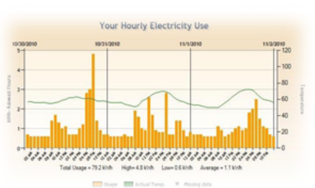
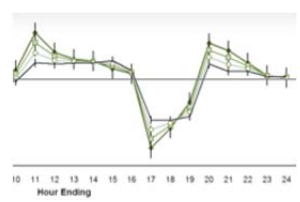
SMUD’s Load Impact Calculator (SLIC) for Smart Grid Cross-Pilot Evaluation





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RESEARCH SOLUTIONS

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EXECUTIVE SUMMARY

Between 2011 and 2013, the Sacramento Municipal Utility District (SMUD) implemented a range of smart grid studies in the residential sector to investigate customer preferences for and electric load impacts of several customer-facing smart grid rates and technologies[1], including smart thermostats, real-time energy information displays, and time-varying rates. The overarching purpose of these studies was to collect the information needed to expand and improve smart-grid-enabled program offerings to residential customers beyond completion of the SmartSacramento smart grid.

This report describes SMUD's Load Impact Calculator (SLIC), a Microsoft Excel calculator created by Herter Energy Research Solutions for SMUD. SLIC allows users to calculate loads and load impacts across and within 7 of the smart grid pilots conducted between 2011 and 2013. Along with programmatic and demographic variables, the SLIC database holds regression coefficients for the average hourly summer weekday loads for each of over 17,000 participants. The coefficients allow estimation of hourly loads and load impacts for event and nonevent days at different daily temperature profiles as defined by user input of minimum and maximum temperatures. Results can be defined for subgroups of participants using drop down menus for database variables such as pilot, treatment, rate, technology, and a long list of programmatic and demographic variables including income, geographic location, and dwelling type.

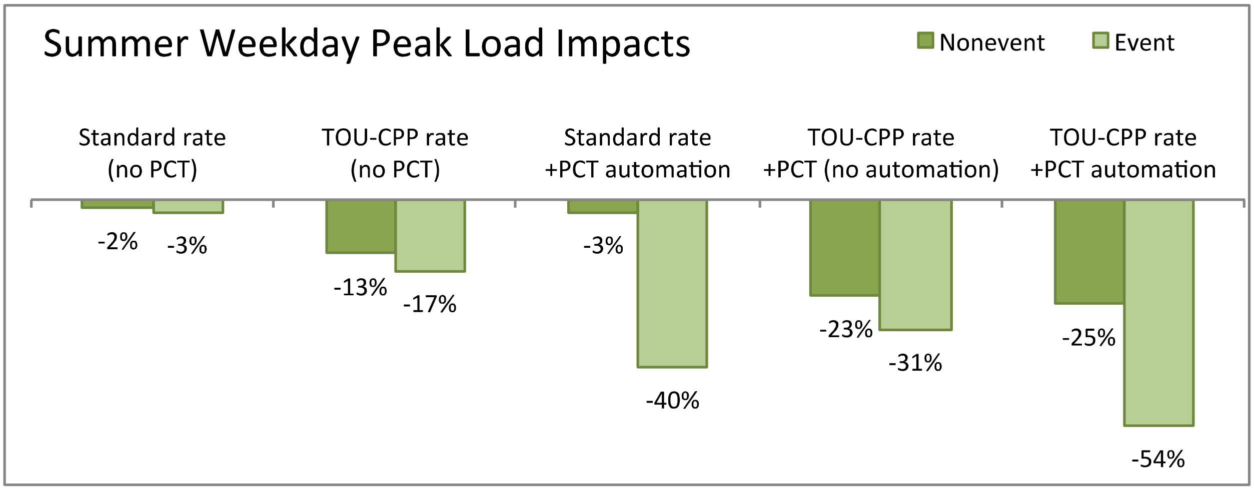
The menu driven nature of SLIC allows a user-friendly interface for finding and comparing hundreds or thousands of different combinations of subgroups within the 17,055 participants included the database. SLIC output includes graphs and tables of hourly and peak load impacts for the subset of participants defined by the chosen variables. Although SLIC produces one set of results at a time, output can easily be reformatted by the user to produce summary plots, such as the average summer peak load impact comparison illustrated in Figure 1.

Some of the major trends suggested by SLIC output presented in this report include:

- The <u>TOU-CPP rate</u> elicited stronger summer peak savings on both event and nonevent days than did the TOU or Standard rates
- Homes on the TOU-CPP rate with <u>PCTs that received an event signal</u> had double the event savings of homes on the TOU-CPP rate with PCTs that were not linked to the event signal
- <u>In-home energy displays</u> (IHDs) had almost no effect on summer peak savings
- Homes with <u>higher summer peak demand</u> had greater summer peak savings

[1] SMUD conducted a study with electric vehicle charging controls that was not included in this calculator.

FIGURE 1. COMPARISON OF LOAD IMPACTS BY RATE AND AVAILABILITY OF PCT AUTOMATION



While the SLIC is a useful tool for estimating the load impacts expected under various program scenarios, it should be used for program planning purposes with caution. For example, choosing too many programmatic and demographic variables can result in sample sizes that are too small to justify strong conclusions. It is recommended that SLIC results used for program planning purposes be carefully selected to avoid such potential pitfalls.

1. INTRODUCTION

Between 2009 and 2012, SMUD deployed an end-to-end advanced metering system, including hourly interval meters, covering nearly 100% of the load in SMUD's service territory.[2] Following this effort, SMUD implemented a variety of residential pilot programs intended to improve SMUD's understanding of the expected effects of new rates, automation technologies, and enhanced information offerings enabled by the new metering system (Table 1).

The purpose of this meta-study is to provide a tool, SMUD's Load Impact Calculator (SLIC), which allows SMUD to evaluate the effectiveness of measures within and across these pilots in reducing summer peak loads.

TABLE 1. SUMMARY OF SMUD RESIDENTIAL PILOTS 2011-2013 INCLUDED IN SLIC

Pilot	Year(s)	Conservation Day Events	Dynamic Pricing	Automation Technology	Enhanced Information
Single-family Summer Solutions	2011-2012	✓	✓	✓	✓
Smart Pricing Options	2012-2013	✓	✓		✓
PowerStat Pricing	2013	✓	✓	✓	
Smart Thermostats	2013	✓	✓	✓*	
Low-Income Weatherization & Energy Management	2013			✓*	✓
In-Home Display Checkout	2013				✓
Multifamily Summer Solutions	2013	✓	✓	✓	✓

** Automation technology was not linked to Conservation Day or CPP event signals*

These seven studies were used to populate a database of participants along with their program elements, hourly load coefficients, and demographic data. The calculator was designed to pull hourly load estimates from this database and provide load impact estimates for different daily temperature profiles made possible through user input of maximum and minimum temperatures.

[2] About 390 residential SMUD customers have chosen not to have smart meters installed on their homes.

RATES

Participants in all of the pilots included in the SLIC paid for electricity according to one of the four following rate categories. All rate categories incorporated a 2-tier increasing block rate structure, as shown in Table 2. The Energy Assistance Program Rate (EAPR) offered low-income customers a 30% discount on off-peak prices, a 20 ¢/kWh weekday peak price, and 50 ¢/kWh Critical Peak price.

TABLE 2. SMUD RESIDENTIAL SUMMER RATES ($/KWH), 2011-2013

Year	Summer Rate	Off-peak Base *(<700kWh)*	Off-peak Base Plus *(>700kWh)*	Weekday Peak (4-7pm)	Critical Peak (12 days/yr)
2011	**Standard**	$0.1045	$0.1859		
	TOU-CPP	$0.0721	$0.1411	$0.2700	$0.7500
2012	**Standard**	$0.1016	$0.1830		
	TOU	$0.0846	$0.1660	$0.2700	
	TOU-CPP	$0.0721	$0.1411	$0.2700	$0.7500
	CPP	$0.0851	$0.1665		$0.7500
2013	**Standard**	$0.0989	$0.1803		
	TOU	$0.0846	$0.1660	$0.2700	
	TOU-CPP	$0.0721	$0.1411	$0.2700	$0.7500
	CPP	$0.0851	$0.1665		$0.7500

Standard rate. SMUD's default residential rate, a 2-tier increasing block electricity tariff.

TOU-CPP rate. An experimental time-of-use (TOU) rate with critical peak pricing (CPP) events consisting of discounted off-peak prices and higher prices during the 4-7 pm non-holiday weekday peak and critical peak periods.

TOU rate. An experimental time-of-use (TOU) rate consisting of discounted off-peak prices and higher prices during the 4-7 pm non-holiday weekday peak periods.

CPP rate. An experimental critical-peak-pricing (CPP) rate consisting of discounted off-peak prices and higher prices during the 12 Conservation Day events.

AUTOMATION TECHNOLOGIES AND ENHANCED INFORMATION

The pilots included in SLIC incorporate a variety of smart thermostats (from Nest, Ecofactor, RCS, and Energate) and enhanced information offerings (from Candi Controls, EnergyAware, and SMUD). Detailed information on each of these technologies can be found in Appendix B.

2. SMUD's Smart Grid Studies, 2011-2013

Nine studies were considered for inclusion in SMUD's Load Impact Calculator (SLIC), as described above, including two for which two consecutive years of pilot data were available. Of these, seven studies were considered a good fit for the calculator and were used to populate a database of participants along with their program elements, hourly load coefficients, and demographic data. A summary of pilot treatments is provided in Appendix B.

Single-family Summer Solutions (2011-2012)

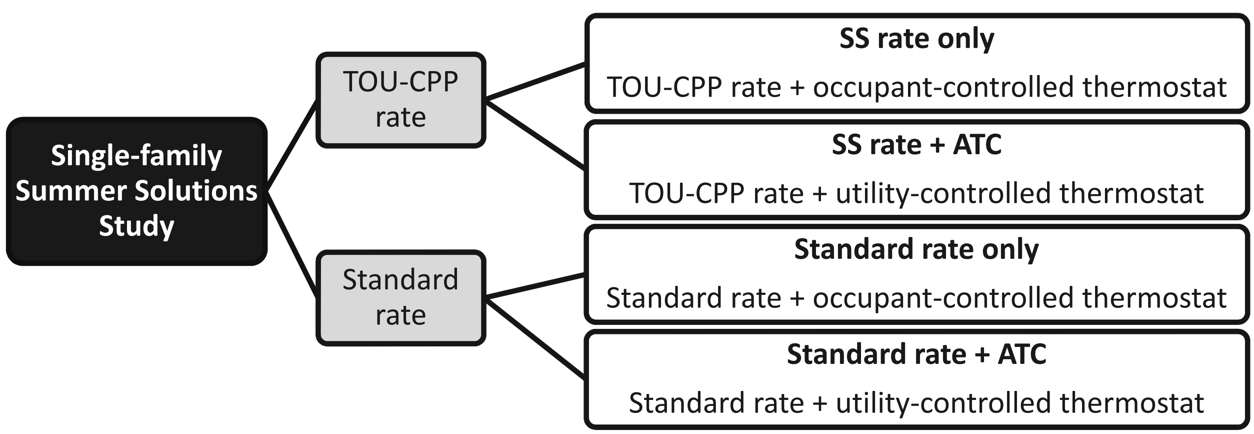
The 2011-2012 Single-family Summer Solutions Study examined customer response to an energy efficiency and demand response (EEDR) program that provided participants with real-time energy information and advice along with smart thermostats that enabled utility or customer automation of price and load control events (Herter & Okuneva 2014a).

The study recruited from a sample of over sixteen thousand eligible single-family homes. Participants were given the option to sign up for one or both of the following:

- an experimental TOU-CPP rate (see Table 2)
- an automatic temperature control (ATC) option, which paid customers to allow utility control of their thermostats during events.

These two options created a total of four program combinations as shown in Figure 2.

Figure 2. Summer Solutions Study sample design



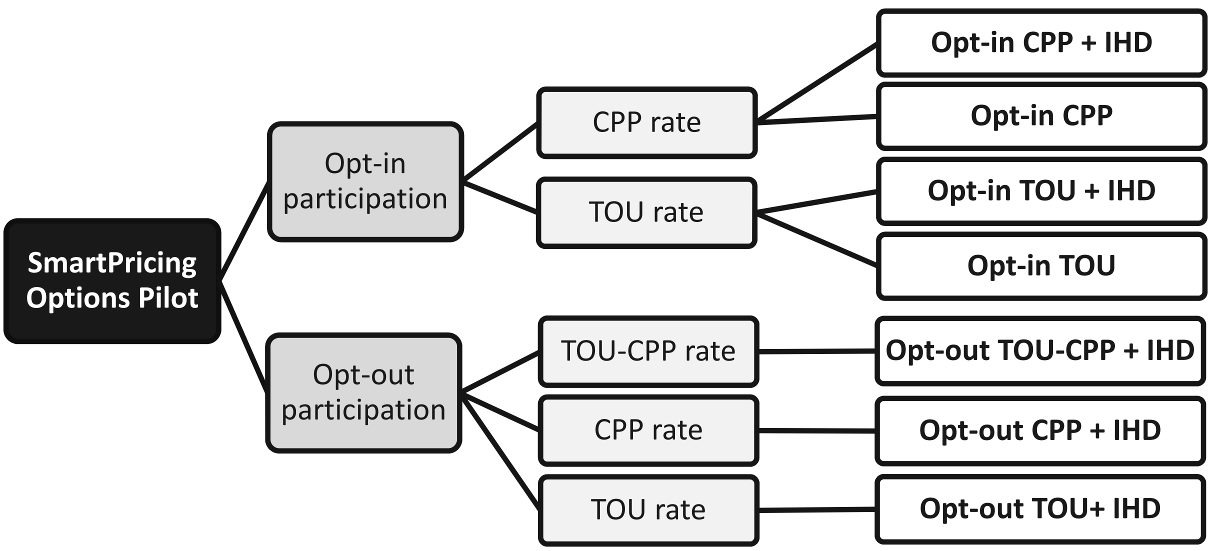
In both 2011 and 2012, twelve Conservation Day events were called on days with maximum temperatures forecast to be greater than 95°F. Participants were notified 24 hours in advance through multiple channels: email, text messaging, thermostat, and real-time energy display.

Smart Pricing Options (2012-2013)

The objective of the SmartPricing Options (SPO) study was to assess customer response to varying combinations of enabling technologies, recruitment methods, and time-based rates (Potter et al. 2014).

Building on lessons learned in the 2011 Single-family Summer Solutions Study, the SPO expanded rate offerings to include experimental TOU and CPP rates in addition to the TOU-CPP rate considered previously, and involved a greater number of participants. Over 100,000 eligible residential customers were randomly selected for the SPO study, from which about 56,000 were randomly placed into 7 treatment groups as shown in Figure 3.

Figure 3. Smart Pricing Options sample design



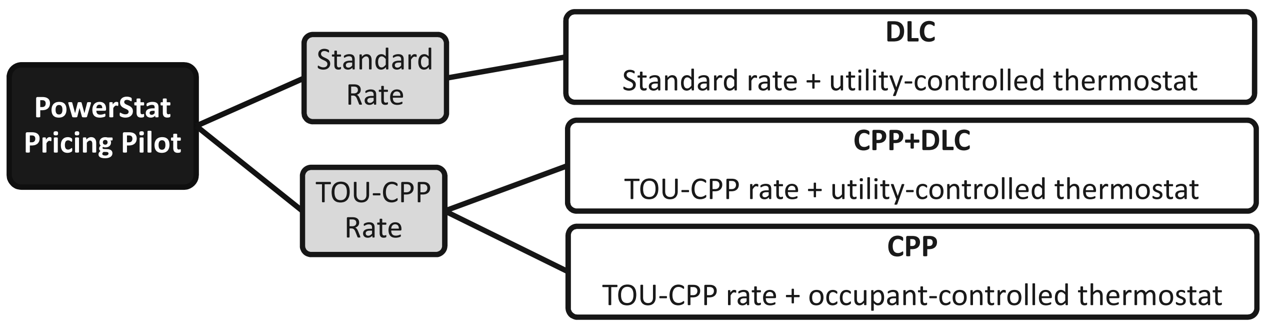
In both 2012 and 2013, twelve Conservation Day events were called on days with maximum temperatures forecast to be greater than 95°F. Participants were notified 24 hours in advance by telephone, email, text message, and in-home display.

POWERSTAT PRICING PILOT (2013)

The 2013 Powerstat with Pricing study was designed to test the effects of offering three program options to customers and allowing each to choose the one that best met their needs and preferences (Herter & Okuneva 2014c).

The study involved the 2013 TOU-CPP rate and one of two thermostat management options – customer managed event response or SMUD managed event response – resulting in a total of three program groups as shown in Figure 4.

FIGURE 4. POWERSTAT SAMPLE DESIGN



Under the DLC option, customers were required to choose a level of event response at the beginning of the summer – a 2, 3 or 4 degree increase. The response was fully managed by SMUD. Participants on the Standard rate were paid $2, $3 or $4 respectively for each completed Conservation Day event. Participants who signed up for the TOU-CPP rate could choose to manage their thermostats themselves or have SMUD manage it for them without the $2, $3, or $4 payment (Table 3).

TABLE 3. RESIDENTIAL ELECTRICITY RATES AND AC CONTROL STRATEGIES DURING EVENTS, BY TREATMENT

Group	Price per kWh During Events	Payment per Event*	AC Control Strategy During Events	Automation options (°F)	Event Overrides per Summer
DLC	Base: $0. 1045 Base+: $0. 1859	$2, $3, or $4	Chosen by customer prior to summer	+2°, +3°, or +4°	Unlimited
CPP+DLC	CPP: $0.7500	None	Chosen by customer prior to summer	+2°, +3°, or +4°	Unlimited
CPP	CPP: $0.7500	None	Chosen/modified by occupant at any time	+1°, +2°, +3°, +4° or +5°	Unlimited

** Payments are not made when events are overridden*

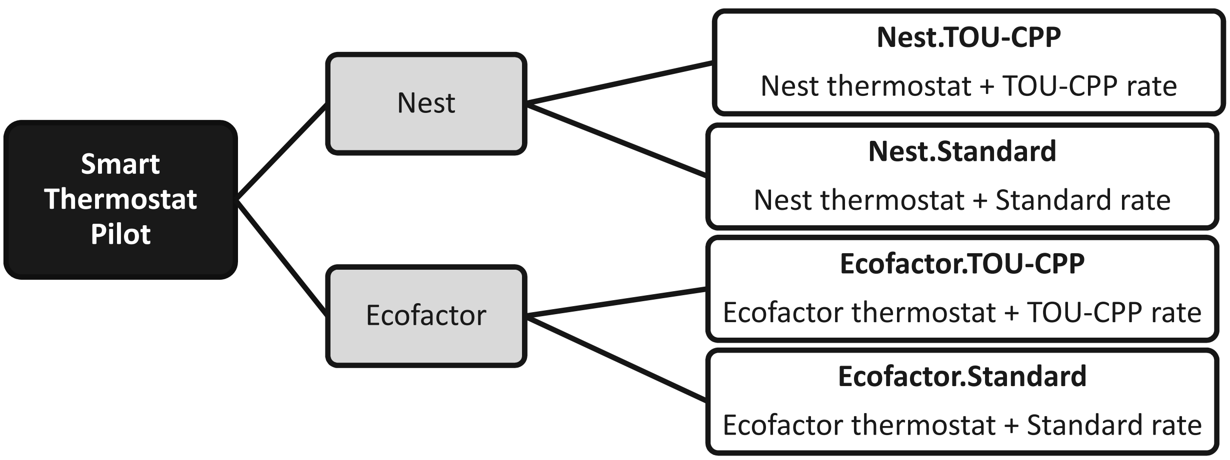
In 2013, the PowerStat pilot implemented 8 out of the 12 Conservation Day events called by SMUD. Participants were not given advance notification of events. Event signals were received directly by the thermostats.

Smart Thermostat Pilot (2013)

The objective of this study was to estimate impacts associated with self-optimizing thermostat systems, the Nest Learning Thermostat or the Ecofactor system, with both the Standard and TOU-CPP rates (Herter & Okuneva 2014d).

SMUD provided and installed one of the two types of thermostats at no cost to over 700 participating single and multi-family residences. During the summer of 2013, roughly half of the participants in each thermostat group were exposed to the TOU-CPP rate, while the other half remained on the Standard 2-tier residential rate. This experimental design resulted in four treatment groups as shown in Figure 5.

Figure 5. Smart Thermostat Pilot sample design



In 2013, twelve Conservation Day events were called on days with maximum temperatures forecast to be greater than 95°F. Participants were notified 24 hours in advance by telephone, text, and email. Event signals were not received directly by the thermostats – i.e. there was no automated event response.

IHD Checkout (2013)

The IHD Checkout Pilot involved a single treatment group recruited through an invitation banner on the SMUD website offering a PowerTab IHD capable of displaying real-time data received wirelessly from the electricity meter. Between October 2012 and November 2013, SMUD mailed 1,120 IHDs to eligible customers. After two months, customers were asked to mail back the IHD device in a prepaid envelope, which was included in the welcome packet.

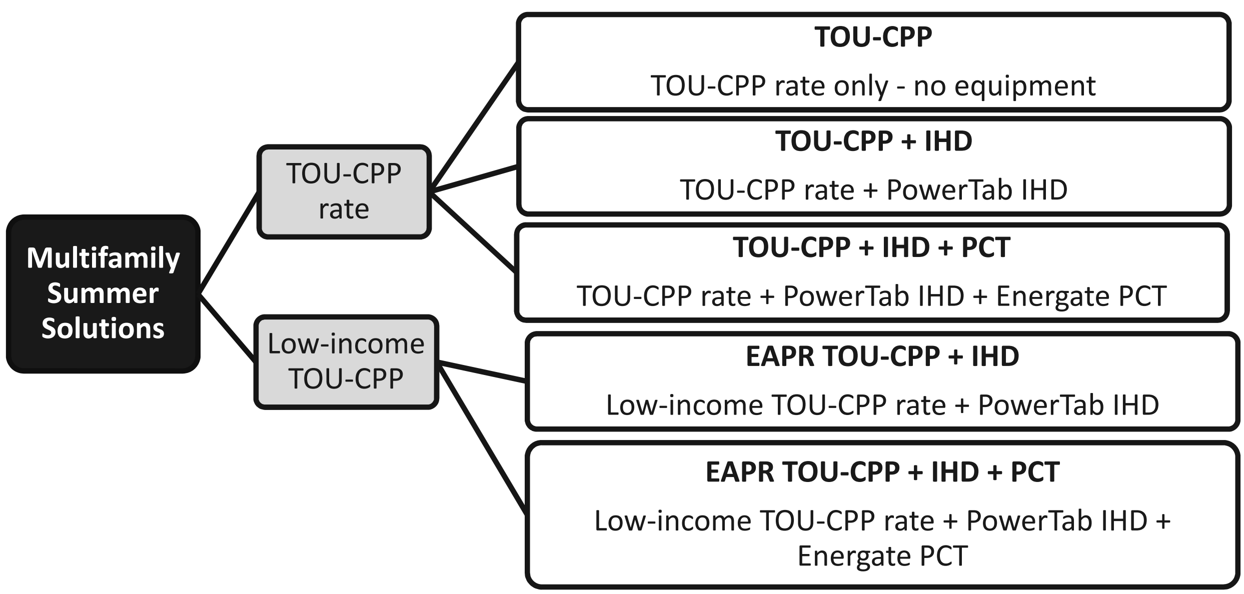
IHD participants were not involved in Conservation Day events.

Multifamily Summer Solutions (2013)

This study considered the effects on multifamily homes of three energy and demand reduction measures: an experimental TOU-CPP rate, an Energy Aware Power Tab energy display (IHD), and an Energate Pioneer Z100 programmable communicating thermostat (PCT), which was capable of adjusting target temperatures in response to price signals from the utility (Sutter et al. 2014).

Prior to solicitation, target households were randomly assigned to one of seven treatment groups, as shown in Figure 6.

Figure 6. Multifamily Summer Solutions sample design



SMUD contacted 323 property managers of the largest 465 multifamily apartment complexes in SMUD's service area to obtain permission to solicit their tenants and install the PCTs. Agreements were obtained for 37 properties housing about 7,500 units. These households were then solicited for pilot participation by mail. In addition, 4,300 condominium residents were solicited directly by mail.

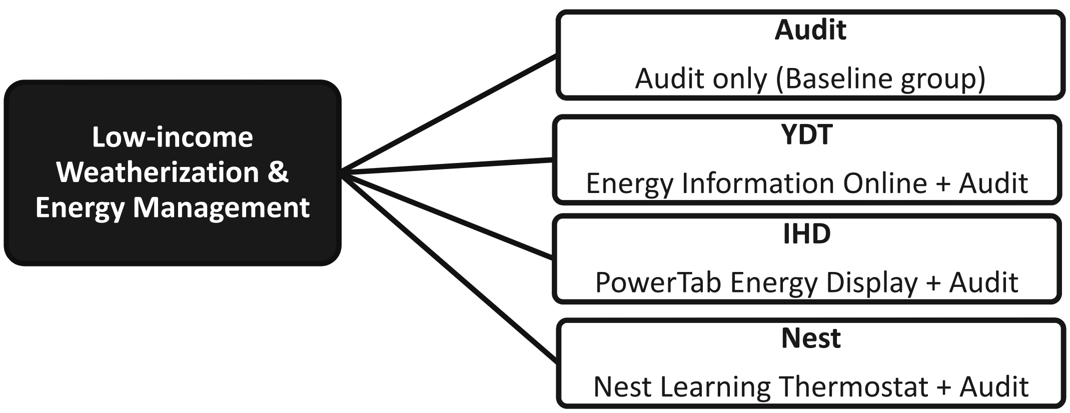
Multifamily Summer Solutions participants were involved in all 12 Conservation Day events in 2013. Participants were notified 24 hours in advance by telephone, text message, and email. Thermostats were programmed to automatically respond to event signals, but could be controlled by occupants at all times.

Low-income Weatherization and Energy Management (2013)

The Energy Insights Weatherization Study (Low-Income Weatherization) recruited over five hundred customers on the Energy Assistance Program Rate (EAPR) for SMUD's standard Low-Income Weatherization Audit, which consisted of in-home energy assessment and limited energy efficiency upgrades (Herter & Okuneva 2014e).

The audit was offered alone or combined with one of three additional measures: training on Yesterday's Data Today (YDT) online energy use summaries, a PowerTab IHD, or the Nest Learning Thermostat, for a total of four experimental groups as shown in Figure 7.

Figure 7. Low-income Weatherization and Energy Management sample design



Low-income Weatherization participants were not involved in Conservation Day events.

3. SMUD'S LOAD IMPACT CALCULATOR (SLIC)

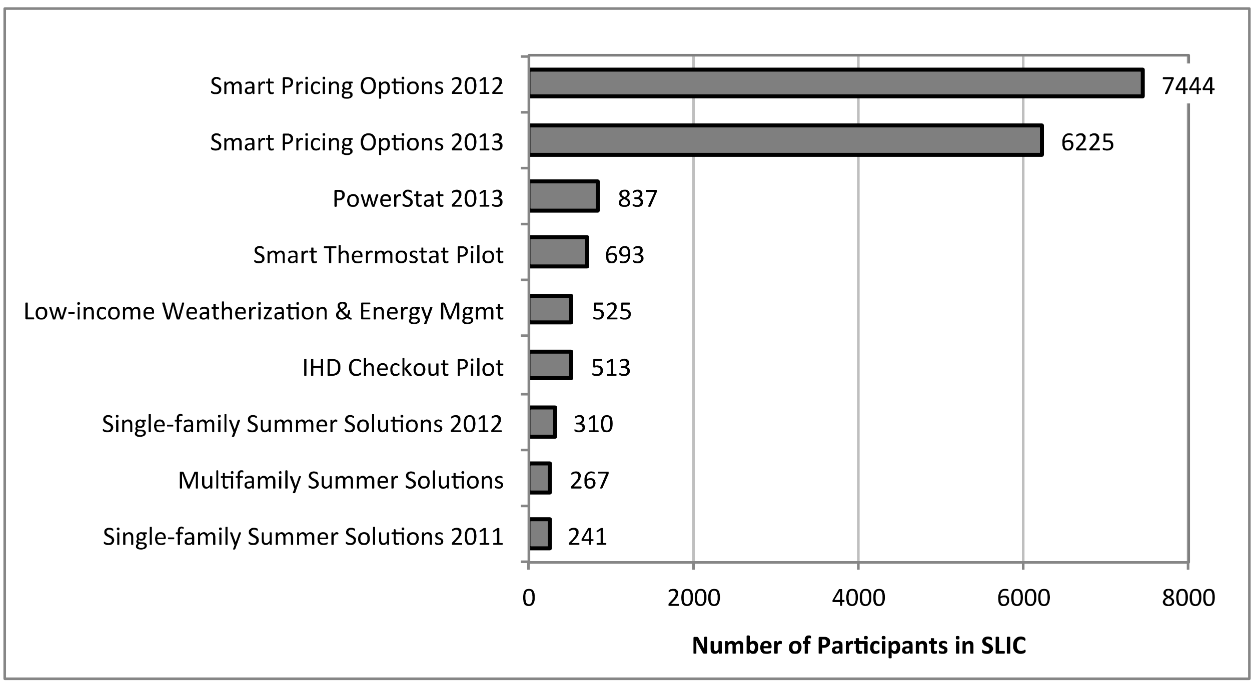
SMUD's Load Impact Calculator is a Microsoft Excel calculator that allows users to approximate the average participant loads and load impacts across and within 7 residential smart grid pilots conducted between 2011 and 2013.

PARTICIPANT DATABASE

Along with programmatic and demographic variables, the SLIC database holds regression coefficients for the average hourly summer weekday loads for each participant. The coefficients allow estimation of hourly loads and load impacts for event and nonevent days at different daily temperature profiles as defined by user input of minimum and maximum temperature. Results can be defined for subgroups of participants using drop down menus for database variables such as pilot, treatment, rate, technology, and a long list of programmatic and demographic variables including income, geographic location, and dwelling type.

A total of 17,055 records are included in the SLIC database. The vast majority of these were participants in the Smart Pricing Options (SPO) pilot, run in both 2012 and 2013 (Figure 8). Note that participant records are not mutually exclusive, meaning that some participants are in the database twice, once for each year they participated in a pilot.

FIGURE 8. NUMBER OF PARTICIPANTS IN EACH PILOT



The final sample sizes for all of the treatments are provided along with in the load impact results in Table 7.

Customer-specific Load Coefficients

Hourly load coefficients were taken from the output of a load model (Equation 1) using the standard hourly load data collected by SMUD's existing metering infrastructure. The model normalizes loads using hourly temperature profiles defined by the minimum and maximum daily temperatures input by the user.

Equation 1. Customer-specific hourly load model

$$kw_{ij} = \beta1_{(j-1)}hour_{ij} + \beta2CDH_{ij} + \beta3CDD_i + \beta4_{m-1}Treatment\_Period_m + \beta5_{(j-1)}\left(CDD_i * hour_{ij}\right) + \beta6_{m-1}(CDD_i * Treatment\_Period_{m-1}) + \beta7_{(j-1):(m-1)}\left(hour_{ij} * Treament\_Period_m\right) + \beta8_{(j-1):(m-1)}(CDD_i * hour_{ij} * Treatment\_Period_m) + \varepsilon_{ij}$$

Where, On day i at hour j for treatment period m:

kw_{ij}: kilowatt load on day i at hour j
$hour_{ij}$: indicator variable for hour of the day (1-24)
CDH_{ij}: cooling degree hour (base 75) on day i at hour j
CDD_i: cooling degree day = sum of 24 CDH values on day i
$Treatment\_Period_m$: indicator for treatment period: baseline, event, nonevent
ε_{ij}: error terms

Load impact values are calculated as the difference between the hourly treatment and baseline load values using Equation 2.

Equation 2. Calculation of load impacts

$Load\_Impact_{ijk} = (Part.treatment_{ijk} – Part.baseline_{ijk})$

Where:

Load_Impact: estimate of hourly load change resulting from the treatment
Part.treatment: modeled average participant loads during the treatment period
Part.baseline: modeled average participant loads during the pretreatment period, corrected for temperature effects

SLIC provides the modeled loads and load impacts for summer weekdays derived using these two formulas. For consistency and ease of comparison, all loads and impacts are presented in units of average kilowatt-hours per hour (kWh/h), abbreviated in most cases to kW, where positive impact values indicate an increase in energy use relative to the baseline, and negative impact values indicate savings. Note that these hourly kW values are easily converted to kWh through multiplication by the number of hours across the desired time period.

Program and Demographic Data

Table 4 and Table 5 list the program, load and customer variables listed for each participant in the SLIC database.

Table 4. Program and load variables in the SLIC database

Variable	Description
Pilot	Name of the pilot in which the customer participated
Treatment	Name of the participant's treatment group
Description	Description of the participant's treatment group
Treatment Year	The treatment year (2011, 2012 or 2013)
Pretreatment Year	The pretreatment year used to estimate the baseline (2010, 2011 or 2012)
Pretreat peak	Actual average 4-7 pm load for pretreatment July and August weekdays
Pilot Years	The number of years the participant has been in the program
Opt-in.out	Participants volunteered (opt-in) or were placed in the treatment (opt-out)
Rate type	The electric rate type, e.g. Standard, TOU, CPP or TOU-CPP
Rate	The code assigned by SMUD to the electric tariff
PCT	Participant was provided with a programmable communicating thermostat
IHD	Participant was provided with an in-home energy display
Audit	Participant received a weatherization audit or a checklist audit
Other	Other measures, such as real-time appliance level information
PCT Offset	Number of degrees by which the PCT setpoint was increased during events

TABLE 5. CUSTOMER VARIABLES IN THE SLIC DATABASE

Variable	Description
Moves	Number of times the customer has had a new move-in date since the customer account number was created
Loan rebate	Customer had a loan or rebate through SMUD (yes or no)
Loan rebate type	Loan rebate type
Budget billing	Enrolled in budget billing (yes or no)
Carbon	Enrolled in carbon offsets program (yes or no)
EAPR	Received energy assistance discount (yes or no)
Med rate	Received medical equipment discount (yes or no)
PV	Photovoltaic system on-site (yes or no)
Solar Shares	Enrolled in Solar Share program (yes or no)
Neighborhood	Location of home by neighborhood
Income	Household Income Level
# Occupants	Number of individuals in household - adults and children
Year built	Year the participant's home was constructed
Dwelling type	Single-unit or multi-unit property
Square feet	Living area of home (ft^2)
Prizm	PRIZM market segment
Owner.renter	Owner or renter of the property
SMUD segment	SMUD market segment
Residency years	Years participant had been at current location
SMUD years	Years participant had been a SMUD customer
Homepower	Enrolled in SMUD's HomePower Program (yes or no)
Account login days	# of days during treatment that participant logged into MyAccount

EVENT DATES

Twelve Conservation Day events were called in each pilot year as shown in Table 6. Events were called only on non-holiday weekdays and lasted from 4 pm to 7 pm. In general, event days were chosen one day prior based on a maximum temperature forecast of at least a 95°F for the following day. Customers were notified by 4 pm on the previous day to allow preparations.

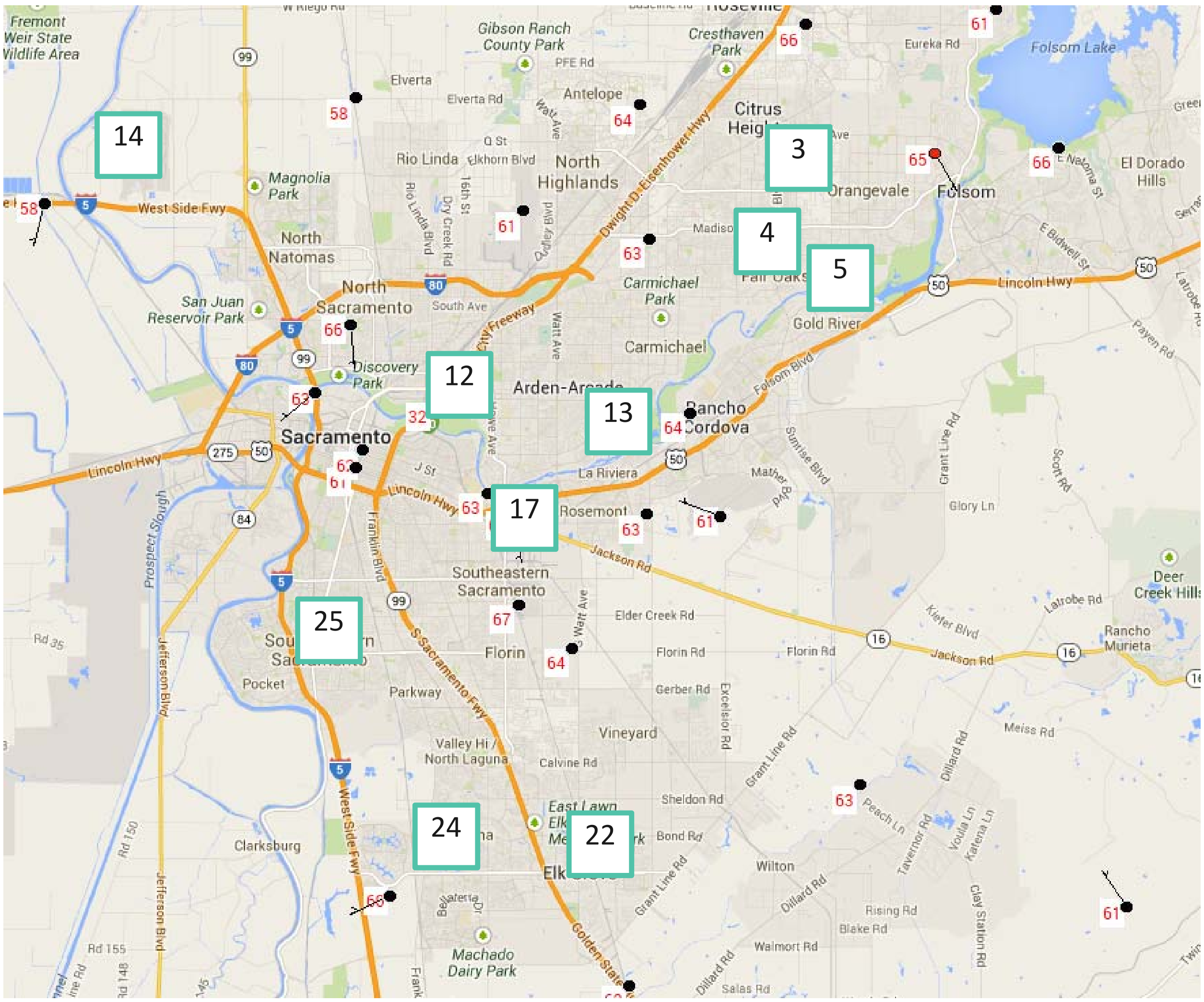
TABLE 6. CONSERVATION DAY EVENT DATES

#	2011 Events	2012 Events	2013 Events
1	8/17/11	6/20/12	6/28/13
2	8/23/11	7/10/12	7/2/13
3	7/28/11	7/12/12	7/3/13
4	7/8/11	8/2/12	7/19/13
5	7/21/11	8/8/12	8/15/13
6	8/25/11	8/9/12	8/19/13
7	8/29/11	8/10/12	9/6/13
8	9/6/11	8/14/12	9/9/13
9	9/7/11	8/15/12	9/10/13
10	9/2/11	9/12/12	9/13/13
11	9/9/11	9/13/12	9/19/13
12	9/19/11	9/14/12	9/30/13

Temperature Data

Figure 9 maps the ten weather stations in the SMUD service territory – charted using unique identifiers in the green boxes – for which hourly temperature data were downloaded. To ensure as-accurate-as-possible outdoor temperatures, participants were each assigned to the data recorded at the station closest to their home.

Figure 9. Weather stations used for load impact evaluation



Using SLIC

SLIC is a user-friendly way to review the load impacts for over 17,000 residential participants in SMUD's 2011-2013 smart grid programs. The following sections provide an overview of how to use SLIC.

Inputs

SLIC requires user inputs of minimum and maximum daily temperatures (Figure 10). In addition, the user can select the baseline against which treatment impacts are calculated. Options include "Relative to Baseline" and "Relative to Nonevent." The latter option can be used to show the event impacts relative to a nonevent day rather than relative to the prior year baseline, which is particularly important for any treatment that includes a TOU rate.

Figure 10. Snapshot of temperature and baseline inputs in the SLIC

Daily Minimum temp (°F)	67
Daily Maximum (°F)	106
Baseline Type	Relative to Baseline

Users can also specify different levels for variables of interest as shown in Figure 11 and Figure 12. Note that these inputs are not necessary for load and impact calculations: if all fields are left blank, the average across all 17,055 participants will be calculated.

Figure 11. Snapshot of program and load inputs in SLIC

Pilot	PowerStat.2013
Treatment	(All)
Treatment Description	(All)
Treatment Year	(All)
Pretreatment Year	(All)
Pretreat Jul-Aug peak	(All)
Pilot years	(All)
Opt-in.out	(All)
Rate type	TOU-CPP
Rate	(All)
PCT	(All)
IHD	(All)
Audit	(All)
Other	(All)
PCT Offset	(All)

FIGURE 12. SNAPSHOT OF CUSTOMER INPUTS IN SLIC

Moves	(All)
Loan rebate	(All)
Loan rebate type	(All)
Budget billing	(All)
Carbon	(All)
EAPR	(All)
Med rate	(All)
PV	(All)
Solar Shares	(All)
Neighborhood	(All)
Income	(All)
# Occupants	(All)
Year built	(All)
Dwelling type	(All)
Square feet	(All)
Prizm	(All)
Owner.renter	(All)
SMUD segment	(All)
Residency years	(All)
SMUD years	(All)
Homepower	(All)
Account login days	(All)

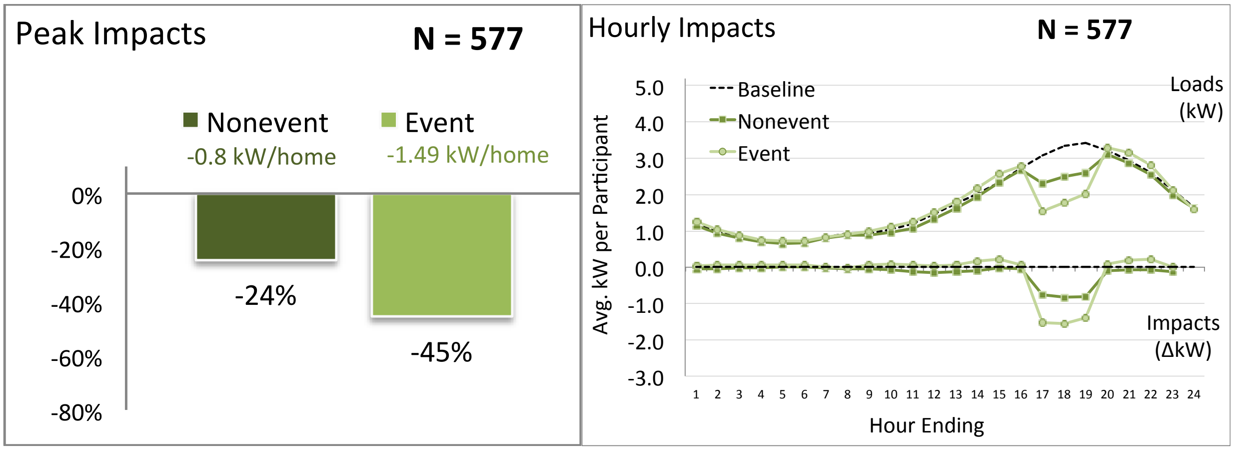
OUTPUTS

SLIC results are presented in tabular form and graphed as average peak and hourly loads and impacts for both event and nonevent days. A bar chart provides absolute (kW) and relative (%) load impacts for the peak hours of 4 to 7 p.m., while a line graphs illustrates hourly baseline loads and load impacts. Figure 13 and Figure 14 provide examples of these graphs, using combined results from the 2012 Single-family and 2013 Multifamily Summer Solutions studies. The difference between Figure 13 and Figure 14 lies in the baseline used to calculate impacts.

When the Baseline Type in SLIC is set to "**Relative to Baseline**" (see Figure 10), load impacts for event and nonevent days are calculated relative to the baseline estimated from prior year data. Subtracting these loads at each hour provides hourly impacts as follows and shown in Figure 13.

- Event Impacts (Relative to Baseline) = Event loads - Baseline loads
- Nonevent Impacts (Relative to Baseline) = Nonevent loads - Baseline loads

Figure 13. Example of SLIC output – Hourly loads and impacts relative to the baseline

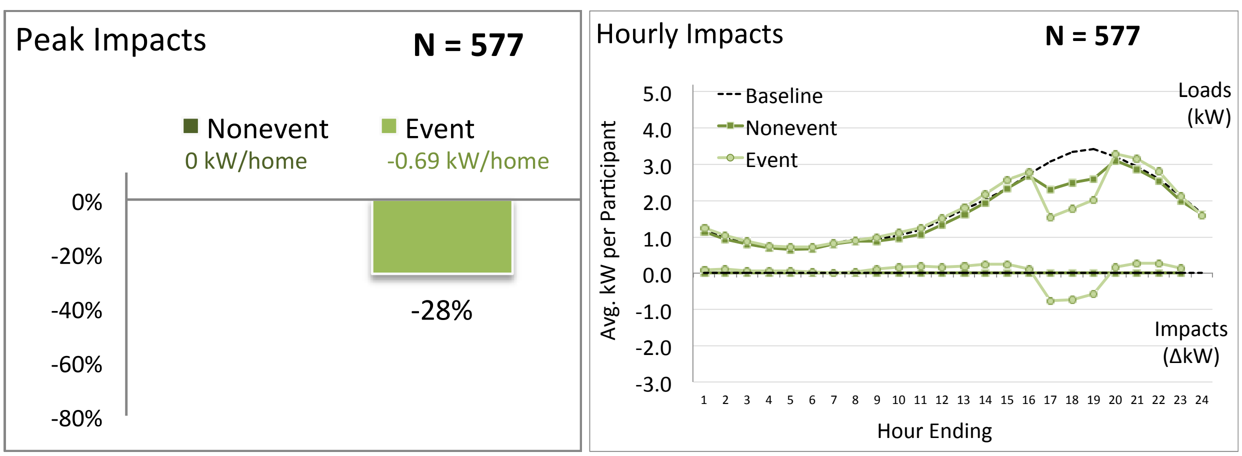


(a) Peak load impacts (b) Hourly baseline loads and load impacts

When the Baseline Type in SLIC is set to "**Relative to Nonevent**" (see Figure 10), the load impacts are calculated relative to nonevent days in the same summer. Subtracting these loads at each hour provides hourly impacts as follows and shown in Figure 14. Note that in this case, the nonevent impacts become zero in all hours.

- Event impacts (Relative to Nonevent) = Event loads - Nonevent loads
- Nonevent impacts (Relative to Nonevent) = Nonevent loads - Nonevent loads = 0

Figure 14. Example of SLIC output – Hourly loads and impacts relative to a nonevent day



(a) Peak load impacts (b) Hourly baseline loads and load impacts

LIMITATIONS OF SLIC

Following are some of the main limitations of SLIC.

Averaging across pilots or treatments. Averages across multiple treatments will not make any corrections for the size of each treatment population. For example, an average of all customers on a TOU-CPP rate will implicitly assume that most customers do not have a PCT, because of all pilots that tested the TOU-CPP rate, the SPO pilot had the largest number of participants. Correction for this could be accomplished by calculating two values for the TOU-CPP rate – one with and one without the PCT variable flagged – and weighting according to the expected distribution.

Small sample sizes. Segmentation of treatment groups by demographic variables can result in very small sample sizes. Care must be taken in placing value on estimates based on fewer than about 50 customers, a minimum sample size estimated through statistical power analysis of SMUD's residential customer loads.

No correction for exogenous effects. Exogenous effects cannot be accurately estimated for individual customers. SLIC averages customer-specific load impacts, which are calculated as the difference between treatment loads and pretreatment loads, as shown in Equation 2.

4. Example Results

This section provides a sample of the types of results that can be achieved using SLIC. The examples were chosen based on an assessment of the types of issues most of interest to SMUD, however, what is provided here is a tiny fraction of the hundreds or thousands of comparisons made possible by SLIC.

Load impacts by treatment, all pilots

One of the features of SLIC is the ability to estimate peak load impacts by pilot and by treatment or program group (see Figure 11). Repeating this process for each pilot and treatment allows the creation of a table of peak load impacts by treatment. Table 7 lists the average peak load impacts for each treatment on event and nonevent days with maximum and minimum temperatures of 106°F and 67°F, representing a 1-in-2 peak day at SMUD. Across all 44 treatments, the 2012 Single-family Summer Solutions participants on the TOU-CPP rate with occupant-controlled automation (via PCT) had the highest peak load reductions, at 2.88 kW (68%) savings on event days and 1.79 kW (42%) savings on nonevent days.

The average peak load impacts provided here are likely to differ slightly from those published for each individual study. This can happen for two reasons:

Different modeling approach. SLIC averages the results of customer-specific regression models, while official results for each study (as reported in the final load impact evaluation reports) are typically the results of pooled regression models.

No correction for exogenous effects. Customer-specific regression models disallow correction for exogenous effects because each participant would need their own exogenous impact estimate. Treatments that occur in the same year are subjected to the same exogenous stimuli, but effects may still differ by subgroups of customers.

Table 7. Load impacts on days with high and low temperatures of 106°F and 67°F

Pilot	Treatment Code	Treatment Description	N	Avg. Nonevent Peak Impact		Avg. Event Peak Impact	
				(kW)	*(%)*	*(kW)*	*(%)*
IHD	IHD	IHD Checkout	513	-0.03	-1%	-0.10	-2%
MF	KOBTE	EAPR IHD+PCT+TOU-CPP	37	-0.53	-27%	-0.65	-33%
	XOBTE	EAPR IHD+TOU-CPP	53	-0.82	-39%	-0.54	-23%
	ZOBNE	EAPR TOU-CPP	56	-0.45	-26%	-0.25	-14%
	MOBTE	IHD+PCT+TOU-CPP	41	-0.41	-17%	-1.10	-52%
	WOBTE	IHD+TOU-CPP	41	-0.38	-24%	-0.46	-26%
	YOBNE	TOU-CPP	39	-0.27	-15%	-0.43	-28%

Pilot	Treatment Code	Treatment Description	N	Avg. Nonevent Peak Impact (kW)	Avg. Nonevent Peak Impact (%)	Avg. Event Peak Impact (kW)	Avg. Event Peak Impact (%)
PowerStat .2013	OIITE	Res +2F incentive	57	-0.18	-4%	-1.20	-33%
	OIJTE	Res +3F incentive	99	-0.39	-12%	-1.38	-38%
	OIKTE	Res +4F incentive	353	-0.31	-8%	-1.23	-40%
	OIBTE	Res TOU-CPP	37	-0.48	-14%	-1.54	-46%
	OIATE	Res TOU-CPP+2F	65	-0.21	-6%	-1.26	-32%
	OIDTE	Res TOU-CPP+3F	70	-0.10	-3%	-1.69	-43%
	OIETE	Res TOU-CPP+4F	156	-0.02	-1%	-1.65	-48%
SPO.2012	RICNE	Opt-in CPP	188	-0.24	-8%	-0.79	-26%
	RICTE	Opt-in CPP+IHD	1403	-0.37	-11%	-1.09	-33%
	RITNE	Opt-in TOU	1042	-0.52	-17%	-0.51	-17%
	RITTE	Opt-in TOU+IHD	1880	-0.67	-21%	-0.69	-21%
	ROBTE	Opt-out TOU-CPP+IHD	514	-0.22	-6%	-0.59	-18%
	ROCTE	Opt-out CPP+IHD	625	-0.36	-11%	-0.54	-16%
	ROTTE	Opt-out TOU+IHD	1792	-0.28	-9%	-0.29	-9%
SPO.2013	RICNE	Opt-in CPP	588	-0.30	-10%	-0.88	-29%
	RICTE	Opt-in CPP+IHD	4709	-0.29	-9%	-0.90	-27%
	RITNE	Opt-in TOU	4018	-0.51	-16%	-0.46	-15%
	RITTE	Opt-in TOU+IHD	6510	-0.56	-17%	-0.50	-15%
	ROBTE	Opt-out TOU-CPP+IHD	400	-0.44	-13%	-0.48	-14%
	ROCTE	Opt-out CPP+IHD	467	-0.24	-7%	-0.56	-16%
	ROTTE	Opt-out TOU+IHD	1248	-0.22	-7%	-0.21	-16%
SS.2011	SS11.1	Standard	45	-0.01	0%	-1.73	-34%
	SS11.2	Standard+ATC	74	-0.58	-14%	-2.54	-59%
	SS11.3	TOU-CPP	37	-1.46	-36%	-2.63	-64%
	SS11.4	TOU-CPP+ATC	85	-1.28	-29%	-2.86	-64%
SS.2012	SS12.1	Standard	56	-0.20	-4%	-1.09	-23%
	SS12.2	Standard+ATC	78	-0.17	-4%	-1.73	-40%
	SS12.3	TOU-CPP	81	-1.79	-42%	-2.88	-68%
	SS12.4	TOU-CPP+ATC	95	-1.79	-40%	-2.97	-66%
STS	TIXTE	EcoFactor	179	-0.96	-24%	-0.31	-7%
	TIBTE	EcoFactor+TOU-CPP	147	-0.13	-3%	-1.14	-27%
	NIXTE	Nest	193	-0.93	-22%	-0.15	-4%
	NIBTE	Nest+TOU-CPP	174	-0.26	-6%	-1.37	-34%
WZN	IIXNE	Audit	132	-0.14	-3%	-0.21	-5%
	GIXTE	IHD	141	-0.01	0%	-0.03	-1%
	HIXTE	Nest	115	0.09	2%	-0.06	-2%
	FIXNE	YDT	137	-0.18	-4%	-0.13	-3%

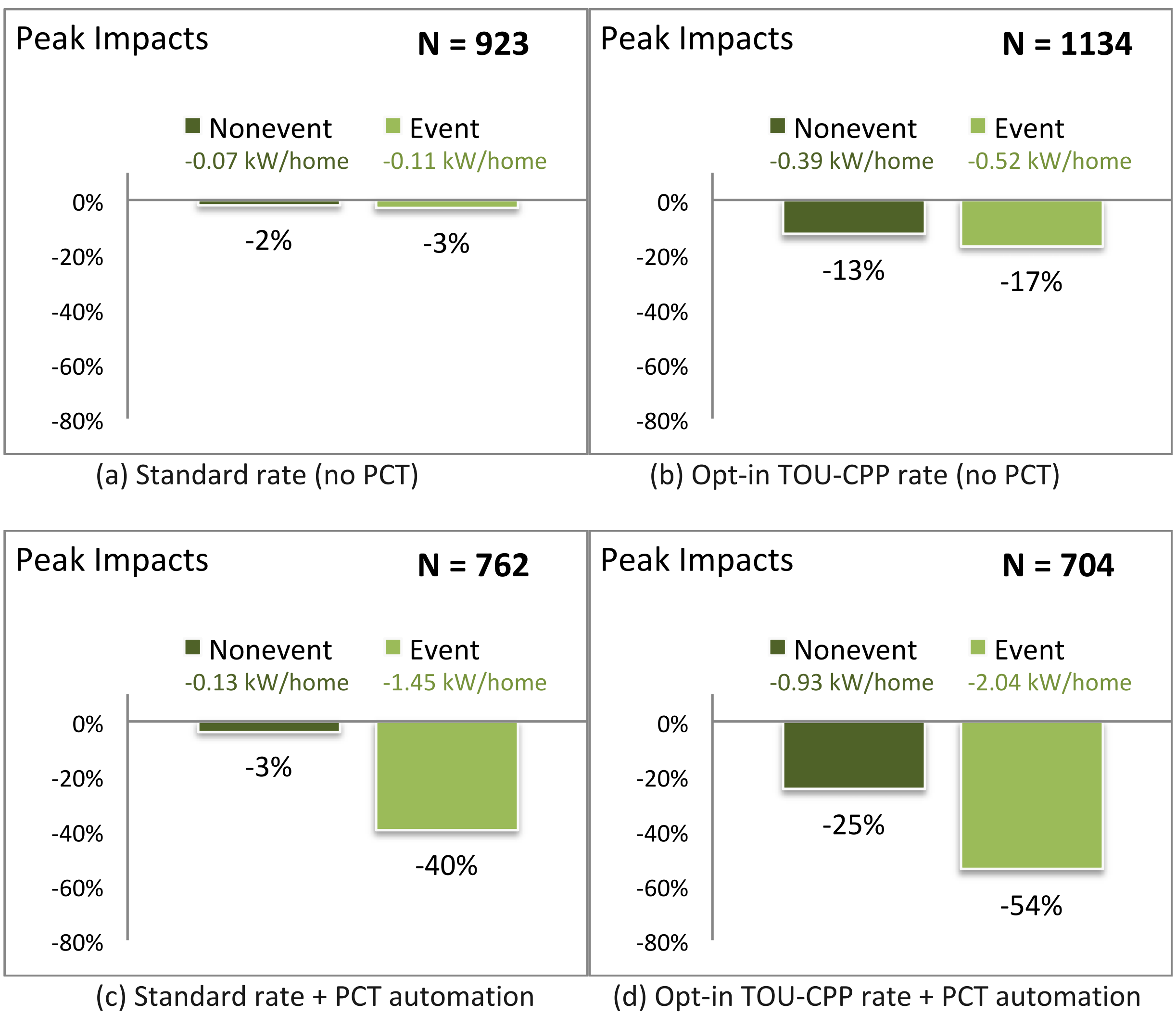
Effects of Program Elements on Load Impacts

SLIC enables segmentation of load impacts by program elements through the drop-down menus on the Input page (see Figure 11). The following sections provide examples of the types of comparisons that can be accomplished through the use of these menus in SLIC. Estimates shown here assume 1-in-2 peak day temperatures of 106°F maximum and 67°F minimum.

Effects of TOU-CPP Rate and Event Automation (via PCT)

Figure 15 and Figure 16 compare the peak and hourly load impacts for (a) participants on the Standard rate to (b) those with a TOU-CPP rate, (c) PCT automation, and (d) both.

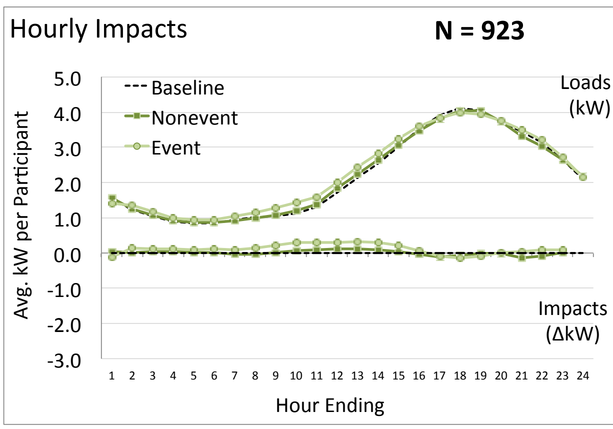
Figure 15. Peak impacts for Standard and TOU-CPP rates, with and without PCT automation



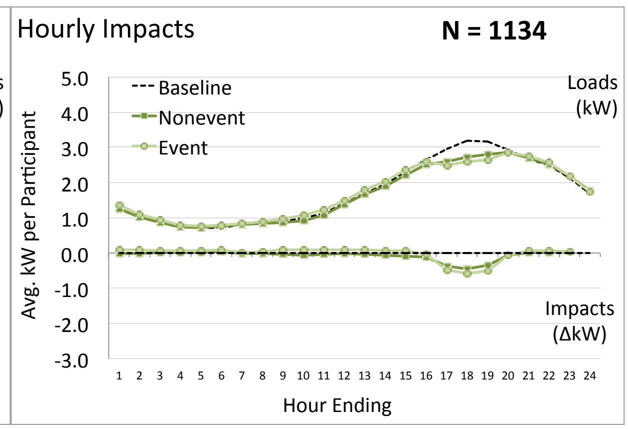
SLIC indicates that average nonevent day peak load savings are similar for the two groups on the Standard rate (2-3%), meaning the addition of PCT automation did little to improve nonevent peak savings for those on the Standard rate. Nonevent peak savings were enhanced by the TOU-CPP rate, as participants responded to the weekday peak rate of 27¢/kWh.

On event days, peak response was greatly enhanced by PCT automation. Participants having both the TOU-CPP rate and PCT automation showed the greatest event response, on average shedding more than 2 kW and half of their peak load during the 4-7 pm events.

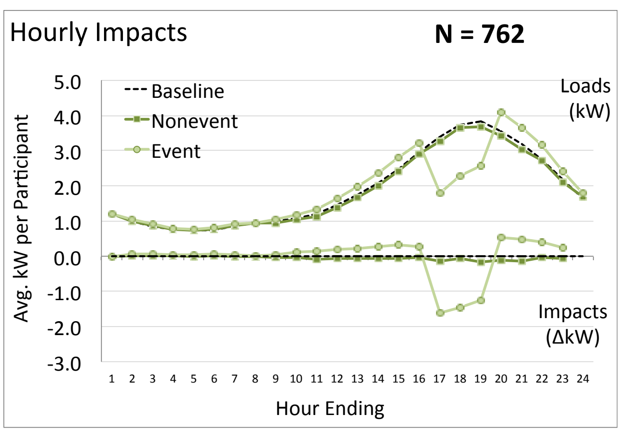
FIGURE 16. HOURLY IMPACTS FOR STANDARD AND TOU-CPP RATES, WITH AND WITHOUT PCT AUTOMATION



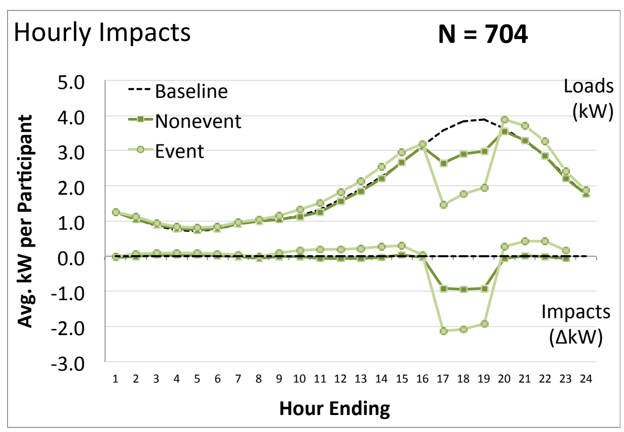
(a) Standard rate (no PCT)



(b) Opt-in TOU-CPP rate (no PCT)



(c) Standard rate + PCT automation

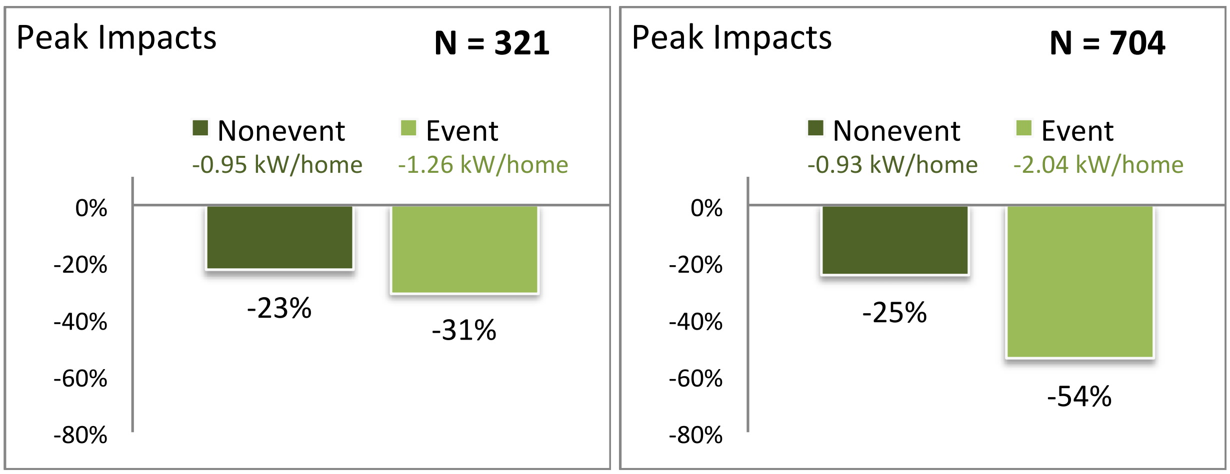


(d) Opt-in TOU-CPP rate + PCT automation

Effect of PCT Event Automation

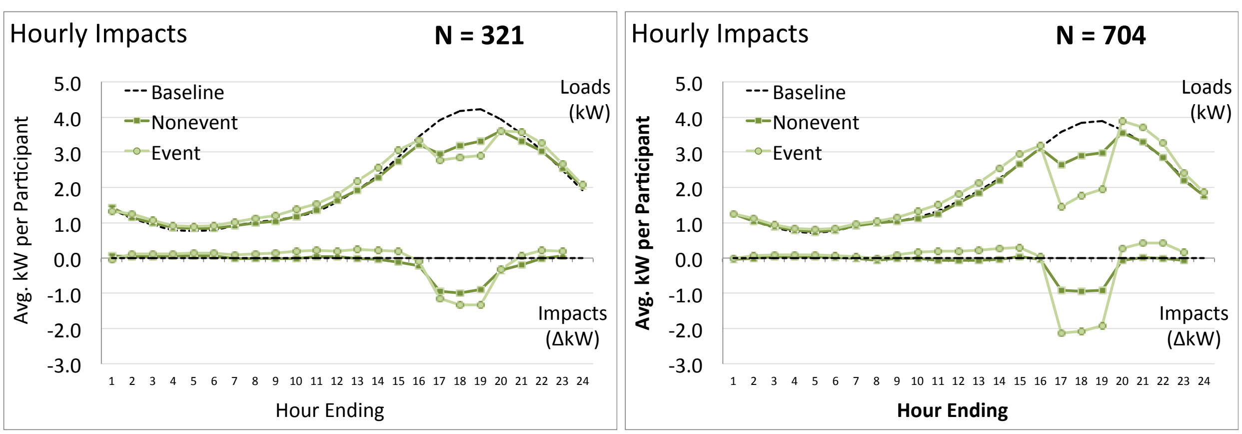
Figure 17 and Figure 18 show the load impacts for all participants on an opt-in TOU-CPP rate divided into two groups: those given a PCT that automated CPP event response, and those given a PCT that did not automate event response. The calculator indicates that the average peak load reduction for those with and without event automation is similar on nonevent days. On event days, however, those without automation shed just 31% of their peak load, compared to 54% peak load savings for those with PCT event automation.

Figure 17. Peak impacts for a TOU-CPP rate, with and without PCT automation



(a) Opt-in TOU-CPP rate + PCT (no automation) (b) Opt-in TOU-CPP rate + PCT automation

Figure 18. Peak impacts for participants on a TOU-CPP rate, with and without PCT automation

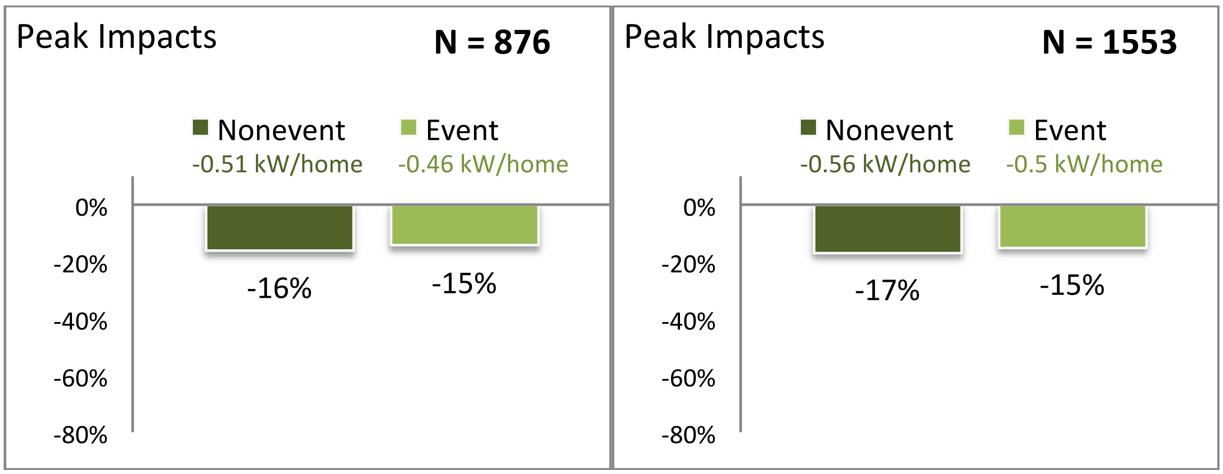


(a) Opt-in TOU-CPP rate + PCT (no automation) (b) Opt-in TOU-CPP rate + PCT automation

Effect of In-Home Energy Displays (IHDs)

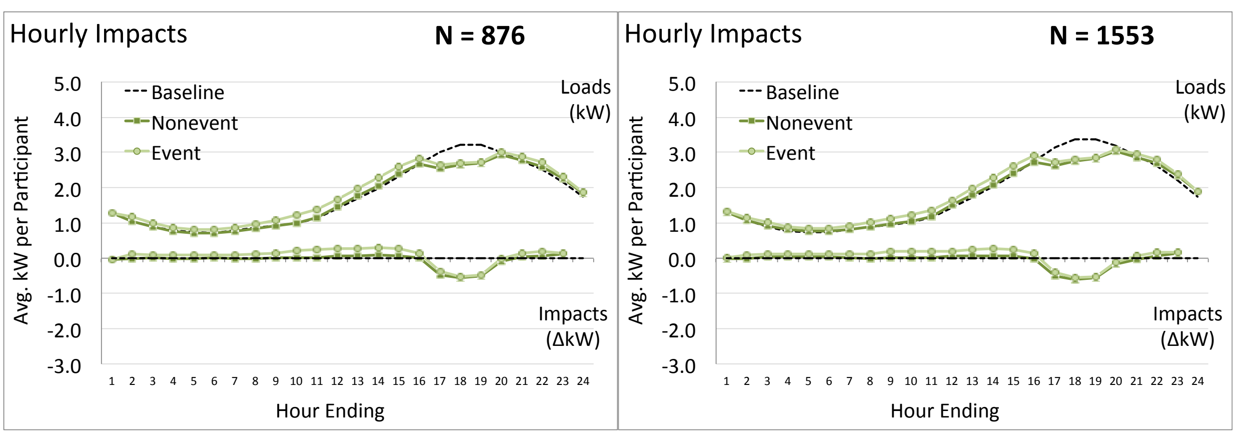
Figure 19 and Figure 20 show the load impacts for two groups of participants on the 2013 opt-in TOU rate: those who were offered an IHD as part of their invitation to participate, and those who were not offered an IHD. The calculator indicates that the average peak load reduction for the two groups is nearly identical, indicating that the IHD offer had almost no effect on peak load reduction on hot summer days.

Figure 19. Peak impacts for opt-in TOU rate, with and without an IHD



(a) Opt-in TOU rate (no IHD) (b) Opt-in TOU rate + IHD offer

Figure 20. Hourly impacts for opt-in TOU rate, with and without an IHD



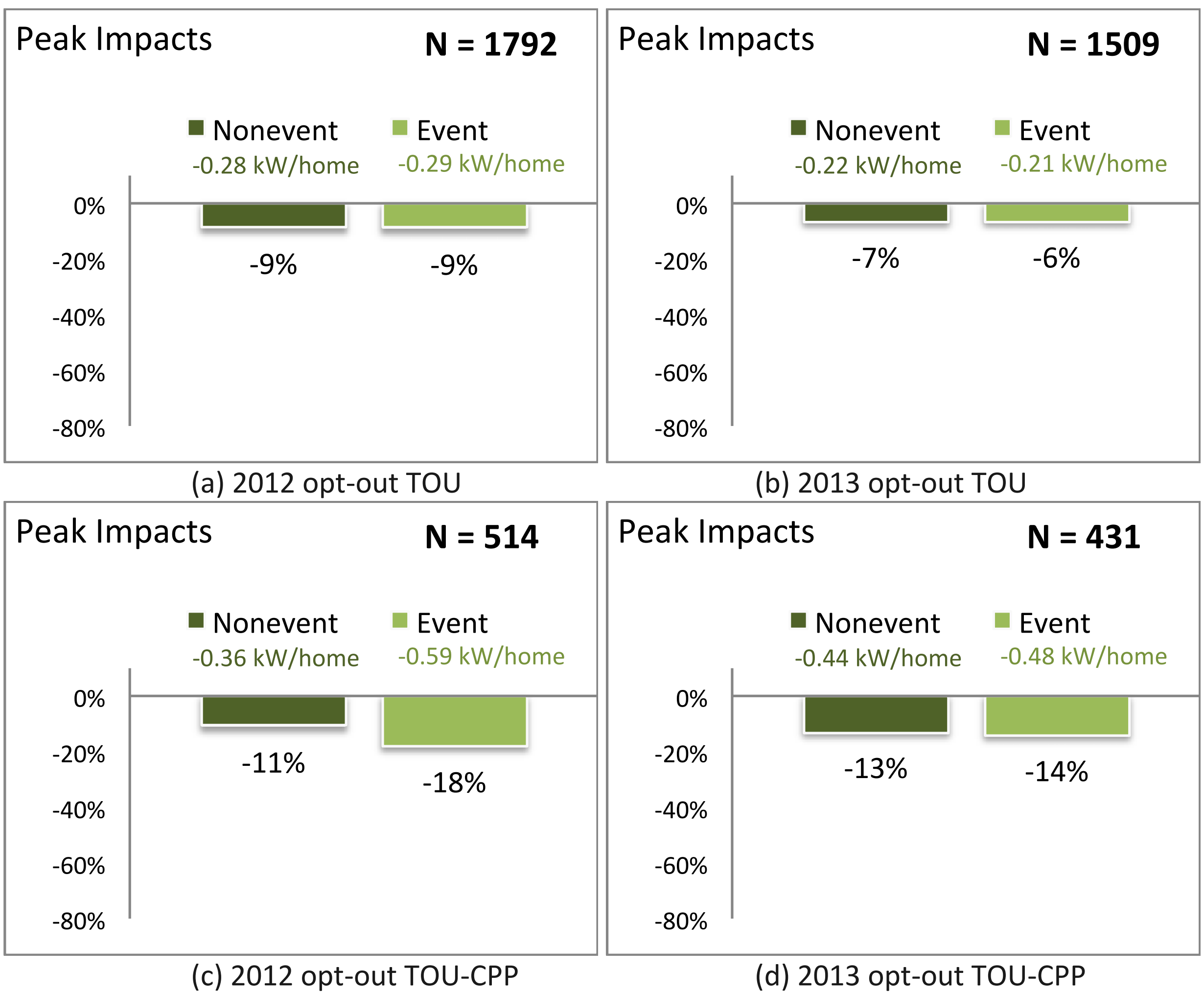
(a) Opt-in TOU rate (no IHD) (b) Opt-in TOU rate + IHD offer

Persistence of Rate Effects: TOU vs. TOU-CPP

As part of the Smart Pricing Options Pilot, SMUD tested the effects of default TOU and TOU-CPP rates by assigning these experimental rates to customers rather than recruiting them. A letter from SMUD notified participants of the rate reassignment, described their new rate, and provided instructions on how to opt-out of the new rate and return to their old rate.

Figure 21 shows the peak impacts of these two groups for the first and second years of the pilot, 2012 and 2013. In both years, the group on the default TOU-CPP rate outperformed those on the default TOU rate on event and nonevent days. Panels (a) and (b) show that peak impacts for those on the TOU rate waned slightly in the second year, on both event and nonevent days. In contrast, those on the opt-out TOU-CPP rate had greater nonevent peak savings and smaller event savings in the second year of the pilot.

Figure 21. Peak impacts for opt-out TOU and TOU-CPP rates, 2012 and 2013



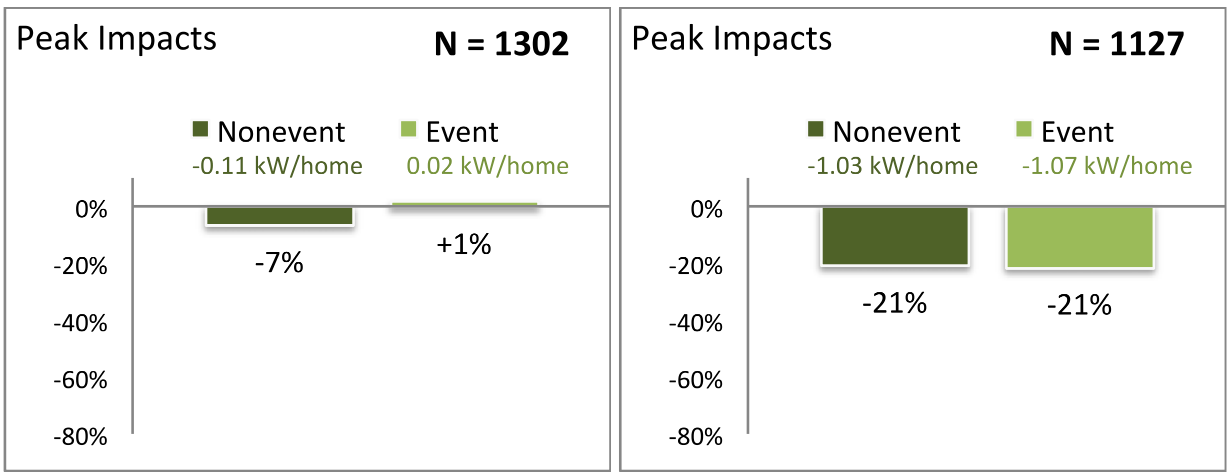
Load Impacts by Customer Segment

The calculator enables the user to retrieve average peak load impacts for demographic segments of the population by choosing from the drop-down menus in the Input page (see Figure 12). The following sections provide examples of just a tiny fraction of the hundreds of comparisons that can be accomplished using SLIC.

Pretreatment Peak Demand (kW)

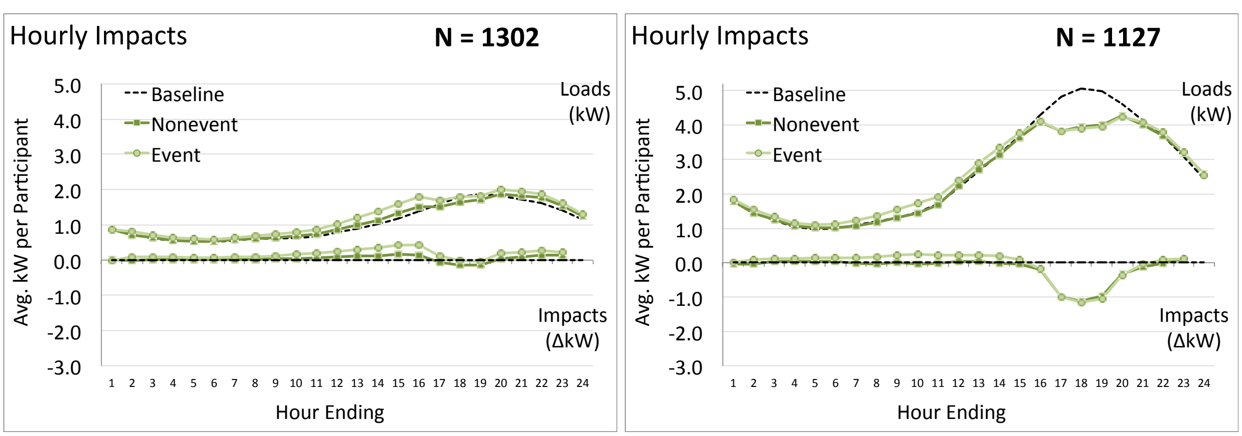
Figure 22 and Figure 23 show the load impacts for all opt-in 2013 TOU rate participants, split into two groups at an average pretreatment peak demand of 1.9 kW. SLIC indicates that homes with lower pretreatment peak demand saved much less than did those with higher pretreatment peak demand.

Figure 22. Peak impacts for Opt-in TOU rate, by peak demand level



(a) Average pretreatment peak <1.9 kW (b) Average pretreatment peak ≥1.9 kW

Figure 23. Hourly impacts for Opt-in 2013 TOU rate, by peak demand level



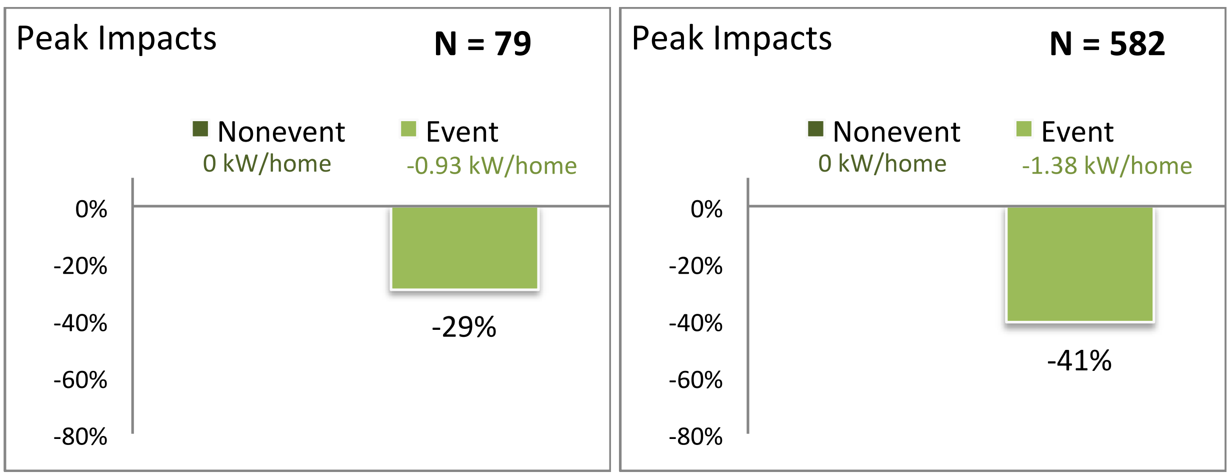
(a) Average pretreatment peak <1.9 kW (b) Average pretreatment peak ≥1.9 kW

ENERGY ASSISTANCE PROGRAM RATE (EAPR)

Figure 24 and Figure 25 show the load impacts for participants with utility-controlled PCT automation. Note that for this comparison, the graphs show event impacts relative to a nonevent day baseline, rather than relative to an historical, prior-year baseline.

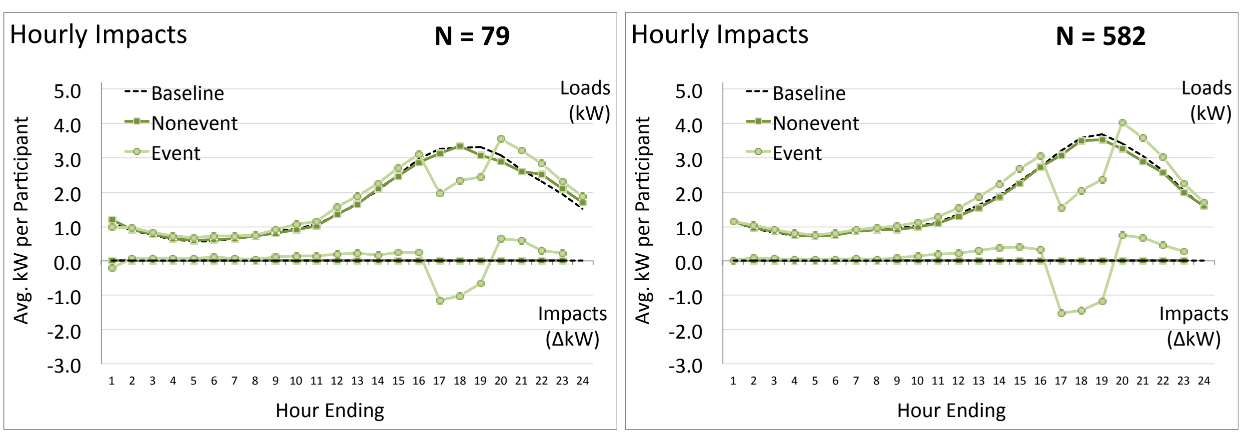
Participants are divided into two groups: those on the standard Energy Assistance Program Rate (EAPR), and those on the Standard non-EAPR rate. The calculator indicates that the average peak load reductions on event days are substantial for both groups, but slightly lower for the EAPR group than for the non-EAPR group, despite similar baselines.

FIGURE 24. PEAK IMPACTS FOR UTILITY-CONTROLLED PCTS, STANDARD EAPR VS. STANDARD RATE



(a) Standard EAPR + utility-controlled PCT (b) Standard rate + utility-controlled PCT

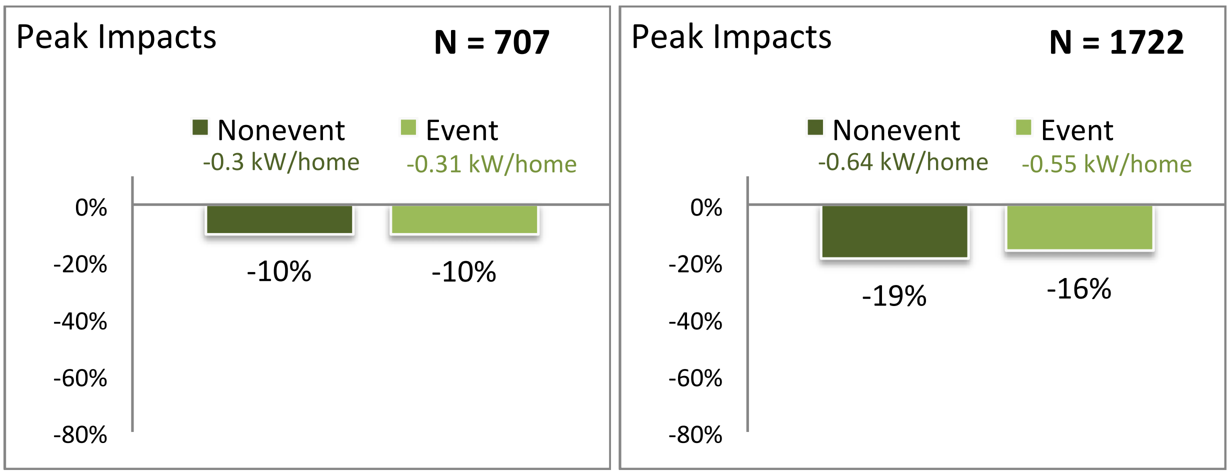
FIGURE 25. HOURLY IMPACTS FOR UTILITY-CONTROLLED PCTS, STANDARD EAPR VS. STANDARD RATE



(a) Standard EAPR + utility-controlled PCT (b) Standard rate + utility-controlled PCT

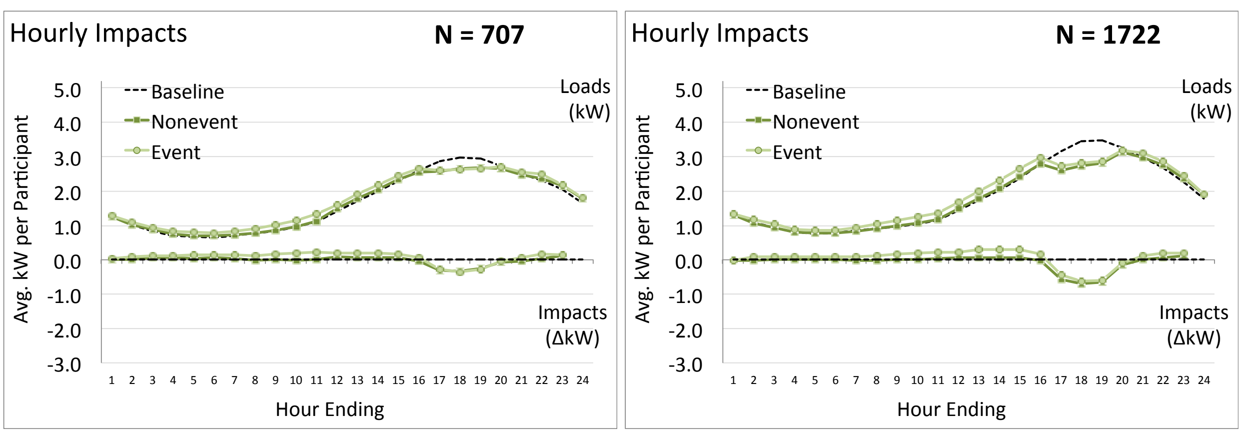
Figure 26 and Figure 27 show the load impacts for two groups: those on the 2013 opt-in EAPR TOU rate and those on the 2013 opt-in TOU rate (non-EAPR). The calculator indicates that the average summer peak load reductions for the EAPR group are lower, both in magnitude and as a percentage of load, on both event and nonevent days.

FIGURE 26. PEAK IMPACTS FOR OPT-IN TOU RATE, EAPR VS. NON-EAPR



(a) 2013 opt-in EAPR TOU rate (b) 2013 opt-in TOU rate

FIGURE 27. HOURLY IMPACTS FOR OPT-IN TOU RATE, EAPR VS. NON-EAPR

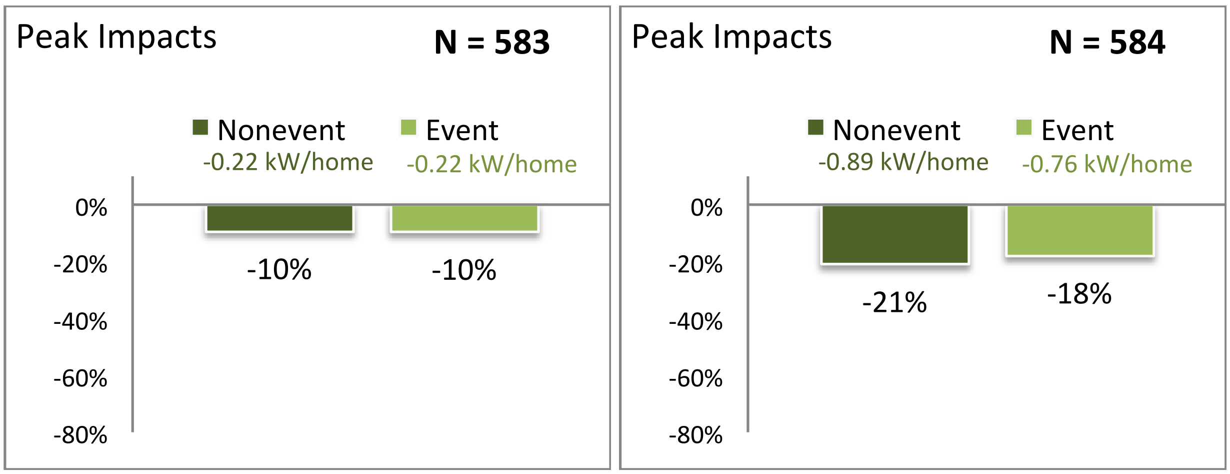


(a) 2013 opt-in EAPR TOU rate (b) 2013 opt-in TOU rate

INCOME

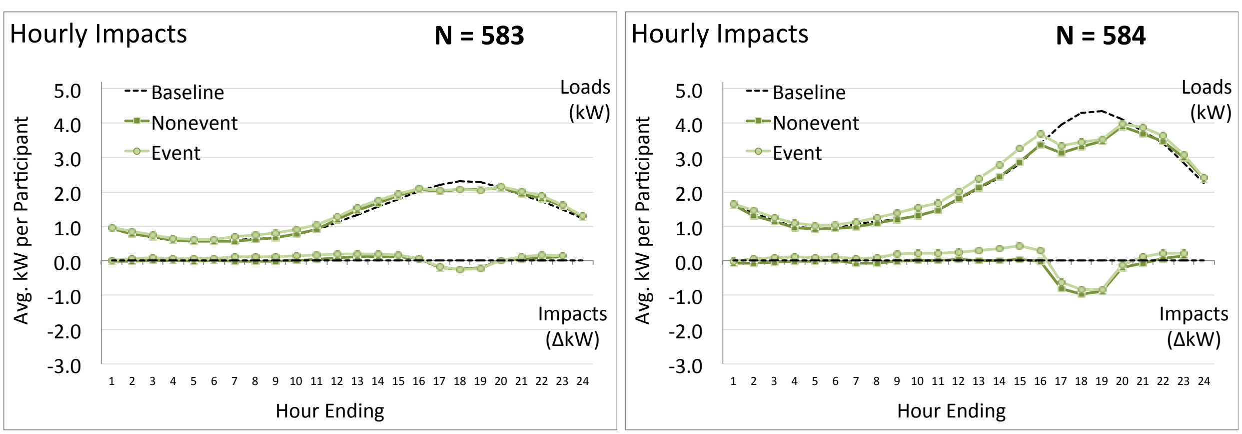
Figure 28 and Figure 29 show the load impacts for all 2013 opt-in TOU participants divided into two groups: those with household incomes below $40,000 and those with household incomes of at least $120,000. SLIC indicates that the average peak impact is substantial for both low and high-income customers, on both event and nonevent days. Those with higher incomes have greater peak loads and peak savings.

FIGURE 28. PEAK IMPACTS FOR OPT-IN TOU, BY INCOME LEVEL



(a) Household income <$40,000 (b) Household income ≥$120,000

FIGURE 29. HOURLY IMPACTS FOR OPT-IN TOU, BY INCOME LEVEL



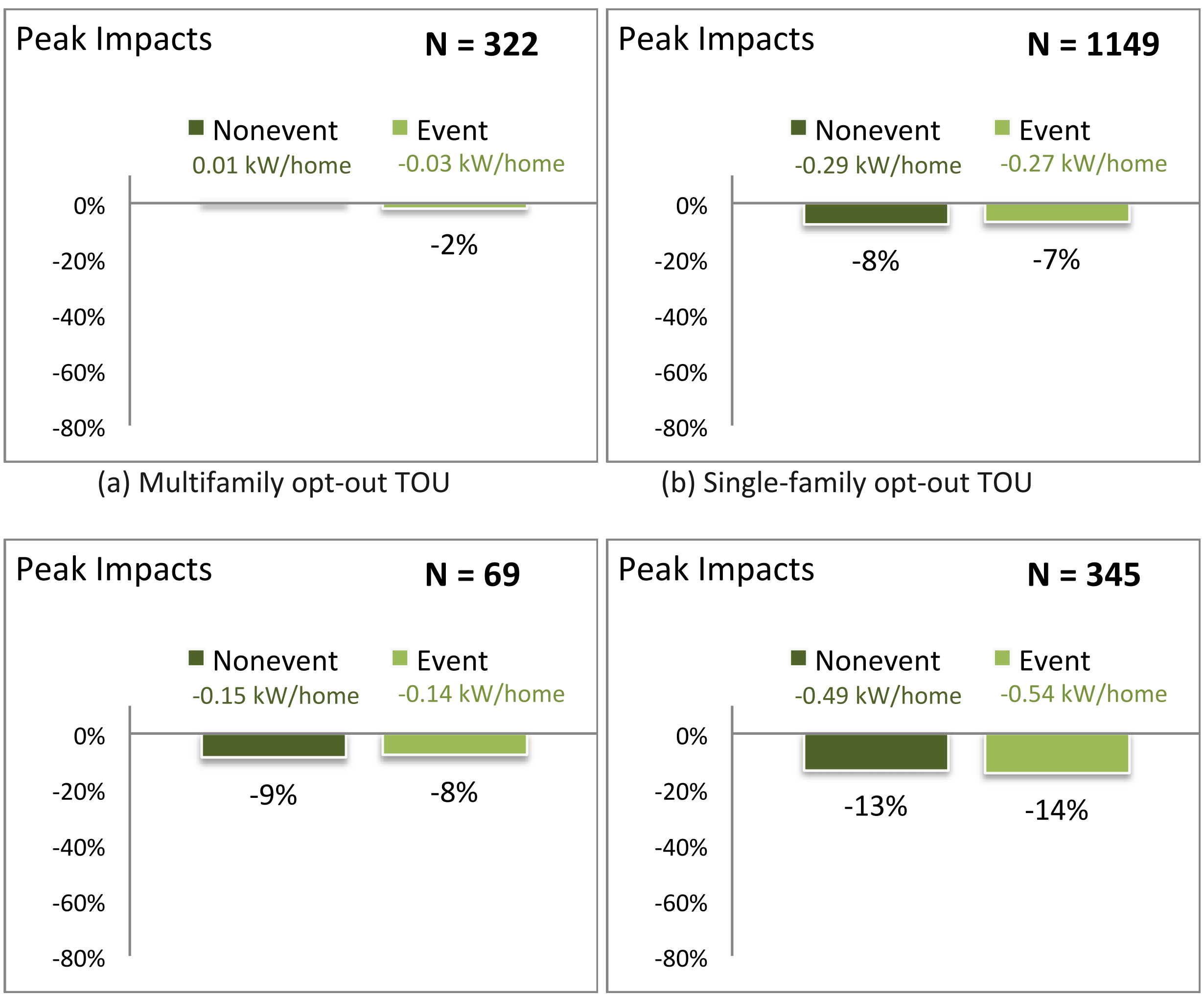
(a) Household income <$40,000 (b) Household income ≥$120,000

Single-family vs. Multi-family homes

Figure 30 and Figure 31 show the load impacts for all 2013 opt-out TOU and TOU-CPP participants divided into multifamily and single-family homes. The calculator shows almost no change for multi-family homes on the opt-out TOU rate (a), while multifamily homes on the opt-out TOU-CPP (c) rate show significant peak savings. Single-family homes outperform multifamily homes on both rates, owing largely to higher baseline peak loads (see Figure 31).

These results confirm that TOU-CPP rates elicit higher event savings than do TOU rates, as would be expected. However, it is interesting to note that those on the TOU-CPP rate also save more on *nonevent* days than do those on the TOU rate. This suggests that summer weekday peak savings are likely to be substantially enhanced by the addition of CPP events to opt-out TOU rates.

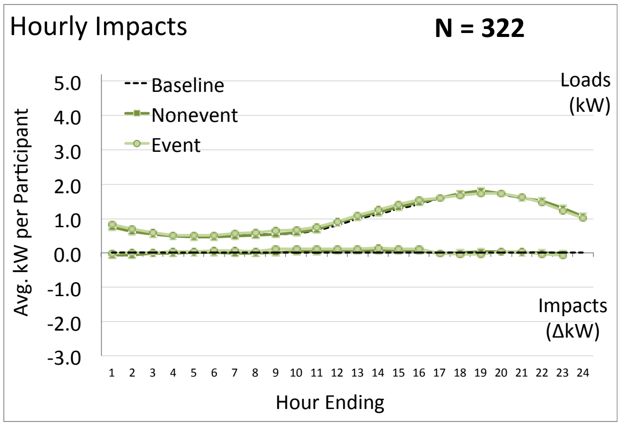
Figure 30. Peak Impacts for Opt-out TOU and TOU-CPP, single-family vs. multifamily homes



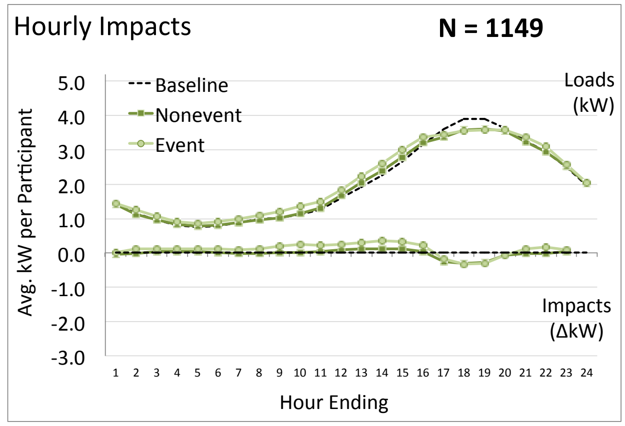
(a) Multifamily opt-out TOU (b) Single-family opt-out TOU

(c) Multifamily opt-out TOU-CPP (d) Single-family opt-out TOU-CPP

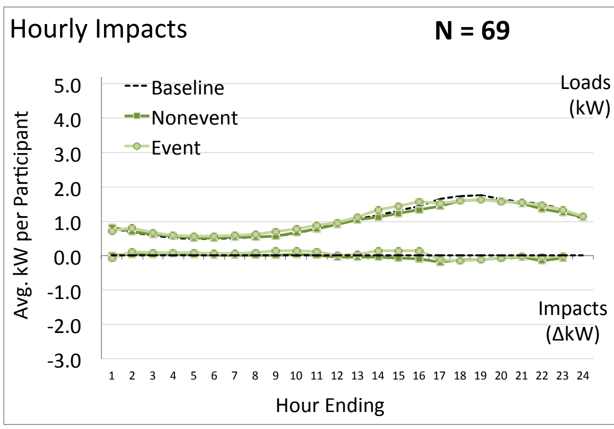
FIGURE 31. HOURLY IMPACTS FOR OPT-IN TOU, SINGLE-FAMILY VS. MULTIFAMILY HOMES



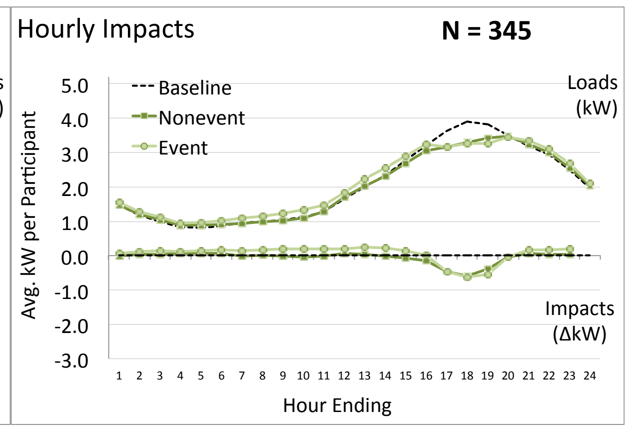
(a) Opt-out TOU, Multifamily homes



(b) Opt-out TOU, Single-family homes



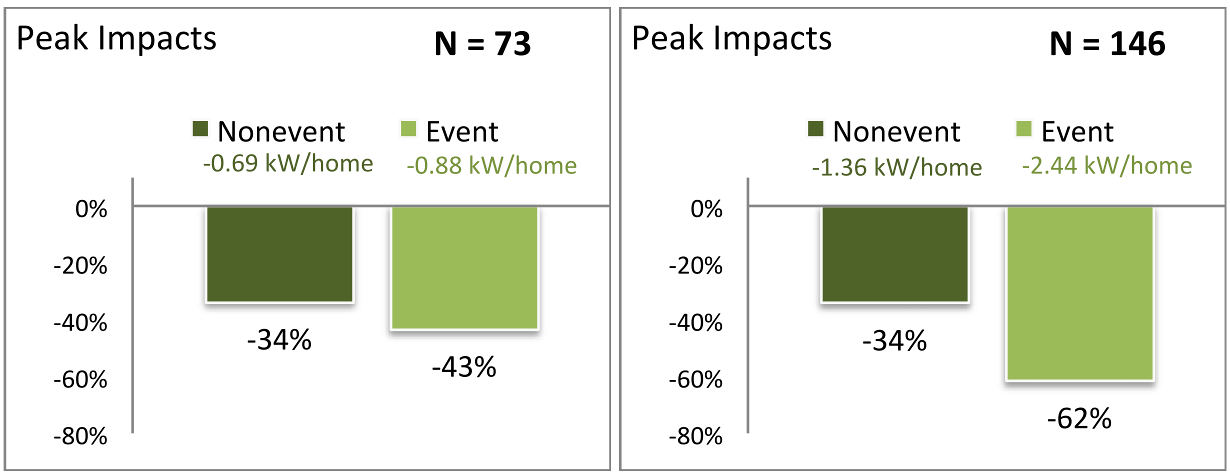
(c) Opt-out TOU-CPP, Multifamily homes



(d) Opt-out TOU-CPP, Single-family homes

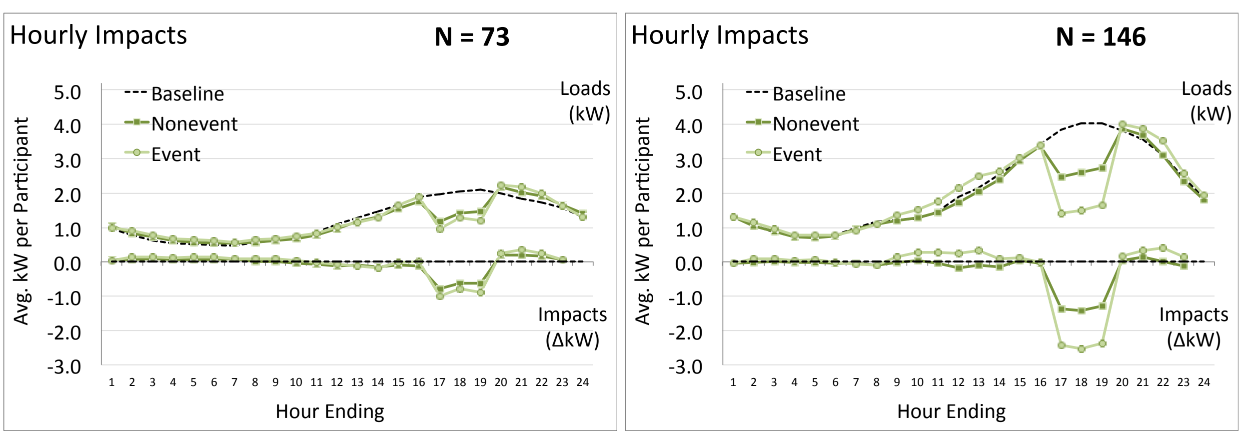
Figure 32 and Figure 33 show the load impacts for opt-in TOU-CPP rate participants divided into two groups: multi-family homes and single-family homes. Note that all participants shown here have customer-controlled PCTs, also referred to as “Occupant-Controlled Smart Thermostats” (OCSTs) in California Title 24 energy codes. In both types of homes, event and nonevent peak savings are exceptionally high. In general, the higher baseline loads exhibited by single-family homes translate into higher kW savings (compared to the multifamily homes); however, given the unusually high savings in both home types, this type of program merits serious consideration for future residential offerings.

FIGURE 32. PEAK IMPACTS FOR OPT-IN TOU-CPP, SINGLE-FAMILY VS. MULTIFAMILY HOMES



(a) Multi-family opt-in TOU-CPP + OCST (b) Single-family on TOU-CPP + OCST

FIGURE 33. OPT-IN TOU-CPP WITH PCTS, HOURLY IMPACTS



(a) Multi-family opt-in TOU-CPP + OCST (b) Single-family on TOU-CPP + OCST

5. CONCLUSIONS

The menu driven nature of SLIC allows a user-friendly interface for finding and comparing thousands of different combinations of subgroups within the 17,055 participants included the database. Some of the general trends suggested by SLIC output provided in this report include:

- **Summer peak savings on <u>nonevent</u> weekdays were greater for:**
    - Participants on the TOU rate, relative to those on the Standard rate
    - Participants on the TOU-CPP rate, relative to those on the TOU rate
        - Persistence in year 2 was also better for TOU-CPP relative to TOU
- **Summer peak savings on <u>event</u> days were greater for:**
    - Participants on the TOU rate, relative to those on the Standard rate
    - Participants on the TOU-CPP rate, relative to those on the TOU rate
    - Participants with PCTs, relative to those without PCTs
    - Participants with PCTs that automated response to the CPP signal, relative to those with PCTs that were not linked to the CPP signal
- **In-home energy displays (IHDs) had almost no effect on peak demand**
- **Certain customer characteristics were associated with greater peak savings, including:**
    - Higher peak demand prior to recruitment
    - Higher income
    - Non-EAPR
    - Single family homes

While the SLIC is a useful tool for estimating the load impacts expected under various program scenarios, it should be used for program planning purposes with caution. For example, choosing too many programmatic and demographic variables can result in sample sizes that are too small to justify strong conclusions. Also, although all pilots were conducted at the same utility, comparisons between similar treatments in different pilots may still be subject to biases introduced through differences in programmatic recruitment and implementation. Finally, choosing more than one treatment group in a single set of results will necessarily weight the results of larger groups more heavily, according to the number of participants. As a result, it is recommended that SLIC results used for program planning purposes be carefully selected to avoid these potential pitfalls.

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Appendix A. Information and Automation Technologies

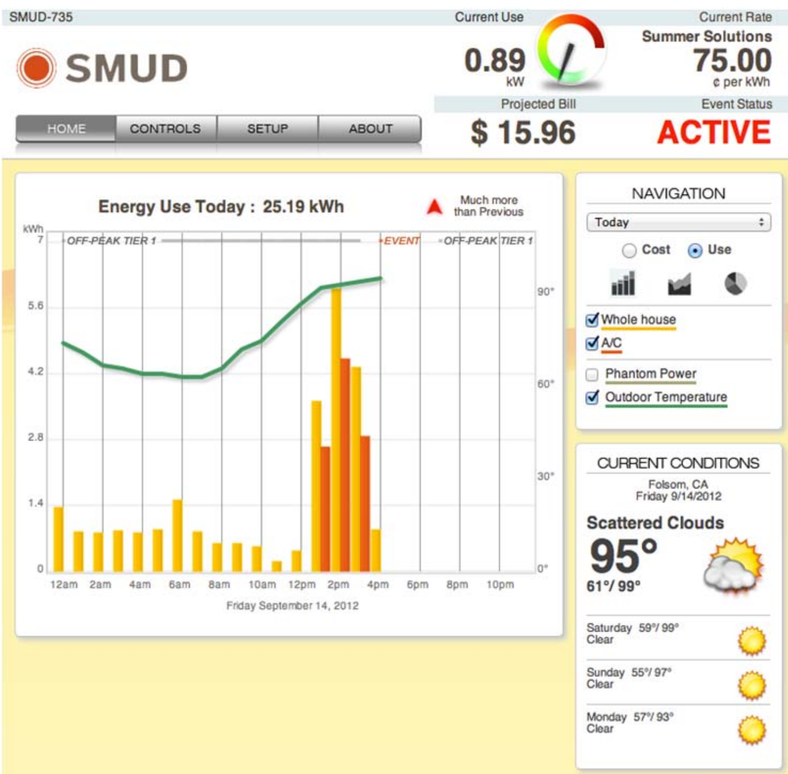
Enhanced Information

Candi Controls Energy Display

Single-family Summer Solutions participants could access the Energy Display interface through an Internet browser on any device on the local area network, most commonly the home computer. At the top of each page was a header displaying the current per-kWh price, an indicator for whether there is an event in progress, and for those with energy data, the real-time home energy use and projected monthly bill.

The Home page (Figure 34) graphed customer data in several user-configurable formats. The drop down to the right of the graph allows graphs in increments of seconds, minutes, hours, days, billing cycles and months. Users can switch between bar, line and pie charts, and can show or hide any combination of the individual sub-meters connected to the system.

Figure 34. Energy Display interface: Home Page



The Summer Solutions thermostat also displayed real-time kW and the aggregate kWh for the day for up to four submeters.

EnergyAware PowerTab IHD

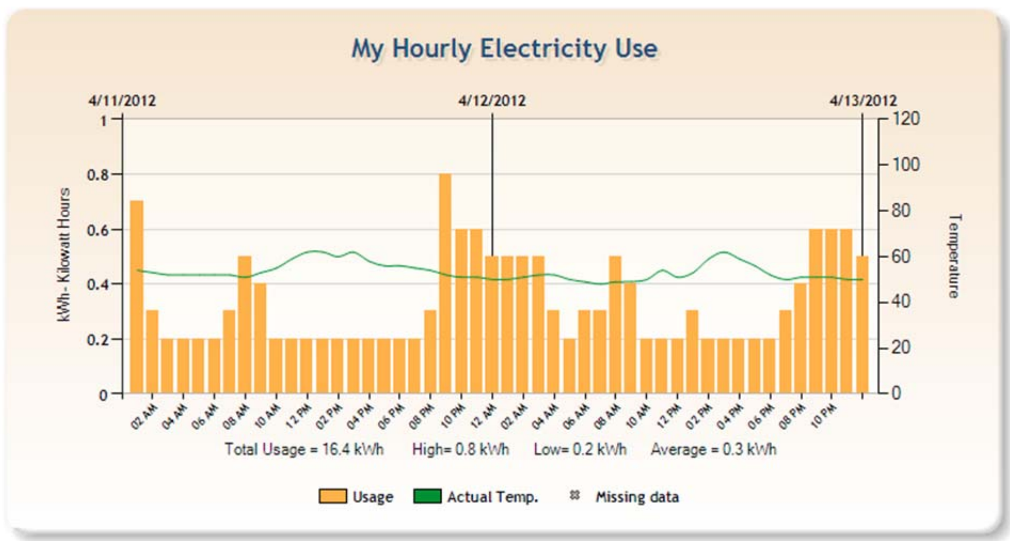
IHD participants received an EnergyAware PowerTab IHD (Figure 35), capable of displaying real-time electricity use data received wirelessly from the electricity meter. Available screens included Current Use in units of instantaneous demand (kW) and dollars per hour, daily Running Total in cumulative energy use (kWh) and dollars, and price per kWh of electricity. The PowerTab required special programming in backend systems to display SMUD's inclining block rates as they came into effect for each customer This backend programming was done for the Smart Pricing Options pilot only. The Low-Income Weatherization and IHD Checkout units displayed the Base rate at all times, regardless of whether the customer was paying this lower rate or the higher Base Plus rate.

Figure 35. The EnergyAware PowerTab IHD

SMUD'S YESTERDAY'S DATA TODAY TRAINING

All residential SMUD customers have access to their electricity data through an account on SMUD's website, where they can view interval data by billing period, day, or hour (Figure 36). During the audit, participants in the YDT group were provided a portable DVD player to view a video that provided an overview of how to use My Account Energy Information data to learn about their energy use and track the effects of the actions they take. Many YDT participants watched this video while the low-income energy assessments were being conducted.

FIGURE 36. YESTERDAY'S DATA TODAY ONLINE: MY HOURLY ELECTRICITY USE

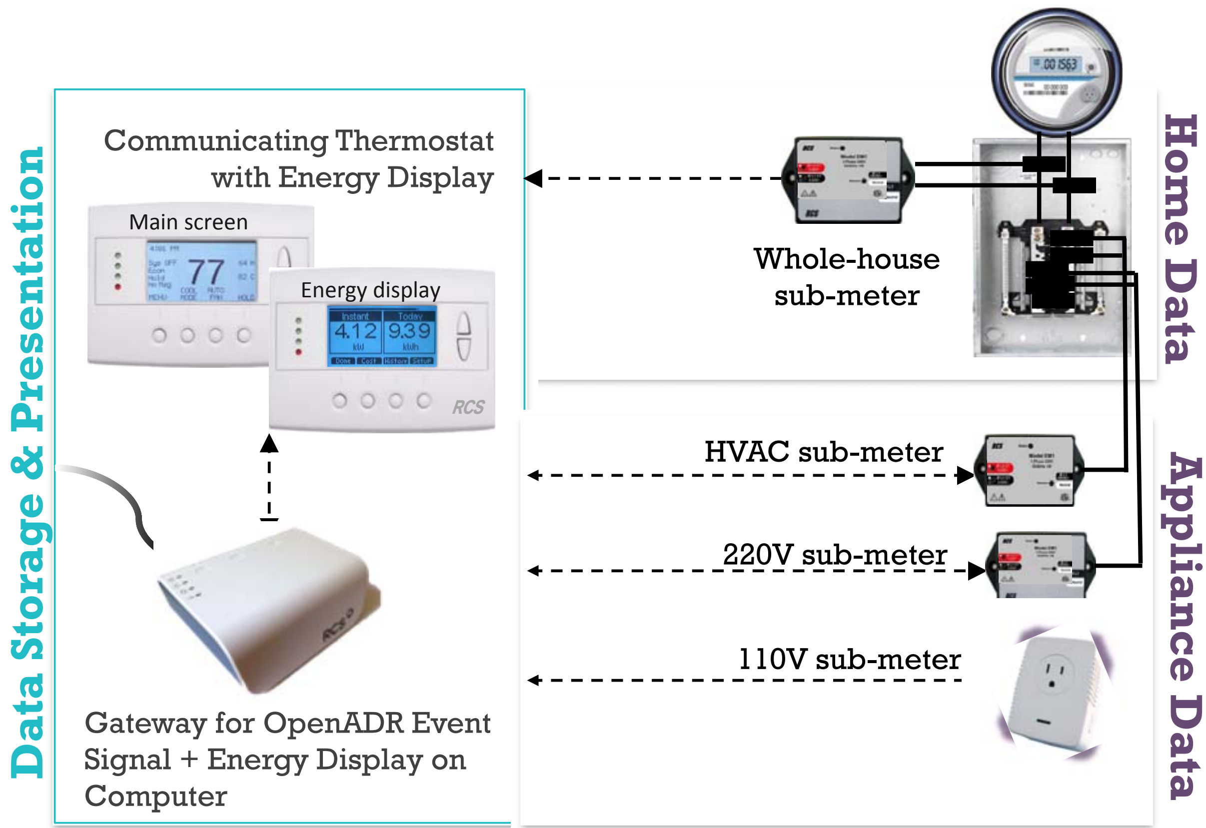


AUTOMATION - SMART THERMOSTATS

RCS TECHNOLOGY TZ43 THERMOSTAT

The Single-family Summer Solutions thermostat responded automatically to events. Customers on the TOU-CPP rate could program their desired CPP event offset using the thermostat menus. The thermostat also had an energy display mode, which showed real-time kW and aggregate daily kWh for up to four submeters (Figure 37).

FIGURE 37. SINGLE-FAMILY SUMMER SOLUTIONS TZ43 THERMOSTAT AND RELATED EQUIPMENT



Energate Pioneer Z100 Thermostat

FIGURE 38. ENERGATE PIONEER Z100

The Energate Pioneer Z100 (Figure 38) is a programmable thermostat with the ability to communicate to and from SMUD's demand response management system (DRMS) through the smart meters using Zigbee Smart Energy Profiler version 1.1. Through this connection, the thermostats were able to receive SMUD's Conservation Day event signals and initiate automated event response by raising the cooling temperature settings. Occupants could override this event response at the thermostat unit. Because communications were routed via SMUD's smart meter rather than via the Internet, participants did not have the ability to remotely adjust temperatures or schedules. The thermostat and its installation were free of cost to participants.

Nest Learning Thermostat

The Nest Learning Thermostat (Figure 39) is marketed as an energy-saving device that automatically programs a temperature schedule based on customer settings in the first two weeks of use. The main advanced features of the Nest thermostat include: Auto-Schedule, Auto-Away, Airwave, Energy History, the Efficiency Leaf, and Remote Control. All features are available on the thermostat in the absence of a web connection with the exception of remote access to thermostat settings, the only feature requiring that the thermostat be connected to the Internet.

FIGURE 39. THE NEST THERMOSTAT AND SMARTPHONE APP

Optimization. The automated schedule learning is intended to simplify schedule programming for customers. It required a two-day process of manual thermostat interaction, from which the Nest defined a customized schedule. Once the first two days of 'aggressive learning' were over, the resulting schedule could be modified on the thermostat, the computer, or the smartphone app. The Nest uses pattern matching to optimize the schedule whenever it recognizes similar temperature settings on two consecutive days, weekdays, or days of the week. Occupants could disable the Auto-Schedule feature in the Nest Settings menu.

Auto-Away. The Auto-Away feature is intended to save energy by initiating energy-efficient temperature settings when the Nest motion sensors do not sense movement for a period of time. Like Auto-Schedule, the Auto-Away feature can be disabled.

Airwave. Airwave™ uses exclusive software algorithms running inside the Nest Learning Thermostat to lower air-conditioning costs by automatically turning off the compressor a few minutes before the scheduled run-time end and keeping the fan running.

Energy History. The Nest displays information about heating and air-conditioning use compared to historical use, including estimates of how weather, Auto-Away and manual adjustments had the greatest effect on energy use.

The Leaf. The Nest Leaf appears when the target temperature is set to an energy-efficient level.

Remote Control. Settings can be modified remotely via smartphone app or website interface.

A detailed review of the Nest Learning Thermostat can be found in *SMUD's Communicating Thermostat Usability Study* (Herter & Okuneva, 2014b).

ECOFACTOR SYSTEM

EcoFactor is a Software-as-a-Service (SaaS) vendor that has developed cloud-based energy services that interact with a subscriber's thermostat via the Internet. On losing its connection to the Internet, the thermostat will continue to run its last known program, but cannot learn, be updated or respond to events. At the time of this study, the Computime CTW218 was the only thermostat configured to work with Ecofactor's software (Figure 40).

FIGURE 40. THE COMPUTIME CTW218 THERMOSTAT AND SMARTPHONE APP

Optimization. The EcoFactor system makes use of a cloud-based processing engine to create energy-saving schedules. To optimize savings, the Ecofactor system automatically adjusts customer temperature settings to reflect manual adjustments and to conserve energy. If the occupants do not manually alter conservation settings when they take effect, the programmed schedule is modified to reflect the more efficient settings.

Remote Control. Settings can be modified remotely via smartphone app or website interface.

A detailed review of the usability of the Ecofactor-Computime CTW218 can be found in *SMUD's Communicating Thermostat Usability Study* (Herter & Okuneva, 2014b).

APPENDIX B. TREATMENT SUMMARY

(continued on the following page)

Pilot	Treatment Description	Pretreat Year	Treat Year	Cons. Years	Opt	Rate	EAPR	PCT	U-PCT Degrees	IHD	Audit	Other
IHD	IHD Checkout	2012	2013	1	in	Standard	yes/no	none	0	yes	none	none
MF	EAPR IHD+PCT+TOU-CPP	2012	2013	1	in	TOU-CPP	yes	customer	0	yes	none	none
MF	IHD+PCT+TOU-CPP	2012	2013	1	in	TOU-CPP	no	customer	0	yes	none	none
MF	IHD+TOU-CPP	2012	2013	1	in	TOU-CPP	no	none	0	yes	none	none
MF	EAPR IHD+TOU-CPP	2012	2013	1	in	TOU-CPP	yes	none	0	yes	none	none
MF	TOU-CPP	2012	2013	1	in	TOU-CPP	no	none	0	no	none	none
MF	EAPR TOU-CPP	2012	2013	1	in	TOU-CPP	yes	none	0	no	none	none
PowerStat.2013	Res TOU-CPP+2F	2012	2013	1	in	TOU-CPP	yes/no	utility	2	no	none	none
PowerStat.2013	Res TOU-CPP	2012	2013	1	in	TOU-CPP	yes/no	customer	0	no	none	none
PowerStat.2013	Res TOU-CPP+3F	2012	2013	1	in	TOU-CPP	yes/no	utility	3	no	none	none
PowerStat.2013	Res TOU-CPP+4F	2012	2013	1	in	TOU-CPP	yes/no	utility	4	no	none	none
PowerStat.2013	Res +2F incentive	2012	2013	1	in	Standard	yes/no	utility	2	no	none	none
PowerStat.2013	Res +3F incentive	2012	2013	1	in	Standard	yes/no	utility	3	no	none	none
PowerStat.2013	Res +4F incentive	2012	2013	1	in	Standard	yes/no	utility	4	no	none	none
SPO.2012	Opt-in CPP	2011	2012	1	in	CPP	yes/no	none	0	no	none	none
SPO.2012	Opt-in CPP+IHD	2011	2012	1	in	CPP	yes/no	none	0	yes	none	none
SPO.2012	Opt-in TOU	2011	2012	1	in	TOU	yes/no	none	0	no	none	none
SPO.2012	Opt-in TOU+IHD	2011	2012	1	in	TOU	yes/no	none	0	yes	none	none
SPO.2012	Opt-out TOU-CPP+IHD	2011	2012	1	out	TOU-CPP	yes/no	none	0	yes	none	none
SPO.2012	Opt-out CPP+IHD	2011	2012	1	out	CPP	yes/no	none	0	yes	none	none
SPO.2012	Opt-out TOU+IHD	2011	2012	1	out	TOU	yes/no	none	0	yes	none	none
SPO.2013	Opt-in CPP	2011	2013	1 or 2	in	CPP	yes/no	none	0	no	none	none
SPO.2013	Opt-in CPP+IHD	2011	2013	1 or 2	in	CPP	yes/no	none	0	yes	none	none
SPO.2013	Opt-in TOU	2011	2013	1 or 2	in	TOU	yes/no	none	0	no	none	none
SPO.2013	Opt-in TOU+IHD	2011	2013	1 or 2	in	TOU	yes/no	none	0	yes	none	none
SPO.2013	Opt-out TOU-CPP+IHD	2011	2013	1 or 2	out	TOU-CPP	yes/no	none	0	yes	none	none
SPO.2013	Opt-out CPP+IHD	2011	2013	1 or 2	out	CPP	yes/no	none	0	yes	none	none
SPO.2013	Opt-out TOU+IHD	2011	2013	1 or 2	out	TOU	yes/no	none	0	yes	none	none
SS.2011	Standard	2010	2011	1	in	Standard	no	customer	0	yes/no	none/checklist	none/appliance
SS.2011	Standard+ATC	2010	2011	1	in	Standard	no	utility	4	yes/no	none/checklist	none/appliance
SS.2011	TOU-CPP	2010	2011	1	in	TOU-CPP	no	customer	0	yes/no	none/checklist	none/appliance

Pilot	Treatment Description	Pretreat Year	Treat Year	Cons. Years	Opt	Rate	EAPR	PCT	U-PCT Degrees	IHD	Audit	Other
SS.2011	TOU-CPP+ATC	2010	2011	1	in	TOU-CPP	no	utility	4	yes/no	none/checklist	none/appliance
SS.2012	Standard	2010	2012	1 or 2	in	Standard	no	customer	0	yes/no	none/checklist	none/appliance
SS.2012	Standard+ATC	2010	2012	1 or 2	in	Standard	no	utility	4	yes/no	none/checklist	none/appliance
SS.2012	TOU-CPP	2010	2012	1 or 2	in	TOU-CPP	no	customer	0	yes/no	none/checklist	none/appliance
SS.2012	TOU-CPP+ATC	2010	2012	1 or 2	in	TOU-CPP	no	utility	4	yes/no	none/checklist	none/appliance
STS	Nest+TOU-CPP	2012	2013	1	in	TOU-CPP	yes/no	Nest	0	no	none	none
STS	Nest	2012	2013	1	in	Standard	yes/no	Nest	0	no	none	none
STS	EcoFactor+TOU-CPP	2012	2013	1	in	TOU-CPP	yes/no	Ecofactor	0	no	none	none
STS	EcoFactor	2012	2013	1	in	Standard	yes/no	Ecofactor	0	no	none	none
WZN	YDT	2011	2013	1	in	Standard	yes	none	0	no	weatherize	YDT training
WZN	IHD	2011	2013	1	in	Standard	yes	none	0	yes	weatherize	none
WZN	Nest	2011	2013	1	in	Standard	yes	Nest	0	no	weatherize	none
WZN	Audit	2011	2013	1	in	Standard	yes	none	0	no	weatherize	none