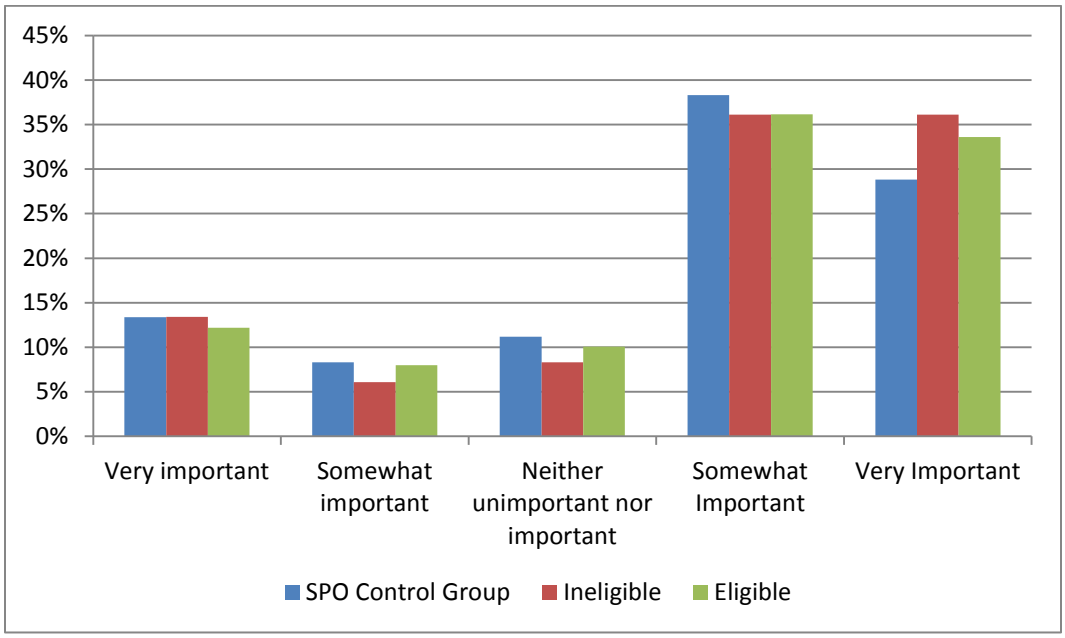
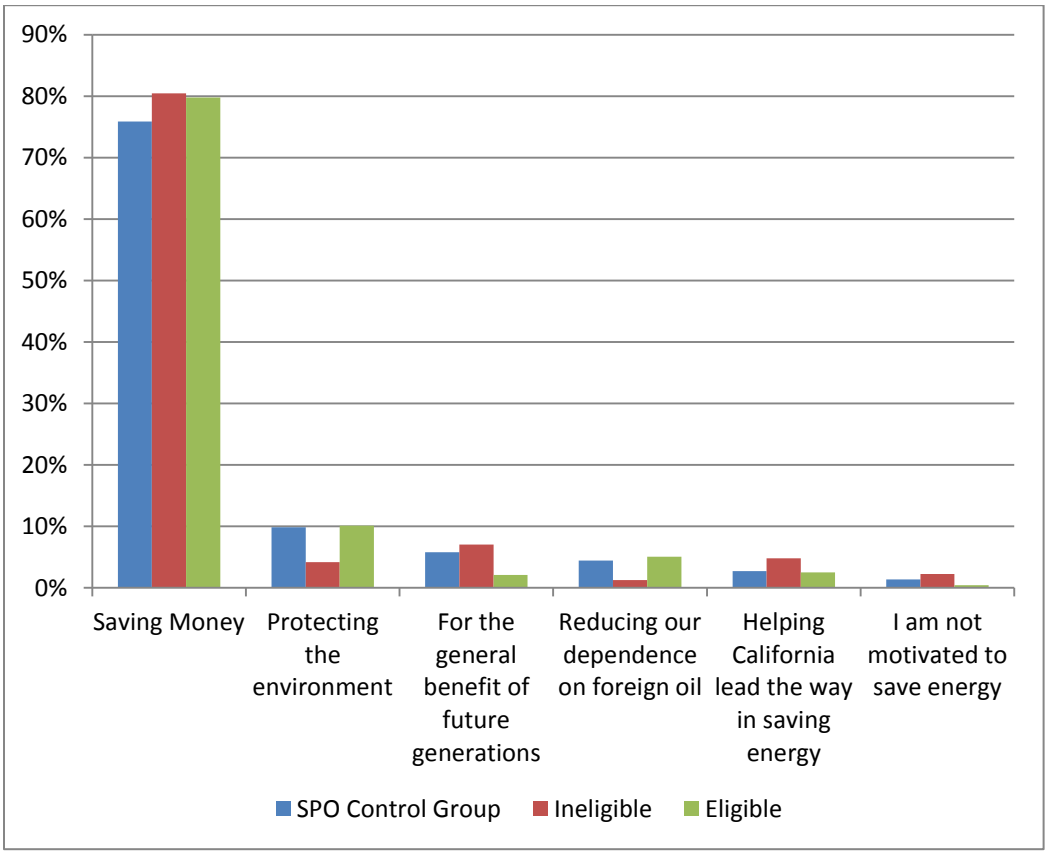


Figure D-9: Largest Motivation to Save Energy (n=1,142)



The survey then moved on from energy use habits and beliefs to more simple demographics. The majority of residences in all three groups were single family homes, seen in Figure D-10. The majority of customers own their homes in the SPO control and ineligible groups but a higher percentage of customers rent their homes in the eligible group. This can be confirmed in Figure D-11.

Figure D-10: Type of Residence (n=1,142)

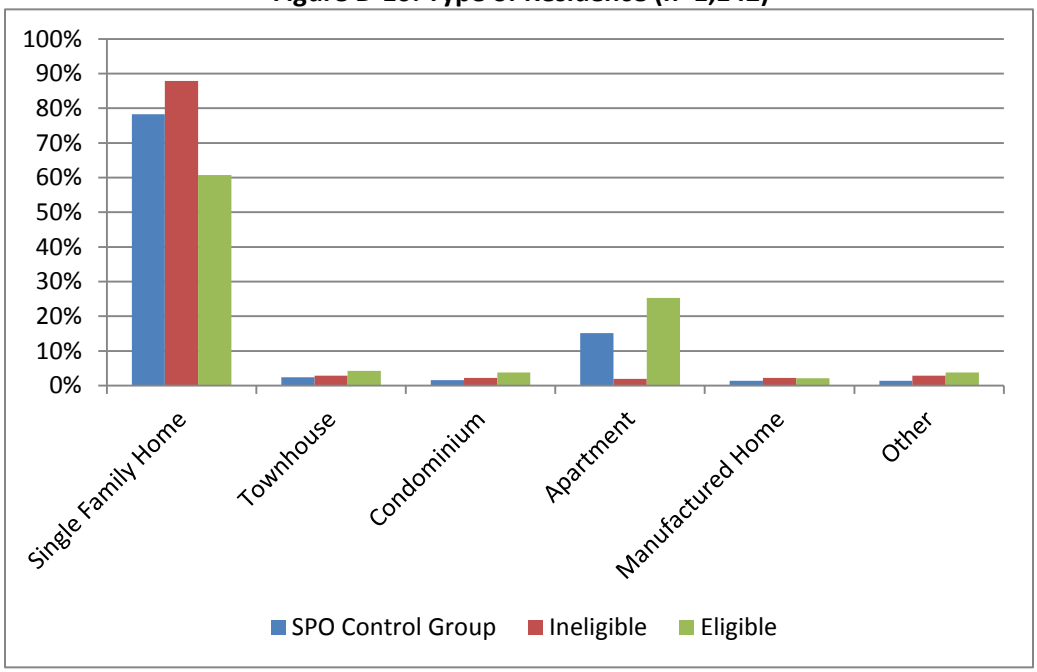
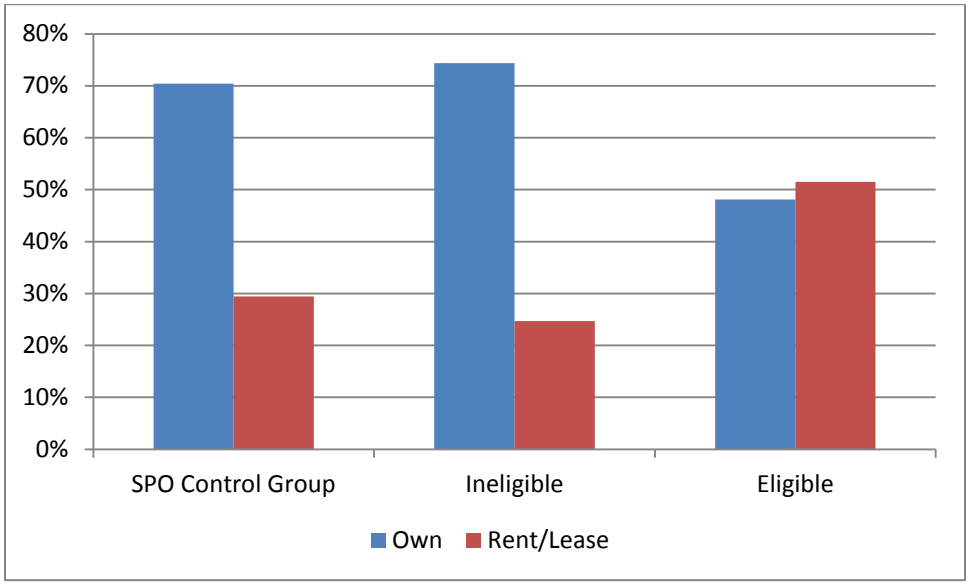
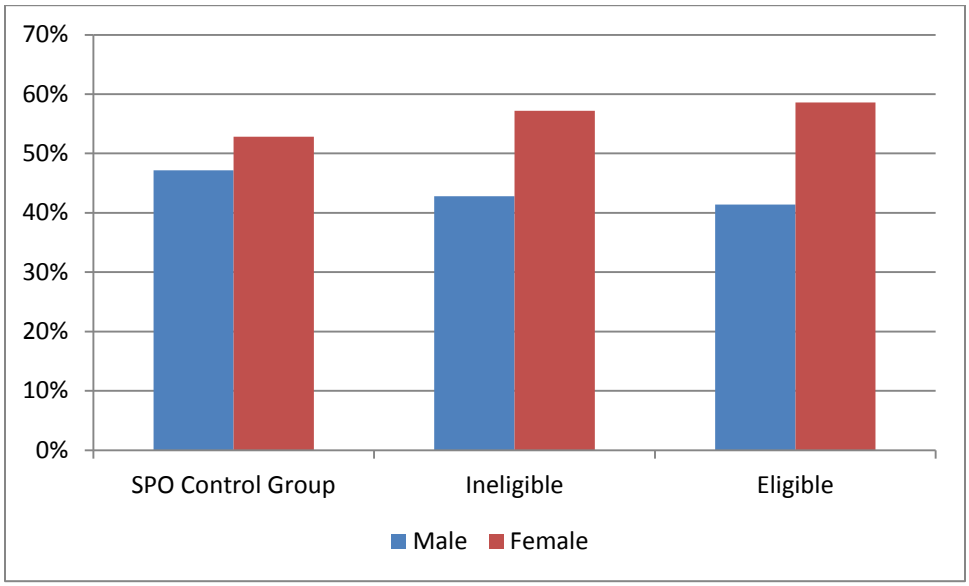


Figure D-11: Home Ownership Status (n=1,142)



There was a higher percentage of females for all three groups, as shown in Figure D-11.

Figure D-11: Gender Distribution (n=1,142)



The mean age of the eligible group was the lowest, at 47.0 years, followed by the SPO control group at 51.8 years and ineligible group at 53.1 years. Figure D-12 shows the age distribution in more detail. The age of other residents in the household were also of interest. Figure D-13 shows the number of adults over the age of 18 living in the household, including the respondent, with two being the most common answer. The average for all three groups was also 2. Zero was a more common answer for the number of children under the age of 18, seen in Figure D-14. The average number ranged from 0.6, for the ineligible group, to 0.9 for the eligible group.

Figure D-12: Age Distribution (n=1,142)

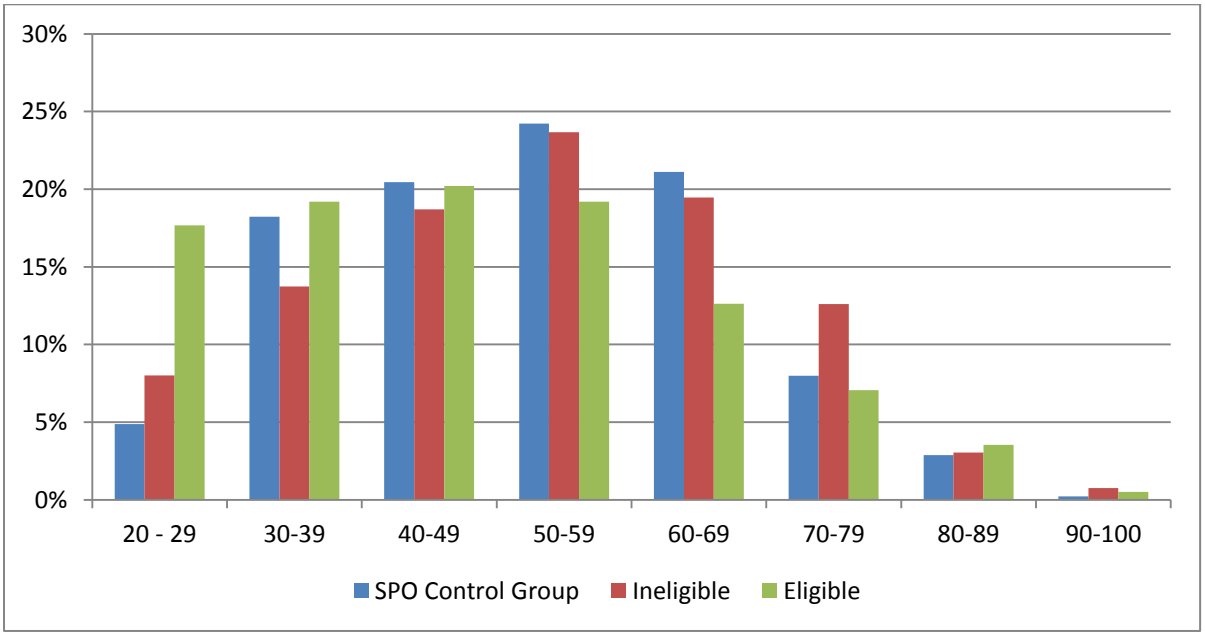


Figure D-13: Number of Adults Over 18 Who Reside in Household (n-1,142)

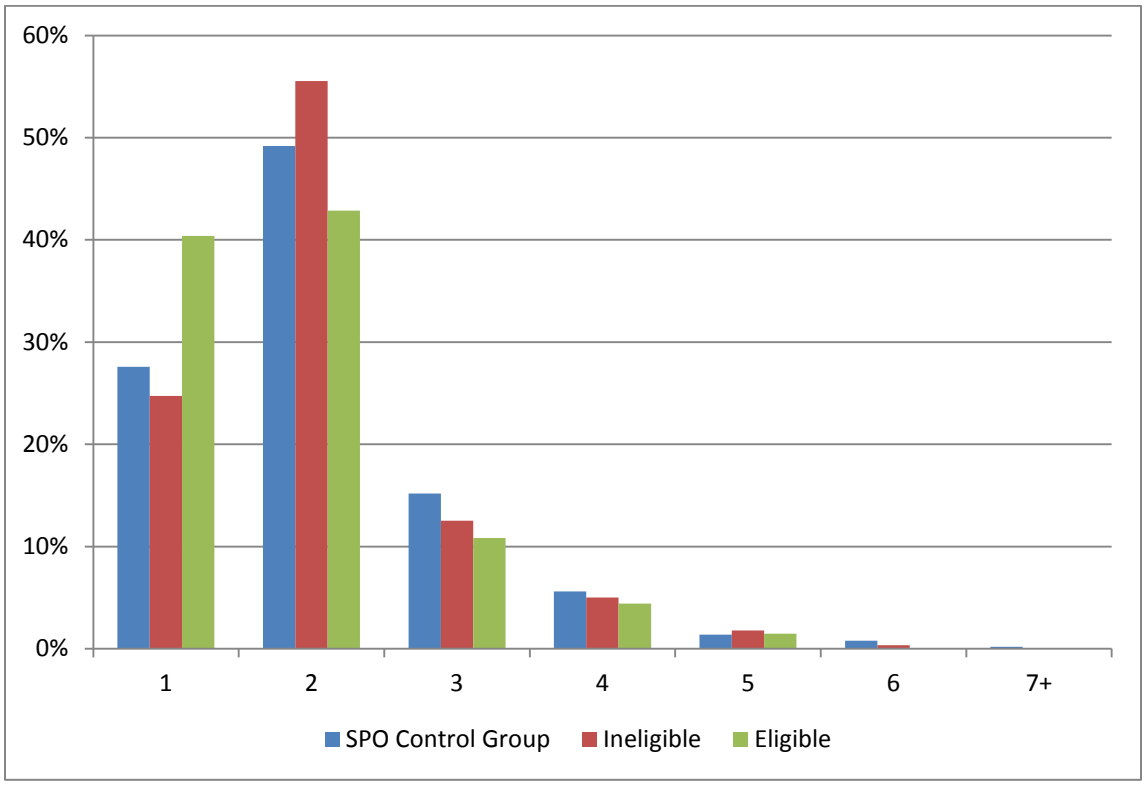
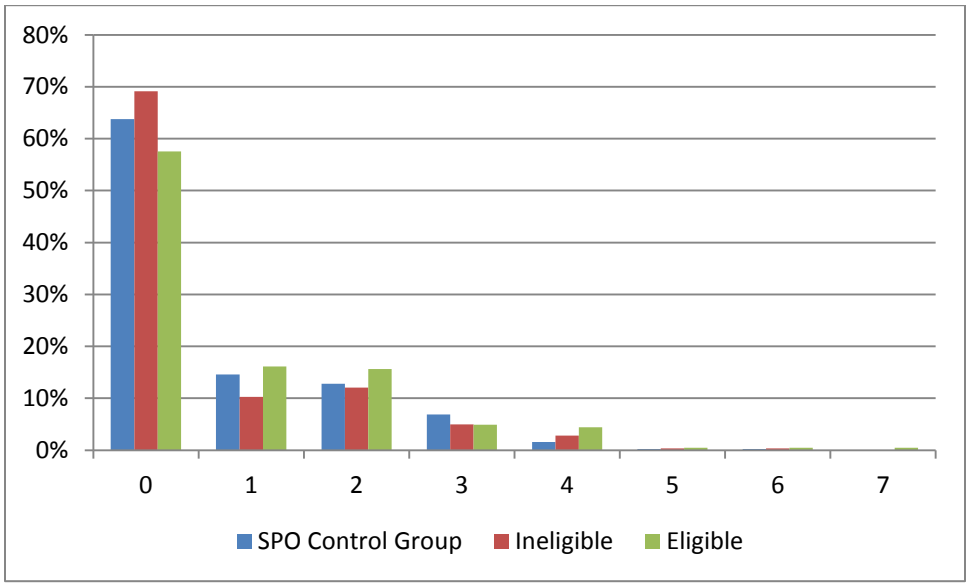


Figure D-14: Number of Children Under 18 Reside in Household (n=1,142)



Racially, the groups were very similar, with the majority being Caucasian/White, presented in Figure D-15. Figure D-16 has the levels of education for the consumers, with the most popular being some college to college degree. The final question looked at income. That distribution is shown in Figure D-17. There was a lot of variation, thus small differences (of less than 10%) appear to be fairly large. Scale must be taken into account.

Figure D-15: Distribution of Race (n=1,142)

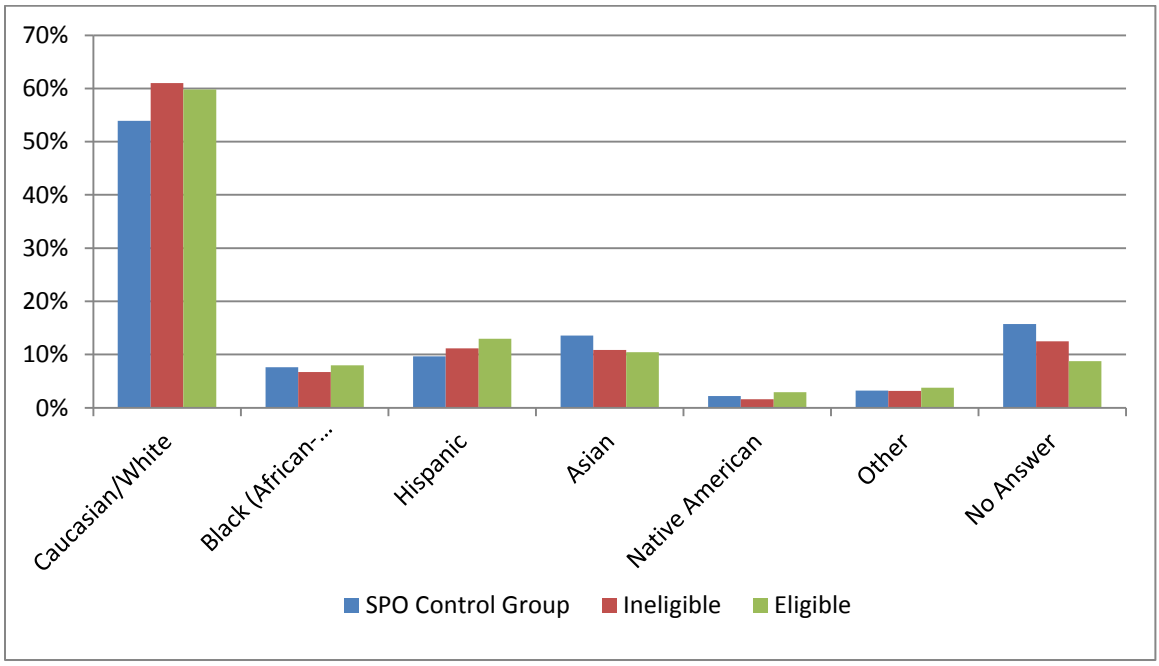


Figure D-16: Highest Level of Education Achieved (n=1,142)

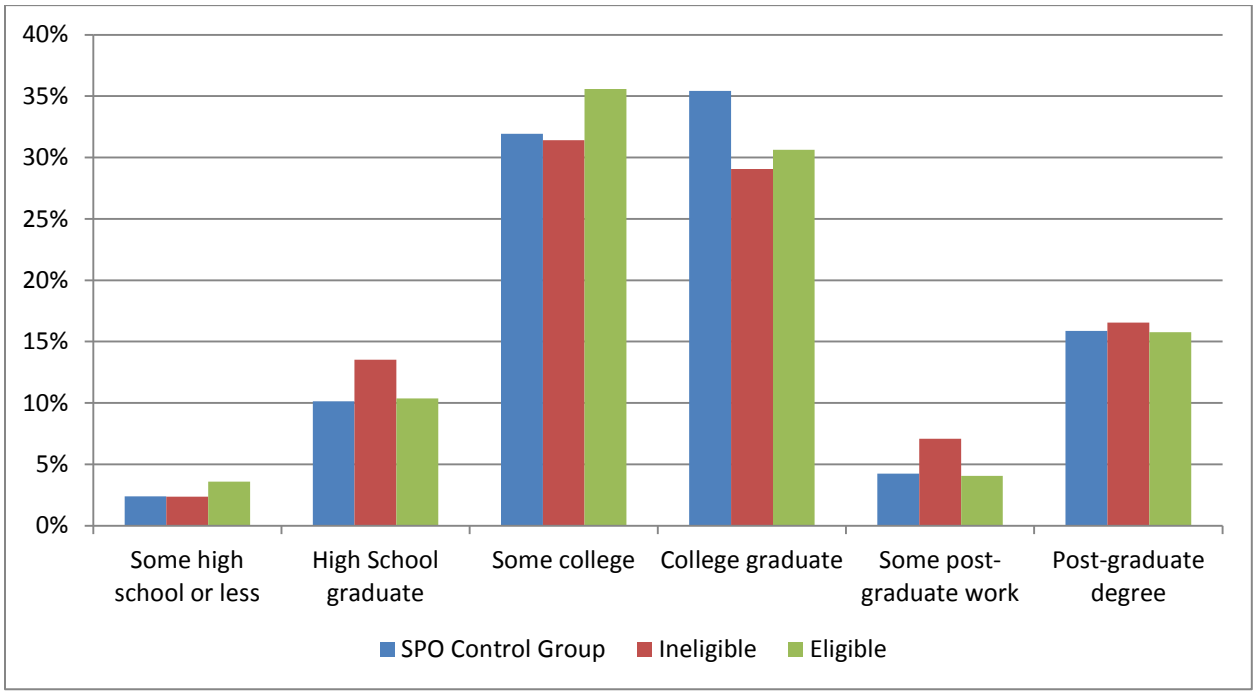
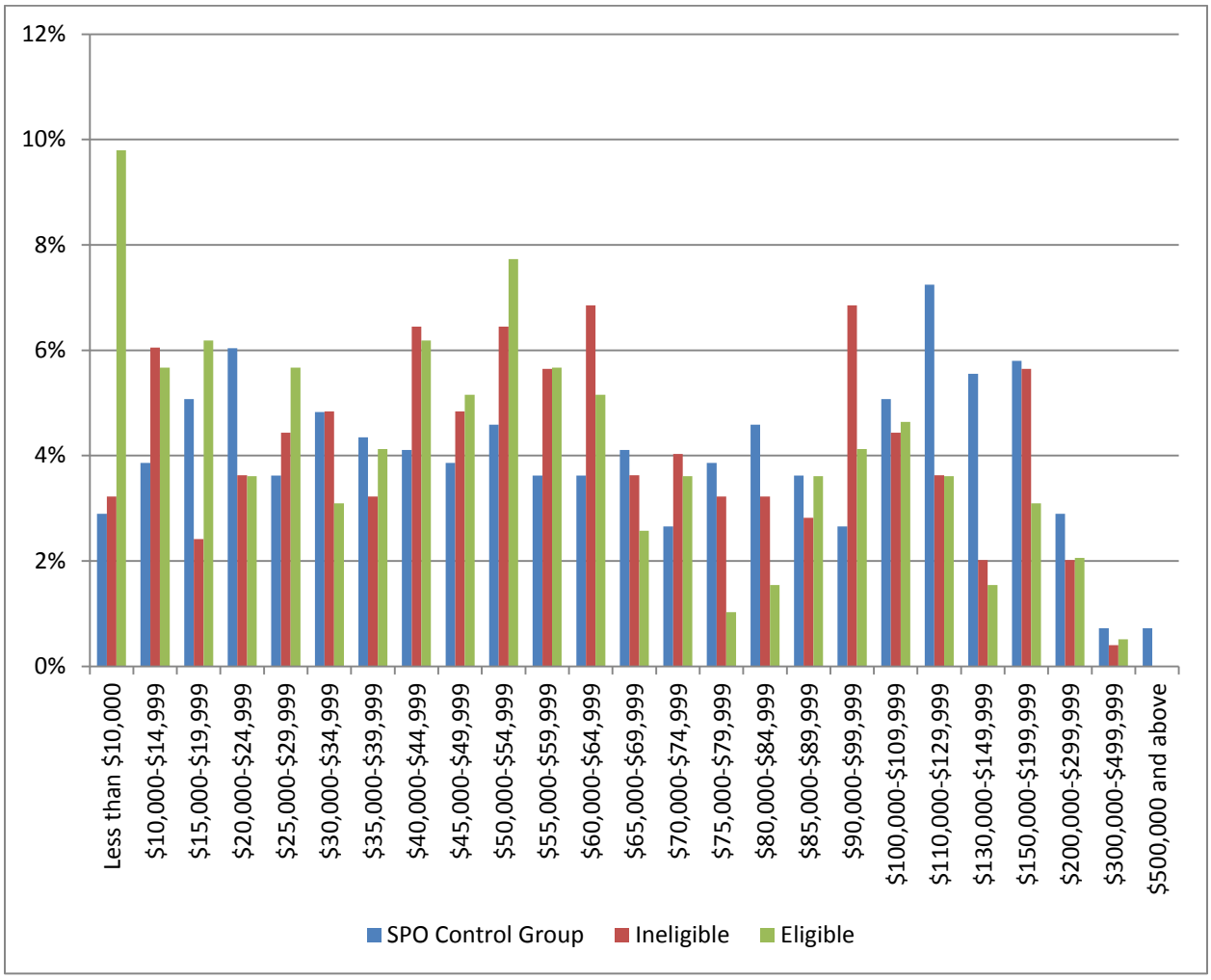


Figure D-17: Annual Household Income (n=1,142)



Appendix E Steps for Developing Choice Dataset for the Conjoint Survey

In the conjoint section of the survey, each respondent viewed 27 randomly selected choice options (9 sets of 3) and made 9 choices in total. To populate the 27 choice options for each respondent, FSC implemented the following steps:

1. Randomly assigned one of four plan types – Standard, TOU, CPP or CPP-TOU
2. Randomly assigned one of two tier structures – with or without
3. Within each of these 8 combinations, randomly selected from a dataset of revenue-neutral rates, which populated the following plan options:
    - Tier 1 price for each plan
    - Tier 2 price for each plan (equal to tier 1 if there were no tiers)
    - On-peak period associated with each plan – 1-7 PM, 3-7 PM or 4-7 PM (if applicable)
    - Number of CPP days associated with each plan – 6, 12, 18 or 24 (if applicable)
    - TOU on-peak price for each plan (if applicable)
    - CPP on-peak price for each plan (if applicable)
4. Randomly selected one of three technology options – none, IHD or PCT
5. Independently for each price component (tier 1, tier 2, TOU on-peak and CPP on-peak), randomly added noise by increasing the price by 12.5%, keeping the price equal or decreasing the price by 12.5% (with limits to avoid nonsensical prices such as a tier 2 price that is less than a tier 1 price or an on-peak price that is less than a tier 2 price)
6. To identify dominant choices, one of the three options in a choice set had to be clearly equal to or better than another for <u>all</u> rate components (i.e., lower prices, shorter on-peak period, fewer CPP days and more technology). When there was a dominant choice, FSC started from step 1 again until there weren't any dominant choices. FSC had to rerun from step 1 for roughly 11% of choice sets.

Step 5 was necessary because, without adding random noise to the prices, the price components would be so highly correlated with each other that it would prevent the ability to estimate the marginal effects for each variable.

Appendix F End of Pilot Survey Questionnaire

Question Set #1 (Satisfaction)

1. Thinking of all of the services you receive from SMUD, how satisfied are you? Select only one answer

   ☐ Very satisfied
   ☐ Somewhat satisfied
   ☐ Somewhat dissatisfied
   ☐ Very dissatisfied

2. Overall, how would you rate SMUD in comparison to the other providers of utilities in your community? Would you say SMUD is…

	Much Better	Somewhat Better	About the Same	Somewhat Worse	Much Worse
Cable/Satellite	☐	☐	☐	☐	☐
Water /Sewer	☐	☐	☐	☐	☐
Garbage	☐	☐	☐	☐	☐
Cell Phone	☐	☐	☐	☐	☐
Gas	☐	☐	☐	☐	☐

3. How would you rate SMUD as an environmental steward in comparison with the other providers of utilities in your community? Would you say SMUD is…

	Much Better	Somewhat Better	About the Same	Somewhat Worse	Much Worse
Cable/Satellite	☐	☐	☐	☐	☐
Water /Sewer	☐	☐	☐	☐	☐
Garbage	☐	☐	☐	☐	☐
Cell Phone	☐	☐	☐	☐	☐
Gas	☐	☐	☐	☐	☐

4. How would rate you SMUD as a corporate citizen in comparison with the other providers of utilities in your community? Would you say SMUD is…

	Much Better	Somewhat Better	About the Same	Somewhat Worse	Much Worse
Cable/Satellite	☐	☐	☐	☐	☐
Water /Sewer	☐	☐	☐	☐	☐
Garbage	☐	☐	☐	☐	☐
Cell Phone	☐	☐	☐	☐	☐
Gas	☐	☐	☐	☐	☐

5. At any time during the past two years have you had occasion to call SMUD?

   ☐ Yes
   ☐ No
   ☐ Not-sure

6. (If Q5 = Yes) What was the purpose of your call? ***Check all that apply***

   ☐ Obtain information about my pricing plan
   ☐ Obtain information about other aspects of service
   ☐ Sign up for a new pricing plan
   ☐ Make an appointment for a service technician
   ☐ Report an outage
   ☐ Inquire about my bill
   ☐ Other

7. (if Q5 = Yes) How would you rate your experience on these calls

	Excellent	Good	Fair	Poor	No Opinion
Obtain information about my pricing plan	☐	☐	☐	☐	☐
Obtain information about other aspects of service	☐	☐	☐	☐	☐
Sign up for a new pricing plan	☐	☐	☐	☐	☐
Make an appointment for a service technician	☐	☐	☐	☐	☐
Report an Outage	☐	☐	☐	☐	☐
Inquire about my bill	☐	☐	☐	☐	☐
Other	☐	☐	☐	☐	☐

Question Set #2 (Awareness)

The following questions ask for your opinions about pricing plans offered by SMUD. A pricing plan is the arrangement you have with SMUD for the price you pay for electricity.

8. Thinking only of the way you are charged for electricity in summer, which of the following best describes your household pricing plan? ***Check only one***

   - ☐ Pay the same price for electricity no matter when you use it
   - ☐ Pay a higher price for electricity used between 4:00 and 7:00 PM on all days
   - ☐ Pay a higher price for electricity used between 4:00 and 7:00 PM on weekdays only
   - ☐ Pay a much higher price for electricity used between 4:00 and 7:00 PM on 12 Conservation Days
   - ☐ Pay a higher price for electricity used between 4:00 and 7:00 PM on weekdays **with** an even higher price on 12 days during the summer called Conservation Days
   - ☐ Don't know

9. How satisfied are you with your current electricity pricing plan? ***Check only one***

   - ☐ Very satisfied
   - ☐ Somewhat satisfied
   - ☐ Somewhat dissatisfied
   - ☐ Very dissatisfied

10. Please indicate whether you agree or disagree with the following statements.

	Strongly Agree	Somewhat Agree	No Opinion	Somewhat Disagree	Strongly Disagree
My current pricing plan is easy to understand	☐	☐	☐	☐	☐
My current pricing plan is fair	☐	☐	☐	☐	☐
My current pricing plan provides me with opportunities to save money	☐	☐	☐	☐	☐
My current pricing plan is better than my old plan (*ask only of participants*)	☐	☐	☐	☐	☐
My current pricing plan fits my lifestyle	☐	☐	☐	☐	☐
I sometimes feel uncomfortable inside my home on summer afternoons and evenings because it is too expensive to run my air conditioner	☐	☐	☐	☐	☐
My current pricing plan is convenient	☐	☐	☐	☐	☐
I make sure I use as little electricity as possible between 4:00 and 7:00 PM	☐	☐	☐	☐	☐

Control and TOU Deferred Groups ➔ Q50, Opt-outs ➔ Q36
Question Set #3 (Expectation and Perception)

11. (*Ask only for opt-in customers)* According to our records, your household enrolled in a new pricing plan called (insert plan name) on (insert date) as part of SMUD's SmartPricing Options Pilot. Do you recall this happening?
    - ☐ Yes
    - ☐ No
    - ☐ Not-sure

12. (*Ask only for default customers*) According to our records, your household is receiving service under a new pricing plan called (insert plan name) on (insert date) as part of SMUD's SmartPricing Options Pilot. Do you recall receiving notice of this service change?
    - ☐ Yes
    - ☐ No
    - ☐ Not-sure

13. (Ask only if 12 = yes) At the time you were switched to the new pricing plan you were offered a free in-home Electricity Use Display capable of displaying the amount of electricity your household was using in real time. Do you recall receiving that offer?
    - ☐ Yes
    - ☐ No
    - ☐ Not-sure

14. (Ask only if 12=yes and customer did not request the IHD) What were your reasons for not requesting the in-home Electricity Use Display ? ***Check all that apply***
    - ☐ I did not want it
    - ☐ I wanted it but forgot to order it
    - ☐ I thought I would be charged for it
    - ☐ I couldn't understand how it would help me
    - ☐ I ordered it but it never came

15. (*Ask only for default customers*) You had an opportunity to switch back to your original pricing plan before going on the new plan. Which of the following best describes your most important reason for staying on the new plan? ***Check only one***
    - ☐ You were not aware that you had been assigned to the new plan
    - ☐ You did not know that you could opt out of the new pricing plan
    - ☐ You were aware of the plan and felt that it was a good plan for you
    - ☐ You were not sure whether it was a good plan for you but wanted to give it a try before deciding whether to stay or revert to your original plan
    - ☐ You planned to opt out but never got around to it

16. (Ask only of TOU customers) Under this rate plan you receive a discount during most of the hours in the summer except for summer weekday afternoons between 4:00 PM and 7:00 PM when the price is about three times as high as it is at other times. Does that sound familiar?
    - ☐ Yes
    - ☐ No
    - ☐ Not-sure

17. (Ask only of CPP customers) Under this rate plan you receive a discount during most of the hours in the summer except on 12 summer days called Conservation Days between 4:00 PM and 7:00 PM when the price is about seven times higher than it is during other hours. Does that sound familiar?
    - ☐ Yes
    - ☐ No
    - ☐ Not-sure

18. (Ask only of TOU/CPP customers) Under this rate plan you receive a discount during most of the hours in the summer. However on weekday afternoons between 4:00 PM and 7:00 PM the price is about three times as high as it is during other hours and on 12 summer afternoons called Conservation Days between 4:00 PM and 7:00 PM the price is about seven times higher. Does that sound familiar?
    - ☐ Yes
    - ☐ No
    - ☐ Not-sure

19. (Ask only for CPP or CPP/TOU customers) As part of your pricing plan you were to receive notice by email, text or phone on the day prior to each Conservation Day. Do you recall receiving notice that there would be any Conservation Days?
    - ☐ Yes
    - ☐ No
    - ☐ Not-sure

20. (If Q19 = Yes) On about how many days last summer did you receive notice that the next day would be a Conservation Day?

    _____ number of days

21. (if Q19 = Yes) Which of the following best describes your opinion about the amount of notice you received of impending Conservation Days: ***Check only one***
    - ☐ I needed more notice (if so how much notice do you need - hours / days _____)
    - ☐ The amount of notice was just right
    - ☐ There was more than enough notice (if so, what is the minimum amount of time that you require for notice of impending Conservation Days hours/days_____)

22. (*Ask only for opt-in customers*) Do you think you saved any money as a result of selecting this rate plan?

    ☐ Yes
    ☐ No
    ☐ Not-sure

23. (*Ask only for default customers*) Do you think you saved any money as a result of receiving service under this rate plan?

    ☐ Yes
    ☐ No
    ☐ Not-sure

24. (If Q22 or Q23= Yes) How much money do you think you saved on a monthly basis? _____$

25. (Ask only for program participants) Compared to your old rate plan, how would you rate the convenience of this rate plan? ***Check only one***

    ☐ A lot more convenient than my old rate plan
    ☐ Somewhat more convenient than my old rate plan
    ☐ About as convenient as my old rate plan
    ☐ Somewhat less convenient than my old rate plan
    ☐ A lot less convenient than my old rate plan

26. (Ask only program participants) Compared to when you were under your old rate plan, how would you rate the comfort of your home on summer afternoons and evenings? Was it… ***Check one***

    ☐ A lot more comfortable than it was under your old rate plan
    ☐ Somewhat more comfortable than it was under your old rate plan
    ☐ About as comfortable as it was under your old rate plan
    ☐ Somewhat less comfortable than it was under your old rate plan
    ☐ A lot less comfortable than it was under your old rate plan

27. (Ask only of program participants) As part of the SmartPricing Options Pilot, SMUD provided you with access to a website containing tips and helpful hints for how to save money under your new pricing plan. Do you recall ever looking at this website?

    ☐ Yes
    ☐ No
    ☐ Not-sure

28. (If Q27 = Yes) About how often did you look at this website during the first summer you were on the new pricing plan? ***Check only one***

- ☐ Only once
- ☐ A few times during the summer
- ☐ Every week during the summer
- ☐ Every day during the summer

29. (If Q27 = Yes) How about last summer? ***Check only one***

- ☐ Only once
- ☐ A few times during the summer
- ☐ Every week during the summer
- ☐ Every day during the summer

30. (if Q27 = Yes) Below are some things you can do at the website. Please indicate whether you tried them and if so, how much you liked or disliked them.

	Tried or used	Liked a lot	Liked a little	Disliked a little	Disliked a lot	No Opinion
Reviewed the conditions of my pricing plan	☐	☐	☐	☐	☐	☐
Read about tips for lowering my cost	☐	☐	☐	☐	☐	☐
Joined Facebook Groups	☐	☐	☐	☐	☐	☐
Played games	☐	☐	☐	☐	☐	☐
Entered sweepstakes	☐	☐	☐	☐	☐	☐
Looked at my usage	☐	☐	☐	☐	☐	☐

31. (Ask only for program participants) Please indicate how much you agree or disagree with the following statements about your pricing plan:

	Strongly Agree	Somewhat Agree	No Opinion	Somewhat Disagree	Strongly Disagree
I understand why SMUD is offering the pricing plan I am on	☐	☐	☐	☐	☐
SMUD should be offering the pricing plan I am on to all of its customers	☐	☐	☐	☐	☐
I believe that I did something good for Sacramento by participating in my pricing plan	☐	☐	☐	☐	☐
I think the Sacramento community would be better off if everybody was on my pricing plan	☐	☐	☐	☐	☐
I remember receiving a Welcome Back kit in the mail this summer from SMUD	☐	☐	☐	☐	☐
SMUD answered all my questions about my pricing plan	☐	☐	☐	☐	☐
I want to stay on my pricing plan	☐	☐	☐	☐	☐

32. Overall, how satisfied are you with your new pricing plan? ***Check only one***

- ☐ Very satisfied
- ☐ Somewhat satisfied
- ☐ Somewhat dissatisfied
- ☐ Very dissatisfied

Question Set #4 (Behavioral Changes and Perceived Difficultly)

33. As a result of participating in (insert plan name) as part of SMUD's SmartPricing Options Pilot, did you have more control over your household's electricity cost?

- ☐ Yes
- ☐ No

34. Please identify any actions that you or other members of your household may have taken to lower your electricity consumption between 4:00 PM and 7:00 PM? ***Check all that apply***

- ☐ Turned off lights not in use during the peak period
- ☐ Turned off office equipment during the peak period
- ☐ Turned off entertainment systems during the peak period
- ☐ Increased the temperature of my thermostat during the peak period
- ☐ Turned off air conditioning during the peak period
- ☐ Did laundry off peak
- ☐ Did dishes off peak
- ☐ Cooked dinners outside
- ☐ Changed spa and pool pumping to off-peak hours
- ☐ None of the above – Skip over Q35

35. How difficult were these changes to make?

- ☐ Not difficult at all
- ☐ Somewhat difficult
- ☐ Very difficult

Question Set #5 (Opt-out Questions)

36. (Ask only of drop out customers) Our records indicate that you elected to return to your standard rate on (drop date). Below is a list of reasons why you may have left the (insert plan name) as part of SMUD's SmartPricing Options Pilot. Please indicate how important each reason was to you in deciding to leave the (insert plan name).

	Very Important	Somewhat Important	No Opinion	Somewhat Unimportant	Completely Unimportant
I was not aware that I was on the (insert plan name) until I received the letter in May	☐	☐	☐	☐	☐
I was not saving money	☐	☐	☐	☐	☐
The (insert plan name) did not give me more control over my bill	☐	☐	☐	☐	☐
I do not want to worry about when I use electricity	☐	☐	☐	☐	☐
I found it too difficult to limit my usage to off-peak times	☐	☐	☐	☐	☐
Other	specify				

Question Set #6 (IHDs)

37. Last year, after you enrolled in (insert plan name) as part of the SmartPricing Options Pilot, SMUD sent you an Electricity Use Display that shows up-to-the-minute information about electricity cost and usage for your entire home. Do you recall receiving the Electricity Use Display in the mail?
    - ☐ Yes
    - ☐ No ➔(skip to Q49)

38. Did you try to use the Electricity Use Display?
    - ☐ Yes, and succeeded
    - ☐ Yes, but couldn't get it to work ➔(skip to Q43)
    - ☐ No – ➔(skip to Q49)
    - ☐ Not sure / Don't remember (skip to Q49)

39. Is the Electricity Use Display you received still working?
    - ☐ Yes ➔(Skip to Q44)
    - ☐ No
    - ☐ Not sure or don't know ➔(Skip to Q44)

40. Approximately when did it stop working?
    - ☐ Within a month or two of receiving it
    - ☐ A few days ago
    - ☐ A few weeks ago
    - ☐ A few months ago
    - ☐ Not sure or don't know

41. When you noticed that it stopped working, did you attempt to restart it?
    - ☐ Yes
    - ☐ No – Why not? _____ ➔(Skip to Q49)

42. What actions did you take to try to restart the Electricity Use Display? ***Check all that apply***
    - ☐ Turned it off and then on
    - ☐ Removed the battery and replaced it
    - ☐ Moved its location
    - ☐ Called the customer service line
    - ☐ Other – Specify _____

43. Have you discarded the Electricity Use Display or is it still in your home? ***Check only one***
    - ☐ Discarded ➔ (Skip to Q47)
    - ☐ Still in the home ➔ (Skip to Q47)
    - ☐ Not sure or don't know ➔ (Skip to Q47)

44. Where is your Electricity Use Display currently located? ***Check only one***
    - ☐ Kitchen
    - ☐ Family room
    - ☐ Living room
    - ☐ Office
    - ☐ Dining room
    - ☐ Other – Specify

45. In the past week, about how often did you look at your Electricity Use Display? ***Check only one***
    - ☐ More than once a day
    - ☐ About once a day
    - ☐ 2-4 times
    - ☐ Once
    - ☐ Never

46. Did you discuss your home's energy use with anyone else inside or outside your home based on information obtained through the Electricity Use Display **in the last 30 days**?

    - ☐ No
    - ☐ Yes, discussed energy use with other adults in the household
    - ☐ Yes, discussed energy use with guests or other adults outside the household
    - ☐ Yes, discussed energy use with children
    - ☐ I stopped using or discarded the device more than 30 days ago.

47. Have you made any changes to the way you use electricity in your home based on the information provided by the Electricity Use Display?

    - ☐ Yes
    - ☐ No
    - ☐ Not sure
    - ☐ I never got the Electricity Use Display to work

48. Based on your experience with the Electricity Use Display, would you recommend to a friend that they get one?

    - ☐ Yes
    - ☐ No
    - ☐ Not sure

49. (Ask of all customers in all surveys) Please describe any changes in the ways in which you use electricity that you or others in your household may have made over the past 24 months. ***Check all that apply***

    - ☐ Installed a smart power strip to control "vampire" loads
    - ☐ Installed compact fluorescent lights (CFLs) or LEDs.
    - ☐ Bought an energy-efficient appliance
    - ☐ Replaced my air conditioner with a more efficient one
    - ☐ Repaired or serviced my air conditioner
    - ☐ Set my thermostat to a higher temperature to use less electricity
    - ☐ Avoided using my air conditioner as much as possible
    - ☐ Did fewer but larger loads of laundry
    - ☐ Did fewer but larger loads of dishes
    - ☐ Only used cold water when doing laundry/dishes
    - ☐ Other – Specify
    - ☐ None of the above

Question Set #7 (DOE/LBNL Questions)

50. (Ask only for those in the opt-in treatment) Since 2012 you have been receiving electric service under the (insert plan name) as part of SMUD's SmartPricing Options Pilot. Below are some reasons why people say they continue to stay on the (Insert pricing plan). Please tell us how important these reasons are to you in staying on the pricing plan.

	Very Important	Somewhat Important	Somewhat Unimportant	Completely Unimportant	Don't Know
I like the pricing plan	☐	☐	☐	☐	☐
I didn't know I was able to drop out of the pricing plan	☐	☐	☐	☐	☐
I intended to drop out of the pricing plan, but never got around to it	☐	☐	☐	☐	☐
I don't think I would be any better off on the standard rate	☐	☐	☐	☐	☐
The more I got used to the pricing plan, the more I liked it	☐	☐	☐	☐	☐

51. (Ask only for those who did not opt out of the default treatment) Since 2012 you were assigned to a new pricing plan called the (insert plan name), as part of SMUD's SmartPricing Options Pilot. Below are some reasons why people say they continue to subscribe to (Insert pricing plan). Please tell us how important these reasons are to you in staying on the pricing plan.

	Very Important	Somewhat Important	Somewhat Unimportant	Completely Unimportant	Don't Know
I like the pricing plan SMUD assigned me to	☐	☐	☐	☐	☐
I didn't know I was assigned to the new pricing plan	☐	☐	☐	☐	☐

I didn't know I was able to drop out of the new pricing plan	☐	☐	☐	☐	☐
I assume the default pricing plan SMUD selected for me is best for me	☐	☐	☐	☐	☐
I intended to drop out of the pricing plan, but never got around to it	☐	☐	☐	☐	☐
I'm not sure I would be any better off on the standard rate	☐	☐	☐	☐	☐
The more I got used to the pricing plan, the more I liked it	☐	☐	☐	☐	☐

Question Set #8 (About Your Household)

52. What type of home is this? ***Check one***

- ☐ A single family house detached from any other house
- ☐ A residential building with 2 to 4 apartments or condominiums
- ☐ A residential building with 5 to 10 apartments or condominiums
- ☐ A building with more than 10 apartments or condominiums
- ☐ A mobile or manufactured home

53. Do you own or rent your home? ***Check one***

- ☐ Own / Buying (Skip to question 55)
- ☐ Rent / Leasing

54. If you rent / lease your home, which of the following services are paid for by your landlord, property management, or building association? ***Check all that apply***

☐ None ☐ Electricity ☐ Gas ☐ Water

55. For each of the following age groups, how many people, including you, live in this home for more than half of the year?

Age	Number of People
5 and under	_____
6 - 18	_____
19 - 34	_____
35 - 54	_____
55 - 64	_____
65 and over	_____

56. How many adults in your household work outside the home on most days?

Number of People

_____

57. How many adults in your household work exclusively at home on most days?

Number of People

_____

58. What is the highest grade of schooling anyone in your household has completed? (Select only one answer)

- ☐ Elementary or middle school
- ☐ Some high school, no diploma
- ☐ High school graduate
- ☐ Trade or technical school
- ☐ Some college, no degree
- ☐ Two-year college graduate
- ☐ Four-year college graduate
- ☐ Graduate degree or higher

59. Which of the following best describes your total household income from all sources in 2012, before taxes? ***Check one***

- ☐ Less than $15,000
- ☐ $15,000 - $24,999
- ☐ $25,000 - $49,999
- ☐ $50,000 - $74,999
- ☐ $75,000 - $99,999
- ☐ $100,000 - $124,999
- ☐ $125,000 or more

Appendix G End of Pilot Survey Results

Q1 - Thinking of all of the services you receive from SMUD, how satisfied are you?

1 Very satisfied
2 Somewhat satisfied
3 Somewhat dissatisfied
4 Very dissatisfied

Category	N	1	2	3	4
control	300	63.7	32.7	0.7	3.0
default_(no_drop_outs)	721	65.7	30.9	1.3	2.1
default_drop_outs	88	55.2	41.5	1.0	2.3
deferred	736	68.6	27.6	0.9	2.9
opt_in_(not_deferred)_(no_drop_outs)	1593	68.8	27.3	1.7	2.2
opt_in_drop_outs	154	58.7	36.8	3.1	1.3

Q8 - Thinking only of the way you are charged for electricity in summer, which of the following best describes your household pri

1 Pay the same price for electricity no matter when you use it
2 Pay a higher price for electricity used between 4:00 and 7:00 PM on all days
3 Pay a higher price for electricity used between 4:00 and 7:00 PM on weekdays only
4 Pay a much higher price for electricity used between 4:00 and 7:00 PM on 12 Conservation Days
5 Pay a higher price for electricity used between 4:00 and 7:00 PM on weekdays with an even higher price on 12 days during the s
6 Don't know

Category	N	1	2	3	4	5	6
control	300	25.7	8.7	4.7	0.3	4.7	56.0
default_CPP_(no_drop_outs)	163	15.9	7.2	4.9	19.6	13.7	38.6
default_CPP_TOU_(no_drop_outs)	141	9.9	12.8	10.4	7.9	21.4	37.6
default_TOU_(no_drop_outs)	417	13.2	16.1	29.9	1.6	5.9	33.1
deferred	736	27.0	12.7	14.3	1.7	2.9	41.4
opt_in_CPP_(no_drop_outs)	576	10.4	9.4	6.1	42.2	13.9	18.0
opt_in_TOU_(no_drop_outs)	1017	10.1	16.5	47.7	1.1	4.6	20.0

Q9 - How satisfied are you with your current electricity pricing plan?

1 Very satisfied
2 Somewhat satisfied
3 Somewhat dissatisfied
4 Very dissatisfied

Category	N	1	2	3	4
control	300	20.3	60.0	15.0	4.7
default_CPP_(no_drop_outs)	163	30.1	57.0	10.6	2.3
default_CPP_TOU_(no_drop_outs)	141	22.1	63.9	10.4	3.6
default_TOU_(no_drop_outs)	417	22.9	61.5	13.6	2.1
deferred	736	23.3	58.5	13.6	4.6
opt_in_CPP_(no_drop_outs)	576	33.1	56.3	9.2	1.4
opt_in_TOU_(no_drop_outs)	1017	32.8	54.3	10.6	2.3

Q10 - Please indicate whether you agree or disagree with the following statements.

1 Strongly agree
2 Somewhat agree
3 No opinion
4 Somewhat disagree
5 Strongly disagree

My current pricing plan is easy to understand

Category	N	1	2	3	4	5
control	300	25.0	31.3	26.3	13.7	3.7
default_CPP_(no_drop_outs)	163	24.7	38.1	21.2	11.0	4.9
default_CPP_TOU_(no_drop_outs)	141	25.6	42.3	18.6	12.3	1.3
default_TOU_(no_drop_outs)	417	27.5	38.6	17.7	13.4	2.8
deferred	736	25.8	41.9	20.4	8.9	3.1
opt_in_CPP_(no_drop_outs)	576	30.9	47.1	10.6	9.9	1.6
opt_in_TOU_(no_drop_outs)	1017	35.0	43.8	11.8	7.5	2.0

My current pricing plan is fair

Category	N	1	2	3	4	5
control	300	16.7	27.7	36.7	14.3	4.7
default_CPP_(no_drop_outs)	163	22.5	39.3	27.6	8.7	1.9
default_CPP_TOU_(no_drop_outs)	141	16.7	41.0	30.5	8.7	3.2
default_TOU_(no_drop_outs)	417	18.2	38.0	27.2	13.7	2.9
deferred	736	19.6	33.3	31.3	12.1	3.8
opt_in_CPP_(no_drop_outs)	576	25.5	40.7	24.1	7.9	1.7
opt_in_TOU_(no_drop_outs)	1017	26.5	39.6	22.1	9.4	2.3

My current pricing plan provides me with opportunities to save money

Category	N	1	2	3	4	5
control	300	11.3	22.0	43.0	17.3	6.3
default_CPP_(no_drop_outs)	163	25.6	35.8	28.4	9.9	0.4
default_CPP_TOU_(no_drop_outs)	141	25.3	32.4	30.1	7.5	4.6
default_TOU_(no_drop_outs)	417	21.4	38.1	25.4	11.7	3.5
deferred	736	20.1	26.7	30.8	16.3	6.1
opt_in_CPP_(no_drop_outs)	576	34.6	41.9	14.5	7.3	1.7
opt_in_TOU_(no_drop_outs)	1017	32.2	41.9	16.6	5.9	3.4

My current pricing plan is better than my old plan

Category	N	1	2	3	4	5
default_CPP_(no_drop_outs)	163	19.1	25.1	46.7	6.4	2.7
default_CPP_TOU_(no_drop_outs)	141	15.3	22.9	51.9	4.9	5.0
default_TOU_(no_drop_outs)	417	16.1	21.6	49.6	10.2	2.5
opt_in_CPP_(no_drop_outs)	576	26.7	30.1	34.4	7.6	1.2
opt_in_TOU_(no_drop_outs)	1017	27.5	30.7	32.6	7.2	2.1

My current pricing plan fits my lifestyle

Category	N	1	2	3	4	5
control	300	16.0	30.7	34.3	12.3	6.7
default_CPP_(no_drop_outs)	163	21.0	28.6	35.2	12.2	3.1
default_CPP_TOU_(no_drop_outs)	141	16.2	30.2	38.9	7.9	6.8
default_TOU_(no_drop_outs)	417	17.8	30.1	32.6	15.0	4.5
deferred	736	18.3	31.1	30.6	15.1	4.9
opt_in_CPP_(no_drop_outs)	576	23.5	38.2	23.4	11.6	3.3
opt_in_TOU_(no_drop_outs)	1017	21.3	38.1	22.6	13.9	4.1

I sometimes feel uncomfortable inside my home on summer afternoons and evenings because it is too expensive to run my air cond

Category	N	1	2	3	4	5
control	300	22.0	31.0	22.7	16.7	7.7
default_CPP_(no_drop_outs)	163	20.2	36.1	18.6	16.0	9.1
default_CPP_TOU_(no_drop_outs)	141	25.2	31.9	19.0	12.8	11.2
default_TOU_(no_drop_outs)	417	22.0	33.7	19.2	16.8	8.4
deferred	736	24.4	34.2	18.8	13.9	8.8
opt_in_CPP_(no_drop_outs)	576	25.7	32.1	14.3	17.0	10.9
opt_in_TOU_(no_drop_outs)	1017	27.8	34.6	14.3	16.7	6.6

My current pricing plan is convenient

Category	N	1	2	3	4	5
control	300	15.3	26.7	42.7	12.3	3.0
default_CPP_(no_drop_outs)	163	16.0	33.6	35.6	13.7	1.2
default_CPP_TOU_(no_drop_outs)	141	13.7	32.0	39.9	9.4	5.0
default_TOU_(no_drop_outs)	417	18.5	28.8	36.8	13.0	3.0
deferred	736	16.7	32.3	35.9	10.4	4.6
opt_in_CPP_(no_drop_outs)	576	21.8	36.9	24.8	13.0	3.5
opt_in_TOU_(no_drop_outs)	1017	20.5	38.1	27.7	11.3	2.4

I make sure I use as little electricity as possible between 4:00 and 7:00 PM

Category	N	1	2	3	4	5
control	300	22.3	30.3	26.7	14.3	6.3
default_CPP_(no_drop_outs)	163	45.0	32.3	11.7	9.1	1.9
default_CPP_TOU_(no_drop_outs)	141	38.7	35.0	15.0	8.2	3.2
default_TOU_(no_drop_outs)	417	36.2	36.4	14.9	9.8	2.6
deferred	736	35.3	35.0	17.6	8.9	3.3
opt_in_CPP_(no_drop_outs)	576	54.4	33.8	5.6	4.5	1.7
opt_in_TOU_(no_drop_outs)	1017	56.9	30.9	6.4	4.6	1.2

Q11 - According to our records, your household enrolled in a new pricing plan called the [plan] as of [date] as part of SMUD's SmartPricing Options Pilot. Do you recall this happening?

1 Yes
2 No
3 Not sure

Category	N	1	2	3
opt_in_CPP_(no_drop_outs)	576	87.3	3.5	9.2
opt_in_TOU_(no_drop_outs)	1017	83.0	4.1	12.9

Q12 - According to our records, your household is receiving service under a new pricing plan called [plan] as of [date] as part of SMUD's SmartPricing Options Pilot. Do you recall receiving notice of this service change?

1 Yes
2 No
3 Not sure

Category	N	1	2	3
default_CPP_(no_drop_outs)	163	55.3	11.4	33.3
default_CPP_TOU_(no_drop_outs)	141	55.1	17.6	27.2
default_TOU_(no_drop_outs)	417	57.6	14.2	28.2

Q13 - At the time you were switched to the new pricing plan you were offered a free in-home Electricity Use Display capable of displaying the amount of electricity your household was using in real time. Do you recall receiving that offer?

1 Yes
2 No
3 Not sure

Group	Outcome	Group #	N	1	2	3
Default CPP	No IHD Delivered	2	100	38.3	34.0	27.7
	IHD Delivered	3	63	98.0	0.0	2.0
Default TOU	No IHD Delivered	5	285	43.6	28.2	28.2
	IHD Delivered	6	132	89.1	3.0	7.9
Default CPP-TOU	No IHD Delivered	8	84	45.0	15.0	40.0
	IHD Delivered	9	57	97.8	0.0	2.2
Total			**721**	65.9	15.4	18.7

Q14 - What were your reasons for not requesting the in-home Electricity Use Display? (Check all that apply)

1 I did not want it
2 I wanted it but forgot to order it
3 I thought I would be charged for it
4 I couldn't understand how it would help me
5 I ordered it but it never came

Group	Outcome	Group #	N	1	2	3
Default CPP	No IHD Delivered	2	100	23.4	27.7	14.9
	IHD Delivered	3	63	9.8	19.6	25.5
Default TOU	No IHD Delivered	5	285	27.5	36.2	14.8
	IHD Delivered	6	132	16.8	21.8	15.8
Default CPP-TOU	No IHD Delivered	8	84	25.0	27.5	10.0
	IHD Delivered	9	57	17.4	8.7	6.5
Total			**721**	21.2	26.3	15.0

Q15 - You had an opportunity to switch back to your original pricing plan before going on the new plan. Which of the following best describes your most important reason for staying on the new plan?

1 You were not aware that you had been assigned to the new plan
2 You did not know that you could opt out of the new pricing plan
3 You were aware of the plan and felt that it was a good plan for you
4 You were not sure whether it was a good plan for you but wanted to give it a try before deciding whether to stay or revert to your original plan
5 You planned to opt out but never got around to it

Category	N	1	2	3	4	5
default_CPP_(no_drop_outs)	163	22.7	22.7	25.7	27.4	1.5
default_CPP_TOU_(no_drop_outs)	141	35.5	17.5	17.6	28.5	0.9
default_TOU_(no_drop_outs)	417	29.0	22.4	20.8	26.2	1.6

Q16 - Under this rate plan you receive a discount during most of the hours in the summer except for summer weekday afternoons between 4:00 PM and 7:00 PM when the price is about three times as high as it is at other times. Does that sound familiar?

1 Yes
2 No
3 Not sure

Category	N	1	2	3
default_TOU_(no_drop_outs)	417	60.7	15.0	24.3
opt_in_TOU_(no_drop_outs)	1017	84.8	4.3	10.9

Q17 - Under this rate plan you receive a discount during most of the hours in the summer except on 12 summer days called Conservation Days between 4:00 PM and 7:00 PM when the price is about seven times higher than it is during other hours. Does that sound familiar?

1 Yes
2 No
3 Not sure

Category	N	1	2	3
default_CPP_(no_drop_outs)	163	59.1	17.8	23.1
opt_in_CPP_(no_drop_outs)	576	86.9	3.3	9.8

Q18 - Under this rate plan you receive a discount during most of the hours in the summer. However on weekday afternoons between 4:00 PM and 7:00 PM the price is about three times as high as it is during other hours and on 12 summer afternoons called Conservation Days between 4:00 PM and 7:00 PM the price is about seven times higher. Does that sound familiar?

1 Yes
2 No
3 Not sure

Category	N	1	2	3
default_CPP_TOU_(no_drop_outs)	141	54.7391	19.472	25.7889

Q19 - As part of your pricing plan you were to receive notice by email, text or phone on the day prior to each Conservation Day. Do you recall receiving notice that there would be any Conservation Days?

1 Yes
2 No
3 Not sure

Category	N	1	2	3
default_CPP_(no_drop_outs)	163	62.2	20.1	17.8
default_CPP_TOU_(no_drop_outs)	141	60.5	24.5	15.0
opt_in_CPP_(no_drop_outs)	576	86.4	6.8	6.8

Q21 - Which of the following best describes your opinion about the amount of notice you received of impending Conservation Days?

1 I needed more notice
2 The amount of notice was just right
3 There was more than enough notice

Category	N	1	2	3
default_CPP_(no_drop_outs)	109	8.0	74.2	17.8
default_CPP_TOU_(no_drop_outs)	93	10.7	72.7	16.6
opt_in_CPP_(no_drop_outs)	498	10.4	75.0	14.6

How much notice do you need? Please specify your answer in either hours or days. Type 0 in the other box.

Hours

Category	N	0	1	2	3	4	5	6	7	8	10	12	14	18	20	24	30	40	48	72
default_CPP_(no_drop_outs)	6	11.3	11.3			22.0										11.3			44.0	
opt_in_CPP_(no_drop_outs)	11	18.1										9.0		9.0					54.8	9.0

Days

Category	N	0	1	2	3	4	5	6	7	8	10	12	14
default_CPP_(no_drop_outs)	5			60.0	20.0	20.0							
default_CPP_TOU_(no_drop_outs)	10			61.9	38.1								
opt_in_CPP_(no_drop_outs)	44		9.1	68.1	11.3			2.3	6.8				2.4

What is the minimum amount of time that you require for notice of impending Conservation Day? Please specify your answer in either hours or days. Type 0 in the other box.

Hours

Category	N	0	1	2	3	4	5	6	7	8	10	12	14	18	20	24	30	40	48
default_CPP_(no_drop_outs)	7	29.9			19.8											50.3			
default_CPP_TOU_(no_drop_outs)	6	20.5						20.5		8.9		8.9				41.1			
opt_in_CPP_(no_drop_outs)	29	10.2	3.4		3.4	3.4		3.7		6.8		13.7				48.6		3.4	3.4

Days

Category	N	0	1	2	3	4	5	6	7	8	10	12	14	18	20	24	30	40	48	72	100
default_CPP_(no_drop_outs)	17		83.9	8.1													7.9				
default_CPP_TOU_(no_drop_outs)	11		85.8		14.2																
opt_in_CPP_(no_drop_outs)	48	2.1	79.1	10.4			2.1				2.1				2.1						2.1

Q22 - Do you think you saved any money as a result of selecting this rate plan?

1 Yes
2 No
3 Not sure

Category	N	1	2	3
opt_in_CPP_(no_drop_outs)	576	48.1	11.0	40.9
opt_in_TOU_(no_drop_outs)	1017	46.2	14.1	39.8

Q23 - Do you think you saved any money as a result of receiving service under this rate plan?

1 Yes
2 No
3 Not sure

Category	N	1	2	3
default_CPP_(no_drop_outs)	163	27.9	13.3	58.8
default_CPP_TOU_(no_drop_outs)	141	26.7	24.6	48.7
default_TOU_(no_drop_outs)	417	28.5	18.5	53.0

Q25 - Compared to your old rate plan, how would you rate the convenience of this rate plan?

1 A lot more convenient than my old rate plan
2 Somewhat more convenient than my old rate plan
3 About as convenient as my old rate plan
4 Somewhat less convenient than my old rate plan
5 A lot less convenient than my old plan

Category	N	1	2	3	4	5
default_CPP_(no_drop_outs)	163	12.1	20.1	44.5	19.1	4.2
default_CPP_TOU_(no_drop_outs)	141	8.8	14.5	50.3	16.6	9.8
default_TOU_(no_drop_outs)	417	8.7	21.4	50.3	12.4	7.1
opt_in_CPP_(no_drop_outs)	576	17.4	26.2	32.8	18.6	5.0
opt_in_TOU_(no_drop_outs)	1017	15.9	30.7	30.6	18.8	4.0

Q27 - As part of the SmartPricing Options Pilot, SMUD provided you with access to a website containing tips and helpful hints for how to save money under your new pricing plan. Do you recall ever looking at this website?

1 Yes
2 No
3 Not sure

Category	N	1	2	3
default_(no_drop_outs)	721	21.1	63.3	15.6
opt_in_(not_deferred)_(no_drop_outs)	1593	41.5	43.4	15.1

Please indicate how much you agree or disagree with the following statements about your pricing plan.

1 Strongly agree
2 Somewhat agree
3 No opinion
4 Somewhat disagree
5 Strongly disagree

I understand why SMUD is offering the pricing plan I am on

Category	N	1	2	3	4	5
default_CPP_(no_drop_outs)	163	27.9	39.2	25.0	3.0	4.9
default_CPP_TOU_(no_drop_outs)	141	25.6	36.5	25.8	9.0	3.2
default_TOU_(no_drop_outs)	417	28.1	34.0	26.8	6.9	4.3
opt_in_CPP_(no_drop_outs)	576	50.4	35.1	10.3	3.2	1.0
opt_in_TOU_(no_drop_outs)	1017	45.6	37.4	12.4	3.5	1.0

SMUD should be offering the pricing plan I am on to all of its customers

Category	N	1	2	3	4	5
default_CPP_(no_drop_outs)	163	29.3	29.3	38.6	1.1	1.5
default_CPP_TOU_(no_drop_outs)	141	21.1	27.9	47.3	1.8	1.8
default_TOU_(no_drop_outs)	417	25.7	28.0	42.8	1.9	1.7
opt_in_CPP_(no_drop_outs)	576	40.7	30.0	27.1	1.5	0.7
opt_in_TOU_(no_drop_outs)	1017	41.9	30.1	25.5	2.3	0.2

I believe that I did something good for Sacramento by participating in my pricing plan

Category	N	1	2	3	4	5
default_CPP_(no_drop_outs)	163	33.2	30.0	31.1	3.0	2.7
default_CPP_TOU_(no_drop_outs)	141	22.6	31.2	40.0	2.5	3.7
default_TOU_(no_drop_outs)	417	22.5	33.1	39.1	3.5	1.8
opt_in_CPP_(no_drop_outs)	576	47.8	34.3	15.5	1.6	0.9
opt_in_TOU_(no_drop_outs)	1017	44.4	33.9	19.8	1.4	0.6

I think the Sacramento community would be better off if everybody was on my pricing plan

Category	N	1	2	3	4	5
default_CPP_(no_drop_outs)	163	26.3	25.1	42.4	3.4	2.7
default_CPP_TOU_(no_drop_outs)	141	17.0	25.4	51.8	2.1	3.7
default_TOU_(no_drop_outs)	417	19.5	26.5	46.9	4.3	2.8
opt_in_CPP_(no_drop_outs)	576	36.0	30.9	28.4	4.1	0.5
opt_in_TOU_(no_drop_outs)	1017	33.8	32.1	30.7	2.6	0.8

I remember receiving a Welcome Back kit in the mail this summer from SMUD

Category	N	1	2	3	4	5
default_CPP_(no_drop_outs)	163	31.0	19.4	33.4	5.3	11.0
default_CPP_TOU_(no_drop_outs)	141	26.4	24.0	36.4	3.0	10.1
default_TOU_(no_drop_outs)	417	27.0	22.4	31.4	8.6	10.6
opt_in_CPP_(no_drop_outs)	576	58.4	21.1	14.8	3.4	2.3
opt_in_TOU_(no_drop_outs)	1017	55.0	24.2	15.4	3.1	2.2

SMUD answered all my questions about my pricing plan

Category	N	1	2	3	4	5
default_CPP_(no_drop_outs)	163	21.7	19.1	46.2	8.3	4.6
default_CPP_TOU_(no_drop_outs)	141	16.3	22.7	49.1	4.4	7.6
default_TOU_(no_drop_outs)	417	14.8	21.0	54.3	4.6	5.2
opt_in_CPP_(no_drop_outs)	576	41.1	26.5	27.2	3.8	1.4
opt_in_TOU_(no_drop_outs)	1017	40.1	26.6	29.9	2.3	1.1

I want to stay on my pricing plan

Category	N	1	2	3	4	5
default_CPP_(no_drop_outs)	163	27.1	27.8	39.4	3.0	2.7
default_CPP_TOU_(no_drop_outs)	141	23.4	23.7	43.3	3.7	5.9
default_TOU_(no_drop_outs)	417	23.2	28.2	40.6	5.0	3.0
opt_in_CPP_(no_drop_outs)	576	50.6	25.5	19.3	3.1	1.6
opt_in_TOU_(no_drop_outs)	1017	48.2	26.5	20.1	3.5	1.6

Q32 - Overall, how satisfied are you with your new pricing plan?

1 Very satisfied
2 Somewhat satisfied
3 Somewhat dissatisfied
4 Very dissatisfied

Category	N	1	2	3	4
default_CPP_(no_drop_outs)	163	24.0	63.0	10.6	2.3
default_CPP_TOU_(no_drop_outs)	141	23.5	59.4	12.1	5.0
default_TOU_(no_drop_outs)	417	21.1	63.1	10.8	5.0
opt_in_CPP_(no_drop_outs)	576	40.9	50.9	7.3	0.9
opt_in_TOU_(no_drop_outs)	1017	36.7	52.9	9.1	1.3

Q33 - As a result of participating in the [SSI Script] as part of SMUD's SmartPricing Options Pilot, did you have more control over your household's electricity cost?

1 Yes
2 No

Category	N	1	2
default_CPP_(no_drop_outs)	163	67.4	32.6
default_CPP_TOU_(no_drop_outs)	141	61.6	38.4
default_TOU_(no_drop_outs)	417	62.0	38.0
opt_in_CPP_(no_drop_outs)	576	81.6	18.4
opt_in_TOU_(no_drop_outs)	1017	79.1	20.9

Q34 - Please identify any actions that you or other members of your household may have taken to lower your electricity consumption between 4:00 PM and 7:00 PM?

Turned off lights not in use during the peak period

Category	N	0	1
default_CPP_(no_drop_outs)	163	26.5	73.5
default_CPP_TOU_(no_drop_outs)	141	28.4	71.6
default_TOU_(no_drop_outs)	417	26.8	73.2
opt_in_CPP_(no_drop_outs)	576	19.5	80.5
opt_in_TOU_(no_drop_outs)	1017	18.6	81.4

Turned off office equipment during the peak period

Category	N	0	1
default_CPP_(no_drop_outs)	163	68.3	31.7
default_CPP_TOU_(no_drop_outs)	141	72.1	27.9
default_TOU_(no_drop_outs)	417	68.1	31.9
opt_in_CPP_(no_drop_outs)	576	50.9	49.1
opt_in_TOU_(no_drop_outs)	1017	60.8	39.2

Turned off entertainment systems during the peak period

Category	N	0	1
default_CPP_(no_drop_outs)	163	64.2	35.8
default_CPP_TOU_(no_drop_outs)	141	78.0	22.0
default_TOU_(no_drop_outs)	417	73.3	26.7
opt_in_CPP_(no_drop_outs)	576	56.8	43.2
opt_in_TOU_(no_drop_outs)	1017	67.0	33.0

Increased the temperature of my thermostat during the peak period

Category	N	0	1
default_CPP_(no_drop_outs)	163	$56.6	$43.4
default_CPP_TOU_(no_drop_outs)	141	$64.2	$35.8
default_TOU_(no_drop_outs)	417	$62.5	$37.5
opt_in_CPP_(no_drop_outs)	576	$59.1	$40.9
opt_in_TOU_(no_drop_outs)	1017	$52.6	$47.4

Turned off air conditioning during the peak period

Category	N	0	1
default_CPP_(no_drop_outs)	163	54.2	45.8
default_CPP_TOU_(no_drop_outs)	141	47.1	52.9
default_TOU_(no_drop_outs)	417	54.9	45.1
opt_in_CPP_(no_drop_outs)	576	30.0	70.0
opt_in_TOU_(no_drop_outs)	1017	38.2	61.8

Did laundry off peak

Category	N	0	1
default_CPP_(no_drop_outs)	163	26.5	73.5
default_CPP_TOU_(no_drop_outs)	141	17.4	82.6
default_TOU_(no_drop_outs)	417	23.7	76.3
opt_in_CPP_(no_drop_outs)	576	13.9	86.1
opt_in_TOU_(no_drop_outs)	1017	11.3	88.7

Did dishes off peak

Category	N	0	1
default_CPP_(no_drop_outs)	163	37.9	62.1
default_CPP_TOU_(no_drop_outs)	141	36.4	63.6
default_TOU_(no_drop_outs)	417	41.1	58.9
opt_in_CPP_(no_drop_outs)	576	29.5	70.5
opt_in_TOU_(no_drop_outs)	1017	27.3	72.7

Cooked dinners outside

Category	N	0	1
default_CPP_(no_drop_outs)	163	63.9	36.1
default_CPP_TOU_(no_drop_outs)	141	64.8	35.2
default_TOU_(no_drop_outs)	417	70.3	29.7
opt_in_CPP_(no_drop_outs)	576	64.1	35.9
opt_in_TOU_(no_drop_outs)	1017	66.8	33.2

Changed spa and pool pumping to off-peak hours

Category	N	0	1
default_CPP_(no_drop_outs)	163	91.6	8.4
default_CPP_TOU_(no_drop_outs)	141	84.5	15.5
default_TOU_(no_drop_outs)	417	91.7	8.3
opt_in_CPP_(no_drop_outs)	576	87.3	12.7
opt_in_TOU_(no_drop_outs)	1017	86.4	13.6

None of the above

Category	N	0	1
default_CPP_(no_drop_outs)	163	89.4	10.6
default_CPP_TOU_(no_drop_outs)	141	89.9	10.1
default_TOU_(no_drop_outs)	417	90.2	9.8
opt_in_CPP_(no_drop_outs)	576	97.0	3.0
opt_in_TOU_(no_drop_outs)	1017	97.8	2.2

Q35 - How difficult were these changes to make?

1 Not difficult at all
2 Somewhat difficult
3 Very difficult

Category	N	1	2	3
default_CPP_(no_drop_outs)	149	64.6	33.2	2.1
default_CPP_TOU_(no_drop_outs)	130	59.8	35.6	4.5
default_TOU_(no_drop_outs)	380	66.6	30.9	2.4
opt_in_CPP_(no_drop_outs)	559	66.4	32.0	1.6
opt_in_TOU_(no_drop_outs)	995	63.9	33.7	2.4

Q45 - In the past week, about how often did you look at your Electricity Use Display?

1 More than once a day
2 About once a day
3 2 - 4 times
4 Once
5 Never

Category	N	1	2	3	4	5
default_(no_drop_outs)	129	24.1	17.3	12.1	15.8	30.7
opt_in_(not_deferred)_(no_drop_outs)	548	22.1	18.8	16.2	15.3	27.6

Q47 - Have you made any changes to the way you use electricity in your home based on the information provided by the Electricity Use Display?

1 Yes
2 No
3 Not sure
4 I never got the Electricity Use Display to work

Category	N	1	2	3	4
default_CPP_TOU_received_IHD	47	70.2	8.5	6.4	14.9
default_CPP_received_IHD	49	71.4	16.3	8.2	4.1
default_TOU_received_IHD	92	63.0	18.5	6.5	12.0
default_combined_received_IHD	**188**	**66.5**	**16.0**	**6.9**	**10.6**
opt_in_CPP_received_IHD	386	59.6	10.9	6.2	23.3
opt_in_TOU_received_IHD	507	60.6	12.2	5.3	21.9
opt_in_combined_received_IHD	**893**	**60.1**	**11.6**	**5.7**	**22.5**

Q48 - Based on your experience with the Electricity Use Display, would you recommend to a friend that they get one?

1 Yes
2 No
3 Not sure

Category	N	1	2	3
default_CPP_TOU_received_IHD	47	63.8	14.8	21.2
default_CPP_received_IHD	49	79.5	12.2	8.1
default_TOU_received_IHD	92	65.2	16.3	18.4
default_combined_received_IHD	**188**	**68.5**	**15.0**	**16.4**
opt_in_CPP_received_IHD	386	58.8	16.3	24.8
opt_in_TOU_received_IHD	507	61.5	15.5	22.8
opt_in_combined_received_IHD	**893**	**60.3**	**15.9**	**23.7**

Q50 - Since 2012 you have been receiving electric service under the (insert plan name) as part of SMUD's SmartPricing Options Pilot. Below are some reasons why people say they continue to stay on the (Insert pricing plan). Please tell us how important these reasons are to you in staying on the pricing plan.

1 Very important
2 Somewhat important
3 No opinion
4 Somewhat unimportant
5 Completely unimportant

I like the pricing plan

Category	N	1	2	3	4	5
opt_in_CPP_(not_deferred)_(no_drop_outs)	576	44.9	35.9	16.3	1.9	1.0
opt_in_TOU_(not_deferred)_(no_drop_outs)	1017	44.1	34.0	19.5	1.7	0.7

I didn't know I was able to drop out of the pricing plan

Category	N	1	2	3	4	5
opt_in_CPP_(not_deferred)_(no_drop_outs)	576	12.9	20.4	46.3	7.0	13.4
opt_in_TOU_(not_deferred)_(no_drop_outs)	1017	14.2	21.4	46.0	6.1	12.4

I intended to drop out of the pricing plan, but never got around to it

Category	N	1	2	3	4	5
opt_in_CPP_(not_deferred)_(no_drop_outs)	576	5.6	10.2	51.8	9.0	23.4
opt_in_TOU_(not_deferred)_(no_drop_outs)	1017	4.3	8.4	55.6	8.6	23.1

I don't think I would be any better off on the standard rate

Category	N	1	2	3	4	5
opt_in_CPP_(not_deferred)_(no_drop_outs)	576	23.1	24.8	39.2	4.2	8.7
opt_in_TOU_(not_deferred)_(no_drop_outs)	1017	17.4	24.2	44.0	5.9	8.4

The more I got used to the pricing plan, the more I liked it

Category	N	1	2	3	4	5
opt_in_CPP_(not_deferred)_(no_drop_outs)	576	32.0	31.5	32.8	2.4	1.2
opt_in_TOU_(not_deferred)_(no_drop_outs)	1017	34.5	29.9	31.6	2.1	1.9

Q51 - Since 2012 you were assigned to a new pricing plan called the (insert plan name), as part of SMUD's SmartPricing Options Pilot. Below are some reasons why people say they continue to subscribe to the (insert plan name). Please tell us how important these reasons are to you in staying on the pricing plan.

1 Very important
2 Somewhat important
3 No opinion
4 Somewhat unimportant
5 Completely unimportant

I like the pricing plan SMUD assigned me to

Category	N	1	2	3	4	5
default_CPP_(no_drop_outs)	163	24.5	35.0	37.9	1.9	0.8
default_CPP_TOU_(no_drop_outs)	141	26.3	27.8	39.5	2.8	3.7
default_TOU_(no_drop_outs)	417	22.6	34.6	39.0	1.9	1.9

I didn't know I was assigned to the new pricing plan

Category	N	1	2	3	4	5
default_CPP_(no_drop_outs)	163	18.2	17.1	52.2	2.3	10.3
default_CPP_TOU_(no_drop_outs)	141	16.8	22.6	50.2	2.2	8.1
default_TOU_(no_drop_outs)	417	16.4	19.4	56.5	2.7	5.1

I didn't know I was able to drop out of the new pricing plan

Category	N	1	2	3	4	5
default_CPP_(no_drop_outs)	163	16.7	21.3	52.1	4.2	5.7
default_CPP_TOU_(no_drop_outs)	141	18.2	25.1	43.4	3.0	10.3
default_TOU_(no_drop_outs)	417	20.6	24.8	49.3	1.9	3.4

I assume the default pricing plan SMUD selected for me is best for me

Category	N	1	2	3	4	5
default_CPP_(no_drop_outs)	163	24.7	27.8	41.8	1.9	3.8
default_CPP_TOU_(no_drop_outs)	141	21.5	27.7	44.8	1.7	4.4
default_TOU_(no_drop_outs)	417	18.6	32.4	45.0	1.9	2.1

I intended to drop out of the pricing plan, but never got around to it

Category	N	1	2	3	4	5
default_CPP_(no_drop_outs)	163	5.3	6.8	61.2	9.5	17.1
default_CPP_TOU_(no_drop_outs)	141	8.3	9.1	64.8	2.2	15.6
default_TOU_(no_drop_outs)	417	5.3	7.9	70.1	7.7	9.0

I'm not sure I would be any better off on the standard rate

Category	N	1	2	3	4	5
default_CPP_(no_drop_outs)	163	15.5	29.2	42.3	3.8	9.2
default_CPP_TOU_(no_drop_outs)	141	14.0	23.9	49.9	2.6	9.6
default_TOU_(no_drop_outs)	417	13.1	25.3	53.9	3.8	4.0

The more I got used to the pricing plan, the more I liked it

Category	N	1	2	3	4	5
default_CPP_(no_drop_outs)	163	19.1	26.7	50.8	2.7	0.8
default_CPP_TOU_(no_drop_outs)	141	21.5	19.7	54.4	1.7	2.8
default_TOU_(no_drop_outs)	417	16.6	22.0	56.4	2.0	2.9