Pacific Gas & Electric SmartAC™ 2008 Residential *Ex Post* Load Impact Evaluation and *Ex Ante* Load Impact Estimates

Final Report

CALMAC Study ID: PGE0278.01

Pacific Gas & Electric Company
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1. Executive Summary

This a summary of the detailed findings found later in this report. This report contains the load impact evaluation of PG&E's SmartAC Program after its second year of operation (2008). The results provided show that the SmartAC program can reduce air conditioning load during event periods.

Program Description

PG&E's SmartAC Program is a direct load control (DLC) program that uses paging signals to reduce the energy consumption of participants' air conditioners during times of peak system demand. The air conditioners are controlled either by a programmable thermostat or a switch that the Program installs at the participant's residence or business. The switch employs an adaptive technology that controls the air conditioner based on prior air conditioning behavior. Thermostats have the capability to change the indoor temperature settings at which the air conditioner starts cooling, or to shut down (cycle) the AC units.

The Program first began enlisting customers in spring 2007. The Program began by recruiting customers in San Joaquin County (the city of Stockton and its surrounding areas), and eventually expanded to other areas of the PG&E service territory. As of the end of the 2007 cooling season, the program had about 10,000 participants. At the end of the 2008 cooling season, this had increased to about 79,000. The vast majority are residential customers.

Of the 8,800 participants with an installed device at the time of system peak in 2007, 30 percent had a programmable thermostat while the remainder had a switch. In 2008, there were about 64,000 customers with installed devices at the time of system peak. Of these, 23 percent were thermostat customers.

In 2008, as in 2007, the Program was not activated in response to a power emergency[1]. If it had been activated, the switches would have employed the adaptive algorithm to reduce air

[1] The Program was activated twice in 2007 and once in 2008, with the purpose of testing the system. Those activations were in days that were not very hot, and lasted for a couple hours earlier in the day.

conditioner use to 50% of that observed on learning days[2], and the thermostats would have shut down the air conditioners 15 minutes out of every half hour[3].

Evaluation Goals

The load impact evaluation's primary goals were to:

- Estimate *ex post* SmartAC residential demand reduction at the program level, and for the following groups of interest:
    - Device type
    - Load Control Area (LCA)
    - PG&E climate zone
    - Year of construction

- Estimate *ex ante* SmartAC residential unit demand reduction, in a way that can be combined with SmartAC enrollment forecasts developed independently of this evaluation.

Load Impact Evaluation Methodology

KEMA selected a sample of 578 homes with 670 AC units for the metering sample. The sample was stratified by the two control technologies, climate zone, size (cooling tons for sites with one unit, or presence of more than one unit), and home vintage.

Models for AC unit-specific baselines were developed for load and duty cycle, and used to compare with event day performance.

As in 2007, the 2008 evaluation took place at a time of daily, and substantial, increases in the number of SmartAC participants. Participation increased from 47 thousand at the time of the first 2008 SmartAC event in May to 78 thousand at the time of the last one in October. The weights utilized for the analysis varied accordingly - for each event, they were based on the composition of the sample and the population on that day.

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[2] Learning days are days selected by PG&E as appropriate to inform the adaptive algorithm. The switch records AC usage on these days, and uses it as a reference to reduce usage on event days.

[3] This is a departure from 2007, when the thermostats generated demand reductions by increasing the indoor temperature settings.

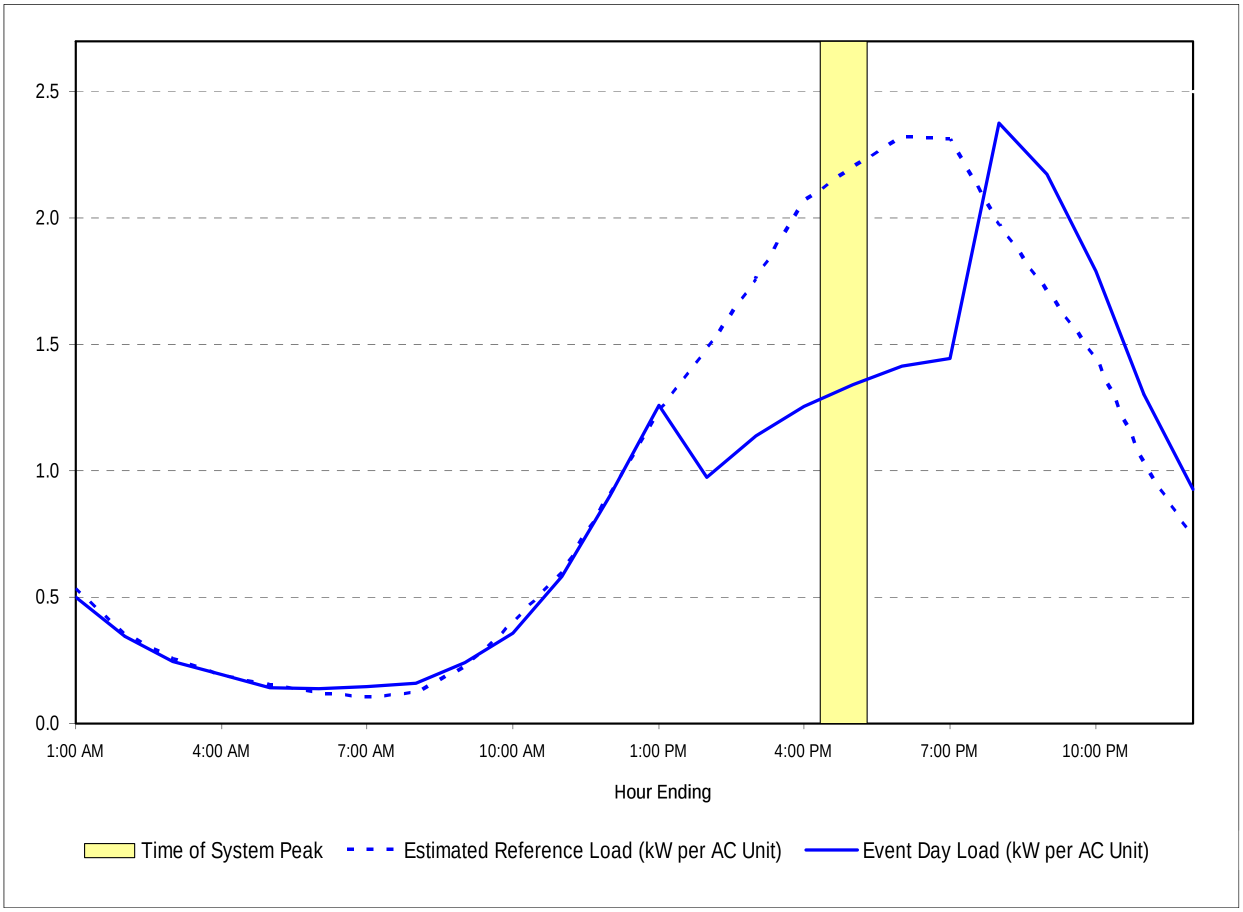
The 2008 SmartAC load impact evaluation included nineteen events. Eighteen of these events were conducted only for the purposes of this evaluation, and affected sample participants only. One was conducted for the entire population of SmartAC participants, for the purposes of testing the system.

SmartAC Program *Ex Post* Load Impact Results

Program impacts per unit at time of the 2008 system peak are illustrated in Figure 1-1. On this day (July 8), the event took place from hours ending 2 PM through 7 PM. During these hours, impacts ranged from a low of 0.51 kW in the first hour to a high of 0.91 kW on the hour ending at 6 PM. The impact at time of system peak was 0.86 kW per device. The hours after the event indicate a snapback effect of up to 0.46 kW. On the day of the system peak, we estimate that SmartAC participants experienced an average maximum temperature of almost 107^{o}F.

These per unit estimates translate into an estimated impact of about 55 MW at time of system peak, if the program had been activated.

Figure 1-1
SmartAC Peak Day Average Unit Impact Estimates
July 8, 2008



Other SmartAC *Ex Post* Load Impact Results

Ex post estimates for other groups of interest were estimated for this study. These are briefly described below, and in more detail in Section 6.

- Device type. At time of 2008 system peak, the average impact is estimated to be 0.91 kW for switches and 0.72 kW for thermostats.

- Load Control Area (LCA). This study estimated *ex post* impacts for three LCAs: Greater Bay Area (average impact at time of 2008 system peak: 1.01 kW), Greater Fresno (0.68 kW) and Stockton (0.90 kW).

- PG&E climate zone. This study estimated *ex post* impacts for the three climate zones where the program was active in 2008. There is a close correspondence between these climate zones and the LCAs described above. It is estimated that climate zone R would have had average impacts of 0.68 kW per AC. Climate zone S, 0.91. And climate zone X, 0.97 kW.

- Thermostat setback. As mentioned above, had the Program been activated in 2009, thermostats would have lowered air conditioner load by cycling the unit (turning it off 15 minutes of every half hour.) This study tested the impact of having the thermostats reduce AC load by increasing indoor temperature 2 degrees the first hour, and 1 degree each of the second and third hours. This approach produced higher load impacts than the 50% cycle under certain circumstances. Appendix D includes results from this test and theoretical discussion regarding the use of this setback strategy. This study recommends additional research prior to deploying this strategy during an actual power emergency.

Ex Ante Load Impact Results

Ex post impacts are estimated at the AC unit level. *Ex ante* load impacts are estimated at the participant level, by type of device and climate zone. On average, in 2008 there were 1.1 AC units per SmartAC participant.

These *ex ante* load impacts were combined with enrollment forecasts estimated in a separate study to produce a comprehensive SmartAC *ex ante* picture.

Ex ante results are estimated for two weather conditions: 1-in-2 (a milder weather year that has the probability of occurring every other year) and 1-in-10 (a very hot year that has the probability of occurring once every ten years.)

Under 1-in-10 conditions, it is estimated that switches would have system peak impacts ranging from 0.96 to 1.10 kW per participant, in climate zone R. This translates into impacts of 0.88 to 1 kW per unit[4]. In contrast, under 1-in-2 conditions, it is estimated that these impacts would be 0.91 to 1.07 kW per participant, or 0.83 to 0.97 kW per unit[5]. Details regarding other

[4] 1-in-10 peak is in July for climate zone R (discussed here) and in June for climate zone S.

[5] 1-in-2 peak is in August for climate zones R and S (discussed here) and in September for climate zone X.

combinations of device, climate zone, and weather conditions are available in Section 6 and in the *ex ante* electronic appendix.

Recommendations

In the last section of this report, we make recommendations for Program and future Study improvements.

Our Program recommendations do not address potential changes to the Program's tariff (for example, increasing the percent of cycling) or to its deployment plans (for example, combining or not with other demand response programs offered by PG&E.) This does not imply that such strategies are not effective. Rather, we focus attention on improvements that can be made within the existing tariff rules, based on findings from this study.

Our recommended Program improvements are the following:

- *Explore ways to increase the adaptive behavior of switches*. This evaluation demonstrated that the adaptive algorithm is effective at increasing load impacts compared to a non-adaptive algorithm. It also produced evidence that the adaptive switch performance is roughly midway between that of "ideal" adaptive control and fixed 50% non-adaptive control. We recommend that PG&E explore ways to bring the adaptive switch performance closer to 50% of uncontrolled load.

- *Expect air conditioner usage, and the corresponding load impacts, to decrease as a result of the economic downturn*. It is very possible that the economic downturn is affecting, and will continue to affect, air conditioner use, lowering Program impacts.

- *Continue investigation and reduction of no-response devices*. PG&E is actively investigating areas of the service territory that experienced higher than expected rates of no event response in 2008. These improvements will result in an increase of ex post load impacts in future years.

Our recommended Study improvements are the following:

- *Consider utilizing an alternating comparison group in the M&V sample*. Future M&V efforts based on end-use interval data should consider controlling only half the sample during each event. The controlled half would alternate for successive events. This approach has the following advantages: it allows more events under different conditions, but with less burden on any one customer; it provides more non-event hot days for defining reference load under peak conditions; it offers a "comparison group" for assessing the accuracy of projected load for controlled customers for each event. The downside to this approach is reduced statistical precision, resulting from smaller sample sizes for ex post impact estimation. Alternatively, increased costs would be incurred to support from larger sample sizes that can accommodate a comparison group without losing target precision. Note that ex ante impacts, which are based primarily on the models of uncontrolled load, would not lose precision compared to the current approach.

- *Explore the decrease in air conditioner usage and its corresponding load impacts as a result of the economic downturn*. As noted above, it is possible that the economic downturn is affecting air conditioner use, and lowering load impacts. This effect can be explored and quantified utilizing a combination of billing data, weather data, and the interval data collected during 2007 and 2008.

- *Incorporate control device log data in the M&V analysis*. The control devices utilized in the SmartAC program can store up to 90 days of information regarding run time and in the case of thermostats, temperature set points. This data can provide a rich source of information regarding air conditioning behavior that can complement the interval data collected for this purpose.

- *Investigate potential changes in behavior of Program participants that have been cycled frequently, and quantify its effects*. Frequent load control, such as was applied to the SmartAC M&V sample participants in 2007 and 2008, has the potential to affect customer behavior over time. After two years of data collection it is possible to investigate whether customers in their second year of frequent program cycling have adopted compensating techniques, such as pre-cooling.

2. Introduction

This report corresponds to the second year (2008) of the SmartAC program. A similar study, addressing the much smaller group of first-year (2007) program participants, was published in 2008.

2.1 Evaluation Scope

Year 2008 is the second program year of the SmartAC operation and its respective load impact evaluation. The California Demand Response Protocols[6] ("the Protocols") were implemented in 2008, which resulted in changes to the reporting requirement of the second year's evaluation. The 2008 evaluation's objectives are to:

- Estimate the Program's *ex post* load impacts for the following groups of interest:
  - Overall
  - Load Control Area (LCA)
  - PG&E climate zone
  - Year of construction
  - Square footage
- Estimate the Program's *ex ante* per-participants load impacts in a way that is consistent with the SmartAC enrollment forecast developed independently of this evaluation
- Assess the effects of opt-outs, signal/device failure, attrition, and snapback
- Measure the difference between two different thermostat control approaches

As in the first year, there was not enough opt-out (event override) behavior or attrition to model the effect of these important drivers of demand reduction. These issues will be revisited as the program continues to grow.

[6] *Load Impact Estimation for Demand Response: Protocols and Regulatory Guidance*. California Public Utilities Commission. Energy Division. April, 2008.

2.2 Report Organization

This report includes the following sections:

1. Executive Summary

2. Introduction and Evaluation Scope

3. Program Description and Goals. This section provides an introductory account of the Program's characteristics, growth, and enrollment and load impact goals.

4. Sample Design and Data Utilized in this Evaluation. The sample design section contains a detailed description of the sample stratification employed in this study, a summary of the sample utilized in 2007, and details of the sample utilized in 2008. The data section describes in detail the main data sources for this evaluation: program enrollment, weather, and end use interval load data.

5. Load Impact Estimation Methodology. This section presents the models and equations utilized to estimate *ex post* and *ex ante* impacts, and the equations utilized to estimate statistical measures for the *ex post* model.

6. Study Findings. Includes the validity assessment of the study findings, *ex post* and *ex ante* estimated impacts, and measures to assess their statistical precision.

7. Recommendations. Includes discussion regarding suggested program improvements and future study improvements.

In addition, the Appendices include the following:

Appendix A. SmartAC Residential Tariff. The residential SmartAC tariff approved by the CPUC, effective March 1, 2008.

Appendix B. SmartAC Weather Analysis for M&V Events. Describes the analysis of prior years' weather and how it was used to develop rules to schedule M&V events based on weather forecasts supplied by PG&E's Meteorology department.

Appendix C. No Response Analysis. Describes this study's findings regarding devices that did not produce load impacts during M&V events.

Appendix D. Thermostat Ramp Vs 50% Straight Cycle Comparison. Describes ex post results that indicate that a thermostat ramp (increase in indoor temperature) is more effective than a 50% cycling strategy in certain circumstances, and explores theoretically that such improved performance may not hold at higher temperatures.

Appendix E. SmartAC 2008 System Peak Ex Post Estimates by AC Unit (kW). Includes detailed load impact estimates tables by device type, load control area, climate zone, year of construction, and square footage.

Appendix F. SmartAC 2008 System Peak Ex Post Population Estimates (MW). Includes detailed load impact estimates tables by device type, load control area, climate zone, year of construction, and square footage.

3. SmartAC Program Description and Goals

3.1 Description of the SmartAC Program

SmartAC is Pacific Gas & Electric's residential and small commercial[7] air conditioning direct load control program.

At this time, the SmartAC program has a very low commercial enrollment – less than 0.50% of all program participants are non-residential accounts[8]. Commercial participants are excluded from this evaluation.

The program uses paging signals and control technologies to limit air conditioner usage during program events. Actual program events will be triggered by California Independent System Operator (CAISO) reliability requirements[9].

The SmartAC Program first began enlisting customers in the spring of 2007. As of the end of August, 2007 the program had approximately 8,800 participants[10]. By January, 2008 there were 26,000 participants with installed devices, and by the end of the summer in 2008 the number increased to about 87,000.

The Program began by recruiting customers in San Joaquin County -the city of Stockton and its surrounding areas- early in 2007, and expanded to other areas of the PG&E service territory late in 2007 and in 2008. This evaluation includes the Greater Bay Area, Greater Fresno, and Stockton – the areas that grouped most of the Program's participants in 2008.

PG&E manages the marketing efforts, initiates the control events, and manages the overall program. An implementation vendor handles the dedicated Program hotline, enrolls customers, schedules installation appointments, and installs the control devices. A technology vendor

[7] Small Commercial customers are defined as having demands of less than 200 kW.

[8] Based on installed program participants as of November 21, 2008.

[9] To date, PG&E has conducted three program-wide events, two in 2007 and one in 2008, for the purpose of testing their SmartAC systems. There have been no program-wide events triggered by system reliability needs.

[10] Throughout this report, "participant" refers to a PG&E customer with one or more installed devices. These counts explicitly exclude customers that have signed up for the Program but do not have an installed device yet.

manufactures the control devices and manages the system that makes the control events possible.

The Smart AC Program pays all participants a one-time $25 "thank you" payment. Participants can opt-out (override) a Program event by calling the hot line or accessing their device through the internet.

The Program's regulatory background, design, deployment plans, cost-benefit analysis, savings assumptions, enrollment forecasts, measurement and verification plans, cost recovery proposal, and other program information are described in detail in PG&E's *Air Conditioning Direct Load Control Program. Prepared Testimony. Public Version*. April, 2007 ("the testimony"). This section presents key information from the testimony to frame the load impact analysis. The reader is referred to the testimony for details not presented in this document.

The testimony describes the SmartAC program as follows:

> […] a voluntary Air Conditioning (AC) Program in which customers allow PG&E to install a device at their premise that can temporarily reduce the electrical demand of their AC unit through remote activation. The program seeks to deliver reliable demand reduction while maintaining a high level of customer satisfaction. The program is designed to create minimal discomfort for the customer to minimize customer attrition.
>
> The AC program will serve as a reliability resource to PG&E and the California Independent System Operator (CAISO). The program is intended to be utilized in emergency or near emergency situations. Program activation may occur in anticipation of or during a Stage 2 emergency. The CAISO will be able to include the estimated load reduction in reserve calculations when determining the need for a Stage 2 emergency and therefore the program may help the CAISO avoid a stage 2 emergency. The AC program is intended to help maintain service reliability to all PG&E customers, defer construction of additional peaking units, and reduce environmental pollutants. Activation of these devices can help reduce the overall cost of power to all electric customers and may also reduce a participant's monthly power costs, particularly those on time-differentiated rate schedules.

The key components of the SmartAC program are presented in Table 3-1.

Table 3-1
Key Components of the SmartAC Program

Line No.	Program Component	Residential Customer	Small C&I Customer
1	Technology offered	Switch and PCT	Switch and PCT
2	Number of events(a)	Emergency Only – up to 100 hours	Emergency Only – up to 100 hours
3	Maximum hours per event	6	6
4	Cycling frequency for switches	50%	33%
5	Maximum temperature adjustment for PCTs	4° F	4° F
6	Penalties for opting out of event	None	None
7	Program incentives	$25–$50 plus appreciation bonuses	$25–$100 plus appreciation bonuses

(a) Participants electing the CPP option of the program will have load reductions up to 15 times per year consistent with CPP's SmartRate™ requirements.

Source: Table 1-1: "Key Components of the AC Program." Pacific Gas and Electric Company's Air Conditioning Direct Load Control Program Prepared Testimony. Public Version. April 6, 2007.

3.2 Summary of SmartAC Goals

PG&E has the goal of expanding SmartAC to include 400,000 customers that can provide 300 MW of load relief by 2010. The testimony reads:

> PG&E proposes a market penetration of approximately 28 percent of the customer AC population, or approximately 400,000 customers, which equates to roughly 300 megawatts (MW) of DR by 2010. The penetration rate is consistent with fully developed and marketed programs in other parts of the country. PG&E will focus its enrollment efforts in hot climate zones. The AC program will be maintained through at least 2020 through the enrollment of approximately 28,000 new customers per year to accommodate any attrition that has taken place over the previous year(s).[5]
>
> ------
>
> [5] Assumes a 7 percent attrition rate. This figure is comprised of a 5 percent loss due to customers moving and a 2 percent loss due to customer drop-out

The overall savings estimates are based on the following *per capita* assumptions:

Table 3-2
SmartAC Savings Assumptions

Line No.	Customer Segment	AC Size (tons)	PCT Impact (kW) With 4 Degree Set Back	Switch Impact (kW) 50% Cycling Residential 35% Cycling C&I
1	Residential	4	1.10	1.10
2	C&I Below 20 kW	4	0.88	1.12
3	C&I 20-200 kW	7	1.54	1.96

Source: Table 4-3: "Average Hourly Event Demand Savings Assumptions per Enrolled Customer for PG&E's AC program prior to adjustments for Attrition, Equipment Operation, and CPP Program Participation." Pacific Gas and Electric Company's Air Conditioning Direct Load Control Program Prepared Testimony. Public Version. April 6, 2007.

3.3 SmartAC Tariffs

The key elements of the SmartAC tariff (eligible participants, cycling parameters, and number of annual event-hours) are presented in Table 3-1, above.

The full text of the residential SmartAC tariff is presented in Appendix A.

3.4 Technology Options

The Program offers two types of devices: adaptive switch, and programmable thermostat.

For most of 2007, program participants were exposed to information regarding both technologies, and allowed to select one of the devices. Subsequently, PG&E changed its marketing approach to offer only one device type at a time, and offer the second device type only if there was no response to the first one. It is possible that the choice of technology may be a proxy for behavioral differences that are not accounted for in this evaluation.

The thermostats and switches used by the PG&E SmartAC program share only basic similarities. Both technologies use one-way communication capabilities to remotely control usage at the AC unit. Each technology can be communicated with via a paging device and activated and de-activated for a program event. Neither the switches nor the thermostats have two-way communication capabilities.

Beyond these basic similarities, each device type offers a different array of characteristics. The thermostat option offered by the program replaces a participant's existing thermostat(s) with a programmable thermostat which is advertised as a $200 device. The programmable thermostat provides the participant the additional functionality of web-based access to remotely change the home AC settings. Installation of the thermostat requires an indoor visit by a technician.

The switch technology offered by the SmartAC program is installed at the AC unit. The installation of the switch generally does not require an indoor visit. The switch provides the participants no additional functionality. The switch may be effectively invisible to the participant.

The different features of these two control technologies give PG&E flexibility in their marketing efforts. Participants may be motivated by monetary value and functionality (thermostat) or privacy and invisibility (switch). A choice of control technologies allows PG&E to cater to a wider range of potential participants.

3.4.1 Control Mechanism

Thermostats and switches control AC usage in different ways. In general, switches control AC unit compressor run-time while thermostats control indoor temperature.

3.4.1.1 Switches

Switches directly control operation of the AC compressor. Old-design switches, described elsewhere in this document as “legacy” switches, control AC usage by limiting potential compressor run-time or duty cycle to a maximum amount during a time period. The duty cycle is the compressor run-time as a fraction of the total time period of interest. For a 50% control level, for instance, the unit will only be able to run a maximum of half of the time, i.e. maximum 50% duty cycle. Most commonly, programs with 50 percent control level limit run-time to 15 minutes per half hour (50% * 30 min = 15 minutes of control). All avoided run-time above 15 minutes per half hour represents load reduction. This could amount to 15 minutes of impact per half an hour if the unit would have been running full time. Load reduction will be less if the unit would have been running less than full time. A unit running at only 50 percent duty cycle or less without control, however, will adjust to the schedule enforced by the switch but will provide essentially no load reduction for the program.

The program-level effectiveness of traditional switches is limited by AC units that are not to running full time. Oversized units and mild weather both cause “natural”, un-controlled run-times to be less than full time, thus lowering the avoided run-time. Oversizing, in particular, is an issue that undermines load reduction even under the extreme conditions that motivate a DLC program event. This limitation to the effectiveness of traditional switches has led to a new generation of adaptive switches designed to adjust to the natural duty cycle of the AC unit. The PG&E SmartAC Program uses Cannon's TrueCycle technology adaptive switch.

The adaptive switches address the traditional switch limitation by "learning" the run-time behavior of the unit. The program administrator or system operator chooses learning days that have the characteristics of potential event days. The switches apply a proprietary algorithm to the observed amount of run-time on these learning days, in order to estimate expected run-time. The switches use this expected run-time to determine a more appropriate control level.

The success of the adaptive switch in overcoming the limitations of the traditional switch relies on the estimate of expected duty cycle. At the beginning of the cooling season, or any time the calculation process fails for a unit, the default "expected" estimate of duty cycle for any hour is 100 percent. Under these default conditions, the TrueCycle switch control is identical to that of the traditional switch. As learning days are identified, an average duty cycle is calculated that includes the observed duty cycle from the learning day. PG&E's technology vendor indicates that they generally use a weight of one eighth for a single learning day. If fewer than eight learning days have been identified then the remaining days included in the mean calculation are assumed to be at the default of 100 percent. Using this approach a rolling estimate of expected duty cycle for each hour is maintained for each AC unit. These estimates are supposed to represent expected duty cycle under the extreme conditions likely for program event days. This vendor also indicates that the expected duty cycle may be adjusted to pre-event duty cycle levels[11].

The TrueCycle adaptive technology has a number of implications for the estimation of load impacts. Most importantly, traditional switch performance is the lower bound for the adaptive switches. That is, the smallest reduction would be obtained if the natural duty cycle is estimated to be 100%, so that the run-time is controlled to 50% duty cycle, just as for a traditional 50% cycling switch. If the natural duty cycle estimate is anything lower than 100%, the run-time will be controlled to a lower level, so that the load reduction will be greater. Thus, the adaptive load reduction can only improve on that offered by the traditional switches. In this respect, the TrueCycle technology has the potential to address the limitations of traditional switches with essentially no risk of decreasing load reduction.

Finally, it is important to reiterate two switch characteristics in the context of the discussion of the effectiveness of load reduction. Switches are essentially invisible to the participant. A light on the switch indicates control mode, but few participants will notice this as the switch is

[11] The mechanics of the adjustment to pre-event duty cycle levels were not provided.

installed at the AC unit. Furthermore, as the switch is designed to provide regular periods of control, it also provides regular periods of cooling. The operating characteristics of the switch technology facilitate the "invisibility" of the process even under event conditions.

On the other hand, switches do not directly control indoor temperature. The increase of indoor temperatures will be a function of the controlled unit run-time, outdoor temperature, and premise and household characteristics. Across participants, the range of indoor temperature increase will vary.

3.4.1.2 Thermostats

A programmable thermostat directly controls indoor temperature. When activated to event mode, the thermostat increases the temperature level at which the AC unit starts cooling. The unit may turn off if already in cooling mode. If the unit is already off, it may remain off for a longer period so as to allow the thermostat to reach the new, higher set-point temperature. Using the thermostat set-point as the focus of control puts the premium on controlling the increase in indoor temperatures. No participant experiences an indoor temperature increase greater than the set-point change. In theory, increasing the thermostat set-point provides a consistent change in comfort level across the participating population regardless of house and AC unit characteristics.

As indicated, the direct control of thermostat set-point has an indirect effect on AC energy usage. How an AC unit responds to the set-point increase will be a function of the pre-event cooling regime, the cycling schedule of the AC unit, house-specific characteristics affecting the rate of indoor heat gain, and the amount of set-point increase. The most common scenario involves the AC unit turning off (or staying off) until the indoor temperature reaches the level of the higher set-point. For this period, while the house warms to the new set-point equilibrium, program-related savings are 100 percent of the pre-program usage. Once the new equilibrium is reached, the AC unit returns to cycling behavior necessary to maintain cooling at this higher set-point. As AC usage is a function of the indoor-outdoor temperature difference, usage at the new set-point will be reduced relative to pre-event usage levels. However, compared to the interim period of readjustment, the energy usage at this new equilibrium temperature will be greater.

In some cases, the thermostat re-set process has an additional complication, which occurs when the uncontrolled set-point varies over the duration of the control period. In such situations, the revised set-point is set at a fixed level across the control period; that level is calculated by adding the re-set amount to the lowest set-point during the event period. Since the thermostat cannot determine a separate setback for each of the thermostat's settings, it does this to comply with the SmartAC tariff, which requires that PG&E setback the thermostat 4 degrees or less. Assume for example that the uncontrolled set-point was set at 80 degrees F until 5 pm, and 75 degrees from 5 pm onward. An event starting at 3 pm, that calls for a 4 degree setback, would change this thermostat's setting to 79 degrees across the entire control period, while the occupant-defined setting is 80 degrees. Assuming the day is hot enough that cooling would be required to bring the house to the revised daytime set-point, the thermostat re-set generates negative load impacts (increased usage) by cooling the house to a lower temperature than if it had been left uncontrolled. The potential for negative load impacts if the natural set-point varies over the control period applies to both ramped and single-reset strategies.

In 2007, the SmartAC program chose to use a ramping strategy for program thermostat participants in the event of full program activations. Once the program was deployed the ultimate strategy chosen imposed an increase of 1°F at the beginning of the first, third, and fifth hours of the event[12].

Seeking to improve thermostat impacts that were lower than expected in 2007, in 2008 the SmartAC program changed its program-wide thermostat control strategy to legacy switch-style cycling. The program's thermostats do not have adaptive cycling capabilities, but can be operated as a 50% non-adaptive control[13].

[12] The 2007 report refers to this strategy as the "gradual" strategy. For the purpose of testing the ramping strategy concept, PG&E identified a second, more aggressive ramping strategy to be tested only on the M&V sample which was referred to as the "steep" strategy. The steep strategy increased the set-point 1°F at the beginning of each of the first four hours.

[13] In 2008, the M&V sample tested a third set-point control strategy, referred to as the "2-1-1 ramp." The 2-1-1 ramp increased the set-point 2°F at the beginning of the first four hour, and 1°F each at the beginning of the second and third hours.

4. Sample Design and Data Utilized in this Evaluation

4.1 Sample Design

This section presents an overview of the 2007 SmartAC end-use metering sample, and a detailed description of the corresponding 2008 sample.

The original specifications for this study called to have the same sample participants in 2007 and 2008. In 2008, the project's scope was augmented to address the rapid growth of the program, include the new geographic areas to which the program expanded, and address new requirements imposed by the Protocols and the Settlement Agreement of December 18, 2007 (approved in February, 2008) regarding PG&E's Application for Direct Load Control programs 2008-2020[14] ("the Settlement Agreement"). The new scope included re-recruiting as many of the 2007 sample participants as possible, and supplementing this repeat sample with sample sites in other areas and strata as necessary.

4.1.1 2007 Sample

The 2007 sample was stratified by type of device (PCT or switch), total number of cooling tons from all units (less than four, or four or more), and multiple units (yes or no). The sample design, design sample sizes, and installed sample sizes are presented in Table 4-1.

The 2007 sample consisted of 297 program participants (146 PCTs and 151 switches), amounting to 352 air conditioning units.

[14] Application No. 07-04-009 of Pacific Gas And Electric Company (U 39-E) for Approval of 2008-2020 Conditioning Direct Load Control Program. Settlement Agreement Between and Among Pacific Gas and Electric Company, The Division of Ratepayer Advocates and The Utility Reform Network. December 18, 2007.

Table 4-1
2007 SmartAC Sample Design

Stratum	Type Of Device	Total Tons From All Units	Multiple AC units on site (1=Yes)	Program Participants as of 06/11/2007	Design Sample Size	Design Number of Loggers	Number of Metered Homes	Number of Metered AC Units
1	PCT	<4	0	483	93	93	88	90
2	PCT	<4	1	6	3	6	2	4
3	PCT	>=4	0	148	37	37	39	39
4	PCT	>=4	1	34	17	34	17	37
5	Switch	<4	0	1,404	77	77	72	73
6	Switch	<4	1	21	5	10	5	10
7	Switch	>=4	0	637	54	54	53	53
8	Switch	>=4	1	123	17	34	21	46
Totals				2,856	303	345	297	352

After sample attrition and data cleaning, there were 254 homes with 297 loggers available for analysis. Details of the 2007 sample are available in the 2007 Final Report[15].

4.1.2 2008 Sample

In 2008, Pacific Gas & Electric expanded the measurement and verification work conducted for the SmartAC program in accordance with the Settlement Agreement, with the following specifications:

- Load data collection that will produce estimates at the 90% confidence, 10% precision ("90/10") at the program level, at time of system peak.
- Stratification by climate zone and home vintage, with the purpose of generating load impact estimates by these categories.

Based on the results obtained in the 2007 study, KEMA determined that a sample of about 520 sites, including 690 air conditioning units, would provide 90/10 precision at the program level.

As in 2007, sampling was conducted at the participating premise level. For premises with multiple AC units, all participating units were metered. During the 2007 project initiation meeting, it was discussed that PG&E was particularly interested in residences with 4 tons of cooling or more. Savings per unit and override behavior are likely to be different when there are multiple units in a home. Considering this, the 2008 sample design stratifies by device type (Switch vs.

[15] KEMA, Inc. *Final Report - Pacific Gas and Electric SmartAC Load Impact Evaluation.* Program Year 2007. Available at www.calmac.org (CALMAC Report Id PGE0262.02)

PCT)[16], and total cooling tonnage at the site (under 4 tons, 4 tons or more, and homes with multiple units.) In addition, climate zone and building vintage were added to the stratification scheme.

The sample design was based on program installation data as of March 25, 2008.

The target sample size (the sample size estimated to produce 90/10 estimates at the program level) was increased by almost 11%, to cover potential data losses. PCTs received a more than proportional number of these extra sample sites, to improve the estimates of an experiment designed to assess the load impact differences between two different PCT control strategies. This experiment is described in Appendix D.

Table 4-2 presents the sample design that was employed in 2008. The table shows the following variables:

- Stratification variables:
  - Device: Thermostat or Switch
  - PG&E climate zone: R, S, or X[17]
  - Total tonnage (size) of the cooling unit(s): small (under 4 tons), large (4 tons or more), and multiple units.
  - Year of construction: pre-1987, 1987 to 1997, or post-1987
- Residential program participants as of March 25, 2008. The sample design was based on this snapshot of the population

[16] In 2007, the sample size was designed with an approximately equal number of PCTs and Switches, despite the fact that there were more program participants electing Switches than PCTs. In 2008, the number of sample sites was allocated proportionally.

[17] PG&E has four climate zones: R, S, T, and X. Climate zone T is excluded from this analysis because SmartAC was not active in it in 2008. Climate zone T is the Northern California coastal area, not expected to have substantial cooling loads.

PG&E's climate zones are based on PG&E's baseline territories. A map of these territories is available at http://www.pge.com/nots/rates/PGECZ_90Rev.pdf.

- Returning sample sites from 2007. Customers that participated in the 2007 M&V sample were solicited to participate again. There were 229 customers (or 77% of the 2007 sample) that agreed to be part of the 2008 sample

- Target sample size for each sampling cell (the sample size estimated to produce 90/10 accuracy at the program level)

- Number of installed sample sites: number of residences at which loggers were installed.

- Number of installed loggers: total number of loggers deployed at those residences.

Table 4-2
SmartAC M&V Sample Stratification and Sample Size

<table>
<tr><th>Stratum</th><th>Device</th><th>PG&E Climate Zone</th><th>Size (Small = less than 4 tons, large = 4 tons or more, multi = multiple units)</th><th>Year of construction</th><th>Program participants as of March 25, 2008</th><th>Returning sample sites from 2007 M&V</th><th>Target sample sites</th><th>Number of installed sample sites</th><th>Number of installed loggers</th></tr>
<tr><td>1</td><td>PCT</td><td>R</td><td>Large</td><td>1987-1997</td><td>165</td><td></td><td>3</td><td rowspan="2">8</td><td rowspan="2">8</td></tr>
<tr><td>2</td><td>PCT</td><td>R</td><td>Large</td><td>post 1997</td><td>116</td><td></td><td>2</td></tr>
<tr><td>3</td><td>PCT</td><td>R</td><td>Large</td><td>pre 1987</td><td>427</td><td></td><td>7</td><td>10</td><td>10</td></tr>
<tr><td>4</td><td>PCT</td><td>R</td><td>Multi</td><td>1987-1997</td><td>96</td><td></td><td>2</td><td rowspan="3">14</td><td rowspan="3">28</td></tr>
<tr><td>5</td><td>PCT</td><td>R</td><td>Multi</td><td>post 1997</td><td>63</td><td></td><td>2</td></tr>
<tr><td>6</td><td>PCT</td><td>R</td><td>Multi</td><td>pre 1987</td><td>296</td><td></td><td>7</td></tr>
<tr><td>7</td><td>PCT</td><td>R</td><td>Small</td><td>1987-1997</td><td>735</td><td></td><td>12</td><td>16</td><td>16</td></tr>
<tr><td>8</td><td>PCT</td><td>R</td><td>Small</td><td>post 1997</td><td>324</td><td></td><td>5</td><td>8</td><td>8</td></tr>
<tr><td>9</td><td>PCT</td><td>R</td><td>Small</td><td>pre 1987</td><td>2,785</td><td></td><td>45</td><td>46</td><td>46</td></tr>
<tr><td>10</td><td>PCT</td><td>S</td><td>Large</td><td>1987-1997</td><td>307</td><td>8</td><td>5</td><td>8</td><td>8</td></tr>
<tr><td>11</td><td>PCT</td><td>S</td><td>Large</td><td>post 1997</td><td>224</td><td>7</td><td>4</td><td>6</td><td>6</td></tr>
<tr><td>12</td><td>PCT</td><td>S</td><td>Large</td><td>pre 1987</td><td>371</td><td>19</td><td>6</td><td>19</td><td>19</td></tr>
<tr><td>13</td><td>PCT</td><td>S</td><td>Multi</td><td>1987-1997</td><td>90</td><td>5</td><td>2</td><td>6</td><td>13</td></tr>
<tr><td>14</td><td>PCT</td><td>S</td><td>Multi</td><td>post 1997</td><td>82</td><td>3</td><td>2</td><td>3</td><td>6</td></tr>
<tr><td>15</td><td>PCT</td><td>S</td><td>Multi</td><td>pre 1987</td><td>109</td><td>8</td><td>3</td><td>8</td><td>15</td></tr>
<tr><td>16</td><td>PCT</td><td>S</td><td>Small</td><td>1987-1997</td><td>737</td><td>9</td><td>12</td><td>8</td><td>8</td></tr>
<tr><td>17</td><td>PCT</td><td>S</td><td>Small</td><td>post 1997</td><td>373</td><td>12</td><td>6</td><td>11</td><td>11</td></tr>
<tr><td>18</td><td>PCT</td><td>S</td><td>Small</td><td>pre 1987</td><td>1,853</td><td>35</td><td>30</td><td>34</td><td>34</td></tr>
<tr><td>19</td><td>PCT</td><td>X</td><td>Large</td><td>1987-1997</td><td>142</td><td></td><td>2</td><td rowspan="3">15</td><td rowspan="3">15</td></tr>
<tr><td>20</td><td>PCT</td><td>X</td><td>Large</td><td>post 1997</td><td>43</td><td></td><td>1</td></tr>
<tr><td>21</td><td>PCT</td><td>X</td><td>Large</td><td>pre 1987</td><td>379</td><td></td><td>6</td></tr>
<tr><td>22</td><td>PCT</td><td>X</td><td>Multi</td><td>1987-1997</td><td>102</td><td></td><td>2</td><td rowspan="3">7</td><td rowspan="3">15</td></tr>
<tr><td>23</td><td>PCT</td><td>X</td><td>Multi</td><td>post 1997</td><td>62</td><td></td><td>2</td></tr>
<tr><td>24</td><td>PCT</td><td>X</td><td>Multi</td><td>pre 1987</td><td>133</td><td></td><td>3</td></tr>
<tr><td>25</td><td>PCT</td><td>X</td><td>Small</td><td>1987-1997</td><td>323</td><td></td><td>5</td><td rowspan="2">11</td><td rowspan="2">11</td></tr>
<tr><td>26</td><td>PCT</td><td>X</td><td>Small</td><td>post 1997</td><td>79</td><td></td><td>1</td></tr>
<tr><td>27</td><td>PCT</td><td>X</td><td>Small</td><td>pre 1987</td><td>1,209</td><td>2</td><td>20</td><td>26</td><td>26</td></tr>
<tr><td>28</td><td>Switch</td><td>R</td><td>Large</td><td>1987-1997</td><td>205</td><td></td><td>3</td><td rowspan="2">6</td><td rowspan="2">6</td></tr>
<tr><td>29</td><td>Switch</td><td>R</td><td>Large</td><td>post 1997</td><td>219</td><td></td><td>3</td></tr>
<tr><td>30</td><td>Switch</td><td>R</td><td>Large</td><td>pre 1987</td><td>570</td><td></td><td>9</td><td>9</td><td>9</td></tr>
<tr><td>31</td><td>Switch</td><td>R</td><td>Multi</td><td>1987-1997</td><td>95</td><td></td><td>2</td><td rowspan="3">12</td><td rowspan="3">24</td></tr>
<tr><td>32</td><td>Switch</td><td>R</td><td>Multi</td><td>post 1997</td><td>123</td><td></td><td>3</td></tr>
<tr><td>33</td><td>Switch</td><td>R</td><td>Multi</td><td>pre 1987</td><td>223</td><td></td><td>5</td></tr>
<tr><td>34</td><td>Switch</td><td>R</td><td>Small</td><td>1987-1997</td><td>740</td><td></td><td>12</td><td>12</td><td>12</td></tr>
<tr><td>35</td><td>Switch</td><td>R</td><td>Small</td><td>post 1997</td><td>413</td><td></td><td>7</td><td>7</td><td>7</td></tr>
<tr><td>36</td><td>Switch</td><td>R</td><td>Small</td><td>pre 1987</td><td>2,608</td><td></td><td>42</td><td>42</td><td>42</td></tr>
<tr><td>37</td><td>Switch</td><td>S</td><td>Large</td><td>1987-1997</td><td>749</td><td>14</td><td>12</td><td>14</td><td>14</td></tr>
<tr><td>38</td><td>Switch</td><td>S</td><td>Large</td><td>post 1997</td><td>1,022</td><td>14</td><td>16</td><td>14</td><td>14</td></tr>
<tr><td>39</td><td>Switch</td><td>S</td><td>Large</td><td>pre 1987</td><td>917</td><td>10</td><td>15</td><td>10</td><td>10</td></tr>
<tr><td>40</td><td>Switch</td><td>S</td><td>Multi</td><td>1987-1997</td><td>184</td><td>6</td><td>4</td><td>6</td><td>14</td></tr>
<tr><td>41</td><td>Switch</td><td>S</td><td>Multi</td><td>post 1997</td><td>231</td><td>5</td><td>6</td><td>4</td><td>8</td></tr>
<tr><td>42</td><td>Switch</td><td>S</td><td>Multi</td><td>pre 1987</td><td>208</td><td>10</td><td>5</td><td>10</td><td>20</td></tr>
<tr><td>43</td><td>Switch</td><td>S</td><td>Small</td><td>1987-1997</td><td>1,475</td><td>10</td><td>23</td><td>14</td><td>14</td></tr>
<tr><td>44</td><td>Switch</td><td>S</td><td>Small</td><td>post 1997</td><td>1,215</td><td>12</td><td>19</td><td>16</td><td>16</td></tr>
<tr><td>45</td><td>Switch</td><td>S</td><td>Small</td><td>pre 1987</td><td>3,074</td><td>36</td><td>49</td><td>43</td><td>44</td></tr>
<tr><td>46</td><td>Switch</td><td>X</td><td>Large</td><td>1987-1997</td><td>413</td><td></td><td>7</td><td rowspan="2">11</td><td rowspan="2">11</td></tr>
<tr><td>47</td><td>Switch</td><td>X</td><td>Large</td><td>post 1997</td><td>221</td><td></td><td>4</td></tr>
<tr><td>48</td><td>Switch</td><td>X</td><td>Large</td><td>pre 1987</td><td>936</td><td>2</td><td>15</td><td>17</td><td>17</td></tr>
<tr><td>49</td><td>Switch</td><td>X</td><td>Multi</td><td>1987-1997</td><td>198</td><td></td><td>5</td><td rowspan="2">10</td><td rowspan="2">20</td></tr>
<tr><td>50</td><td>Switch</td><td>X</td><td>Multi</td><td>post 1997</td><td>136</td><td>1</td><td>3</td></tr>
<tr><td>51</td><td>Switch</td><td>X</td><td>Multi</td><td>pre 1987</td><td>232</td><td></td><td>6</td><td>7</td><td>15</td></tr>
<tr><td>52</td><td>Switch</td><td>X</td><td>Small</td><td>1987-1997</td><td>862</td><td></td><td>14</td><td rowspan="2">18</td><td rowspan="2">18</td></tr>
<tr><td>53</td><td>Switch</td><td>X</td><td>Small</td><td>post 1997</td><td>258</td><td></td><td>4</td></tr>
<tr><td>54</td><td>Switch</td><td>X</td><td>Small</td><td>pre 1987</td><td>1,941</td><td>1</td><td>31</td><td>32</td><td>32</td></tr>
<tr><td></td><td></td><td></td><td></td><td>TOTAL</td><td>31,093</td><td></td><td>521</td><td>578</td><td>670</td></tr>
</table>

4.2 Data Utilized in this Evaluation

This section describes the data used to complete this load impact evaluation, and their sources. The data includes:

- Program enrollment data
- End-use interval data, collected specifically for this EM&V process
- SmartAC M&V events
- Weather data from PG&E

4.2.1 Program Enrollment Data

Program tracking data files were provided by PG&E's implementation contractor. Site, work order, device and dropout data were received in separate datasets. Similar datasets were received in March, for the purposes of sample design, and in November, for the purposes of developing weights that were specific to each SmartAC event.

Important fields from the tracking data include:

- Site data
  - Customer ID
  - Structure size
  - Structure age
- Work order data
  - Date installed
- Device data
  - Type of device
  - Unit tonnage
- Dropout Data
  - Date removed

Unit tonnage is central to the load impact analysis presented in this report. Unit tonnage is relatively easy to collect from the unit nameplate and is strongly correlated with unit connected load. Impact results are calculated as impact per ton. As of November of 2008, 82.5 percent of the AC unit records in the tracking data included unit tonnage.

Structure size and structure age were important for the imputation process used to fill the missing unit tonnage data. Both fields were present for 90 percent of the units in the tracking data. Average unit tonnage was computed for each combination of structure size and structure age categories. This average was used to impute tonnage for records with missing tonnage values.

Date installed and removed determined the rolling program population total for any given event day. Units were assumed to be active the next day after installation.

Seasonal Energy Efficiency Ratio (SEER) would have been useful information to have. Unfortunately, SEER is frequently not available on the unit nameplate. Alternative approaches to finding SEER like model number look-ups are time-consuming and have some limitations. It is usual for DLC program evaluation to lack SEER data from program participants.

Table 4-3 provides a summary of the program tracking data as of July 8th, the day of the 2008 system peak. The table provides the number of sites and units, and the average tons across the full population, control technology sub-groups and single and multiple units.

Table 4-3

System Peak SmartAC Program Population Statistics, July 8th, 2008

	Program				Thermostat Control				Switch Control			
Category	All	Small	Large	Multi	All	Small	Large	Multi	All	Small	Large	Multi
Participant Sites	57,725	37,518	14,373	5,834	13,387	9,473	2,542	1,372	44,338	28,045	11,831	4,462
Units	63,789	37,518	14,373	11,898	14,710	9,473	2,542	2,695	49,079	28,045	11,831	9,203
Avergage Tons	3.3	2.9	4.4	3.2	3.2	2.8	4.3	3.1	3.4	2.9	4.4	3.2

4.2.2 End-use Interval Data

4.2.2.1 Onsite Data Collection

KEMA installed one-minute loggers on all units at the sites selected for the meter sample. The logger used was the HOBO Energy Logger Pro™ [18].

The logger uses a current transformer (CT), installed around a single leg of an air-conditioning unit, to monitor the voltage of the electromagnetic field produced by the alternating current. The loggers are programmed to convert that voltage reading into amperes ("amps".) The loggers used 20 and 50 amp CTs. The loggers captured a date/time stamp and amps.

Spot kW and power factor readings are also taken on site to allow conversion of the interval-metered amps to kW.

4.2.2.2 Logger Installation Quality Control

The 2008 procedure for installing and retrieving loggers was designed to optimize the collection of valid data. In particular, the procedure improved confidence that the logger was installed properly and that it was still properly recording data at the end of the data collection period.

KEMA developed a standard protocol followed for the installation of all loggers.

- At installation, with AC unit running, confirm logger records acceptable amp levels
- At retrieval, with AC unit running, confirm logger records acceptable amp levels
- At retrieval, with AC unit running, use true RMS kW meter to measure power factor

The installation protocol improved the likelihood that the logger was properly installed by providing immediate feedback to the installer. The test intervals from the installation remain on the logger and provide baseline amp level with which to compare later recorded values. The retrieval procedure ensured that the logger was still recording data properly *before the logger was removed from the unit*. The combination of these two procedures addressed one of the challenges of air conditioner metering – does zero usage indicate no usage of the AC unit or a malfunctioning logger. By guaranteeing that the logger was working properly at the beginning

[18] The HOBO Energy Logger Pro™ is a modular, reconfigurable data logging system which was combined with the S-FS-TRMSA FlexSmart TRMS Module to record an instantaneous amp reading every minute.

and the end of the logging period, we have great confidence that the data recorded on the logger is reliable.

Because air conditioners are an inductive load, the appropriate calculation of kW from amps uses both volts and power factor. When retrieving the loggers, technicians carried true RMS kW meters to measure the true kW and volts of the AC unit load. These measurements were recorded and used to transform the logged amps to true kW.

4.2.2.3 Interval Data Cleaning

Fourteen loggers were removed due to questionable data. These include three loggers with negative recorded readings. The remaining loggers were removed due to a combination of flags related to installation and data that did not conform to reasonable air conditioner usage.

The cleaning of individual loggers started with the trimming of the partial day at the beginning of the logging period and all data recorded after November 1st, when KEMA started collecting the loggers from the field. The test intervals from these first and last days were checked for consistency with the remainder of the logged data.

In addition to trimming the data, the data was checked for missing intervals. There were no missing data intervals present. The data do include a very small number of intervals that show higher load than is consistent with the energy use signature. These intervals are few in number and are consistent with an instantaneous read that coincided with the initial energy draw at the beginning of a duty cycle. While these few artificially high intervals are easily detected in the interval data plotted by hourly temperature, artificially low readings are difficult to impossible to discern. In the interest of not biasing cleaned data, these few possibly questionable intervals were not removed.

4.2.2.4 Final Logger Disposition

In total, 19 loggers were not retrieved. These loggers were either missing (stolen), destroyed, or access to the installation site was denied. In addition, a number of loggers were flagged for careful consideration in the cleaning process. These included sites where power was unavailable for the retrieval logger check and sites where the technician had concerns regarding the installation.

The final logger disposition is provided in Table 4-4.

Table 4-4
Logger Disposition

Loggers Installed	670
Unrecoverable logger: Stolen, broken, unable to access	-19
Logger removed from analysis: Bad or questionable data	-14
Left program, Device changed, Device not included in M&V event, Logger stopped recording	-12
Loggers Available for First Event	625

Table 4-5 provides the final strata counts of metered homes and AC units.

Table 4-5

Final, Post-Cleaning Number of Homes and AC Units by Strata, First Event, May 16th, 2008

Device Type	Climate Zone	Tonnage Category	Year of Construction	Counts	
				Sites	Loggers
PCT	R	Large	post 1987	8	8
PCT	R	Large	pre 1987	8	8
PCT	R	Multi	all	18	31
PCT	R	Small	1987-1997	14	14
PCT	R	Small	post 1997	8	8
PCT	R	Small	pre 1987	41	41
PCT	S	Large	post 1987	13	13
PCT	S	Large	pre 1987	18	18
PCT	S	Multi	all	17	32
PCT	S	Small	1987-1997	8	8
PCT	S	Small	post 1997	10	10
PCT	S	Small	pre 1987	31	31
PCT	X	Large	all	13	13
PCT	X	Multi	all	8	16
PCT	X	Small	post 1987	7	7
PCT	X	Small	pre 1987	25	25
Switch	R	Large	post 1987	6	6
Switch	R	Large	pre 1987	9	9
Switch	R	Multi	1987-1997	2	4
Switch	R	Multi	post 1997	4	8
Switch	R	Multi	pre 1987	7	13
Switch	R	Small	1987-1997	10	10
Switch	R	Small	post 1997	5	5
Switch	R	Small	pre 1987	38	38
Switch	S	Large	1987-1997	14	14
Switch	S	Large	post 1997	13	13
Switch	S	Large	pre 1987	9	9
Switch	S	Multi	1987-1997	6	14
Switch	S	Multi	post 1997	4	8
Switch	S	Multi	pre 1987	9	16
Switch	S	Small	1987-1997	14	14
Switch	S	Small	post 1997	15	15
Switch	S	Small	pre 1987	39	39
Switch	X	Large	1987-1997	8	8
Switch	X	Large	post 1997	2	2
Switch	X	Large	pre 1987	16	16
Switch	X	Multi	1987-1997	7	14
Switch	X	Multi	post 1997	3	6
Switch	X	Multi	pre 1987	7	14
Switch	X	Small	1987-1997	12	12
Switch	X	Small	post 1997	6	6
Switch	X	Small	pre 1987	29	29
			TOTAL	541	625

4.2.3 Sample Sizes Across Events

The number of sample sites that were used in this load impact analysis varied with each event. Table 4-6 includes the number of program participants and of available sample sites (sites that were active in the program and had good data) that were used for estimates on the first, the last, and the system peak events. It illustrates the increase in program population and the decline in sample sites available as the summer progressed.

The sample size declined for two main reasons: (1) sample participants that dropped out of the program entirely, either by choice or by moving out of the residence where they enrolled, and (2) sample participants that received new devices[19].

[19] The data assessment steps undertaken at the conclusion of the data collection phase revealed that a relatively large number of SmartAC devices were changed out during the cooling season. When the SmartAC device of a sample participant was replaced, KEMA was not notified. This means that the list of devices activated for subsequent events was not updated, which in turn means that sample participants with new devices did not receive the event signals.

Table 4-6
SmartAC Program Participants and M&V Sample Size
on the first event, the day of system peak event, and the last event

Device Type	Climate Zone	Tonnage Category	Year of Construction	Program Participants			Available Sites		
				5/16/2008	7/8/2008	10/16/2008	5/16/2008	7/8/2008	10/16/2008
PCT	R	Large	post 1987	278	279	274	8	8	7
PCT	R	Large	pre 1987	439	440	431	8	8	8
PCT	R	Multi	all	591	589	599	18	18	16
PCT	R	Small	1987-1997	718	710	694	14	14	12
PCT	R	Small	post 1997	317	314	298	8	8	7
PCT	R	Small	pre 1987	2863	2888	2866	41	41	37
PCT	S	Large	post 1987	593	600	598	13	13	12
PCT	S	Large	pre 1987	443	447	455	18	18	18
PCT	S	Multi	all	426	441	457	17	17	16
PCT	S	Small	1987-1997	828	831	833	8	8	8
PCT	S	Small	post 1997	397	393	390	10	10	9
PCT	S	Small	pre 1987	2187	2228	2243	31	30	30
PCT	X	Large	all	756	778	792	13	14	13
PCT	X	Multi	all	458	473	486	8	7	8
PCT	X	Small	post 1987	488	508	518	7	11	10
PCT	X	Small	pre 1987	1567	1625	1675	25	25	25
Switch	R	Large	post 1987	536	659	996	6	6	6
Switch	R	Large	pre 1987	1112	1498	1926	9	9	8
Switch	R	Multi	1987-1997	124	156	242	2	2	2
Switch	R	Multi	post 1997	146	169	252	4	4	4
Switch	R	Multi	pre 1987	549	763	964	7	7	7
Switch	R	Small	1987-1997	875	1011	1339	10	10	10
Switch	R	Small	post 1997	490	587	896	5	3	3
Switch	R	Small	pre 1987	4932	6532	8541	38	38	31
Switch	S	Large	1987-1997	943	1334	2037	14	14	11
Switch	S	Large	post 1997	1213	1641	2429	13	13	13
Switch	S	Large	pre 1987	1118	1742	2912	9	9	8
Switch	S	Multi	1987-1997	241	377	662	6	6	6
Switch	S	Multi	post 1997	293	446	731	4	4	4
Switch	S	Multi	pre 1987	288	513	984	9	9	8
Switch	S	Small	1987-1997	1756	2335	3324	14	14	14
Switch	S	Small	post 1997	1424	2133	3274	15	15	12
Switch	S	Small	pre 1987	3796	5789	10079	39	38	35
Switch	X	Large	1987-1997	1031	1200	1593	8	8	8
Switch	X	Large	post 1997	604	745	1089	2	2	2
Switch	X	Large	pre 1987	2391	3024	4224	16	17	16
Switch	X	Multi	1987-1997	481	583	848	7	7	7
Switch	X	Multi	post 1997	405	523	767	3	3	3
Switch	X	Multi	pre 1987	654	837	1196	7	7	7
Switch	X	Small	1987-1997	1811	2037	2496	12	12	12
Switch	X	Small	post 1997	676	824	1217	6	6	6
Switch	X	Small	pre 1987	5430	6825	9680	29	28	27
			TOTAL	46,668	57,827	78,307	541	541	506

4.2.4 SmartAC 2008 M&V Events

In 2008, PG&E conducted a program-wide event at the beginning of the cooling season, for system test purposes. PG&E and KEMA conducted eighteen sample-only events, for the sole purpose of collecting data for this evaluation.

The M&V event days were chosen according to criteria detailed in Appendix C.

Table 4-7 provides the relevant characteristics for the nineteen SmartAC events in the summer of 2008.

Table 4-7
2008 SmartAC Event Characteristics

Date	Day of Week	Maximum Temperature (ºF)	Event Begins	Event Ends	Hours	Which PCT Group Received Population (50% switch) Control	Sites	Units	Program Tons
5/16/2008	Fri	102	14:00	16:00	2	Both	46,699	51,430	171,049
6/17/2008	Tue	94	13:00	19:00	6	A	52,661	58,122	193,407
6/27/2008	Fri	90	11:00	17:00	6	B	55,570	61,362	204,304
7/8/2008	Tue	107	13:00	19:00	6	Both	57,725	63,789	212,458
7/9/2008	Wed	105	14:00	18:00	4	Both	58,063	64,168	213,719
7/14/2008	Mon	88	14:30	17:30	3	A	59,121	65,336	217,618
7/18/2008	Fri	92	13:30	17:30	4	B	60,596	66,982	223,114
7/30/2008	Wed	91	14:00	19:00	5	A	63,636	70,398	234,596
8/5/2008	Tue	88	14:00	18:00	4	B	65,627	72,650	242,132
8/11/2008	Mon	97	14:00	19:00	5	A	67,548	74,772	249,242
8/15/2008	Fri	101	14:00	19:00	5	B	69,001	76,400	254,514
8/21/2008	Thu	86	13:00	18:00	5	Both	70,587	78,154	260,447
8/25/2008	Mon	93	14:00	17:30	3	A	71,568	79,232	263,985
8/29/2008	Fri	104	15:00	18:00	3	Both	72,907	80,723	268,983
9/4/2008	Thu	100	14:00	18:00	4	B	73,281	81,179	270,610
9/15/2008	Mon	89	14:00	18:00	4	Both	75,515	83,732	279,361
9/25/2008	Thu	93	14:00	16:00	2	Both	77,702	86,207	287,798
10/2/2008	Thu	79	14:00	17:00	3	Both	78,403	86,999	290,433
10/16/2008	Thu	86	14:30	18:30	4	Both	78,074	86,647	289,302

4.2.5 Weather Data

PG&E provided 30-minute weather data for this analysis. The data covers the six weather stations that best described the prevailing weather at the SmartAC M&V sample sites. The dataset includes both dry-bulb temperature and relative humidity. Each sample site was mapped to a weather station through geographical variables available in PG&E's billing system[20].

This analysis uses weather data in a number of different forms. Temperature is used at the hourly level and at the daily level. Hourly temperatures capture the immediate ambient temperature while daily average temperature summarizes the range of temperatures experienced by the house through the day. Daily average temperature is particularly important

[20] PG&E assigns a weather station to each of its Division offices, and each PG&E customer is mapped to to a Division office.

because houses are temperature integrators. That is, they heat up and cool down more slowly than ambient temperatures.

In some parts of the country, humidity is a very important variable in determine cooling load. In California, humidity generally plays a secondary role. However, it is useful to include it to control for higher humidity when it does occur. In statistical models of cooling use, humidity is an important variable if it varies over the cooling season; it is less important to include it in the model if it is very stable over the season, even if it is consistently high.

Weather variables drive cooling and thus drive other program-related processes. Weather helps determine when the M&V sample is controlled to simulate a program event. SmartAC M&V events were called for two purposes: to facilitate system peak day impact estimates and to get a selection of event data that spanned the cooling season and a range of temperatures. Event day selection was successful on both counts for the 2008 cooling season.

In addition, weather also drives the selection of learning days used to inform the switches' adaptive algorithm. The learning days provide the switch information on the unit's natural duty cycle. The algorithm uses this information to determine the level of control to apply to the unit.

4.2.5.1 Weather and Learning Days

Figure 4-1 thru Figure 4-3 and Table 4-8 provide an overview of the weather in the three climates zones studied for this evaluation. The figures show the daily average temperature on the 25 hottest days of the summer, the M&V sample event days, and the days designated as learning days. If an event day is designated as a learning day, the device will reject it as a learning day. Both event days and learning days did take place on some of the 25 hottest days. As a result, the population of SmartAC program participants had a different set of learning days compared to the M&V sample participants. Figure 4-4 provides the same information for the Stockton area for the 2007 cooling season.

These plots and the table show that the summer of 2008 was a reasonably warm summer. The weather stations of Fresno, Stockton and Concord (East Bay), used to monitor weather in order to schedule M&V events, had at least 25 days over 85, 80 and 75 degrees, respectively. Comparing the Stockton plots from 2007 to 2008, they show similar weather across the two years. Extreme weather came later in 2007, but the range of the top 25 days is similar.

The 2008 plots indicate that PG&E was more aggressive in their selection of learning days in 2008. Five learning days were chosen in June and one of them was a day with a daily average temperature below 70º Fahrenheit across all three climate zones. Early, moderate learning day move the algorithm away from the default straight 50 percent cycling into the adaptive mode. It is difficult to assess the success of this strategy without a full understanding of the adaptive algorithm.

These figures and table support the following observations regarding the suitability of the data collected for this evaluation:

1) There were several learning days before all but the first event. This indicates that switches had information to develop their adaptive algorithm.

2) There were similar numbers of event and non-event days across the hot temperature days. Non-event days with high temperatures are crucial to adequately model reference loads.

3) There were several events on mild temperature days. These increase the range of conditions at which demand was observed.

4) There were several learning days that were also event days. These impose a different learning pattern for the sample than for the rest of the program participants.

Table 4-8

SmartAC 2008

25 Hottest Days, Event Days and Learning Days (all climate zones combined)

Date	Daily Average Temperature (degrees Farenheit)	Top 25	Learning Day	M&V Event
7/9/2008	90.2	X		X
7/8/2008	89.7	X		X
6/21/2008	88.6	X		
8/29/2008	88.5	X	X	X
7/10/2008	88.5	X		
6/20/2008	86.3	X		
8/28/2008	86.2	X	X	
5/16/2008	86.2	X		X
7/7/2008	86.1	X		
5/17/2008	85.0	X		
8/15/2008	84.4	X		X
9/6/2008	84.4	X		
8/14/2008	84.3	X	X	
8/13/2008	84.3	X	X	
5/15/2008	83.7	X	X	
9/5/2008	83.5	X	X	
8/27/2008	83.4	X	X	
9/7/2008	82.8	X		
9/4/2008	82.6	X		X
7/26/2008	82.5	X		
5/18/2008	81.9	X		
8/11/2008	81.4	X		X
6/19/2008	81.3	X		
6/13/2008	80.9	X	X	
7/6/2008	80.9	X		
8/25/2008	80.2			X
7/11/2008	78.3		X	
6/27/2008	77.8			X
6/12/2008	77.5		X	
9/25/2008	77.4		X	X
7/14/2008	77.4			X
6/10/2008	77.1		X	
5/19/2008	76.8		X	
5/14/2008	76.4		X	
7/18/2008	76.2			X
8/21/2008	76.1			X
7/30/2008	76.1			X
6/17/2008	75.4			X
8/5/2008	74.5			X
9/15/2008	74.4			X
8/8/2008	73.2		X	
10/2/2008	72.4			X
5/13/2008	70.4		X	
10/16/2008	69.7			X
5/21/2008	65.8		X	

Figure 4-1
2008 Climate Zone S (Stockton)
25 Hottest Days, Event Days and Learning Days

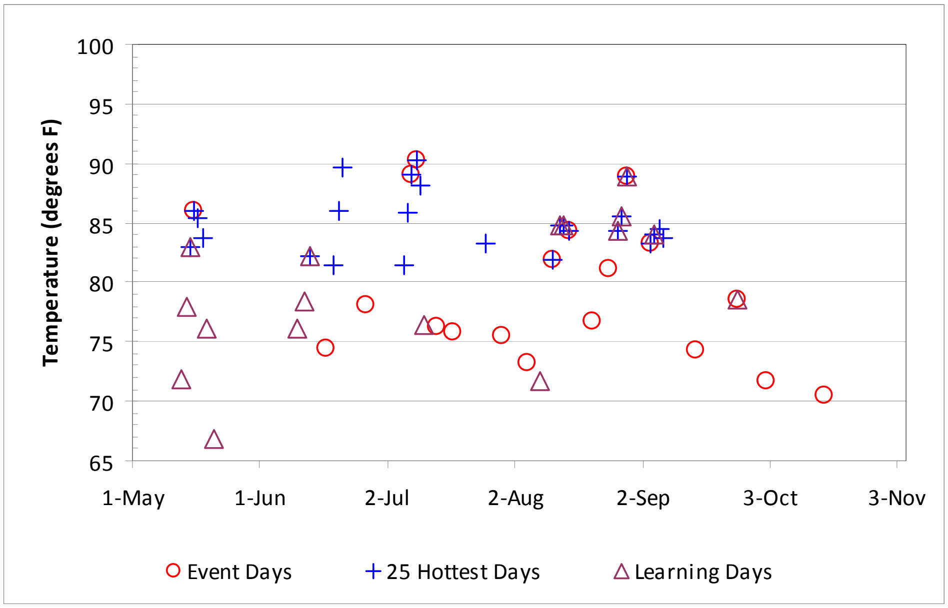


Figure 4-2
2008 Climate zone R (Fresno)
25 Hottest Days, Event Days and Learning Days

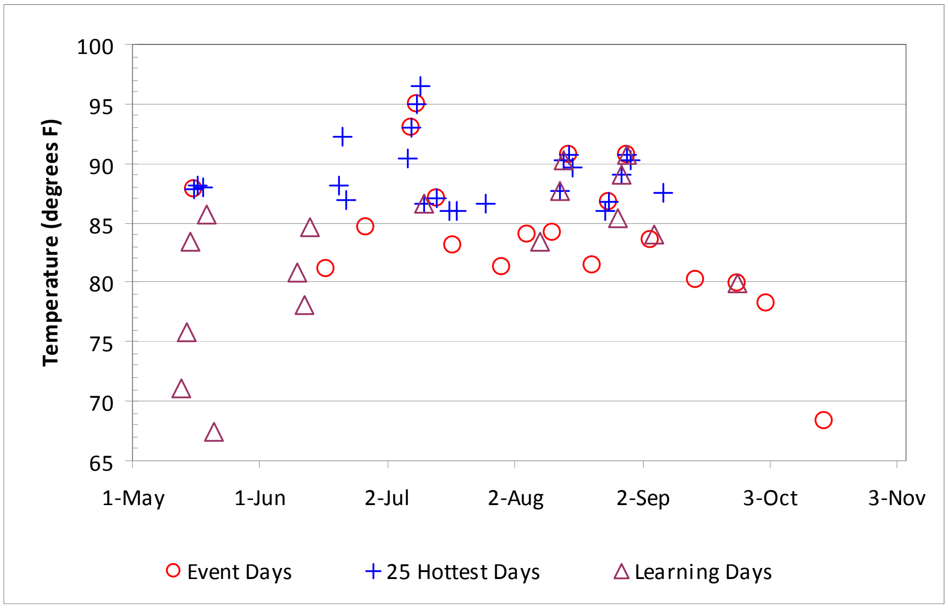


Figure 4-3
2008 Climate zone X (East Bay)
25 Hottest Days, Event Days and Learning Days

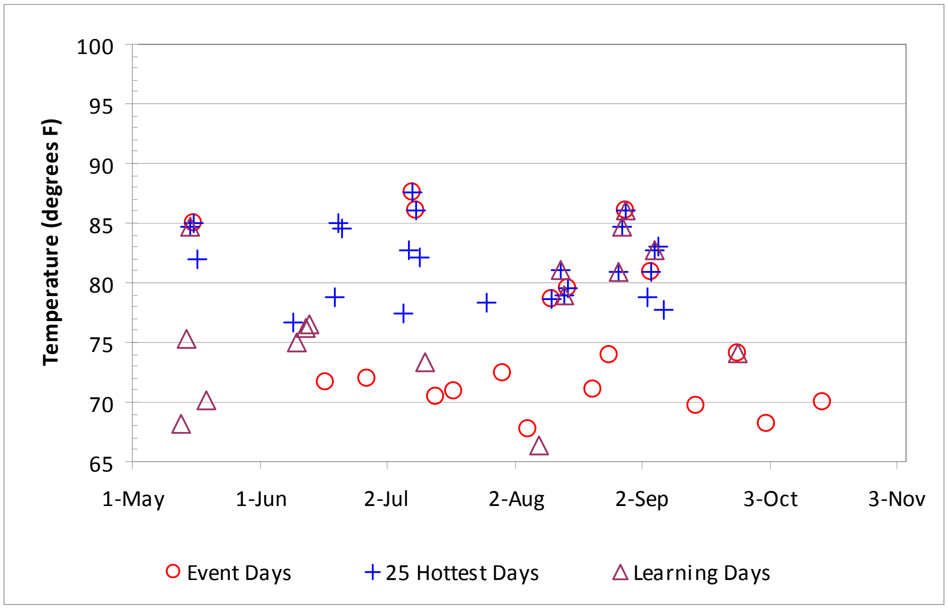
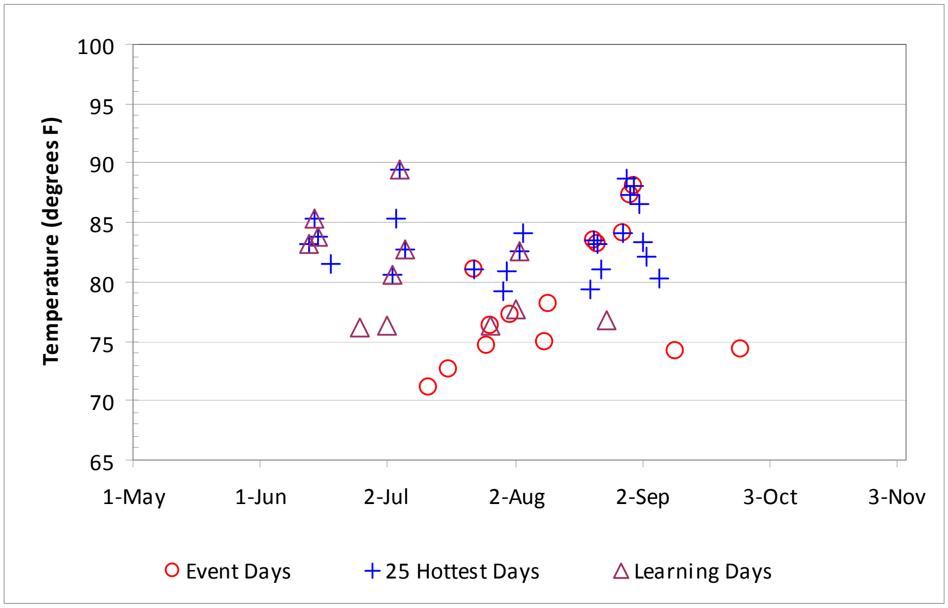


Figure 4-4
2007 Climate zone S (Stockton)
25 Hottest Days, Event Days and Learning Days



5. Load Impact Estimation Methodology

This section provides the methods used to estimate *ex post* and *ex ante* SmartAC load impacts. Section 5.1 provides the methodology for producing *ex post* results, and section 5.2 for the *ex ante* results.

5.1 *Ex Post* Load Impact Estimation

5.1.1 Overview

To develop the *ex post* impacts, we fit a model to the metered load data, to estimate load in the absence of a control event. Our estimation procedure uses the metering data to estimate two related sub-models of air conditioner response to weather.

1. Connected Load Model

Connected load is the instantaneous kW draw of the unit when the compressor is running. Connected load is often assumed to be constant, taken from nameplate specifications or a single spot kW reading. Prior studies including our own work have demonstrated a consistent linear trend of increasing connected load with ambient temperature, 1-2% increase per degree F, depending on the unit.[21]

The instantaneous 1-minute kW readings are either 0, if the compressor is not running, or the connected load, if it is running. Thus, each non-zero reading is a direct observation of the connected load. We model these non-zero observations as functions of current ambient temperature and relative humidity.

Figure 5-1 is an example for a typical unit. The figure shows:

a. The linear relationship between connected load and ambient temperature is very well determined.

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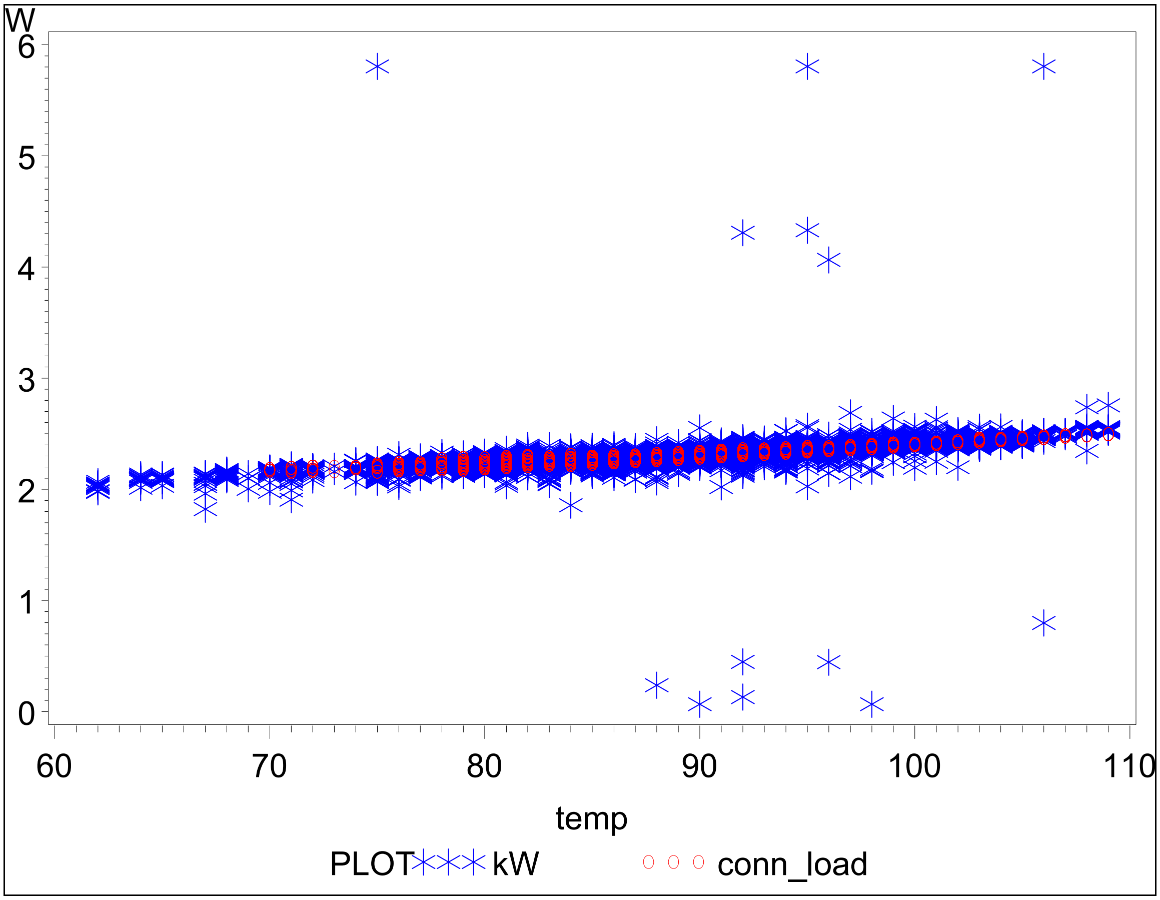
[21] See, e.g., Neal and O'Neal, 1992, "The Impact of Residential Air Conditioner Charging and Sizing on Peak Electrical Demand," in *ACEEE 1992 Summer Study on Energy Efficiency in Buildings,* pp 2.189-2.200.

b. A very small fraction (fewer than 0.04 %) of instantaneous readings fall in the space above the cloud of connected load data. Thus, this fitted line can be treated as an effective upper bound to the demand at a point in time or averaged over an interval.

Figure 5-1

Observed and Estimated Connected Load (kW) by Hourly Temperature.



2. Cooling Load Model

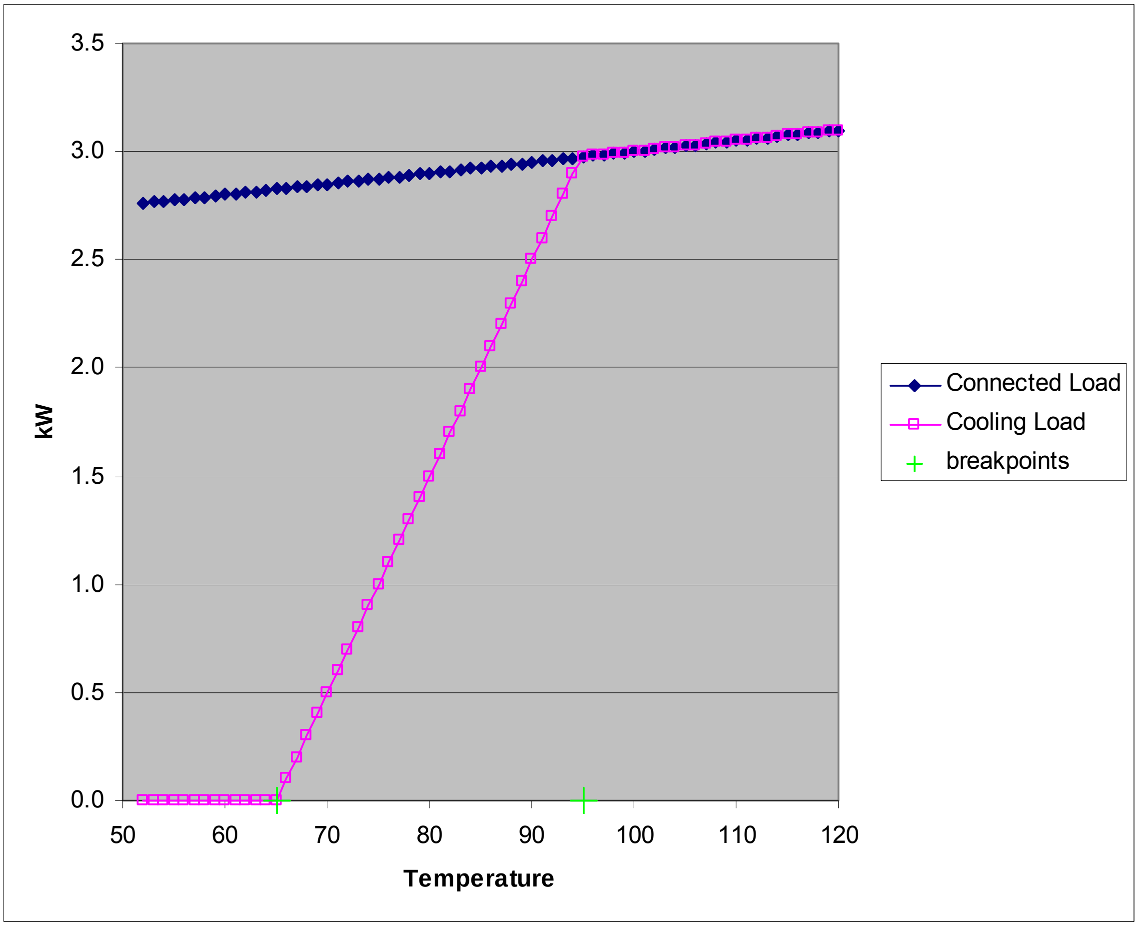
From the 1-minute instantaneous kW readings, we calculate hourly averages. For a given interval, this average reflects both the kW drawn when the unit is running (i.e., the connected load for the interval), and the fraction of time the unit runs during the interval (the duty cycle, indicated by the fraction of 1-minute observations that are nonzero).

The hourly average demand is estimated using a 2-breakpoint model. The first breakpoint is the home's base or reference temperature, the outside temperature above which air conditioning is required. This breakpoint is estimated for each unit as part of the model fit. We model hourly average kW as a function of cooling degree-days with respect to this reference temperature, and other terms.

The second breakpoint is the point above which the unit runs at 100% duty cycle, meaning that the average demand over an interval is equal to the connected load. This second breakpoint is estimated implicitly, by setting the model estimate equal to the minimum of the unconstrained estimate and the estimated connected load.

The overall cooling model is illustrated schematically in the figure below.

Figure 5-2
Cooling Load Model Illustration



The dark line at the top is the connected load, estimated from the non-zero 1-minute instantaneous kW readings. The pink line is the estimated cooling load model: it is 0 below the estimated reference temperature or lower break point, and linear in temperature above that, up to the capacity limit, the connected load line. Our model has more terms in it than temperature, but this schematic illustrates the structure.

5.1.2 Connected Load Model Specification

As noted, connected load increases with ambient temperature. That is, as ambient temperature increases, the compressor becomes slightly less efficient[22], so that the power needed to run motor increases slightly. Humidity also has an effect on the compressor's instantaneous demand. Thus, we model each unit's non-zero full load kW as a linear function of hourly temperature and humidity:

$$L*_{jphd} = \alpha_j + \beta_j F_{jhd} + \delta_j H_{jhd} + \varepsilon_{jphd}$$

Where:

$L*_{jphd}$	=	Connected load for unit *j* for minute *p*, day *d* , hour *h* ;
F_{jdh}	=	Dry bulb temperature (Fahrenheit) for day *d* and hour *h* for the weather station assigned to unit j;
H_{jhd}	=	Relative humidity for day *d* and hour *h* for the weather station assigned to unit j;
$\alpha_j, \beta_j, \delta_j$	=	Estimated connected load parameters for unit j;
ε_{jphd}	=	Residual error for unit j, minute p, hour h, day d.

The fitted values of this equation represent the connected load for that unit across the full range of cooling temperature and humidity. For most units j, connected load increases approximately one percent per degree Fahrenheit increase.

$$\hat{L}*_{jhd} = \hat{\alpha}_j + \hat{\beta}_j F_{jhd} + \hat{\delta}_j H_{jhd}$$

[22] As outdoor ambient temperature increases, the air conditioning unit cannot reject as much heat to the ambient outdoor air. This causes the temperature of the condensed refrigerant to rise, which in turn requires the compressor to work harder. Since the compressor needs to work harder, it will draw more power for the system to work and the efficiency of the system will decrease.

$\hat{L}*_{jhd}$	=	Connect load for unit *j* for day *d* , hour *h*
$\hat{\alpha}_j, \hat{\beta}_j, \hat{\delta}_j$	=	Estimated connected load model parameters for unit *j*

5.1.3 Cooling Load Model Specification

The cooling load model estimates unit-level load under normal (non-event) conditions as a function of temperature, humidity, and other variables that capture the different cooling levels across hour of the day, day of the week and months. The model provides an estimate of expected cooling load (the reference load) from which event impacts are calculated.

The model is primarily driven by temperature. More specifically, the model uses cooling degree days, which are calculated from daily average temperature and a base temperature. Base temperature represents the outdoor temperature at which the unit starts cooling. Because each unit reflects unique occupant cooling characteristics, it is essential to identify the appropriate temperature for each unit. For each unit, we estimate multiple versions of the model using degree days calculated from bases ranging from 70º to 90º F. The best model for each unit is chosen by comparing mean absolute percentage error for periods with unit load greater than 0.5 kW[23].

5.1.3.1 Unconstrained Cooling Load Model

We begin by fitting an unconstrained cooling model that ignores the upper breakpoint or capacity limit. The unconstrained cooling model is expressed by the following equation:

$$L_{jhd} = \alpha_{jh} + \beta_{jh} C_d(\tau_j) + \chi_{jh} LC_d(\tau_j) * C_{dh}(\tau_j) + \sum_{m=6}^{10} f_{md} \delta_{mjh} C_d(\tau_j) + \sum_{w=2}^{6} \phi_{wjh} I_{wd} C_d(\tau_j) + \gamma_{jh} H_{jhd} + \varepsilon_{jhd}$$

[23]Mean absolute percentage error approaches infinity as load approaches zero. Furthermore, intervals with non-zero load are the important intervals on which to assess model fit.

Where:

L_{jhd}	=	average AC load (kW) at hour *h* of day *d* for unit *j*;
$C_d(\tau_j)$	=	cooling degree-days at the cooling base temperature τ_j for unit *j*, on day *d*, based on daily average temperature;
$C_{dh}(\tau_j)$	=	cooling degree-hours at the cooling base temperature τ_j for unit *j*, on day *d*, hour *h* based on outside temperature at that hour;
$LC_{dh}(\tau_j)$	=	Lagged cooling degree-days and hourly cooling degree-days;
H_{jhd}	=	relative humidity for unit *j* at hour *h* for day *d*;
ε_{jhd}	=	regression residual;
f_{md}	=	Fraction of current month at each day. During month *m*, f_{md} ranges from zero to one and $f_{m+1,d}$ ranges from 1 to 0 as d ranges from the first day of month m to the first day of the month m+1. For months m that do not include day d or the following month, f_{md} is 0.
w	=	Day of week indicator, one dummy variable for each weekday, and one for weekends and holidays combined;
I_{wd}	=	0/1 dummy indicating that w is the day of week type for day d
$\alpha_{jh}, \beta_{jh}, \chi_{jh}, \delta_{mjh}, \phi_{wjh}, \gamma_{jh}$	=	coefficients determined by the regression; and
τ_j	=	base temperature determined by choice of the optimal regression.

The degree-day variables are calculated as:

$$C_d(\tau_j) = \max(F_d - \tau_j, 0)$$

Where F_d is daily average temperature calculated as the average of the daily maximum and minimum temperature Fahrenheit.

Similarly, the degree-hour variables are

Where the hourly cooling degrees $C_{dh}(\tau_j)$ are calculated from the hourly temperature F_{dh} as

$$C_{dh}(\tau_j) = \max(F_{dh} - \tau_j, 0).$$

Where F_{dh} is the temperature at hour he of day d.

Lagged cooling degree days $LC_d(\tau_j)$ are calculated as:

$$LC_d(\tau_j) = \left(10C_d(\tau_j) + 5C_{d-1}(\tau_j) + 2C_{d-2}(\tau_j)\right)/17$$

The lag terms account for both physical response to heat build-up in the premise over several days and behavioral changes in reaction to conditions over prior days. This particular average of degree-days for the current day and 1- and 2-day lags has weights that approximate a simple exponential decay. Physical lag effects are expected to decay exponentially. This particular decay rate was found to work well in previous work.

Lagged cooling degree days are entered in the model in a quadratic form, multiplying the lag term with hourly cooling degrees.The quadratic term allows for non-linear physical and behavior responses to weather conditions. The particular quadratic form entered offers a parsimonious model that combines several model elements in a single term: a quadratic form with an interaction between the exponentially lagged degree-days based on min-max average temperature, with current-hour degree-hours. Degree-days using daily average temperature are effective because to a large extent the dwelling does not respond instantaneously to outside temperature changes, but serves as a physical integrator over time. Degree-hours using current temperature are nonetheless helpful because there are some responses to the immediate temperature.

Because air conditioning load is affected by humidity, we also include hourly relative humidity in the model.

Each day of the week has its own set of cooling degree coefficients except for Saturday, Sunday, and Holidays which are combined. To capture seasonality effects, the model includes interactions of cooling with blended month variables, f_m. The monthly terms account for systematic changes over the season apart from the physical or behavioral response to particular weather conditions, which are captured by lag effects. For example, customers may delay turning cooling on in May, change how much time they spend at home, or become less tolerant of hot conditions as the summer progresses. The blended month variable allows us to account for a seasonal pattern across months in a smooth fashion, something that would not be possible with simple binary variables. To illustrate how f_m is calculated, we provide a few reference values in Table 5-1.

Table 5-1
Example of Blended Month Variable for Varying Dates *d* and Months *m*

Date	May	June	July	August	September	October	November
May/1	**0.0**	0.0	0.0	0.0	0.0	0.0	0.0
May/15	**0.5**	0.0	0.0	0.0	0.0	0.0	0.0
Jun/1	**1.0**	**0.0**	0.0	0.0	0.0	0.0	0.0
Jun/15	**0.5**	**0.5**	0.0	0.0	0.0	0.0	0.0
Jul/1	**0.0**	**1.0**	**0.0**	0.0	0.0	0.0	0.0
Jul/15	0.0	**0.5**	**0.5**	0.0	0.0	0.0	0.0
Aug/1	0.0	**0.0**	**1.0**	**0.0**	0.0	0.0	0.0
Aug/15	0.0	0.0	**0.5**	**0.5**	0.0	0.0	0.0
Sep/1	0.0	0.0	**0.0**	**1.0**	**0.0**	0.0	0.0
Sep/15	0.0	0.0	0.0	**0.5**	**0.5**	0.0	0.0
Oct/1	0.0	0.0	0.0	**0.0**	**1.0**	**0.0**	0.0
Oct/15	0.0	0.0	0.0	0.0	**0.5**	**0.5**	0.0
Nov/1	0.0	0.0	0.0	0.0	**0.0**	**1.0**	**0.0**

5.1.3.2 kW Estimated from the Unconstrained Cooling Load Model

The unconstrained cooling load model provides estimates of load calculated as:

$$\hat{L}_{jhd} = \hat{\alpha}_{jh} + \hat{\beta}_{jh} C_d\left(\hat{\tau}_j\right) + \hat{\chi}_{jh} LC_{dh}\left(\hat{\tau}_j\right) * C_{dh}\left(\hat{\tau}_j\right) + \sum_{m=6}^{10} f_{md}\hat{\delta}_{mjh} C_d\left(\hat{\tau}_j\right) + \sum_{w=2}^{6}\hat{\phi}_{wjh} I_{wd} C_d\left(\hat{\tau}_j\right) + \hat{\gamma}_{jh} H_{jhd} + \varepsilon_{jhd}$$

Where:

$\hat{L}_{jhd}$ = Unconstrained estimate of AC load at hour *h* of day *d* for unit *j*;

$\hat{\alpha}_{jh}, \hat{\beta}_{jh}, \hat{\chi}_{jh}, \hat{\delta}_{mjh}, \hat{\phi}_{wjh}, \hat{\gamma}_{jh}, \hat{\tau}_j$ = Estimated parameters from the cooling load model;

5.1.4 Estimated Cooling Load with the Full Model

The estimate of unit-level cooling load for each hour is a combination of the unit's unconstrained cooling load model estimate and its connected load estimate. The unconstrained cooling load model does not explicitly recognize connected load as the upper bound of unit cooling load. We use the unit's specific estimate of connected load for the hour's weather conditions as an explicit upper bound for modeled cooling load estimates, as indicated in Figure 5-2 above. Thus, the full model estimate of cooling load used for impact estimates is calculated as:

$$\overline{\overline{L}}_{jhd} = \min(\hat{L}_{jhd}, \hat{L}*_{jhd})$$

where

$\overline{\overline{L}}_{jhd}$	=	Estimated load for unit j on date d in hour h,
$\hat{L}_{jhd}$	=	Unconstrained load model estimate of load for unit j on date d in hour h,
$\hat{L}*_{jhd}$	=	Estimated connected load for unit j on date d in hour h

5.1.5 Individual Load Impacts

Individual unit impacts are calculated using the full model estimate of cooling load for each event hour and the observed load for that hour. Impacts are estimated as:

$$D_{jhd} = \overline{\overline{L}}_{jhd} - L_{jhd}$$

Where:

D_{jhd}	=	Estimated load impact for unit j on date d in hour h,
$\overline{\overline{L}}_{jhd}$	=	Estimated load for unit j on date d in hour h,
L_{jhd}	=	Observed load for unit j on date d in hour h

The cooling load model is estimated using hourly observations. Impacts are calculated for each 15-minute interval. The cooling load estimate is the same for each 15-minute interval in the hour. The impacts are calculated separately for each observed 15-minute average.

5.1.6 Aggregation to Population Estimates

Unit-level results are expanded to represent the full program population. We use a ratio estimation approach to aggregate estimates on a per ton basis. Ratio estimation has a number of advantages over a non-ratio based approach: improved precision, lower bias due to changes in population composition, and a direct estimate of impact per ton.

The ratio estimator is calculated as.

Equation 1

$$\frac{\overline{D}_{hd}}{\overline{T}} = \frac{\sum_{k=1}^{n_s}\sum_{c=1}^{n_k}\sum_{j=1}^{n_c} w_{kcj} D_{kcjhd}}{\sum_{k=1}^{n_s}\sum_{c=1}^{n_k}\sum_{j=1}^{n_c} w_{kcj} T_{kcj}}$$

Where:

$\overline{D}_{hd}/\overline{T}$	=	gross demand impact per ton of the average AC unit in the program population in hour *h* at daily average temperature *d,*
D_{kcjhd}	=	gross demand impact of the for AC *j* in hour *h* on day *d,*
T_{kcj}	=	tons for AC *j* in cluster *c* and strata *k*,
w_{kcj}	=	sampling weight for impact of AC *j*, identified as AC *k* in cluster *c* of stratum *k,*
k	=	stratum number with a total of n_k clusters,
c	=	cluster number within stratum *k*, with a total of n_c units
j	=	AC unit number within cluster *c* of stratum *k*,
n_s	=	Number of strata
n_k	=	number of clusters in stratum *k,*
n_c	=	number of units in cluster *c*,

With sampling weights calculated as:

$$w_{kcj} = \left(N_k \big/ n_k \right) \left(M_{kc} \big/ m_{kc} \right)$$

Where:

n_k = total number of clusters (sites) in meter sample, stratum *k*,

N_k = total number of clusters (sites) in program population, stratum *k*,

m_{kc} = Number of ACs in meter sample, stratum k and cluster c,

M_{kc} = Number of ACs in program population, stratumk and cluster c,

The ratio estimator result provides the estimate of unit load reduction per ton. The final estimate of unit load reduction for the events of the summer are calculated:

$$\overline{\overline{D}}_{hd} = \frac{\overline{D}_{hd}}{\overline{\overline{T}}} \overline{T^*}$$

Where $\overline{T^*}$ is the average or total tons for the population on the day of the event.

$\overline{\overline{D}}_{hd}$ = Average per unit or total program impact, depending on $\overline{T^*}$

$\overline{T^*}$ = Average or total tons for the population on the day of the event.

Load impact estimates were produced by a number of categories: device type, load control area, climate zone, square footage of house, year built, and for thermostats, the 50 percent cycling strategy compared to the ramping strategy. These estimates are produced using the ratio estimation approach described above.

5.1.7 Uncertainty Adjusted Load Estimates

In addition to the standard average estimate of load impacts, the Protocols require uncertainty adjusted load impact estimates.

The Protocols discuss a number of ways of calculating the uncertainty adjusted load impact estimates. This evaluation uses the first option listed, based on the use of the standard errors of the aggregate estimates of the load impact[24]. In the model used in this evaluation, the standard errors of the aggregated impact estimates encompass both between- and within-unit variances for the participants for each hour.

Each participant's impact estimate includes the estimation error for that participant (the error in estimating the participant's load.) This is the within-unit variance.

The standard errors explicitly measure the variation in impacts across participants – the between-unit variance. Thus the modeling errors for individual participants are entrained in the standard errors calculated across participants.

Using the aggregate standard errors to calculate uncertainty adjusted-load impacts requires that we assume that the aggregate estimation error is normally distributed with mean zero. That is, we exclude any explicit bias correction. This assumption is standard for regression-based error measures. The normal distribution assumption is reasonable for estimates that are averaged over large numbers of similar units. Bias is inherently not measurable, but the estimation process, including sampling, data collection, data cleaning, and model development and testing were designed to limit bias as much as possible. With this mean-zero normal distribution assumption, the uncertainty adjusted percentiles are simply the percentiles of a t distribution, based on the estimated standard errors and centered on the impact estimate for that hour.

5.1.8 Statistical Measures for the Day-Matching Method

The Protocols dictate "the calculation and reporting of statistical measures designed to reveal the statistical precision and extent of bias that may be present in the methods used to estimate impacts." Protocol 9 addresses day-matching *ex post* methods, and Protocol 10 does the same for regression-based methods.

The Protocol 9 methods produce statistical measures for *ex post* methods that are developed by constructing a reference load estimate for each unit and event day. Protocol 9 assumes that the reference load is constructed using matched days. However, the Protocol 9 calculations are equally applicable to and meaningful for any other method of constructing reference loads for each unit and event.

[24] Bullet 1, footnote 38, page 53 of the Protocols (*Load Impact Estimation for Demand Response: Protocols and Regulatory Guidance*. California Public Utilities Commission. Energy Division. April, 2008)

For *ex post* load impact estimation, KEMA uses regression-based, unit-level modeling of AC usage to estimate event day reference load. *Ex post* impacts are then estimated by comparing this estimated reference load to observed load levels during event hours. This estimated reference load can be assessed with criteria set forth in Protocol 9, just as if it had been constructed by day-matching methods.

This section provides the equations used to satisfy Protocol 9 statistical measures. The resulting statistics for Protocol 9, and the Protocol 10 measures that are based on standard regression, are presented elsewhere in this document.

5.1.8.1 Selection of Proxy Days

Proxy days are used to establish the accuracy of the impact estimation approach. In theory, the estimation approach ought to estimate a reference load that equals observed load on non-event days. The error associated with estimating load on proxy days is the basis of the statistical measures reported here.

Five proxy days were selected based on premise-level usage. Usage between the hours of 11 AM and 6 PM were summed across all sites in the sample. The six non-event, non-holiday weekdays with the greatest daily usage were chosen as proxy days.

5.1.8.2 Statistical Measure Equations

Protocol 9 provides equations for its statistical measures. We reproduce those equations here with clarifications that reflect the way the statistics were calculated for this report. A weight variable is included to makes these equations as general as possible.

5.1.8.2.1 Average Error

The first statistic is the average error across customers and proxy days, for each hour of the day. With sample weights, the formula becomes:

$$\bar{e}_h = \frac{\sum_{j=1}^{n_{cust}} \sum_{p=1}^{n_{days}} \left(L_{jph} - \bar{\bar{L}}_{jph} \right) \cdot w_j}{n_{cust} \cdot n_{days} \cdot \sum_{j=1}^{n_{cust}} w_j}$$

where:

j	=	the cross-sectional unit or customer
p	=	the event-like day

h	=	the hour of the day
L_{jph}	=	the actual load for the customer on the proxy day of interest for the hour of interest
$\bar{\bar{\hat{L}}}_{jph}$	=	the predicted load for the customer on the proxy day of interest for the hour of interest
n_{cust}	=	the total number of customers in the observation group
n_{days}	=	the total number of days in the observation group
w_j	=	the sample weight for each unit or customer

5.1.8.2.2 Relative Average Error

Associated with the previous measure is the relative weighted average error for each hour, across customers and proxy days. It is calculated as the ratio of the weighted average error to the weighted average actual load that occurred in the specific hour. Its formula is given by:

$$r\bar{e}_h = \frac{\bar{e}_h}{\dfrac{\sum_{j=1}^{n_{cust}} \sum_{p=1}^{n_{days}} L_{jph} \cdot w_j}{n_{cust} \cdot n_{days} \cdot \sum_{j=1}^{n_{cust}} w_j}}$$

Where:

j	=	the cross-sectional unit or customer
p	=	the event-like day
h	=	the hour of the day
$\bar{e}_h$	=	the average errors across customers and proxy days for the hour of interest
L_{jph}	=	the actual load for the customer on the proxy day of interest for the hour of interest
n_{cust}	=	the total number of customers in the observation group
n_{days}	=	the total number of days in the observation group
w_j	=	the sample weight for each unit or customer

5.1.8.2.3 Median Error

The Protocol also requires the median error to be reported. A weighted median error is the error corresponding to the center of the distribution of error weights, when the error weights are arranged in order of magnitude. In case there is a tie between two weights, the simple average between them is used.

$$\tilde{e}_h = \begin{cases} e_{jph+1} & \text{if } \sum_{i=1}^{j} w_i < 50\% \cdot \sum_{i=1}^{n_{cust}} w_i < \sum_{i=1}^{j+1} w_i \\ \frac{1}{2}(e_{jph} + e_{jph+1}) & \text{if } \sum_{i=1}^{j} w_i = 50\% \cdot \sum_{i=1}^{n_{cust}} w_i \end{cases}$$

where:

j	=	the cross-sectional unit or customer
p	=	the event-like day
h	=	the hour of the day
e_{jph}	=	the prediction error, $L_{jph} - \overline{\overline{L}}_{jph}$
n_{cust}	=	the total number of customers in the observation group
n_{days}	=	the total number of days in the observation group
w_j	=	the sample weight for each unit or customer

5.1.8.2.4 Relative Median Error

A relative weighted median error can be calculated by dividing the weighted median error by the weighted median load for each hour of the day. It is calculated as:

$$r\tilde{e}_h = \frac{\tilde{e}_h}{\tilde{L}_h}$$

where:

h	=	the hour of the day
$\tilde{e}_h$	=	the median error across customers and proxy days for each hour of the entire day, as calculated above
$\tilde{L}_h$	=	the weighted median load for the customer on the proxy day of interest

5.1.8.2.5 Coefficient of Alienation

One way of evaluating how well a model performs is to measure how much variation is not accounted for by it. Protocol 9 demands the calculation of the Coefficient of Alienation, which measures the proportion of variation in load that is not explained by variation in the forecast load. Using sample weights, the coefficient is given by:

$$A = \sum_{j=1}^{n_{cust}} \sum_{p=1}^{n_{days}} \sum_{h=1}^{n_{hours}} \frac{(L_{jph} - \overline{\overline{L}}_{jph})^2 \cdot w_j}{(L_{jph} - \overline{L}_{ph})^2} \cdot \frac{1}{\sum_{j=1}^{n_{cust}} w_j}$$

Where:

j	=	the cross-sectional unit or customer
p	=	the event-like day
h	=	the hour of the day
L_{jph}	=	The actual load for the customer on the proxy of interest for the hour of interest
$\overline{\overline{L}}_{jph}$	=	the predicted load for the customer on the proxy day of interest for the hour of interest
$\overline{L}_{ph}$	=	the average load on the proxy day of interest for the hour of interest
n_{cust}	=	the total number of customers in the observation group
n_{days}	=	the total number of days in the observation group
n_{hours}	=	the total number of hours being observed on the proxy day
w_j	=	the sample weight for each unit or customer

5.1.8.2.6 Theil's U Statistic

To measure the predictive power of the model, the Protocol requires the calculation of Theil's *U* statistic[25]. Bound between 0 and 1, this statistic measures how better the model performs when compared to a simple prediction of no change. The closer the *U* statistic is to zero, the more accurate the model is. We report a unit level Theil value that is calculated as follows:

[25] The denominator of the Theil's U statistic describe in the DR protocols is a combination of estimated and actual load. We believe the intent of this version of the statistic was to normalize by the average level of the squared loads from the two sources. This would entail that the whole denominator is divided by two. For consistency, the Theil's U statistics presented in this report follow the DR protocol equations as they were published.

$$U = \frac{\left[\frac{\sum_{p=1}^{n_{days}}\sum_{h=1}^{n_{hours}}(L_{jph} - \overline{\overline{L}}_{jph})^2}{n_{days}\cdot n_{hours}}\right]^{\frac{1}{2}}}{\left[\frac{\sum_{p=1}^{n_{days}}\sum_{h=1}^{n_{hours}}L_{jph}^2}{n_{days}\cdot n_{hours}}\right]^{\frac{1}{2}} + \left[\frac{\sum_{p=1}^{n_{days}}\sum_{h=1}^{n_{hours}}\overline{\overline{L}}_{jph}^2}{n_{days}\cdot n_{hours}}\right]^{\frac{1}{2}}}$$

Where:

j	=	the cross-sectional unit or customer
p	=	the event-like day
h	=	the hour of the day
L_{jph}	=	the actual observed load for the period of interest
$\overline{\overline{L}}_{jph}$	=	the predicted load for the period of interest
n_{days}	=	the total number of days in the observation group
n_{hours}	=	number of periods

5.2 *Ex Ante* Load Impact Estimation

5.2.1 Duty Cycle Approach

As explained above, the model used in this evaluation to estimate *ex post* load impacts is a *reference load* model. The *ex post* impacts are estimated at the unit level as the difference between the reference load (calculated with the model) and the event day load. These unit level impact estimates are aggregated on a per-ton basis using a ratio estimator approach weighted according to the sample's strata weights.

The *ex post* impacts are not directly estimated in the regression. For this reason, this approach does not produce a regression-based estimate of *ex ante* event impacts. Instead, we estimate *ex ante* load impacts using the cooling load-based model of each unit's duty cycle. Duty cycle is during an interval is calculated as the average load during that interval divided by the connected load.

5.2.2 *Ex Ante* Load Impact Estimation for Switches

5.2.2.1 *Ex Ante* for Fixed Duty Cycle and Perfect Adaptive Switches

A priori, we expect that the switches' load impact will lie somewhere between that of 50% straight cycle (legacy-style cycling) and that of the "perfect adaptive" cycling that would obtain the maximum load impact in the presence of perfect information. If the switch has been well trained, savings should be near the perfect adaptive level. If there have been too few training days or the switch has re-started its learning, the switch will operate at or close to fixed 50% control..

The savings under legacy fixed 50% cycling and under adaptive 50% control can both be calculated directly from the fitted cooling model for each unit. To produce *ex ante* estimates, we need to know where between these two estimates the impact will fall. As described below, we estimate this mix empirically, from the 2008 *ex post* results. First, we give the formulas for the two extremes.

For legacy cycling, the savings will be zero if the natural duty cycle is 50% or less (i.e., the uncontrolled cooling load is less than half the connected load). The savings will be the difference between the uncontrolled load and 50% of the connected load, if the duty cycle is above 50%. Thus, the estimate of legacy 50 percent cycling load reduction Δ^{50}_{jhd} is calculated from the estimated uncontrolled load $\overline{\overline{L}}_{jhd}$ and the estimated connected load CL_{jdh} as:

$$\Delta^{50}_{jhd} = 0 \text{, if } \overline{\overline{L}}_{jhd} \le 0.5CL_{jdh}$$

$$\Delta^{50}_{jhd} = \overline{\overline{L}}_{jhd} - 0.5CL_{jhd} \text{, if } \overline{\overline{L}}_{jhd} > 0.5CL_{jhd}$$

The adaptive cycling impact estimates are 50 percent of estimated load regardless of duty cycle. Thus, the estimate of adaptive cycling load reduction Δ^{A}_{jhd} is calculated:

$$\Delta^{A}_{jhd} = 0.5\overline{\overline{L}}_{jhd} .$$

The adaptive switches have, as their default setting, the legacy cycling approach. Thus, legacy cycling impact estimates serve as the theoretical lower bound on the potential impact from the adaptive switch. The model-based adaptive cycling estimate assumes the adaptive switch has the same knowledge of expected load for any hour as the load model. This serves as a theoretical upper bound on the potential impact from the adaptive switch

It is possible that an individual unit could generate impacts greater than the theoretical upper bound. This would happen if the adaptive switch under-estimated the true expected duty cycle. Empirically, however, the aggregate impacts tend to fall between the theoretical bounds given by the legacy cycling and adaptive cycling estimates

5.2.3 Combination of 50 Percent (“Legacy”) Cycling and Adaptive Estimates into a Single *Ex Ante* Estimate

To determine the single *ex ante* estimate, we need to know where the impacts will fall between the theoretical bounds for the legacy and adaptive cycling impact estimates. The overall impact $\hat{\Delta}_{jdh}$ is a linear combination of the impact if the switch behaved like the theoretical adaptive switch and the impact if the switch behaved like a legacy switch. This mix is calculated as:

$$\hat{\Delta}_{jhd} = \alpha\Delta^{A}_{jhd} + (1-\alpha)\Delta^{50}_{jhd}$$

Where:

j	=	the cross-sectional unit
h	=	the hour of the day
d	=	day
$\hat{\Delta}_{jhd}$	=	the overall predicted impact
Δ^{A}_{jhd}	=	the predicted impact for adaptive switches
Δ^{50}_{jhd}	=	the predicted impact for legacy switches
α	=	the fraction of impact from switches in adaptive mode

This equation can be rearranged to solve for α for each unit and event hour, given the observed reduction $\hat{\Delta}_{jhd}$:

$$\hat{\Delta}_{jhd} - \Delta^{50}_{jhd} = \alpha(\Delta^{A}_{jhd} - \Delta^{50}_{jhd})$$

$$\alpha = \frac{\hat{\Delta}_{jhd} - \Delta^{50}_{jhd}}{(\Delta^{A}_{jhd} - \Delta^{50}_{jhd})}$$

Because we believe that the effectiveness of the adaptive switches varies under different temperature conditions, we calculate α separately for each temperature level F, across units and event hours. The calculation uses a ratio estimator:

$$\alpha(F) = \frac{\sum_j \sum_h \sum_{d \in d(F)} (\hat{\Delta}_{jhd} - \Delta^{50}_{jhd})}{\sum_j \sum_h \sum_{d \in d(F)} (\Delta^{A}_{jhd} - \Delta^{50}_{jhd})}$$

Where the summations are over all units, and all days and hours with daily average Temperature equal to F*, and*:

j	=	the cross-sectional unit or customer
h	=	the hour of the day
d	=	day
F	=	daily average temperature
$\hat{\Delta}_{jdh}$	=	the predicted impact
Δ^{A}_{jdh}	=	the predicted impact for adaptive switches
Δ^{50}_{jdh}	=	the predicted impact for legacy switches
$\alpha(F)$	=	the fraction of impact from the adaptive switch at temperature F

We then fit an ordinary least-squares model with α as a function of daily temperature:

$$\alpha(F) = \beta_0 + \beta_1 F_d + \varepsilon_t$$

Where:

$\alpha(F)$	=	the fraction of impact from the adaptive switch at temperature F.
β_0	=	the model intercept
β_1	=	the coefficient of temperature
F_d	=	average daily temperature
ε_t	=	regression residual

To remove the possible downward bias of non-responsive signals, this regression was fitted only for units with no evidence of non-response.

The results of this regression are provided in Table 5-2. For example, at a daily average temperature of 90º F (the daily average temperature of the system peak day), the combined *ex ante* estimate is 54 percent adaptive impact estimate and 46 percent legacy estimate.

Table 5-2
Estimated Alpha
(Proportion of Adaptive *Ex Ante* Impact Estimate in Combined *Ex Ante* Estimate)

Daily Average Temperature (F_d)	Estimated Alpha (α)
75	27%
76	29%
77	30%
78	32%
79	34%
80	36%
81	38%
82	40%
83	41%
84	43%
85	45%
86	47%
87	49%
88	50%
89	52%
90	54%
91	56%
92	58%
93	60%
94	61%
95	63%

Finally, we calculate the overall *ex ante* impact using the predicted value, $\hat{\alpha}(F)$, at each daily temperature F:

$$\hat{\Delta}_{jhd} = \hat{\alpha}(F_d)\Delta^{A}_{jhd} + (1 - \hat{\alpha}(F_d))\Delta^{50}_{jhd}$$

6. Study Findings

This section provides the results of the impact evaluation. It includes selected *ex post* results at time of system peak, including a comparison between the 2007 and the 2008 *ex post* results, and selected *ex ante* results for 1-in-2 and 1-in-10 weather conditions. These are followed by sections regarding the validity assessment of the *ex post* findings, and the statistical measures to assess the precision and bias of the estimates dictated by the Protocols.

6.1 *Ex Post* Estimates of Load Impact at Time of the 2008 System Peak

PG&E's 2008 system peak occurred on July 8, at 4 PM (hour ending 5 PM), at a load of 20,385 MW. This section describes the load impact estimates on this day.

As noted, in 2008 there was only one program-wide event, in May. With the exception of the May event, "population" or "program-wide" results refer to estimates of impacts had the entire program been activated on that day.

A complete set of tables with load impacts at time of the 2008 system peak are presented in Appendix E (at the AC unit level) and Appendix F (at the population level.) Tables for other event days are provided in electronic format only.

6.1.1 *Ex Post* Program Impact

Program impacts per unit at time of the 2008 system peak are illustrated in Figure 6-1 and Table 6-1. On this day, the event took place from hours ending 2 PM through 7 PM. During these hours, impacts ranged from a low of 0.51 kW in the first hour to a high of 0.91 kW on the hour ending at 6 PM. The impact at time of system peak was 0.86 kW per device. The hours after the event indicate a snapback effect of up to 0.46 kW.

These per unit estimates translate into an estimated impact of about 55 MW at time of system peak, if the program had been activated.

Figure 6-1

SmartAC *Ex Post* Estimated Reference Load and Event Day Load at Time of System Peak July 8, 2008

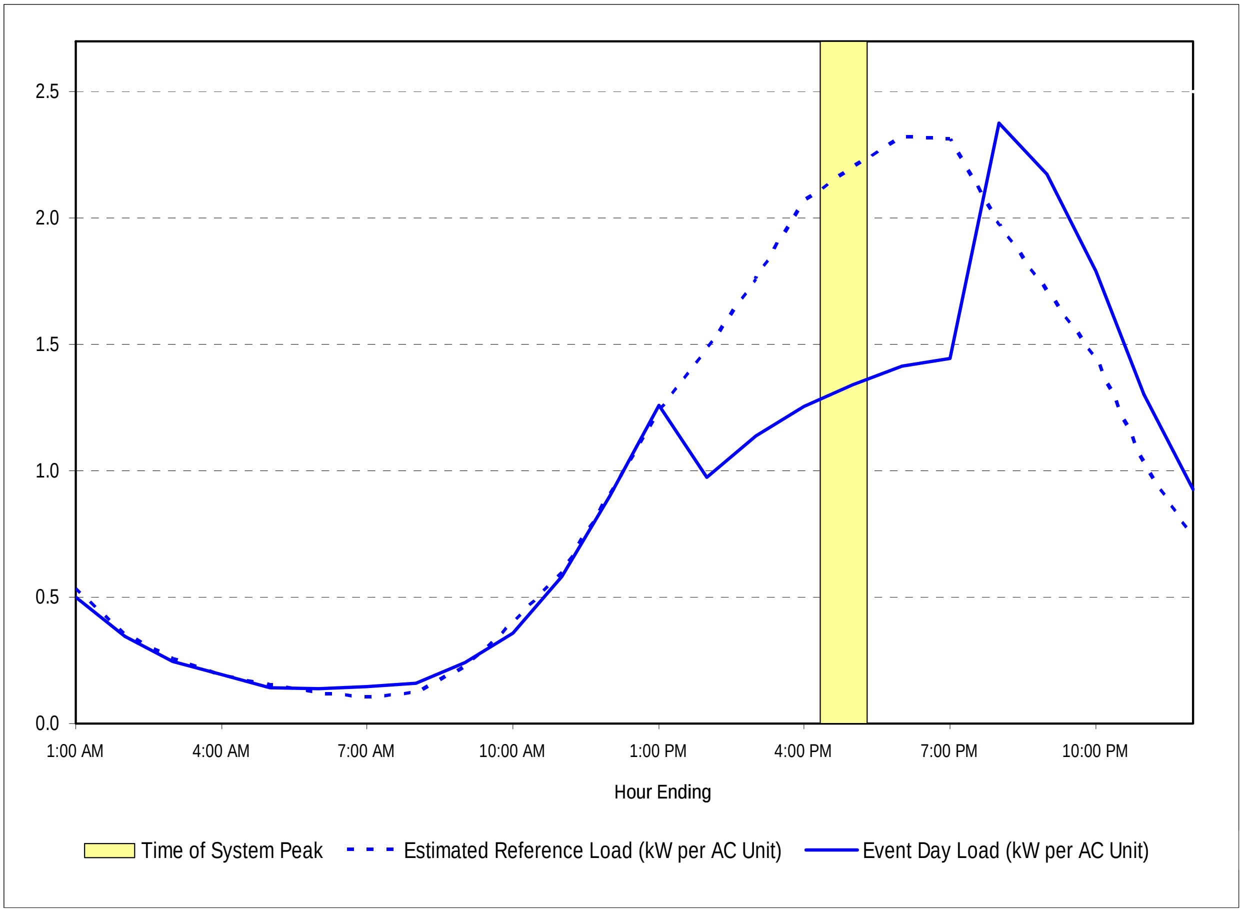


Table 6-1
SmartAC Peak Day Average Unit Estimates
July 8, 2008

PG&E SmartAC™ 2008 *ex post* estimates										
Group: Program Level						View: Unit (kW)				
Date (Year 2008)	Hour Ending	Estimated Reference Load (kW per AC Unit)	Event Day Load (kW per AC Unit)	Estimated Load Impact (kW per AC Unit)	Weighted Average Temperature (ºF)	Uncertainty Adjusted Load Impact (kW per AC Unit)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul	1:00 AM	0.53	0.50	0.04	82.94	-0.01	0.02	0.04	0.06	0.08
8-Jul	2:00 AM	0.35	0.35	0.01	80.63	-0.03	-0.01	0.01	0.02	0.04
8-Jul	3:00 AM	0.25	0.25	0.01	78.68	-0.03	-0.01	0.01	0.02	0.04
8-Jul	4:00 AM	0.19	0.20	-0.01	76.98	-0.03	-0.02	-0.01	0.00	0.02
8-Jul	5:00 AM	0.15	0.14	0.01	76.26	-0.02	0.00	0.01	0.02	0.03
8-Jul	6:00 AM	0.12	0.14	-0.02	75.01	-0.04	-0.03	-0.02	-0.01	0.00
8-Jul	7:00 AM	0.10	0.14	-0.04	73.52	-0.07	-0.05	-0.04	-0.03	-0.02
8-Jul	8:00 AM	0.12	0.16	-0.04	76.41	-0.06	-0.05	-0.04	-0.03	-0.02
8-Jul	9:00 AM	0.22	0.24	-0.01	81.54	-0.05	-0.03	-0.01	0.00	0.02
8-Jul	10:00 AM	0.40	0.36	0.04	86.81	0.00	0.03	0.04	0.06	0.08
8-Jul	11:00 AM	0.60	0.58	0.02	92.10	-0.03	0.00	0.02	0.04	0.07
8-Jul	12:00 PM	0.90	0.90	0.00	96.49	-0.06	-0.02	0.00	0.03	0.06
8-Jul	1:00 PM	1.24	1.26	-0.02	99.61	-0.10	-0.06	-0.02	0.01	0.06
8-Jul	2:00 PM	1.49	0.97	0.51	102.31	0.45	0.49	0.51	0.54	0.58
8-Jul	3:00 PM	1.76	1.14	0.62	104.36	0.55	0.59	0.62	0.65	0.70
8-Jul	4:00 PM	2.07	1.25	0.81	105.68	0.74	0.78	0.81	0.84	0.89
8-Jul	5:00 PM	2.20	1.34	**0.86**	106.65	0.79	0.83	0.86	0.90	0.94
8-Jul	6:00 PM	2.32	1.42	0.91	105.85	0.82	0.87	0.91	0.94	0.99
8-Jul	7:00 PM	2.31	1.45	0.87	103.74	0.79	0.84	0.87	0.90	0.94
8-Jul	8:00 PM	1.98	2.37	-0.40	100.25	-0.48	-0.43	-0.40	-0.37	-0.32
8-Jul	9:00 PM	1.71	2.17	-0.46	95.16	-0.54	-0.49	-0.46	-0.43	-0.38
8-Jul	10:00 PM	1.44	1.79	-0.35	91.61	-0.42	-0.38	-0.35	-0.31	-0.27
8-Jul	11:00 PM	1.03	1.30	-0.27	88.21	-0.34	-0.30	-0.27	-0.24	-0.20
8-Jul	12:00 AM	0.74	0.93	-0.19	86.05	-0.25	-0.21	-0.19	-0.17	-0.13
Date	Daily Summary	Estimated Reference Load (kWh per AC Unit)	Event Day Load (kWh per AC Unit)	Estimated Load Impact (kWh per AC Unit)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (kW per AC Unith)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul		24.24	21.34	2.90	371.30	1.58	2.36	2.90	3.43	4.21

6.1.2 *Ex Post* Impacts by Type of Device

Load impacts were calculated separately for each device type. At time of system peak, the average Switch produced a demand reduction of 0.91 kW, compared to 0.72 kW for PCTs. The largest demand reductions were at hour ending 6 PM, when it is estimated that Switches yielded average demand reductions of 0.94 kW, compared to 0.80 kW for PCTs. This is illustrated in Figure 6-2, Table 6-2, and Table 6-3.

Because there are more installed Switches than PCTs, their program-wide impact at time of system peak would have been about 44.6 MW for Switches, and about 10.8 MW for PCTs.

Figure 6-2
SmartAC *Ex Post* Estimated Reference Load and Event Day Load at Time of System Peak by Device Type - July 8, 2008

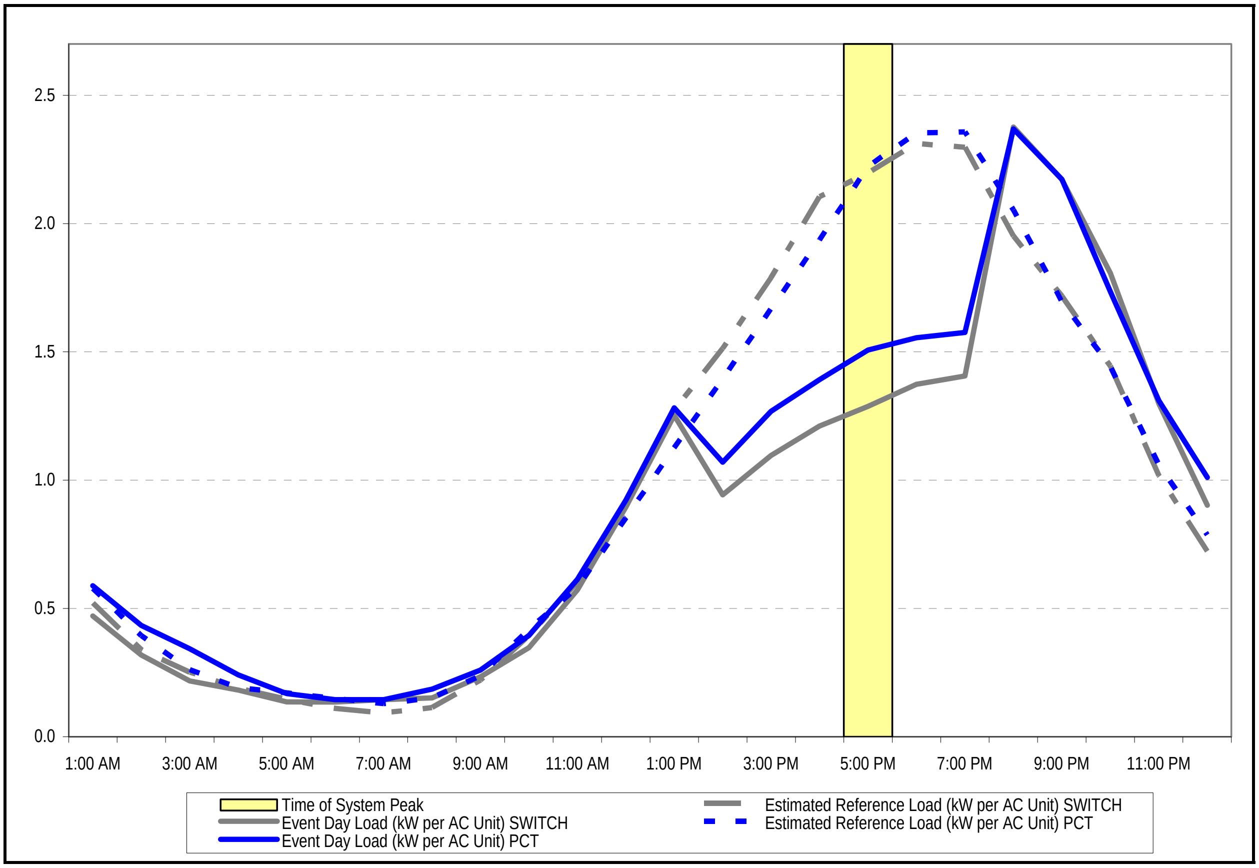


Table 6-2

SmartAC Peak Day Ex Post Average Unit Impact Estimates by Device Type: Switches

July 8, 2008

PG&E SmartAC™ 2008 *ex post* estimates										
Group:	Control: Switch					View:	Unit (kW)			
Date (Year 2008)	Hour Ending	Estimated Reference Load (kW per AC Unit)	Event Day Load (kW per AC Unit)	Estimated Load Impact (kW per AC Unit)	Weighted Average Temperature (ºF)	Uncertainty Adjusted Load Impact (kW per AC Unit)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul	1:00 AM	0.52	0.47	0.05	82.56	-0.01	0.03	0.05	0.07	0.11
8-Jul	2:00 AM	0.34	0.32	0.02	80.19	-0.03	0.00	0.02	0.04	0.07
8-Jul	3:00 AM	0.25	0.22	0.03	78.22	0.00	0.02	0.03	0.05	0.07
8-Jul	4:00 AM	0.19	0.18	0.01	76.58	-0.03	-0.01	0.01	0.02	0.04
8-Jul	5:00 AM	0.15	0.14	0.01	75.88	-0.02	0.00	0.01	0.02	0.04
8-Jul	6:00 AM	0.11	0.14	-0.03	74.66	-0.05	-0.04	-0.03	-0.01	0.00
8-Jul	7:00 AM	0.09	0.14	-0.05	73.25	-0.08	-0.06	-0.05	-0.04	-0.02
8-Jul	8:00 AM	0.11	0.15	-0.04	76.13	-0.06	-0.05	-0.04	-0.03	-0.01
8-Jul	9:00 AM	0.22	0.23	-0.01	81.31	-0.05	-0.03	-0.01	0.00	0.02
8-Jul	10:00 AM	0.39	0.35	0.05	86.65	0.00	0.03	0.05	0.07	0.09
8-Jul	11:00 AM	0.60	0.57	0.03	92.06	-0.03	0.01	0.03	0.06	0.09
8-Jul	12:00 PM	0.92	0.90	0.02	96.50	-0.05	-0.01	0.02	0.06	0.10
8-Jul	1:00 PM	1.27	1.25	0.02	99.60	-0.08	-0.02	0.02	0.06	0.12
8-Jul	2:00 PM	1.51	0.94	0.57	102.31	0.49	0.54	0.57	0.60	0.65
8-Jul	3:00 PM	1.79	1.10	0.69	104.35	0.60	0.66	0.69	0.73	0.78
8-Jul	4:00 PM	2.11	1.21	0.89	105.69	0.80	0.86	0.89	0.93	0.99
8-Jul	5:00 PM	2.20	1.29	**0.91**	106.56	0.81	0.87	0.91	0.95	1.00
8-Jul	6:00 PM	2.31	1.37	0.94	105.68	0.84	0.90	0.94	0.98	1.04
8-Jul	7:00 PM	2.30	1.41	0.89	103.43	0.80	0.85	0.89	0.93	0.98
8-Jul	8:00 PM	1.95	2.38	-0.43	99.91	-0.53	-0.47	-0.43	-0.38	-0.32
8-Jul	9:00 PM	1.72	2.17	-0.45	94.86	-0.55	-0.49	-0.45	-0.42	-0.36
8-Jul	10:00 PM	1.45	1.81	-0.36	91.32	-0.46	-0.40	-0.36	-0.32	-0.27
8-Jul	11:00 PM	1.02	1.30	-0.28	87.91	-0.37	-0.32	-0.28	-0.24	-0.19
8-Jul	12:00 AM	0.72	0.90	-0.18	85.73	-0.25	-0.21	-0.18	-0.15	-0.11
Date	Daily Summary	Estimated Reference Load (kWh per AC Unit)	Event Day Load (kWh per AC Unit)	Estimated Load Impact (kWh per AC Unit)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (kW per AC Unith)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul		24.25	20.93	3.31	365.72	1.69	2.65	3.31	3.98	4.94

Table 6-3
SmartAC Peak Day Ex Post Average Unit Impact Estimates by Device Type: Thermostats
July 8, 2008

PG&E SmartAC™ 2008 *ex post* estimates										
Group: Control: PCT						View: Unit (kW)				
Date (Year 2008)	Hour Ending	Estimated Reference Load (kW per AC Unit)	Event Day Load (kW per AC Unit)	Estimated Load Impact (kW per AC Unit)	Weighted Average Temperature (ºF)	Uncertainty Adjusted Load Impact (kW per AC Unit)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul	1:00 AM	0.58	0.59	-0.01	84.17	-0.08	-0.04	-0.01	0.01	0.05
8-Jul	2:00 AM	0.39	0.43	-0.04	82.06	-0.10	-0.06	-0.04	-0.01	0.02
8-Jul	3:00 AM	0.26	0.34	-0.08	80.17	-0.15	-0.11	-0.08	-0.06	-0.02
8-Jul	4:00 AM	0.19	0.24	-0.05	78.30	-0.09	-0.07	-0.05	-0.03	-0.01
8-Jul	5:00 AM	0.17	0.17	0.00	77.51	-0.03	-0.01	0.00	0.02	0.04
8-Jul	6:00 AM	0.15	0.14	0.00	76.16	-0.02	-0.01	0.00	0.02	0.03
8-Jul	7:00 AM	0.13	0.14	-0.02	74.40	-0.06	-0.03	-0.02	0.00	0.02
8-Jul	8:00 AM	0.15	0.19	-0.03	77.33	-0.07	-0.05	-0.03	-0.02	0.00
8-Jul	9:00 AM	0.24	0.26	-0.02	82.29	-0.07	-0.04	-0.02	0.00	0.02
8-Jul	10:00 AM	0.42	0.39	0.03	87.32	-0.03	0.00	0.03	0.05	0.08
8-Jul	11:00 AM	0.58	0.61	-0.03	92.24	-0.10	-0.06	-0.03	0.00	0.04
8-Jul	12:00 PM	0.85	0.92	-0.07	96.47	-0.15	-0.10	-0.07	-0.04	0.01
8-Jul	1:00 PM	1.13	1.28	-0.16	99.61	-0.24	-0.19	-0.16	-0.12	-0.07
8-Jul	2:00 PM	1.39	1.07	0.33	102.30	0.25	0.29	0.33	0.36	0.40
8-Jul	3:00 PM	1.67	1.27	0.40	104.40	0.31	0.36	0.40	0.43	0.49
8-Jul	4:00 PM	1.94	1.39	0.55	105.65	0.45	0.51	0.55	0.59	0.64
8-Jul	5:00 PM	2.22	1.51	**0.72**	106.91	0.61	0.67	0.72	0.76	0.82
8-Jul	6:00 PM	2.35	1.56	0.80	106.39	0.69	0.75	0.80	0.84	0.90
8-Jul	7:00 PM	2.36	1.58	0.78	104.75	0.68	0.74	0.78	0.82	0.88
8-Jul	8:00 PM	2.05	2.37	-0.32	101.36	-0.42	-0.36	-0.32	-0.27	-0.21
8-Jul	9:00 PM	1.69	2.17	-0.48	96.15	-0.59	-0.52	-0.48	-0.43	-0.37
8-Jul	10:00 PM	1.44	1.73	-0.29	92.58	-0.39	-0.33	-0.29	-0.25	-0.19
8-Jul	11:00 PM	1.06	1.31	-0.25	89.18	-0.35	-0.29	-0.25	-0.21	-0.15
8-Jul	12:00 AM	0.79	1.01	-0.22	87.12	-0.31	-0.26	-0.22	-0.19	-0.14
Date	Daily Summary	Estimated Reference Load (kWh per AC Unit)	Event Day Load (kWh per AC Unit)	Estimated Load Impact (kWh per AC Unit)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (kW per AC Unith)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul		24.22	22.69	1.53	377.96	-0.25	0.80	1.53	2.26	3.31

6.1.3 *Ex Post* Impacts by Load Control Area[26]

Load impacts are calculated separately for each load control area (LCA) where SmartAC was active in 2008. We estimated load impacts for the Greater Bay Area, Greater Fresno, and Stockton.

At time of system peak, the highest savings per unit are in the Greater Bay Area, at about 1 kW per unit. The savings in Stockton are estimated at 0.90 kW, and in Fresno, at 0.70 kW per unit, respectively. This is illustrated in Figure 6-3, and Table 6-4 thru Table 6-6.

It is noteworthy that on the day of the system peak (the hottest day of the year for SmartAC enrollees), the temperatures in the Greater Bay Area exceeded those in Stockton for the on-peak hours. At time of system peak, the weighted average temperature was actually higher in the Greater Bay Area than in Greater Fresno. Weighted temperatures for these three areas are illustrated in Figure 6-4.

It is estimated than a program-wide event would have contributed about 26 MW from the Greater Bay Area, 12 MW from Greater Fresno, and 6 MW from Stockton. Program-wide estimates by LCA are reported in Appendix D.

[26] A Local Capacity Requirement (or LCR) exists for each transmission-constrained area (i.e., each load pocket) identified by the CAISO within an IOU's service area. This report uses the term "Local Capacity Area" (or LCA) to refer to each of those areas.

Figure 6-3

SmartAC *Ex Post* Estimated Reference Load and Event Day Load at Time of System Peak by Load Control Area - July 8, 2008

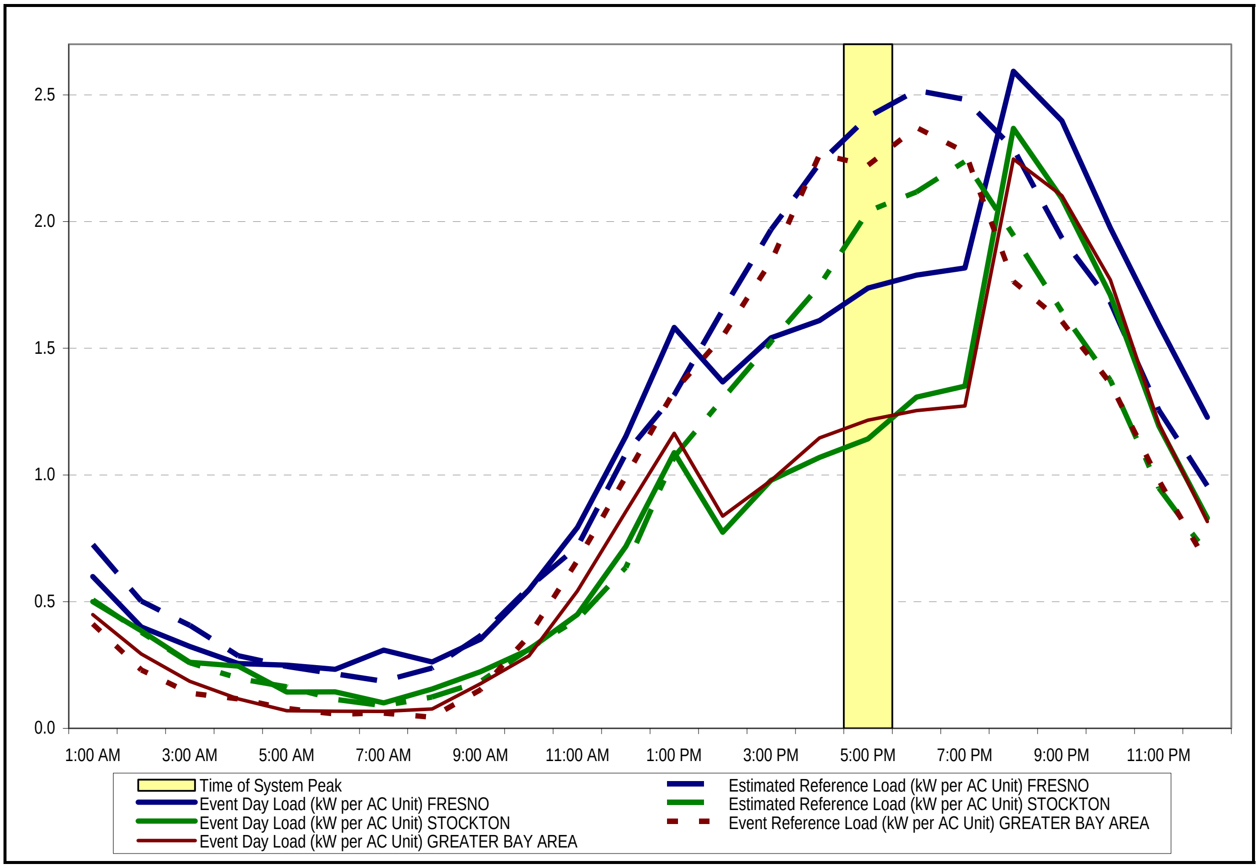


Figure 6-4
SmartAC Weighted Temperatures by Load Control Area
July 8, 2008

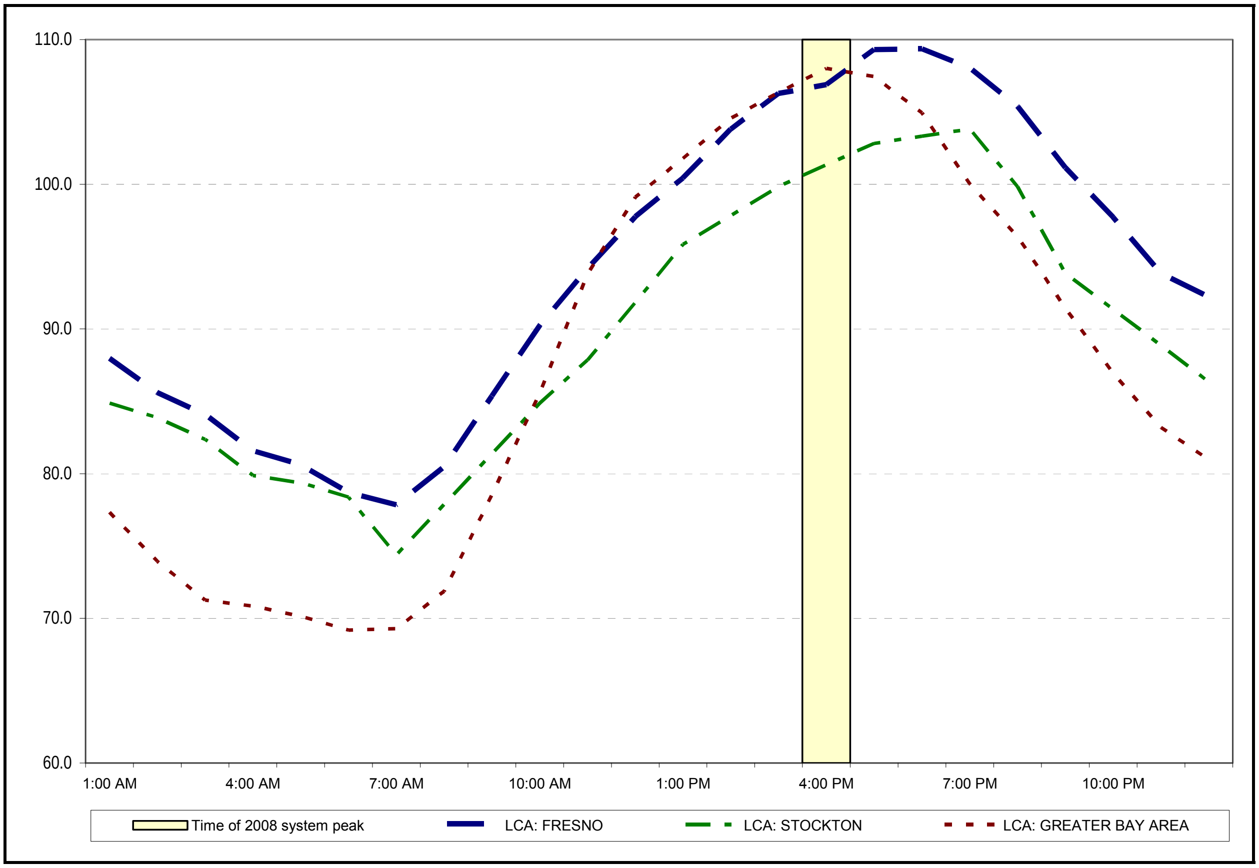


Table 6-4

SmartAC Peak Day Ex Post Average Unit Impact Estimates by Load Control Area: Greater Fresno

July 8, 2008

PG&E SmartAC™ 2008 *ex post* estimates										
Group: LCA: Greater Fresno						View: Unit (kW)				
Date (Year 2008)	Hour Ending	Estimated Reference Load (kW per AC Unit)	Event Day Load (kW per AC Unit)	Estimated Load Impact (kW per AC Unit)	Weighted Average Temperature (°F)	Uncertainty Adjusted Load Impact (kW per AC Unit)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul	1:00 AM	0.72	0.60	0.13	87.97	0.05	0.10	0.13	0.16	0.20
8-Jul	2:00 AM	0.50	0.40	0.10	85.59	0.04	0.08	0.10	0.13	0.16
8-Jul	3:00 AM	0.41	0.32	0.08	84.08	0.03	0.06	0.08	0.11	0.14
8-Jul	4:00 AM	0.29	0.26	0.03	81.56	-0.01	0.01	0.03	0.05	0.07
8-Jul	5:00 AM	0.24	0.25	-0.01	80.60	-0.07	-0.03	-0.01	0.02	0.06
8-Jul	6:00 AM	0.22	0.23	-0.02	78.68	-0.08	-0.04	-0.02	0.01	0.05
8-Jul	7:00 AM	0.19	0.31	-0.12	77.84	-0.19	-0.15	-0.12	-0.09	-0.05
8-Jul	8:00 AM	0.24	0.26	-0.02	80.45	-0.07	-0.04	-0.02	-0.01	0.02
8-Jul	9:00 AM	0.37	0.35	0.01	85.35	-0.05	-0.01	0.01	0.04	0.08
8-Jul	10:00 AM	0.56	0.55	0.01	90.24	-0.06	-0.02	0.01	0.04	0.08
8-Jul	11:00 AM	0.72	0.79	-0.08	94.18	-0.17	-0.11	-0.08	-0.04	0.02
8-Jul	12:00 PM	1.08	1.15	-0.07	97.76	-0.18	-0.11	-0.07	-0.02	0.04
8-Jul	1:00 PM	1.31	1.58	-0.27	100.42	-0.38	-0.31	-0.27	-0.22	-0.16
8-Jul	2:00 PM	1.65	1.37	0.28	103.80	0.19	0.25	0.28	0.32	0.38
8-Jul	3:00 PM	1.97	1.54	0.43	106.28	0.32	0.38	0.43	0.47	0.54
8-Jul	4:00 PM	2.23	1.61	0.62	106.88	0.50	0.57	0.62	0.67	0.74
8-Jul	5:00 PM	2.41	1.74	**0.68**	109.30	0.55	0.63	0.68	0.73	0.80
8-Jul	6:00 PM	2.52	1.79	0.73	109.35	0.61	0.68	0.73	0.78	0.85
8-Jul	7:00 PM	2.48	1.82	0.67	108.03	0.55	0.62	0.67	0.71	0.78
8-Jul	8:00 PM	2.29	2.59	-0.31	105.36	-0.42	-0.35	-0.31	-0.26	-0.20
8-Jul	9:00 PM	1.93	2.40	-0.46	101.14	-0.58	-0.51	-0.46	-0.42	-0.35
8-Jul	10:00 PM	1.68	1.98	-0.29	97.71	-0.41	-0.34	-0.29	-0.25	-0.18
8-Jul	11:00 PM	1.26	1.59	-0.34	93.82	-0.45	-0.38	-0.34	-0.29	-0.22
8-Jul	12:00 AM	0.96	1.23	-0.27	92.21	-0.37	-0.31	-0.27	-0.23	-0.17
		Estimated Reference Load (kWh per AC Unit)	Event Day Load (kWh per AC Unit)	Estimated Load Impact (kWh per AC Unit)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (kW per AC Unith)				
Date	Daily Summary					10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul		28.22	26.70	1.51	438.75	-0.66	0.62	1.51	2.40	3.69

Table 6-5
SmartAC Peak Day Ex Post Average Unit Impact Estimates by Load Control Area: Stockton
July 8, 2008

PG&E SmartAC™ 2008 *ex post* estimates										
Group: LCA: Stockton						View: Unit (kW)				
Date (Year 2008)	Hour Ending	Estimated Reference Load (kW per AC Unit)	Event Day Load (kW per AC Unit)	Estimated Load Impact (kW per AC Unit)	Weighted Average Temperature (°F)	Uncertainty Adjusted Load Impact (kW per AC Unit)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul	1:00 AM	0.51	0.50	0.01	84.98	-0.07	-0.03	0.01	0.04	0.09
8-Jul	2:00 AM	0.38	0.38	-0.01	83.98	-0.07	-0.03	-0.01	0.02	0.06
8-Jul	3:00 AM	0.26	0.26	0.00	82.48	-0.05	-0.02	0.00	0.02	0.05
8-Jul	4:00 AM	0.20	0.25	-0.05	79.98	-0.10	-0.07	-0.05	-0.03	0.01
8-Jul	5:00 AM	0.16	0.14	0.02	79.48	-0.02	0.00	0.02	0.04	0.06
8-Jul	6:00 AM	0.11	0.14	-0.03	78.48	-0.06	-0.04	-0.03	-0.02	0.00
8-Jul	7:00 AM	0.09	0.10	-0.01	74.48	-0.05	-0.03	-0.01	0.00	0.02
8-Jul	8:00 AM	0.12	0.16	-0.03	77.98	-0.07	-0.05	-0.03	-0.01	0.01
8-Jul	9:00 AM	0.18	0.22	-0.04	81.48	-0.09	-0.06	-0.04	-0.02	0.02
8-Jul	10:00 AM	0.31	0.31	0.00	84.98	-0.07	-0.03	0.00	0.03	0.07
8-Jul	11:00 AM	0.43	0.45	-0.02	87.98	-0.11	-0.06	-0.02	0.02	0.07
8-Jul	12:00 PM	0.63	0.72	-0.08	91.98	-0.17	-0.12	-0.08	-0.05	0.00
8-Jul	1:00 PM	1.07	1.09	-0.02	95.98	-0.12	-0.06	-0.02	0.03	0.09
8-Jul	2:00 PM	1.30	0.77	0.53	97.98	0.41	0.48	0.53	0.58	0.65
8-Jul	3:00 PM	1.53	0.98	0.55	99.98	0.41	0.49	0.55	0.60	0.68
8-Jul	4:00 PM	1.75	1.07	0.68	101.48	0.55	0.63	0.68	0.73	0.80
8-Jul	5:00 PM	2.04	1.14	**0.90**	102.98	0.77	0.85	0.90	0.95	1.03
8-Jul	6:00 PM	2.12	1.31	0.81	103.48	0.68	0.75	0.81	0.86	0.94
8-Jul	7:00 PM	2.24	1.35	0.89	103.98	0.75	0.83	0.89	0.94	1.02
8-Jul	8:00 PM	1.95	2.37	-0.42	99.98	-0.57	-0.48	-0.42	-0.36	-0.27
8-Jul	9:00 PM	1.65	2.09	-0.45	93.98	-0.56	-0.49	-0.45	-0.40	-0.33
8-Jul	10:00 PM	1.37	1.71	-0.34	91.48	-0.46	-0.39	-0.34	-0.29	-0.21
8-Jul	11:00 PM	0.95	1.19	-0.24	88.98	-0.37	-0.29	-0.24	-0.19	-0.12
8-Jul	12:00 AM	0.69	0.83	-0.14	86.48	-0.24	-0.18	-0.14	-0.10	-0.04
	Daily Summary	Estimated Reference Load (kWh per AC Unit)	Event Day Load (kWh per AC Unit)	Estimated Load Impact (kWh per AC Unit)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (kW per AC Unith)				
Date						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul		22.03	19.54	2.50	356.00	0.31	1.60	2.50	3.39	4.69

Table 6-6

SmartAC Peak Day Ex Post Average Unit Impact Estimates by Load Control Area: Greater Bay Area

July 8, 2008

PG&E SmartAC™ 2008 ex post estimates										
Group: LCA: Greater Bay Area						View: Unit (kW)				
Date (Year 2008)	Hour Ending	Estimated Reference Load (kW per AC Unit)	Event Day Load (kW per AC Unit)	Estimated Load Impact (kW per AC Unit)	Weighted Average Temperature (ºF)	Uncertainty Adjusted Load Impact (kW per AC Unit)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul	1:00 AM	0.41	0.45	-0.04	77.32	-0.11	-0.07	-0.04	-0.01	0.04
8-Jul	2:00 AM	0.23	0.29	-0.06	73.93	-0.14	-0.09	-0.06	-0.03	0.01
8-Jul	3:00 AM	0.14	0.19	-0.05	71.25	-0.11	-0.07	-0.05	-0.02	0.02
8-Jul	4:00 AM	0.12	0.12	0.00	70.85	-0.05	-0.02	0.00	0.02	0.05
8-Jul	5:00 AM	0.08	0.07	0.01	70.14	-0.02	0.00	0.01	0.02	0.04
8-Jul	6:00 AM	0.06	0.07	-0.01	69.18	-0.03	-0.02	-0.01	0.00	0.01
8-Jul	7:00 AM	0.06	0.07	-0.01	69.28	-0.04	-0.02	-0.01	0.01	0.02
8-Jul	8:00 AM	0.04	0.08	-0.03	71.86	-0.06	-0.04	-0.03	-0.02	-0.01
8-Jul	9:00 AM	0.15	0.18	-0.02	78.53	-0.07	-0.04	-0.02	-0.01	0.02
8-Jul	10:00 AM	0.37	0.29	0.08	85.56	0.02	0.05	0.08	0.10	0.14
8-Jul	11:00 AM	0.66	0.54	0.12	93.80	0.03	0.08	0.12	0.15	0.21
8-Jul	12:00 PM	0.99	0.86	0.14	99.11	0.02	0.09	0.14	0.19	0.26
8-Jul	1:00 PM	1.33	1.16	0.17	101.79	-0.01	0.09	0.17	0.24	0.34
8-Jul	2:00 PM	1.55	0.84	0.71	104.57	0.58	0.66	0.71	0.76	0.84
8-Jul	3:00 PM	1.84	0.98	0.87	106.34	0.74	0.81	0.87	0.92	0.99
8-Jul	4:00 PM	2.27	1.15	1.12	108.01	0.98	1.06	1.12	1.17	1.25
8-Jul	5:00 PM	2.22	1.22	**1.01**	107.45	0.86	0.95	1.01	1.06	1.15
8-Jul	6:00 PM	2.37	1.25	1.12	104.93	0.95	1.05	1.12	1.18	1.28
8-Jul	7:00 PM	2.27	1.27	1.00	100.02	0.87	0.95	1.00	1.06	1.14
8-Jul	8:00 PM	1.76	2.25	-0.48	96.38	-0.64	-0.55	-0.48	-0.42	-0.33
8-Jul	9:00 PM	1.60	2.10	-0.50	91.42	-0.65	-0.56	-0.50	-0.43	-0.34
8-Jul	10:00 PM	1.36	1.77	-0.41	86.92	-0.56	-0.47	-0.41	-0.35	-0.25
8-Jul	11:00 PM	0.98	1.20	-0.23	83.18	-0.36	-0.28	-0.23	-0.17	-0.09
8-Jul	12:00 AM	0.65	0.82	-0.16	80.96	-0.28	-0.21	-0.16	-0.12	-0.05
Date	Daily Summary	Estimated Reference Load (kWh per AC Unit)	Event Day Load (kWh per AC Unit)	Estimated Load Impact (kWh per AC Unit)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (kW per AC Unith)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul		23.52	19.19	4.33	318.89	1.94	3.35	4.33	5.31	6.72

6.1.4 Comparison to load impact estimates at time of the 2007 system peak

Since 2008 was the second year of the Smart AC program, it is natural to ask whether the 2008 impacts are higher or lower than would be expected based on the 2007 findings, and why.

This question has a complex answer. Even establishing what results from the two years can be compared is not straightforward. The two years had different weather streams, different dispatch days, and different timing of the system peak.

The 2007 impact report was written prior to the Protocols. A corollary is that *ex ante* estimates for standard weather conditions were not developed for the 2007 study, to be compared with corresponding 2008 *ex ante* estimates. Below, we identify the comparisons that are most useful and meaningful, and discuss the factors that contribute to the observed differences on this basis.

The general conclusions from this comparison are the following:

- Differences between the 2007 and 2008 results reflect several factors:
  - Different weather
  - Different hour of day of the system peak
  - Different timing of program dispatch
  - Substantial differences in the participant populations for the two years
  - Different control strategy for PCTs
  - Possible changes in general behavior over the two years
  - Possible changes in participant behavior related to frequent control events over two years
  - Random differences in the study samples
  - Systematic differences in the model structures used
  - Different treatment of power factor in 2008.
- Controlling for weather, timing, sample, control technology, and power factor, we still found that the 2008 estimates to be lower than those for 2007 for the extreme days surrounding the system peak day.
- The 2007 reference loads for the extreme days appear to be overstated. As a result, 2007 *ex post* savings are likely overstated for those days.

- Some of the difference may also reflect general behavioral changes across the population from 2007 to 2008, or changes among sample participants after a full year of frequent controls events.

- The 2008 model was more extensively tested and refined than the 2007 model. Thus, the 2008 results are more accurate and reliable. Random errors and the potential for further refinement remain.

6.1.4.1 Direct comparison of *ex post* findings for the system peak day

The savings of greatest interest are those on the peak day. Starting with the impacts that appear in the two reports, we look at *ex post* impacts for the peak hour in 2007 and in 2008.

In 2007 there was no event called on the system peak day, August 29. However, the four days spanning the day before the system peak and two days after the system peak were the hottest days of the summer, and events were called on three days of these four days. The 2007 report provided *ex post* estimates of savings for each of these event days. Based on the trends across the three days, the report also projected savings for the system peak day, had an event been called. The interpolated estimate given in the 2007 impact report was 0.88 kW per unit at the system peak hour, 5 PM.

The 2008 impact at the peak hour of the peak day, 4 PM, was somewhat lower, 0.81 kW per unit. The lower impact compared to 2007 stems in part from the earlier system peak for 2008. Residential demand response impacts are, in general, lower at 4 PM compared to 5 PM. For 2008, the estimated impact at 5 PM on the system peak day was 0.87 kW per unit, very close to the 2007 result for that hour of the peak day. On this basis, the results for the two years appear to be close.[27]

However, this direct comparison omits several factors that need to be considered to provide an appropriate assessment. First, the weather was not the same on the system peak days for the two years. Second, the 2008 results include a power factor adjustment that was not used in the

[27] The 2007 report also provided the lowest 5 PM *ex post* savings across the 3 event days, 0.78 kW per unit, on August 28, and the highest, 1.23 kW per unit, on August 31. One might assume that the savings on the peak day would be the highest savings observed. However, as noted in the 2007 report, residential air conditioner usage and corresponding impacts appear to increase during a multiple-day heat wave, even as temperatures drop during the latter days of the heat wave. A similar pattern was observed in 2008.

2007 analysis[28]. Third, the 2008 results include participants from three climate zones[29], while the 2007 results are based on a sample of early Stockton participants only. Some additional steps are therefore needed to provide an "apples to apples" comparison.

6.1.4.2 Comparison of 2007 and 2008 savings on a consistent basis

To provide a consistent basis for comparison, we applied the following steps:

1. We calculated the savings for the event day before and the two event days after the 2007 peak day, using the 2008 *ex ante* model with the 2007 weather for those days.

2. We applied the average power factor determined in 2008 to the 2007 *ex post* results.

3. We restricted attention to switches, because the 2008 *ex ante* PCT model was developed only for the fixed 50% cycling strategy used in 2008, not for the ramped thermostat re-set used in 2007.

For all three event days surrounding the 2007 peak day, the impact estimate based on the adjusted 2007 model was higher than that from the corresponding 2008 *ex ante* estimate. Thus, the 2007 model provides higher impact estimates than the 2008 model, for the same population, control technology, weather conditions and power factor treatment. This relationship is not necessarily true across all conditions, but is true for the extreme days around the system peak. This is illustrated in Table 6-7.

The higher impact estimates in the 2007 report reflect higher reference load using the 2007 model compared to those from the 2008 *ex ante* model. Re-examination of results for 2007 indicates that the correspondence between the modeled and observed loads outside control periods was more erratic in general for the 2007 model than was true for the 2008 modeled and observed loads. The 2007 modeling approach provided reasonable fits overall, but was less consistent than the 2008 model in aligning with actual loads across hours, temperature conditions, and days. The 2007 model used a nonlinear structure (the Tobit model) that

[28] For the 2008 M&V, KEMA changed the formula used to compute kW from metered amps to include a power factor calculated individually for each site. This follows an industry trend in the computation of kW from amp loggers that acknowledges the importance of this variable in calculating kW. Applying a power factor adjustment to the 2007 load impact estimates would result in overall reductions of about 15% in all 2007 estimates (reference load, event load, and load impacts).

[29] This analysis is based on PG&E's baseline-based climate zones. There are four such climate zones. SmartAC is primarily deployed in three of them.

accounts appropriately for the limits on air conditioner capacity, but the model used only one independent variable, temperature. The 2008 model was more extensively refined, and accounted for variation related to day type, humidity, month, and lagged temperature effects.

Table 6-7
Comparison of 2007 Ex Post Load Impact Estimates to 2008 Ex Ante Load Impact Estimates Using 2007 Weather (*)

	2007 Reported ex post savings, adjusted for power factor (kW/unit for Stockton area)		2008 ex ante model using 2007 weather. Assumes perfect adaptive cycling. (kW/unit for Climate Zone S)		2008 ex ante model using 2007 weather. Assumes blended adaptive cycling. (kW/unit for Climate Zone S)	
Date	8/28/2007	8/30/2007	8/28/2007	8/30/2007	8/28/2007	8/30/2007
Hour Ending						
4 PM	0.77	0.87	0.50	0.87	0.35	0.68
5 PM	0.82	1.06	0.69	1.00	0.52	0.82
6 PM	0.91	1.11	0.78	1.09	0.61	0.93
Average	0.83	1.01	0.66	0.99	0.49	0.81

(*) "Perfect adaptive cycling" refers to adaptive cycling that is a true 50% reduction compared to uncontrolled days of similar temperature. "Blended adaptive cycling" refers to a mix of adaptive and straight cycling that was observed in the 2008 sample. Details about this blend are presented in the Methodology section.

Comparison of 2007 modeled and actual loads on August 28 and 31 clearly shows some overstatement in the model. For August 30, however, the model fit looks reasonable before and after the control event. The 2008 *ex ante* load impacts are still roughly 30 percent lower than those from the 2007 model, a greater difference than would be expected due to random error. Note that a modest difference in reference loads can translate into a large difference in impacts. Possible reasons for this difference include:

- General reductions in usage across the population. Several utilities have reported declining consumption in the summer of 2008, unrelated to weather.

- Changing usage patterns among second year participants. In particular, customers who experienced controls on 3 of the 4 days of the hottest period of the 2007 summer may have started cooling their homes more during the day in 2008, to reduce discomfort in the event of an afternoon control event. In addition, the economic downturn over this period hit the Stockton area particularly hard.

6.2 *Ex Ante* Estimates of Load Impact at the Time of System Peak

Unlike *ex post* estimates, which are reported at the AC unit level, *ex ante* estimates are reported at the premise level. On average, SmartAC program participants have 1.1 ACs per premise.

This study found no response rates of 2.3% for switches and 6.2% for PCTs[30]. For the estimation of ex ante PCT estimates, we assumed a no response rate of 3%, which is consistent with PG&E's current efforts to improve the thermostats' response rates.

Ex ante load impacts were estimated separately for each combination of device and climate zone, for the 1-in-2 and 1-in-10 year weather conditions[31]. This was done to facilitate combining these estimates with the SmartAC enrollment forecast that was produced independently of this study. This section focuses on the impacts for switches in climate zones R, S, and X[32], at time of their projected highest impacts under the conditions dictated by these two years. Forecasts for other months, and for thermostats, are provided in the electronic *ex ante* appendix provided with this report[33].

The relative magnitude of the load impact varies from climate zone to climate zone, depending on the year:

- In 1-in-10, climate zones X and R achieve maximum load impact in July. Climate zone S achieves maximum load impact in June.
- In 1-in-2, climate zone X has its highest forecasted impact in September, while the impacts for climate zone R peak in August. Climate zone S has equally high load impacts in August and September.

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[30] See Appendix C "No Response Analysis" for more details.

[31] PG&E selected year 2004 to represent the 1-in-2 weather conditions, and 2003 to represent 1-in-10.

[32] Climate zone R is represented by the Greater Fresno area, climate zone S by Stockton, and climate zone X by the Greater Bay Area. *Ex ante* impacts were estimated for climate zone T (coastal areas – PG&E's coolest climate zone) and reported in the electronic file provided with this report. Because they are very low compared to those of the other three climate zones, they are not included in this discussion.

[33] The file name is <FINAL SmartAC 2008 ex ante impacts per SAID.xls>

The timing of the maximum load impact is roughly consistent with the California Independent System Operator's (CAISO) reported system peaks, on July 17, 2003 (1-in-10) and September 8, 2004 (1-in-2)[34]. From 1998 to 2007, 2004 was the only year that the CAISO peaked in September. All other peaks occurred in July and August.

Figure 6-5 and Figure 6-6 illustrate the differences among the climate zones in year 1-in-2. The first figure illustrates switch load impact at time of system peak (month of September), for three of the climate zones. While climate zone R has the highest of all impacts, the maximum load impact for this climate zone in year 1-in-2 is not in September. The second figure illustrates switch load impact at time of system peak in July, August, and September, also for climate zone R. In *ex ante*, this climate zone peaks in August instead of September.

Table 6-8 and Table 6-9 present the full set of ex ante estimates for climate zone R, at the time of highest impact in years 1-in-2 and 1-in-10, respectively. It is estimated that the average program participant in climate zone R can provide up to 1.1 kW of load relief at time of system peak under these weather conditions.

Figure 6-7 compares the large differences between the highest impacts forecasted for years 1-in-2 and 1-in-10:

- Climate zone R displays the smallest of these differences. The maximum load impact is reached in August for year 1-in-2, and in July for year 1-in-10. There is an average difference of about 7% in the load impacts for these two years.
- In sharp contrast, in climate zone S the forecasted load impact in 1-in-10 (June) is twice as much as that in 1-in-2 (August).
- In climate zone X the difference between 1-in-10 (July) and 1-in-2 (September) is about 35% - not quite as high as with climate zone S, but still much higher than with climate zone R.

[34] Source of CAISO system peak dates: http://www.caiso.com/1fb4/1fb4af6c73260.pdf
It is of course possible that PG&E's system peak did not coincide with the CAISO's. For example, in 2008, the CAISO peaked on July 7, while PG&E peaked on July 8. Nevertheless, the CAISO's peaks provide a reasonable reference for this discussion.

KEMA

Figure 6-5
SmartAC *Ex Ante* Estimated Reference Load and Event Day Load
September System Peak (Year Type: 1-in-2)

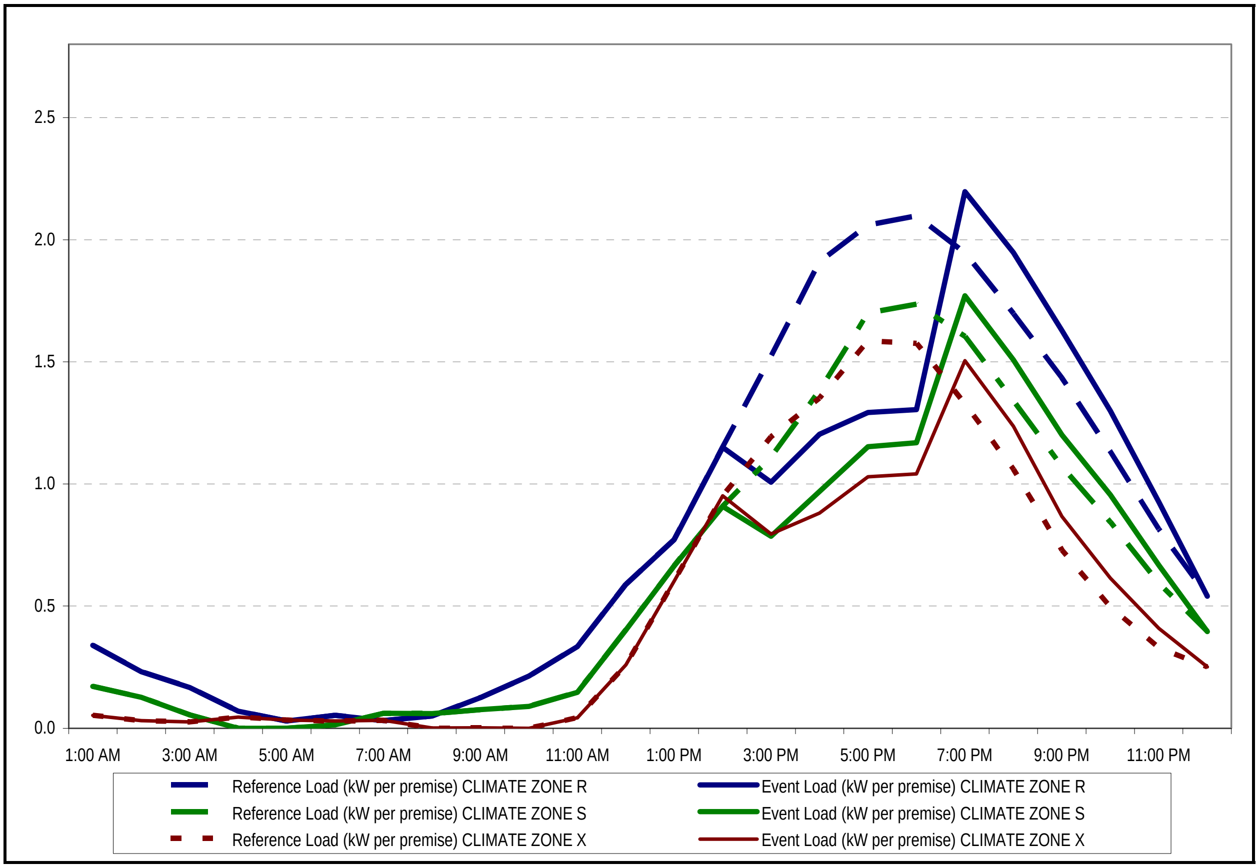


Figure 6-6
SmartAC *Ex Ante* Estimated Reference Load and Event Day Load
Climate Zone R
(Year Type: 1-in-2)

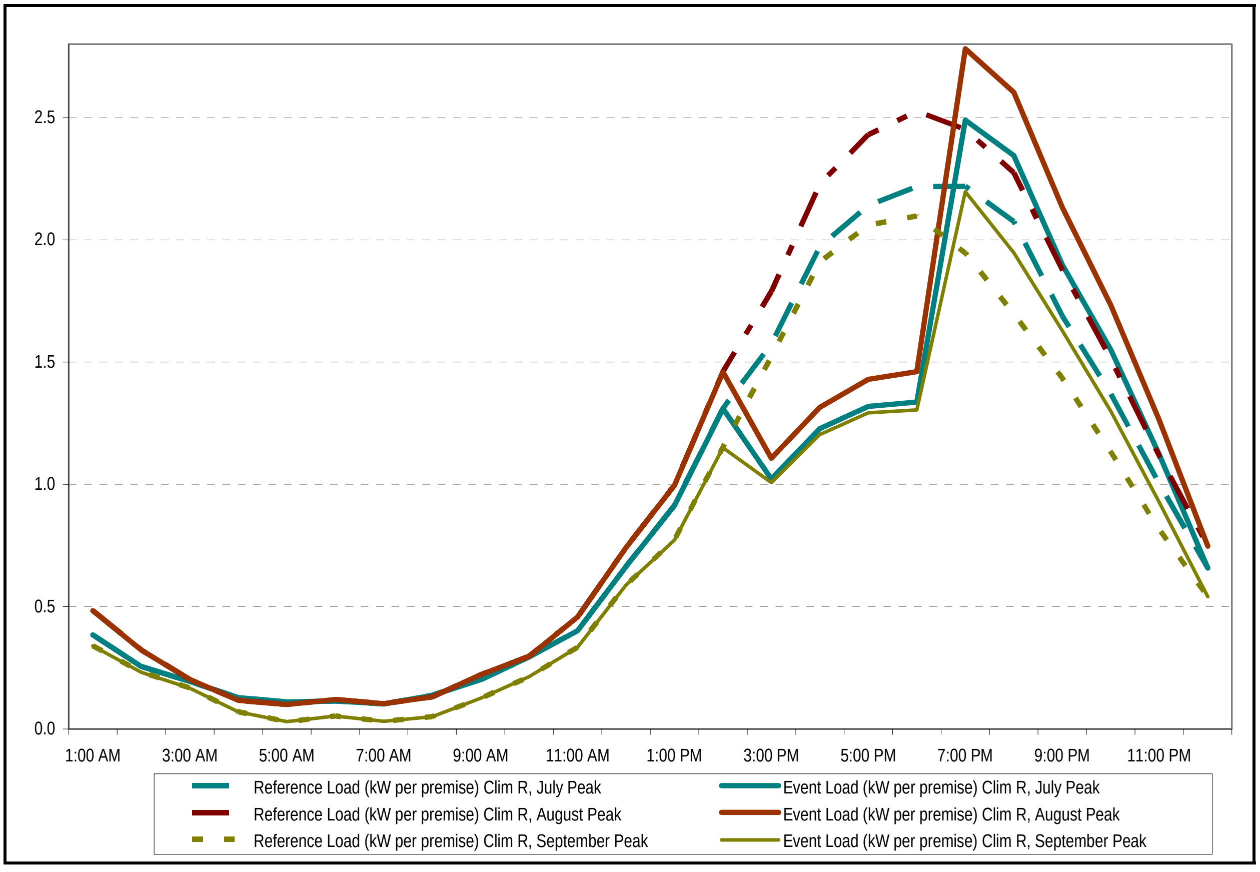
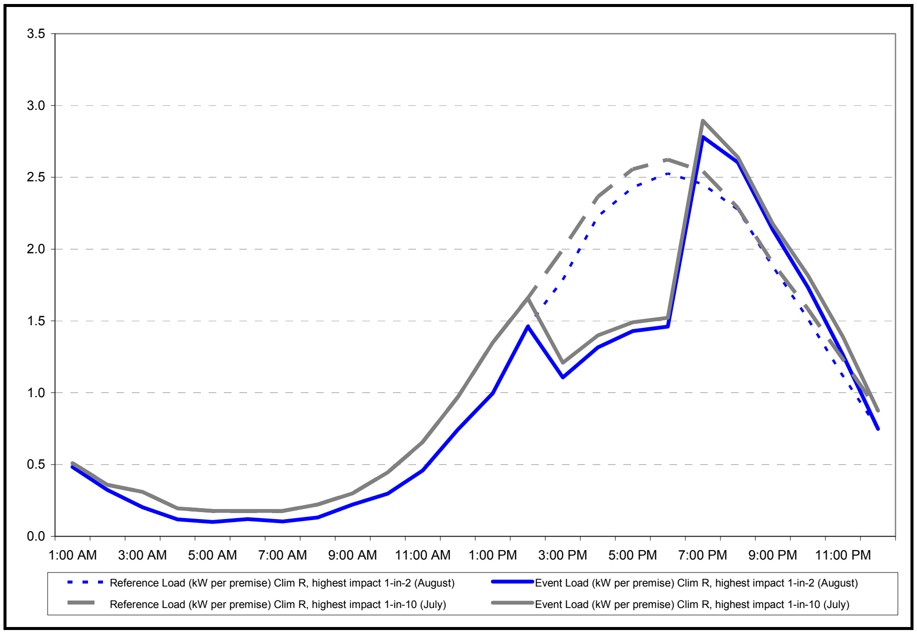


Figure 6-7
SmartAC *Ex Ante* Estimated Reference Load and Event Day Load
(Year Type: 1-in-2 Vs 1-in-10)

Climate Zone R



Climate Zone S

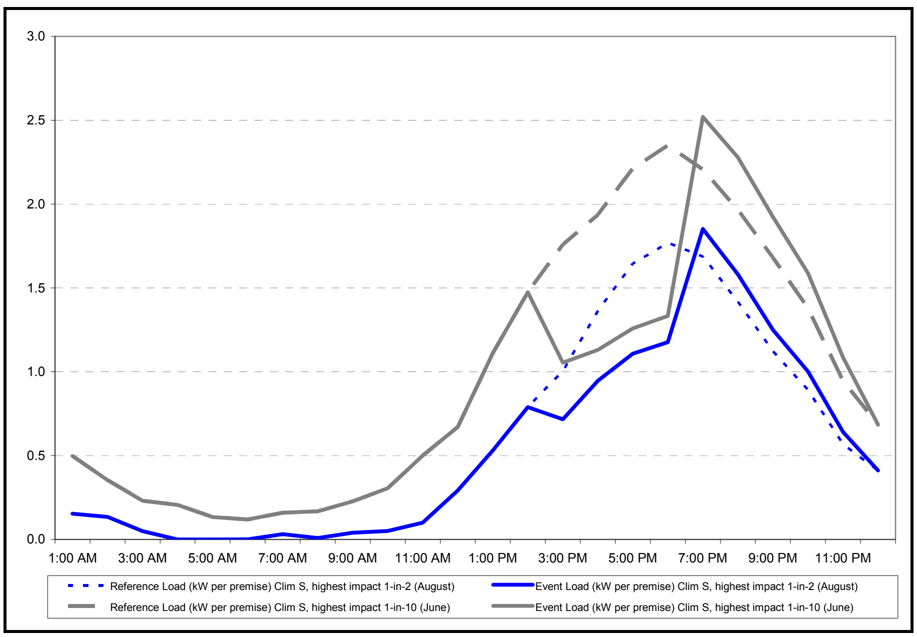


Figure 6-7 (continued)

SmartAC *Ex Ante* Estimated Reference Load and Event Day Load (Year Type: 1-in-2 Vs 1-in-10)

Climate Zone X

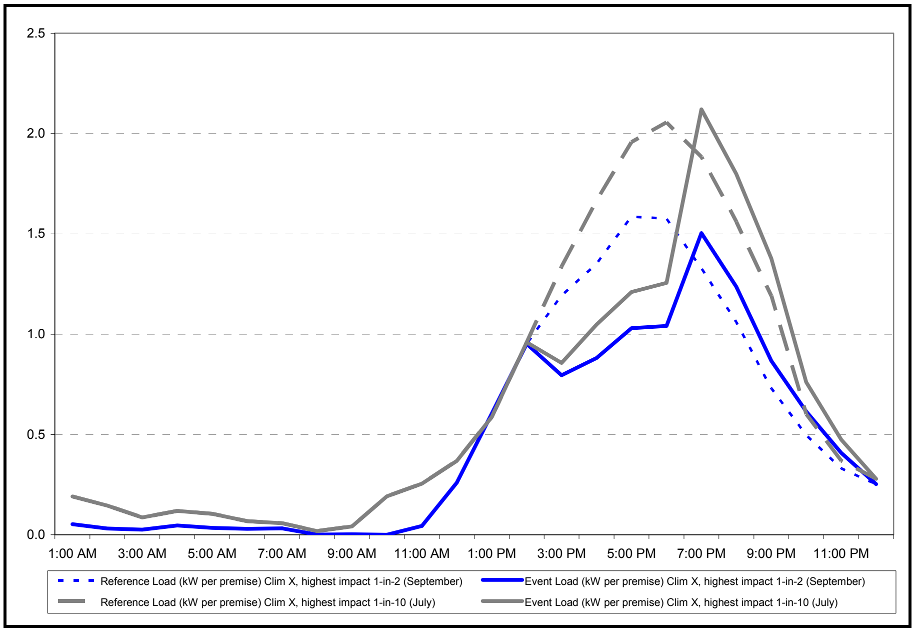


Table 6-8

SmartAC Peak Day Ex Ante Average Premise Impact Estimates:

Switches in Climate Zone R

Month: August - Year Type: 1-in-2

PG&E SmartAC™ 2008 *ex ante* estimates **PER PARTICIPATING PREMISE (SAID)**										
Control: Switch				1 in 2 year				Climate Zone R		
Date	Hour Ending	Estimated Reference Load (kW per Service Agreement - SA_ID)	Event Day Load (kW per Service Agreement - SA_ID)	Estimated Load Impact (kW per Service Agreement - SA_ID)	Weighted Average Temperature (ºF)	Uncertainty Adjusted Load Impact (kW per Service Agreement - SA_ID)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
August Peak	1:00 AM	0.48	0.48	0.00	84.04	0.00	0.00	0.00	0.00	0.00
August Peak	2:00 AM	0.32	0.32	0.00	81.11	0.00	0.00	0.00	0.00	0.00
August Peak	3:00 AM	0.20	0.20	0.00	76.72	0.00	0.00	0.00	0.00	0.00
August Peak	4:00 AM	0.12	0.12	0.00	74.81	0.00	0.00	0.00	0.00	0.00
August Peak	5:00 AM	0.10	0.10	0.00	74.31	0.00	0.00	0.00	0.00	0.00
August Peak	6:00 AM	0.12	0.12	0.00	73.68	0.00	0.00	0.00	0.00	0.00
August Peak	7:00 AM	0.10	0.10	0.00	73.50	0.00	0.00	0.00	0.00	0.00
August Peak	8:00 AM	0.13	0.13	0.00	75.97	0.00	0.00	0.00	0.00	0.00
August Peak	9:00 AM	0.22	0.22	0.00	81.46	0.00	0.00	0.00	0.00	0.00
August Peak	10:00 AM	0.30	0.30	0.00	85.48	0.00	0.00	0.00	0.00	0.00
August Peak	11:00 AM	0.46	0.46	0.00	90.40	0.00	0.00	0.00	0.00	0.00
August Peak	12:00 PM	0.74	0.74	0.00	93.62	0.00	0.00	0.00	0.00	0.00
August Peak	1:00 PM	1.00	1.00	0.00	96.74	0.00	0.00	0.00	0.00	0.00
August Peak	2:00 PM	1.46	1.46	0.00	100.86	0.00	0.00	0.00	0.00	0.00
August Peak	3:00 PM	1.79	1.11	**0.68**	103.44	0.58	0.64	0.68	0.72	0.78
August Peak	4:00 PM	2.23	1.31	**0.91**	105.50	0.80	0.87	0.91	0.96	1.02
August Peak	5:00 PM	2.43	1.43	**1.00**	108.43	0.89	0.95	1.00	1.05	1.11
August Peak	6:00 PM	2.53	1.46	**1.07**	108.47	0.95	1.02	1.07	1.11	1.18
August Peak	7:00 PM	2.45	2.78	-0.33	106.55	-0.28	-0.31	-0.33	-0.35	-0.38
August Peak	8:00 PM	2.27	2.60	-0.33	103.90	-0.28	-0.31	-0.33	-0.35	-0.38
August Peak	9:00 PM	1.88	2.13	-0.26	100.21	-0.22	-0.24	-0.26	-0.27	-0.29
August Peak	10:00 PM	1.51	1.73	-0.22	96.16	-0.19	-0.21	-0.22	-0.23	-0.25
August Peak	11:00 PM	1.12	1.26	-0.15	94.02	-0.12	-0.14	-0.15	-0.16	-0.17
August Peak	12:00 AM	0.75	0.75	0.00	90.04	0.00	0.00	0.00	0.00	0.00
Date	Daily Summary	EstimatedReference Load (kWh)	Event Day Load, (kWh)	Estimated Load Impact (kWh)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (kWh)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
August Peak		24.70	22.32	2.38	360.10	.	.	.	.	.

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Table 6-9
SmartAC Peak Day Ex Ante Average Premise Impact Estimates
Switches in Climate Zone R
Month: July - Year Type: 1-in-10

PG&E SmartAC™ 2008 *ex ante* estimates **PER PARTICIPATING PREMISE (SAID)**										
Control: Switch					1 in 10 year			Climate Zone R		
Date	Hour Ending	Estimated Reference Load (kW per Service Agreement - SA_ID)	Event Day Load (kW per Service Agreement - SA_ID)	Estimated Load Impact (kW per Service Agreement - SA_ID)	Weighted Average Temperature (ºF)	Uncertainty Adjusted Load Impact (kW per Service Agreement - SA_ID)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
July Peak	1:00 AM	0.51	0.51	0.00	84.79	0.00	0.00	0.00	0.00	0.00
July Peak	2:00 AM	0.36	0.36	0.00	83.63	0.00	0.00	0.00	0.00	0.00
July Peak	3:00 AM	0.31	0.31	0.00	83.06	0.00	0.00	0.00	0.00	0.00
July Peak	4:00 AM	0.19	0.19	0.00	80.20	0.00	0.00	0.00	0.00	0.00
July Peak	5:00 AM	0.18	0.18	0.00	79.23	0.00	0.00	0.00	0.00	0.00
July Peak	6:00 AM	0.18	0.18	0.00	78.18	0.00	0.00	0.00	0.00	0.00
July Peak	7:00 AM	0.18	0.18	0.00	77.66	0.00	0.00	0.00	0.00	0.00
July Peak	8:00 AM	0.22	0.22	0.00	80.59	0.00	0.00	0.00	0.00	0.00
July Peak	9:00 AM	0.30	0.30	0.00	84.65	0.00	0.00	0.00	0.00	0.00
July Peak	10:00 AM	0.44	0.44	0.00	88.59	0.00	0.00	0.00	0.00	0.00
July Peak	11:00 AM	0.66	0.66	0.00	92.65	0.00	0.00	0.00	0.00	0.00
July Peak	12:00 PM	0.97	0.97	0.00	96.81	0.00	0.00	0.00	0.00	0.00
July Peak	1:00 PM	1.35	1.35	0.00	99.92	0.00	0.00	0.00	0.00	0.00
July Peak	2:00 PM	1.66	1.66	0.00	102.96	0.00	0.00	0.00	0.00	0.00
July Peak	3:00 PM	2.00	1.21	**0.79**	105.50	0.69	0.75	0.79	0.83	0.90
July Peak	4:00 PM	2.36	1.40	**0.96**	107.49	0.85	0.92	0.96	1.01	1.08
July Peak	5:00 PM	2.56	1.49	**1.07**	108.07	0.96	1.02	1.07	1.11	1.18
July Peak	6:00 PM	2.62	1.52	**1.10**	108.58	0.99	1.06	1.10	1.15	1.21
July Peak	7:00 PM	2.54	2.89	-0.35	108.10	-0.31	-0.33	-0.35	-0.37	-0.40
July Peak	8:00 PM	2.29	2.64	-0.35	106.04	-0.31	-0.33	-0.35	-0.37	-0.40
July Peak	9:00 PM	1.90	2.17	-0.27	100.97	-0.24	-0.26	-0.27	-0.29	-0.31
July Peak	10:00 PM	1.58	1.82	-0.24	97.36	-0.20	-0.22	-0.24	-0.25	-0.27
July Peak	11:00 PM	1.23	1.39	-0.16	95.72	-0.14	-0.15	-0.16	-0.17	-0.18
July Peak	12:00 AM	0.87	0.87	0.00	93.23	0.00	0.00	0.00	0.00	0.00
Date	Daily Summary	EstimatedReference Load (kWh)	Event Day Load, (kWh)	Estimated Load Impact (kWh)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (kWh)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
July Peak		27.46	24.91	2.55	415.81	.	.	.	.	.

6.3 Validity Assessment of the *Ex Post* Estimates

6.3.1 Confidence Level

One of the goals of this evaluation was to achieve a statistical precision of 10 percent at 90 percent confidence (“90/10”), at time of system peak.

The *ex post* estimates for July 8, 2008 achieved a 10.6% precision at time of system peak at 4 pm, and 10.2% at 6 pm, the time of day when the load impact tends to be the highest.

Precision at time of system peak for several groups of interest is illustrated in the following table.

Table 6-10
Statistical Precision at Time of System Peak (July 8, 2008)

Group	Estimated Reference Load (kW per AC Unit)	Event Day Load (kW per AC Unit)	Precision at 90% confidence
Program	2.20	1.34	10.6%
Switches	2.20	1.29	12.4%
Thermostats	2.22	1.51	17.6%
LCA: Greater Bay Area	2.22	1.22	16.8%
LCA: Greater Fresno	2.41	1.74	21.7%
LCA: Stockton	2.04	1.14	17.0%
Climate Zone R	2.41	1.74	21.7%
Climate Zone S	2.08	1.17	15.2%
Climate Zond X	2.16	1.19	18.8%

The lower than expected precision level can be traced back to a couple factors:

- **Over sampling of PCTs**. Following the information available from the 2007 evaluation, PCTs received a more than proportional sample size in order to account for:
    - *Higher standard deviations*. PCTs exhibited higher standard deviations with respect to switches in 2007. However, that was not the case in 2008. This is most likely attributed to the difference in PCT control employed in 2008, which reduced the variance of the observed loads and load impacts.
    - *Future increase in the ratio of PCTs to switches*. PG&E plans to deploy a ratio of 60% switches and 40% thermostats. We were expecting an increase in the percent of installed thermostats during 2008, which did not occur.

- **Changes in share of program participants in each of the climate zones.** The sample size was allocated proportionally among the three climate zones at the time the sampling frame was assembled and the sample was designed, in April. Subsequently, there were major changes in the program composition. For example, program installations in Climate Zone X increased from 25% to 35% of all program participants.

6.3.2 Limitations of the Model

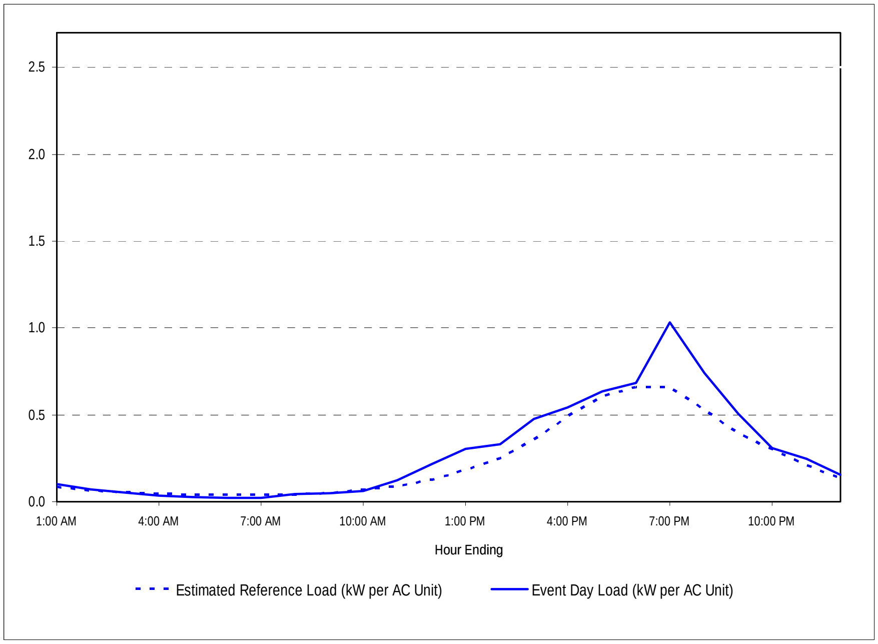
During the specification and testing of multiple functional forms of this model, there was a strong emphasis placed on obtaining the best estimates at times when the load impact is the highest. In addition, behavior that changes consistently across program participants will yield more consistent model results. As it gets hotter, AC use becomes more prevalent and yields more reliable model results.

Because of this, the model utilized to estimate *ex post* results produces unreliable results at lower temperatures. It appears to underestimate the reference load. A visual inspection of the modeled reference load compared to the event day load suggests that the model yields unreliable load impact estimates when the highest temperature of the day falls under 95^{o}F.

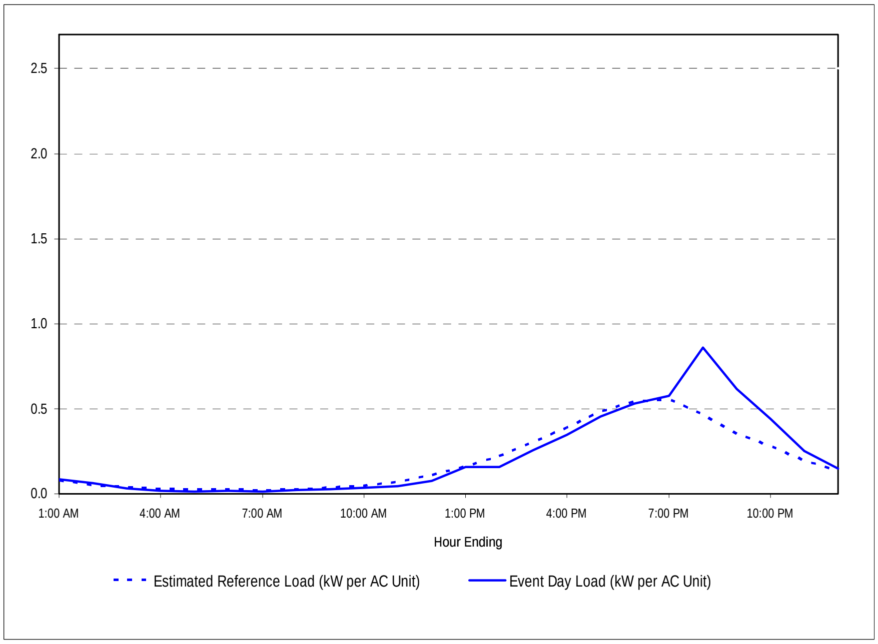
Note that at lower temperatures, the reference loads, and thus the estimated *ex post* load impacts, are unreliable. However, the event day load (which is not modeled, but estimated as a weighted average of the sample's observations) is not affected. For these days, the event day load (controlled load) between 2 and 6 pm has ranges of 0.40 to 0.73 kW. The median is 0.45 kW. For comparison purposes, on the day of system peak and the day after, the controlled load average for these four hours was 1.3 kW.

Ex post results for two mild event days are presented in Figure 6-8. Ignoring the two events conducted in October, which exhibit event day loads close to 0 kW, the lowest event day high temperature is that of August 21. On this day, the reference load is consistently under the event day load starting at about 8 AM. The high temperature of the day was 85.6^{o}F, with a day's average of 76.1^{o}F. Load impacts during event hours have statistical accuracies ranging from 33 to 167 percent at 90 percent confidence (90/33 to 90/167). These accuracies reflect the high variability of AC at milder temperatures. The second chart is for June 17, when the high temperature of the day was higher than for August 21 (at 93.8^{o}F) but the average temperature was lower, at 75.3^{o}F. The reference load is above the event day load during event hours. However, the large amount of snapback and the general dimension of the event day load compared to the reference load suggest that the reference load is indeed underestimated.

Figure 6-8
SmartAC *Ex Post* Estimated Reference Load and Event Day Load on Mild Days
August 21, 2008 (temperature: average 76.1 °F, high 85.6 °F)



SmartAC *Ex Post* Estimated Reference Load and Event Day Load on Mild Days
June 17, 2008 (temperature: average 75.3 °F, high 93.8 °F)



6.4 Statistical Measures of the *Ex Post* Load Impact Estimates

An important purpose of the Protocols is the establishment of “minimum requirements for load impact estimation for DR resources and to provide guidance concerning issues that must be addressed and methods that can be used to develop load impact estimates for use in long term resource planning.” To this end, the Protocols discuss two common approaches used to estimate demand response impacts: Regression and Day-Matching approaches, and dictate statistical measures for their assessment.

KEMA’s model has elements of both of these methods. KEMA uses regression-based, unit-level models of AC usage to estimate event day reference load. *Ex post* impacts are then estimated by comparing this estimated reference load to observed load levels during event hours. *Ex ante* impacts are estimated by applying a duty cycle framework to load model estimates.

The protocol for regression-based estimates (Protocol 10) is designed for a pooled regression model fit across all units and time periods jointly in one model. Such a model typically includes event days in the model, so that impacts are determined directly from regression coefficients. The accuracy of the estimate is therefore indicated by regression diagnostics, including standard errors of coefficients and R^2 statistics.

While KEMA’s approach is regression based, the regression diagnostics that result from our models are not directly comparable to those that would be provided for a pooled model. Standard errors for individual fits will tend to be much larger than those for a single overall fit. The individual standard errors also do not directly measure the accuracy of the estimate that combines results across the units. Thus, while we provide summaries of the regression diagnostics for the individual units, we caution that these are not comparable to the corresponding diagnostics that could be obtained for a pooled model.

The day-matching protocol (Protocol 9) addresses the accuracy of the reference load estimate by comparing estimate reference load to actual load on proxy days. While this approach was not designed for the individual-unit estimation process used in this evaluation, this Protocol can also be adapted to provide meaningful results for our method. The equation used for Protocol 9 statistics are included in the Methodology section.

6.4.1 Statistical Measures for Day-Matching Methods (Protocol 9)

Table 6-11 provides proxy day accuracy statistics. These statistics measure bias. This table includes loads, errors and relative error based on both averages and medians. These averages and medians are calculated for each hour of the day across all days and units, using the sample expansion weights. The relative error measures the average and median error as a percentage of average or median load, respectively. Both average and median loads approach zero during non-cooling hours giving relative errors that approach infinity. For this reason we confine the median relative errors to the hours between 1 PM (hour ending 2 PM) and 11 PM (hour ending at midnight.) The most common event hours during summer 2008 were 3 PM through 6 PM. For these hours the relative average error is 2.1 percent or less while the relative median error is very small, and is rounded to to zero at the 2-digit level.

Table 6-11

Proxy Day Accuracy Statistics (*)

Hour Ending	Average Load (kW)	Median Load (kW)	Average Error	Median Error	Relative Average Error	Relative Median Error
1	0.30	0.00	-0.01	0.00	-1.8%	
2	0.21	0.00	-0.01	0.00	-3.9%	
3	0.16	0.00	-0.01	0.00	-3.8%	
4	0.12	0.00	0.00	0.00	0.9%	
5	0.10	0.00	0.00	0.00	3.2%	
6	0.09	0.00	0.01	0.00	9.0%	
7	0.08	0.00	0.01	0.00	7.9%	
8	0.09	0.00	0.01	0.00	7.2%	
9	0.12	0.00	0.01	0.00	5.0%	
10	0.21	0.00	0.01	0.00	3.5%	
11	0.32	0.00	0.02	0.00	5.2%	
12	0.51	0.00	0.03	0.00	5.6%	
13	0.75	0.00	0.04	0.00	5.6%	
14	1.03	0.34	0.03	0.00	3.2%	0.0%
15	1.32	1.03	0.03	0.00	2.1%	0.0%
16	1.62	1.56	0.02	0.00	1.5%	0.0%
17	1.81	1.81	0.01	0.00	0.4%	0.0%
18	1.89	1.92	-0.01	0.00	-0.3%	0.0%
19	1.84	1.86	0.00	0.00	0.0%	0.0%
20	1.58	1.46	0.00	0.00	0.1%	0.0%
21	1.29	1.11	0.03	0.00	2.0%	0.0%
22	0.99	0.67	0.01	0.00	1.4%	0.0%
23	0.73	0.18	0.02	0.00	3.0%	0.0%
24	0.51	0.00	0.02	0.00	3.8%	
	Average Load (kW)	**Median Load (kW)**	**Average Error**	**Median Error**	**Relative Average Error**	**Relative Median Error**
Daily	0.74	0.00	0.01	0.00	1.6%	

(*) In this table, the median error and the relative median error are non-zero. However, they are very small, and are rounded to zero at the 2-digit level.

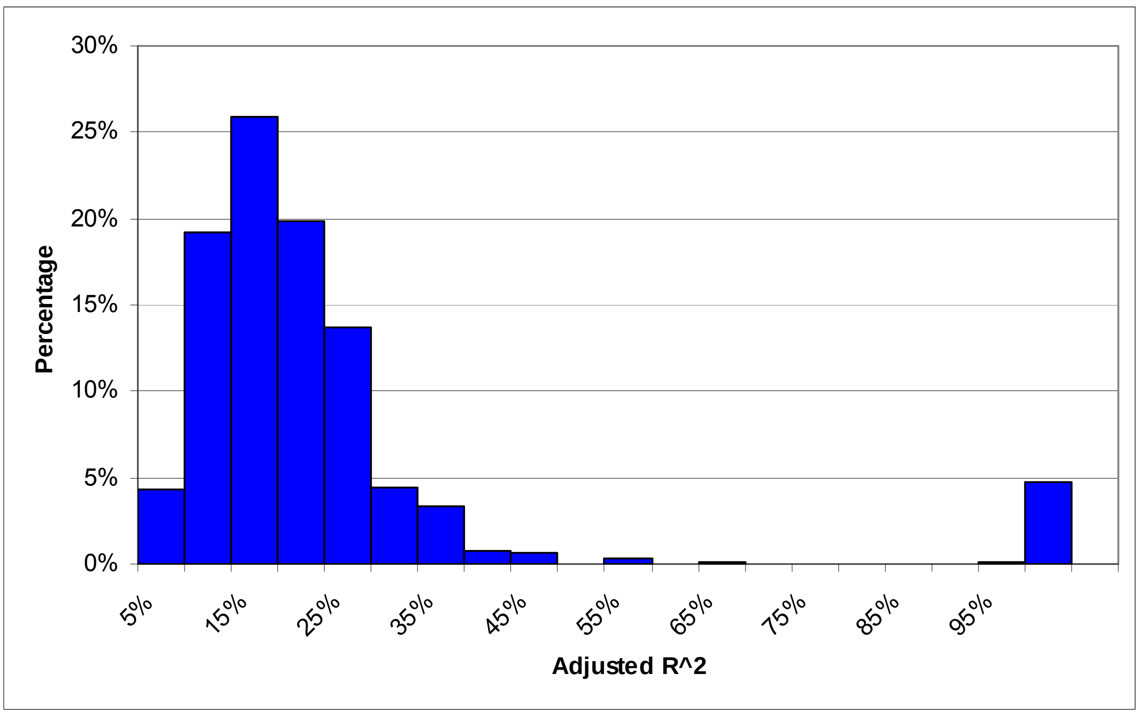
Per the Protocols, the coefficient of alienation is a measure of the error in "a prediction algorithm relative to the variation about the mean of the variable being predicted."[35] The coefficient of alienation over the smart AC sample is 16.9 percent. This is the same as an R^2 of 0.831.

Theil's U is a measure of variation. It's a relative measure of variance, scaled by the magnitude of the load, so is appropriate for comparison across units of different sizes. For the DR

[35] Definitions obtained from the DR Protocols.

protocols, Theil's U is applied to individual AC unit data series for the selelcted proxy days. The distribution of Theil's U across the sample provides an indication of the level of estimation error on the proxy days. Figure 6-9 provides the distribution of Theil's U across the individual AC units. The median value is of the distribution is 17.3 percent and the mean value is 22 percent. The AC units with a Theil's U value of one were unused on the proxy days but had non-zero usage on other days.

Figure 6-9
Distribution of Theil's U for Proxy days

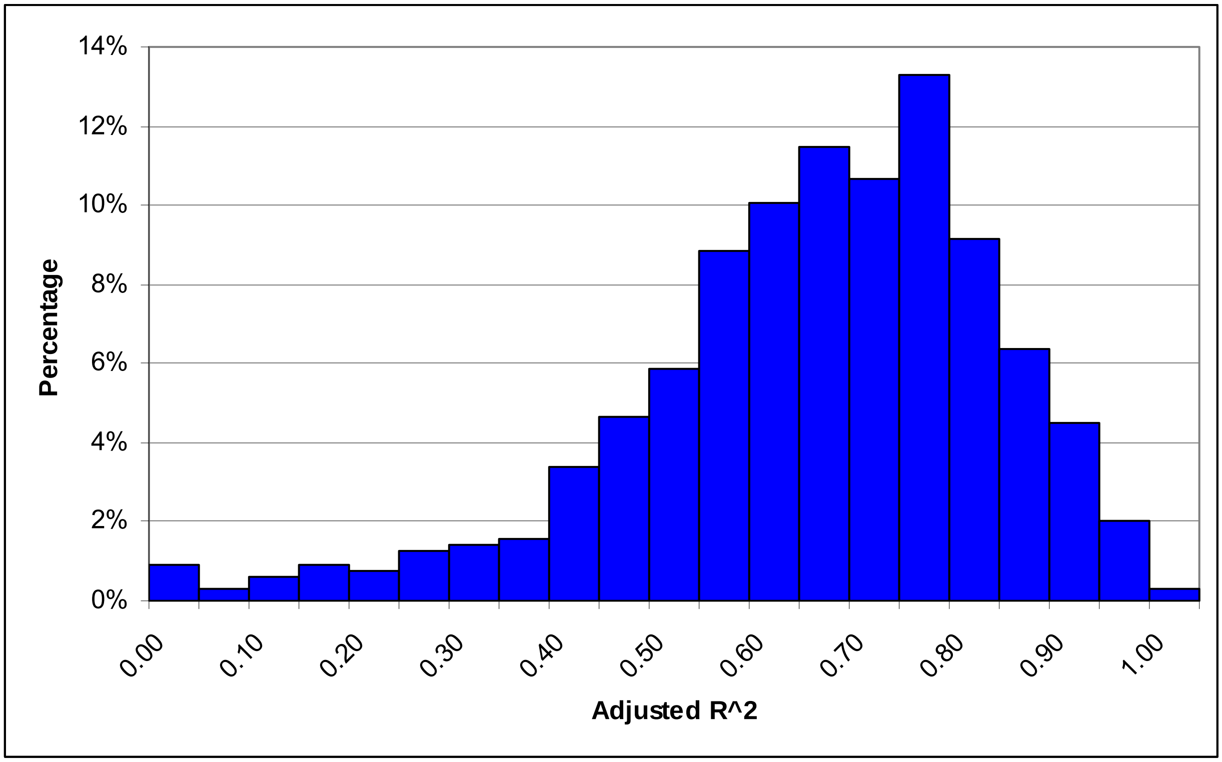


6.4.2 Statistical Measures for Regression Based Methods (Protocol 10)

Protocol 10 requires a wide range of regression diagnostics to establish the accuracy of the regression(s) underlying the impact estimates. KEMA fits regression models separately to each participating unit non-event day data to estimate the unit's event-day reference load. The diagnostics from these many regressions are challenging to summarize.

Figure 6-10 shows that the cooling load model employed for this analysis explained more than 50 percent of the variation in 86 percent of the individual unit regressions. The median of the distribution is 0.69.

Figure 6-10
Distribution of AC Cooling Load Regression Adjusted R^2s



The regression results were the end product of a process that tested several model specifications. Each model specification was estimated across a range of degree day bases to identify the optimal degree day base for each unit, as determined by mean average percentage error (MAPE). In addition, different model specifications were judged based on their relative MAPE as well as the appropriateness of the variable mix.

For the impact methodology followed for this evaluation, the kW load model results ultimately inform only the individual unit reference loads. This is in contrast to a pooled regression that directly estimates event impacts. For the pooled model, combinations of the regression parameter estimates directly provide the overall reference load or event impact. The Protocol 10 requirement to provide parameter estimates, standard errors and the covariance matrix is based on this kind of model with impacts directly given by pooled model coefficients. The corresponding model diagnostics for the 625 individual unit-level regressions that were estimated for this evaluation are less directly indicative of the accuracy of the aggregate impact.

These model diagnostics for the 625 individual regressions are provided in electronic files[36]. An example of one of these regressions is presented in Appendix G.

[36] The names of these files are:
SmartAC load impact 2008 kw_model_stats.sas7bdat
SmartAC load impact 2008 kw_model_coef.sas7bdat
SmartAC load impact 2008 kw_model_varcov.sas7bdat

7. Recommendations

This section summarizes KEMA's recommendations for Program and Study improvements.

Our Program recommendations do not address potential changes to the Program's tariff (for example, increasing the percent of cycling) or to its deployment plans (for example, combining or not with other demand response programs offered by PG&E.) This does not imply that KEMA believes that such strategies are not effective. Rather, we focus attention on improvements that can be made within the existing tariff rules, based on findings from our analysis.

7.1 Recommended Program Improvements

Explore ways to increase the adaptive behavior of switches

The switches employed by the SmartAC program employ adaptive algorithms that aim to reduce air conditioner load compared to its own load observed in the past, rather than restricting its run time to a pre-determined number of minutes per hour. In the absence of enough data to inform the adaptive algorithm, the switches revert to a non-adaptive algorithm. This evaluation demonstrated that the adaptive algorithm is effective at increasing load impacts compared to a non-adaptive algorithm. It also produced evidence that the adaptive switch performance is roughly midway between that of "ideal" adaptive control and fixed 50% non-adaptive control. Further, the performance moves closer to ideal adaptive behavior at higher temperature. At higher temperatures, switches produce load impacts that are a combination of about 60% adaptive, 40% non-adaptive control.

We recommend that PG&E explore with its technology vendor ways to bring the adaptive switch performance closer to 50% of uncontrolled load.

Expect air conditioner usage, and the corresponding load impacts, to decrease as a result of the economic downturn

There are some utilities that have noted non-weather related reductions in sales in 2008. It is very possible that the economic downturn is affecting, and will continue to affect, air conditioner use, lowering Program impacts.

Continue investigation and reduction of no-response devices

PG&E is actively investigating areas of the service territory that experienced higher than expected rates of no event response in 2008. These improvements will result in an increase of *ex post* load impacts in future years. Rates of no response are explicitly determined in the *ex ante* load impacts.

7.2 Recommended Study Improvements

Consider utilizing an alternating a comparison group in the M&V sample

Future M&V efforts based on end-use interval data should consider controlling only half the sample during each event. The controlled half would alternate for successive events. This approach has the following advantages:

- It allows more events under different conditions, but with less burden on any one customer.
- It provides more non-event hot days for defining reference load under peak conditions.
- It offers a "comparison group" for assessing the accuracy of projected load for controlled customers for each event.

The downside to this approach is:

- Reduced precision, resulting from smaller sample sizes for *ex post* impact estimation. Alternatively, increased costs would be incurred to support from larger sample sizes that can accommodate a comparison group without losing target precision. Note that *ex ante* impacts, which are based primarily on the models of uncontrolled load, would not lose precision compared to the current approach.

Explore the decrease in air conditioner usage and its corresponding load impacts as a result of the economic downturn

As noted above, it is possible that the economic downturn is affecting air conditioner use, and lowering load impacts. This effect can be explored and quantified utilizing a combination of billing data, weather data, and the interval data collected during 2007 and 2008.

Incorporate control device log data in the M&V analysis

The control devices utilized in the SmartAC program can store up to 90 days of information regarding run time and in the case of thermostats, temperature set points. This data can provide a rich source of information regarding air conditioning behavior that can complement the interval data collected for this purpose.

Investigate potential changes in behavior of Program participants that have been cycled frequently, and quantify its effects

Frequent load control, such as was applied to the SmartAC M&V sample participants in 2007 and 2008, has the potential to affect customer behavior over time. After two years of data collection it is possible to investigate whether customers in their second year of frequent program cycling have adopted compensating techniques, such as pre-cooling.

This analysis can also benefit from the use of the control device log data mentioned above. In particular, changes to lower temperature set points earlier in the day are an indication of pre-cooling behavior.

Appendix A. SmartAC Residential Tariff

Pacific Gas and Electric Company
San Francisco, California
U 39

Original Cal. P.U.C. Sheet No. 25963-E
Cancelling Cal. P.U.C. Sheet No.

ELECTRIC SCHEDULE E-RSAC
RESIDENTIAL SMART A/C PROGRAM

Sheet 1

APPLICABILITY: This schedule provides customers with an option to supplement the service provided under the customer's otherwise applicable electric rate schedule. Schedule E-RSAC – Residentical Smart A/C Program (Program) is a voluntary demand response program where PG&E installs a device at a customer's premise that can temporarily disengage the customer's air-conditioning (A/C) unit or raise the temperature at the thermostat when the device is remotely activated by PG&E. The Program is intended to be a service option for individually metered residential customers with single stage central electric A/C units that generally operate during PG&E's summer peak periods. (N)

PURPOSE: PG&E will activate the devices in order to reduce its system peak demand during emergency or near-emergency situations, or during limited program testing. The operation of this program will act as a demand-side resource to PG&E to help maintain service reliability for all electric customers, defer construction of additional generation facilities, and reduce environmental pollutants. This program will be limited to 100 hours per year.

TERRITORY: This schedule applies throughout PG&E's electric service territory.

ELIGIBILITY: This schedule applies to residential electric customers who are otherwise being served on one of the following PG&E rate schedules:

Non-Time-Of-Use (TOU) Rate Schedules: E1, EL-1, E-8, EL-8, EM, EML, ES, ESL, ESR, ESRL, ET, and ETL

TOU Rate Schedules: E-6, E-7, E-A7, EL-7, EL-A7, and E-9

Customers may not participate in the Program if any of the following conditions apply: (1) A/C unit is not compatible with PG&E's device or is located in an area where there is inadequate signal strength to reliably and remotely operate it; (2) A/C equipment is in an unacceptable operating condition in PG&E's sole discretion; (3) A/C system is not a central electric unit, such as window air conditioners or evaporative coolers; (4) A/C unit is generally not used during PG&E's system peak time periods; (5) A/C unit installation does not meet electrical code; (6) Installation of the device would pose a safety risk for the installer of the equipment; (7) Any premise occupant has a medical condition that would prohibit their participation; or (8) Customer does not authorize PG&E to install a device. (N)

(Continued)

Advice Letter No:	2946-E-A	Issued by	Date Filed	February 23, 2007
Decision No.		**Brian K. Cherry**	Effective	February 23, 2007
		Vice President	Resolution No.	E-4061
1C1		Regulatory Relations		

Pacific Gas and Electric Company
San Francisco, California
U 39

	Revised	Cal. P.U.C. Sheet No.	27298-E
Cancelling		Cal. P.U.C. Sheet No.	26514-E

ELECTRIC SCHEDULE E-RSAC Sheet 2
RESIDENTIAL SMART A/C PROGRAM

RATES: A customer's monthly electric bill will continue to be calculated in accordance with the otherwise applicable rate schedule.

DEVICE OPTIONS: Customers may elect that PG&E install, free of charge, one of the following two devices at their premise, subject to availability and the Program's device subscription limits: (T)

1. A/C Cycling Switch: The A/C Cycling switch will generally be installed outdoors, on or adjacent to the customer's A/C unit. When activated by PG&E, the switch will turn off or cycle the A/C unit for approximately 50% of the time over each (T) subsequent 30 minute interval. This is called a "cycle." Program events will be (T) limited to no more than six hours each day. An A/C unit can be cycled no more than 100 hours each year.

2. Programmable Controllable Thermostat (PCT): A PCT is a thermostat that can be programmed and operated or activated remotely by a signal. When the program is (T) called, PG&E will activate the device one of two ways: (1) the thermostat | temperature will be incrementally increased up to four degrees or, (2) the device | will cycle the A/C unit for approximately 50% of the time over each 30 minute | interval, similar to the switch, until the event is complete. Program events will be (T) limited to no more than six hours each day. A PCT can be activated no more than 100 hours each year.

PG&E understands that there may be times that a temperature increase, however modest, may inconvenience customers. PG&E will provide its customers with a toll free telephone number and/or a dedicated website to override, without penalty, PG&E's control of their device for a program event absent rotating block outages.

DEVICE CALL OPTION: Customers on the SmartRate Program may request PG&E to activate their A/C Cycling switch or PCT when the customer is participating solely in a SmartDay event.

SPECIAL CONDITIONS:

1. Devices may be activated by PG&E based on system peak loading conditions, or transmission or distribution system loading conditions. PG&E may on a limited basis conduct operational tests on a segment of customer devices.

2. Program events will occur during PG&E's summer season, which runs from May 1 (T) through October 31 each year.

3. Customers must remain on the Program for 12 months.

4. PG&E will furnish, install, operate, and maintain an A/C Cycling switch or PCT at no cost to the customer for as long as the customer remains on this Program. Ownership of the installed devices will vest with the property owner. As a condition of participating in this Program, customer and property owner must agree to not deface, remove or otherwise interfere with the device or its operation while the customer is enrolled in this Program.

5. PG&E will install specialized metering on a small sample of participants' A/C units to facilitate program impact estimates. PG&E will retain ownership of the specialized meters.

6. Customer participation is limited to equipment and installation availability.

(Continued)

Advice Letter No:	3214-E-A	Issued by	Date Filed	March 19, 2008
Decision No.	08-02-009	**Brian K. Cherry**	Effective	March 1, 2008
		Vice President	Resolution No.	
2C1		Regulatory Relations		

Pacific Gas and Electric Company
San Francisco, California
U 39

	Original	Cal. P.U.C. Sheet No.	27299-E
Cancelling		Cal. P.U.C. Sheet No.	

ELECTRIC SCHEDULE E-RSAC
RESIDENTIAL SMART A/C PROGRAM

Sheet 3

SPECIAL CONDITIONS: (Cont'd.)

7. Program participation must be authorized by a property owner at the premise. Renters or lease holders may participate with the owner's written approval. (L)

8. Customers with multiple air conditioning units at one premise must have all units controlled in order to participate in this program.

9. The ability to override device may not be available in the event of an extreme emergency, such as a rotating block outage. (L)

CUSTOMER INCENTIVE: Following program enrollment and installation of an A/C Cycling switch or PCT, customers will receive a one-time financial incentive of up to $50.00, depending on fund availability and PG&E's program marketing in effect at the time of installation. (N)

Advice Letter No:	3214-E-A	*Issued by*	*Date Filed*	March 19, 2008
Decision No.	08-02-009	***Brian K. Cherry***	*Effective*	March 1, 2008
		Vice President	*Resolution No.*	
3C1		*Regulatory Relations*		

Appendix B. SmartAC Weather Analysis for M&V Events

This appendix describes the process employed in this 2008 evaluation to monitor the daily weather forecast provided by PG&E, and used to determine SmartAC M&V event days.

The 2008 SmartAC weather analysis involved two major differences with respect to 2007:

- The Settlement Agreement[37] provided some guidance regarding the climate conditions under which M&V events are to be conducted
- There were three climate zones involved, instead of just one.

These differences are discussed below.

The Settlement Agreement

Page 7 of the Settlement Agreement says:

> a. The load impact analysis will study the persistence of PCT load reductions during event periods to assess whether PCTs will result in material increases in aggregate customer load during later hours of an event (i.e. hours 3 to 6 of a 6 hour event) and enough test dispatches of system during various climate days (i.e., mid-90s, 100s, and greater than 100 degree days) to assess the persistence of demand response during an entire 6 hour event.

PG&E determined that the settlement agreement did not mandate that all M&V events be six hours long, and it was determined to run a mix of event lengths for this evaluation.

Climate Zone Considerations

Since the M&V events cannot be segmented by climate zone, the decision to call events will be based on the forecasts for climate zones R and S, weighted by the number of units installed in each climate zone as of June 10.

[37] Application No. 07-04-009 of Pacific Gas And Electric Company (U 39-E) for Approval of 2008-2020 Conditioning Direct Load Control Program. Settlement Agreement Between and Among Pacific Gas and Electric Company, The Division of Ratepayer Advocates and The Utility Reform Network. December 18, 2007.

However, it is important to note that there are more SmartAC devices installed in climate zone X than in each of the other two climate zones. Because climate zone X is milder, it was assumed that devices in climate zone X would produce less average savings than those in the two other climate zones[38].

When the sample was designed, using program data as of the end of March, there were almost 34 thousand SmartAC devices in the field. Climate zones R, S, and X represented 33%, 42%, and 25% of the installed devices. With the number of deployed devices at over 57 thousand as of the first week of June, these shares have changed as illustrated in Table 1.

Table 1
Number of Installed Devices
(Data received on 6/10/2008 – Not adjusted for number of devices that have left the program)

climzone	Frequency	Percent	Cumulative Frequency	Cumulative Percent
	516	0.90	516	0.90
R	16,913	29.53	17,429	30.43
S	19,604	34.23	37,033	64.67
T	258	0.45	37,291	65.12
X	19,976	34.88	57,267	100.00

Temperature Thresholds for M&V Events

PG&E provided KEMA with half-hourly temperature for three weather stations representative of the climate zones where SmartAC is most active: Stockton, Fresno, and Concord. Since the Concord area experiences milder temperatures than Stockton and Fresno, and since Stockton and Fresno combined (a) have more SmartAC devices, and (b) are expected to generate more program impacts, Concord was excluded from the temperature analysis to determine when to run M&V events.

KEMA examined the weighted maximum temperature distribution of Stockton, Fresno, and a composite temperature generated from weighting Stockton and Fresno by the number of SmartAC devices installed in each climate zone. This distribution is presented in Table 2.

[38] As noted in the *ex post* results section of this report, this assumption was not correct.

Table 2

Distribution of Maximum Daily Temperature (1993-2007)

CITY	month	mean	max	q3	median	q1	min	mode	p10	p20	p30	p40	p50	p60	p70	p80	p90	p99
FRESNO	6	92	109	98	93	88	66	94	81	86	89	91	93	95	97	99	103	107
FRESNO	7	99	113	103	99	95	83	99	92	94	96	98	99	100	102	104	106	111
FRESNO	8	98	114	102	98	94	79	97	91	93	95	97	98	99	101	103	105	110
FRESNO	9	91	107	97	92	86	68	95	81	84	88	90	92	94	96	99	101	105
FRESNO	10	80	101	86	80	74	55	81	69	73	75	78	80	82	84	87	90	98
STOCKTON	6	86	106	92	86	81	62	82	75	80	82	84	86	88	91	94	97	103
STOCKTON	7	91	112	96	92	87	75	92	83	86	88	90	92	93	95	97	100	107
STOCKTON	8	91	106	96	91	86	67	92	82	85	87	89	91	92	95	97	99	105
STOCKTON	9	87	103	92	87	82	65	88	77	80	83	85	87	89	91	94	96	100
STOCKTON	10	77	99	82	77	72	55	74	67	71	74	75	77	79	82	83	87	95
Weighted Fresno/Stockton	6	89	106	95	89	84	65	95	78	83	85	88	89	91	93	96	99	105
Weighted Fresno/Stockton	7	95	112	99	95	91	80	92	88	90	92	94	95	96	98	100	102	108
Weighted Fresno/Stockton	8	94	110	98	94	90	75	95	87	89	91	92	94	96	97	99	101	107
Weighted Fresno/Stockton	9	89	104	94	89	84	66	92	79	83	85	87	89	92	93	95	98	102
Weighted Fresno/Stockton	10	78	99	84	78	73	56	76	68	72	74	76	78	81	83	85	88	97

The yellow highlight represents the temperature ranges at which events were called.

In order to spread the number of events evenly, events were called following the pattern outlined below[39]:

July and August

- We expect to have about 15 days in each of these two months when the weighted max temperature for the day of the forecast is between 95 and 100. We will enumerate these days, such that the first day in this temperature range is day number 1. Events will be called on day numbers 4, 8, and 12.

- We expect to have about 6 days in each of these two months when the weighted max temperature is 101 or more. We will enumerate these days, such that the first day in this temperature range is day number 1. Events will be called on day numbers 3 and 6.

September

- We expect to have about 6 days when the weighted max temperature for the day of the forecast is between 95 and 100. We will enumerate these days, such that the first day in this temperature range is day number 1. We will call events on day numbers 3 and 6.

[39] This process excludes the event in May, which was called as a SmartAC test, and the two events of June, which were conducted prior to finalizing this weather analysis procedure.

- We expect to have about 3 days when the weighted max temperature is 101 or more. We will enumerate these days, such that the first day in this temperature range is day number 1. We will call an event on day number 3.

October

- In 2007 there were no events conducted in October. In order to comply with the Protocols[40], we will conduct events in October of 2008. Since temperatures will be milder, we will lower the weighted temperature threshold to 85 degrees or more. We expect to have about 6 days in this range. We will enumerate these days, such that the first day in this temperature range is day number 1. We will call events on days 2 and 5.

Other

- We will attempt to conduct events on all days when a system peak is likely. When such events are conducted, we will gauge their impact on the total number of events, and of event-hours conducted, to determine when to conduct the next event. If possible, we will resume our count from the last likely system peak event. For example, we conducted two likely system peak events on July 8 and July 9, when the temperature range was 101 or more. This protocol dictates to conduct an event on hot days number 3 and 6 of such temperature range. These events were on hot days numbers 2 and 3. Our next event in July in this temperature range will be on hot day number 6 –the event conducted on hot day 2 will not be counted toward our maximum number of events in this temperature range.

- In the event that the hot day falls on a weekend or holiday, the event will be conducted on the next weekday that has the target temperature range.

[40] California Public Utilities Commission, Energy Division. *Attachment A - Load Impact Estimation for Demand Response: Protocols and Regulatory Guidance*. March 2008.

Appendix C. No Response Analysis

A "no response" is defined as an event when the device did not respond to the load control signal. This analysis does not differentiate among the possible causes of no response, mainly missed signals, and devices that malfunctioned. To determine no response, KEMA visually inspected the load data for each sample participant during times of M&V control events, determined if the AC was running right before the event, and if so, if it did not react to that day's event signal. These results were then compared to the SmartAC opt-out list, to ensure that the lack of response was not caused by an opt-out.

There are two components to no response: the percent of customers that experience at least one no response, and the percent of no responses experienced by customers that experienced at least one no response.

Sites with no responses are not distributed equally among all areas. In order to quantify some of the differences, KEMA utilized the SmartAC sample to estimate these rates in the five cities with the most enrollments. Since it is likely that the lack of response is device-dependent, this was also quantified.

KEMA's observations regarding missed signals are described below. All numbers reported are population estimates derived from a weighted sample.

(1) The percent of customers that would have experienced at least one no response in 2008. This is about 17% overall.

(2) For customers that experienced at least one no response, the percent of all load control days when the AC was running that did not have a response. This is about 37% overall.

(3) These two rates combined indicate that the overall probability that any given device would have missed any given signal in 2008 is about 6%

(4) The percent of customers that would have experienced at least one no response is 17% overall. It is higher for PCTs (19%) than for switches (4%). This rate varies with the city. Of the five cities with the most participants:

- Clovis had an overall rate of 26% - switches 25%, PCTs 26%
- Fresno had an overall rate of 20% - switches 4%, PCTs 30%

- Livermore had an overall rate of 20% - switches 0%, PCTs 38%
- Manteca had an overall rate of 15% - switches 11%, PCTs 17%
- Stockton had an overall rate of 13% - switches 7%, PCTs 22%

(5) The 17% of customers that would have experienced at least one no response, would have experienced an estimated 37% no response rate. This rate is higher for switches (56%) than PCTs (33%), and it also varies by city:

- Clovis - 43% overall, 83% switches, 23% thermostats
- Fresno - 37% overall, 66% switches, 35% thermostats
- Livermore - 31% overall, 0% switches, 31% thermostats
- Manteca - 45% overall, 27% switches, 50% thermostats
- Stockton - 46% overall, 74% switches, 34% thermostats

Implications for the load impact study

DLC programs such as SmartAC have a "naturally occurring" rate of no response. For example, it is relatively common to have signals be occasionally blocked from devices that are otherwise working properly. This is the reason why last year, SmartAC chose to send the activate and stop signals at the same time - some devices were getting the signal to activate but not to stop, so they kept curtailing after the event had stopped. Which is also why zero response loads do not raise any flags *per se*. However, the rate of no response that SmartAC appears to have experienced in 2008 appears to be larger than what would be reasonably considered to be "naturally occurring."

For the *ex post* estimation, this is not a problem. What happened, happened, and it will be reflected in lower impacts. It does, however, pose a challenge for the *ex ante* estimation. On one hand, it may not be adequate to apply a high rate of no response to estimates of future impacts, since this problem is expected to be corrected. On the other, it is also not adequate to assume a 0% no response rate. To find middle ground will be challenging.

Statistical considerations

The SmartAC M&V sample is designed to produce results for the program, the device type, and with varying degrees of confidence, some of the other stratification variables. It was not designed to produce results at the city level. Further, some cities were deliberately excluded from the sample based on enrollment figures as of April, 2008, and their distance to larger clusters of Program participants.

In summary, we do not have enough information to conduct a proper city-level analysis. When producing results at the city level only 63% of all program participants are represented. However, we believe that this sample can produce sound results at the city level in cities where there the sample size is relatively large.

We do not recommend making any inferences based on very small sample sizes - considering the constraints of this analysis, 5 is a good cutoff. For example, it may be Ok to say that in Martinez, about 14% of program participants would have had at least one no response, because the Martinez sample size is 7. But estimates at the device level are highly discouraged, because each device's sample size is less than 5.

Appendix D. Thermostat Ramp Vs 50% Straight Cycle Comparison

This Appendix presents conceptual analysis and discussion exploring the potential for improved savings with ramped PCTs.

The *ex post* results for the 2008 ramped thermostat (2-1-1) show higher nominal savings at certain dates and hours than those for 50% straight cycle, and even the adaptive cycle. This result led us to investigate whether this control strategy may be able to deliver higher load impacts for SmartAC PCTs than the 50% straight cycle.

Based on our review of the results and some illustrative theoretical analysis, it appears unlikely that PCTs can out-perform the 50% duty cycle control at high temperatures.

Temperature increases and duty cycle reductions produce impacts in different ways. While the two are frequently compared (i.e. “a 4 degree setback is equal to 50 percent cycling”), any realistic comparison should consider a number of variables: outdoor temperature, indoor rate of temperature gains, set point, and AC sizing, at a minimum.

To investigate this issue, KEMA mapped out the theoretical behavior of the control technologies, and developed a Ramp Vs Duty Cycle worksheet tool to illustrate these relationships. This Appendix includes a description of the worksheet tool, a discussion of the key qualitative relationships illustrated by the tool, and a brief comparison among the three strategies on the two *ex post* days with the highest 2-1-1 load impacts.

Ramp Vs Duty cycle worksheet tool

The Ramp Vs Duty cycle worksheet tool provides a simple illustration of the impacts generated by switches and PCTs under varying conditions. The tool is, by necessity, simplified, but it provides a rough relative picture of the potential impacts for the different technologies under different scenarios.

This tool illustrates the relationship between the two technologies and three control strategies across a range of temperatures. The *ex post* results for the ramping PCT indicate impacts comparable to or better than adaptive switches on a number of days when the ramping strategy was in effect. This tool shows how this is possible and how at hotter temperatures, it is likely that this relationship will not be maintained.

The tool has three parameters that are adjustable to reflect

- Thermostat set points (in this model, this is the *outside* temperature at which the thermostat initiates cooling)
- Outdoor temperature at which the AC runs constantly (100% duty cycle)
- Float time: Elapsed time from a thermostat set-forward until the house temperature rises to the new set point and cooling begins again. This time is represented as a percent of an hour.

The tool has two tabs:

- One presents savings as percent of uncontrolled load.
- The other presents the duty cycle of the unit. A unit running at 100% duty cycle is running non-stop.

Note that:

- This tool does not address the issue of thermostats that are re-set to lower temperatures than their daytime settings during an event, resulting in negative load impacts.
- In order to expedite creation of this tool, it is modeling a 2-2 ramp, rather than a 2-1-1.
- Other assumptions are listed in the tool.
- A more elaborate model would recognize that the float period depends on the re-set amount as well as the starting set point and outside temperature, and would be different in the second hour than the first. In addition, the float time could be greater than an hour.

For the first example below, the model parameters are set so that:

- The house starts cooling at an outdoor temperature of 80 degrees,
- The unit reaches 100% duty cycle at 110 degrees, and
- The house has a 36 minute "float" period after re-set before the unit comes back on, now maintaining a temperature 2 degrees higher than the original temperature.

Figure 1 illustrates 50% non-adaptive and adaptive switch impacts, and a 2/2 ramp PCT impact during a 4-hour event.

Figure 7-1
Outdoor temperature at which the AC operates = 80°F
Temperature at which unit reaches 100% duty cycle = 110 °F
Float= 60% (36 minutes each of first two hours)

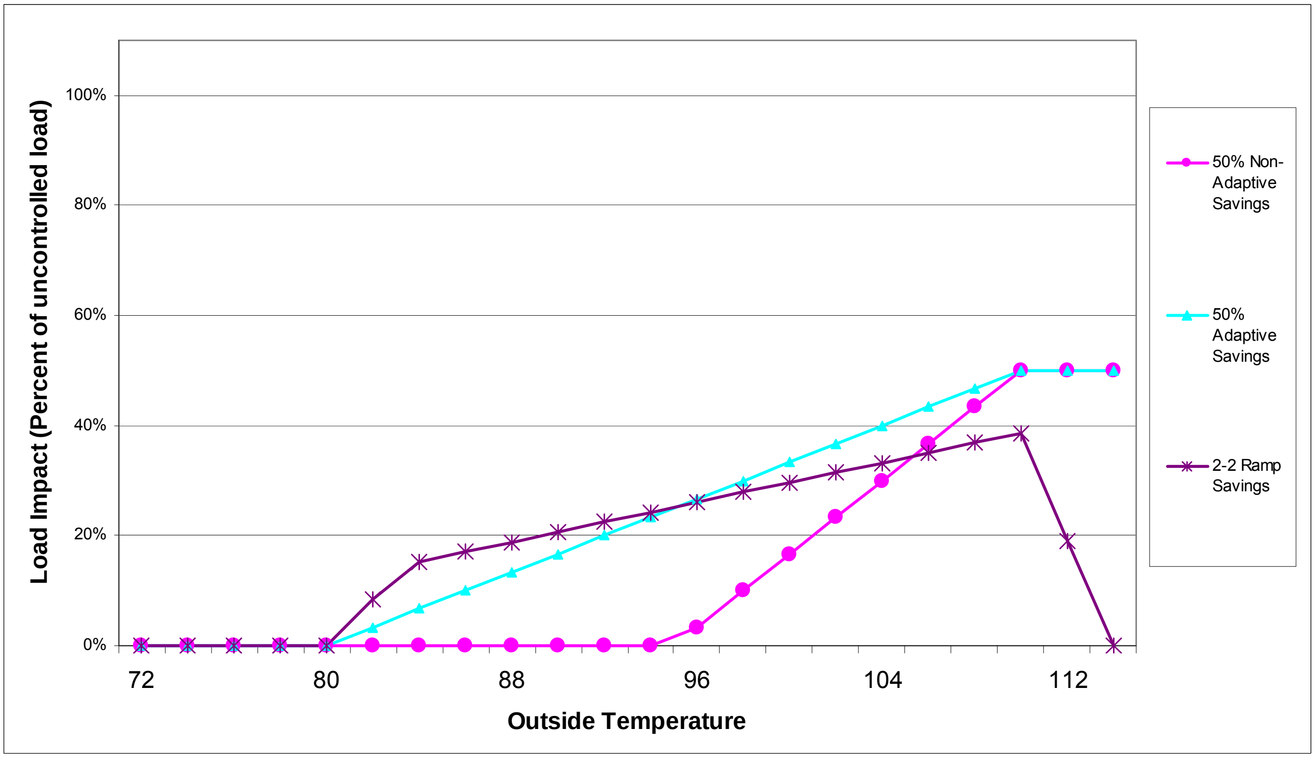


Figure 1 illustrates some general relationships:

- At moderate temperatures, the PCT is capable of providing impacts that compare favorably to those from both duty cycle control strategies.
- At extremely hot temperatures, the PCT set point adjustment will have no effect. That is, once the temperature is 4 degrees or more above the point where the unit is maxed out, the unit will continue to run at 100% if the set-point is raised by up to 4 degrees. Oversized units may never reach conditions where this takes place, but properly sized units may reach this point within the range of realistic temperatures.

PCT impacts are a combination of two factors: (1) complete elimination of AC operation during the float period, while the house rises to the new set point and the AC starts running again;, and (2) the lower duty cycle required to maintain the house temperature at the higher set point. For the case illustrated in Figure 1, the former factor, float, provides the majority of the PCT savings. Figure 1 assumes 36 minutes of float for each 2 degree set point increase. Some houses may take more time, others less. As temperatures increase, float decreases.

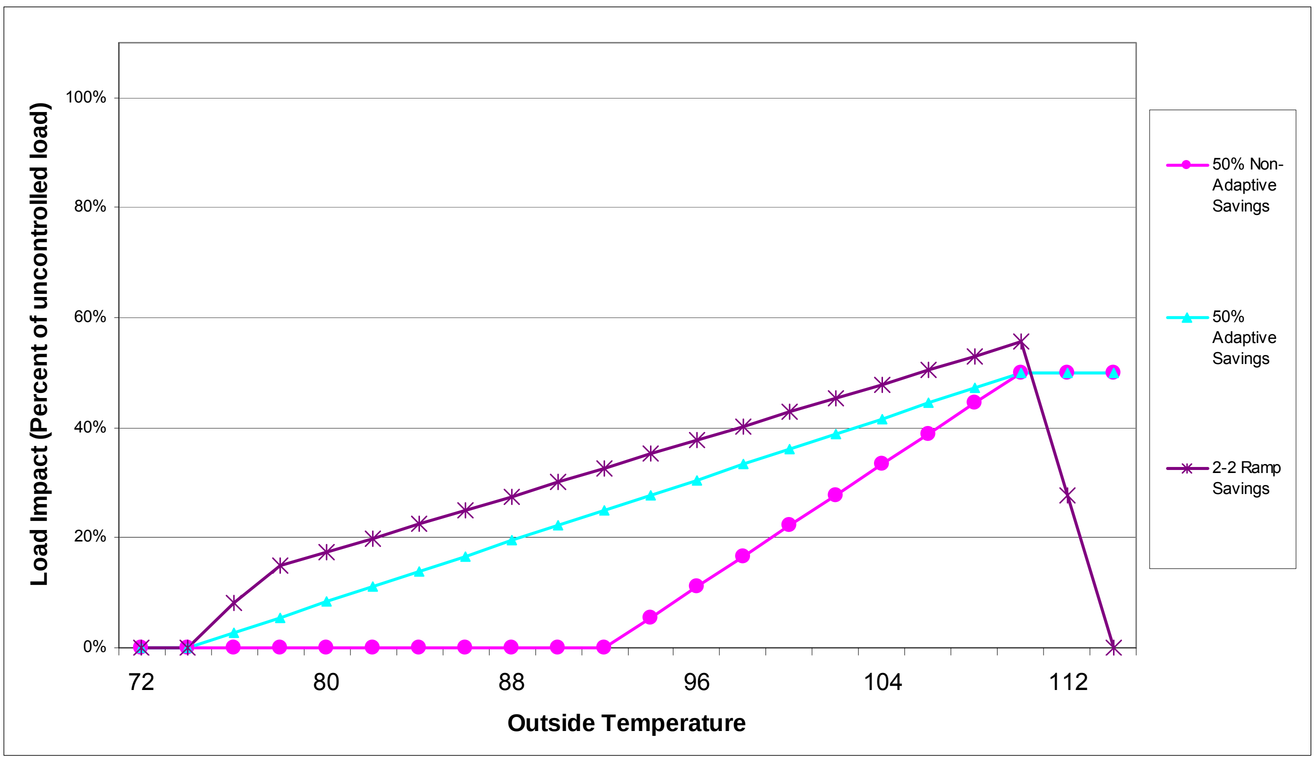
Ramped PCTs can provide better impacts than adaptive switches at high temperatures for houses with certain conditions. Figure 2 illustrates a house that is kept at very low temperature, and that increases in temperature very slowly. Under these conditions, the 2/2 ramp would effectively turn the unit off for two hours or more. Across a wide range of temperatures, the ramp impact is above that of the adaptive switch. At a very high temperature (in this example, 114°F) the PCT impact again goes to zero.

Figure 7-2

Outdoor temperature at which the AC operates = 74°F

Temperature at which unit reaches 100% duty cycle = 110 °F

Float= 100% (60 minutes each of first two hours)



Last, Figure 3 illustrates a likely scenario, where an air conditioner kicks in when the outdoor temperature reaches 85 degrees, it runs at 100% duty cycle when it reaches 104 degrees, and it can float for 20 minutes after it reaches the temperature dictated by the thermostat. As with the first example:

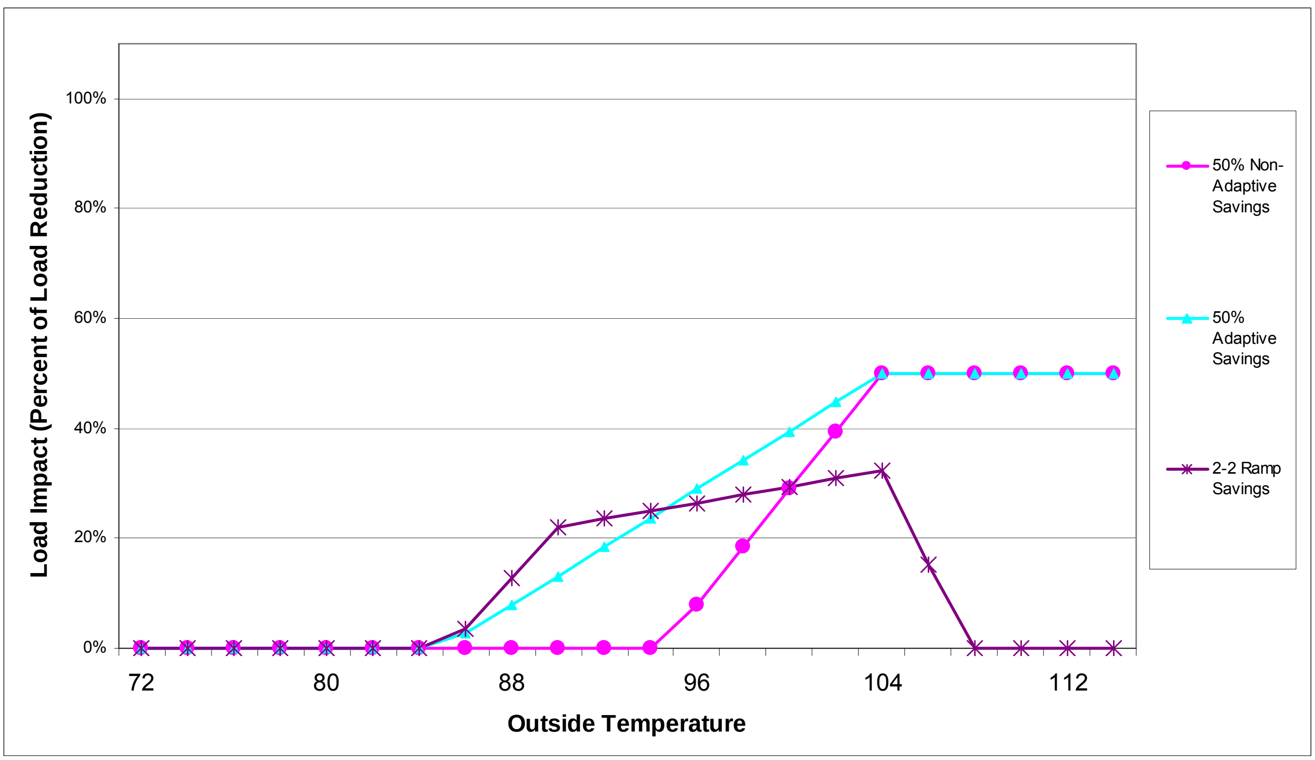
- at temperatures just above the home's reference temperature, the PCT yields the highest impacts of the three technologies
- at higher temperatures, PCT ramping outperforms a fixed 50% cycling switch but not the adaptive switch, and
- at very high temperatures the PCT ramp provides no savings

Figure 7-3

Outdoor temperature at which the AC operates = 85

Temperature at which unit reaches 100% duty cycle = 104

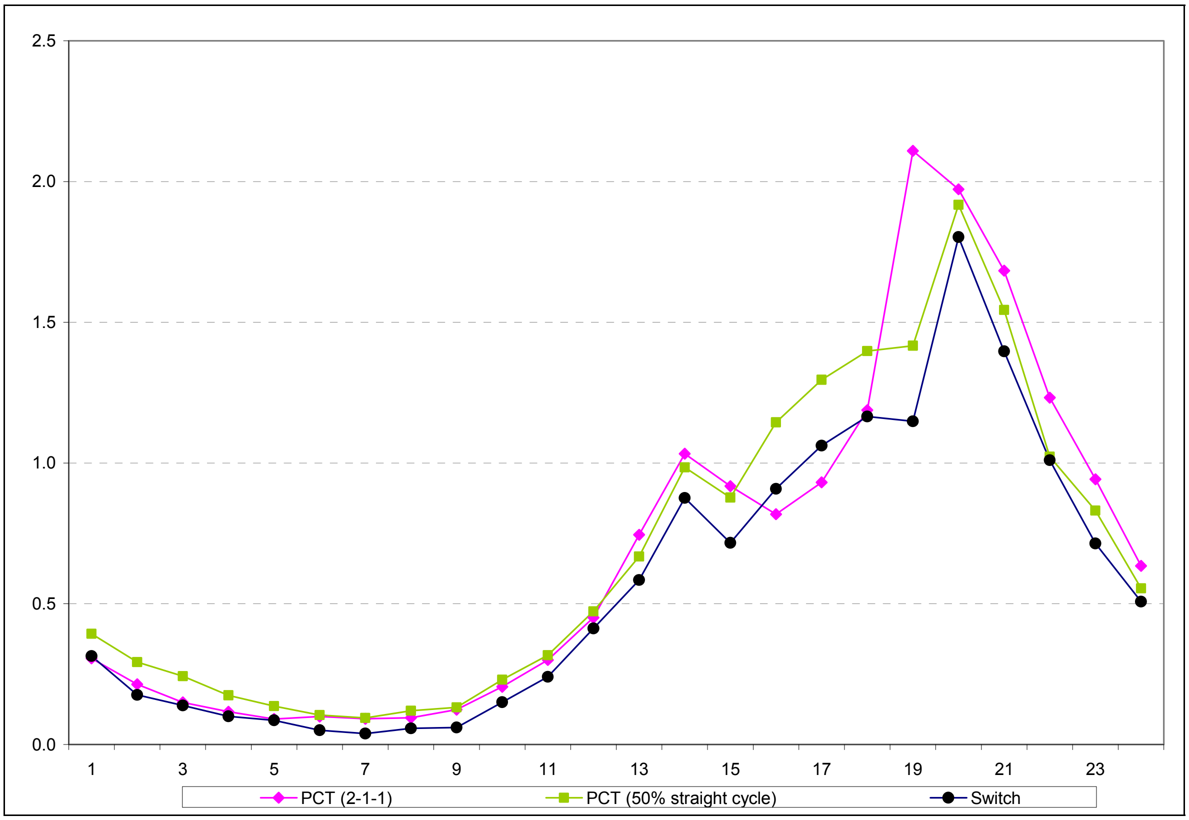
Float= 33% (20 minutes each of first two hours)



Ex post results comparison of the two PCT strategies

The two days with the highest *ex post* load impacts for the 2-1-1 strategy are presented in the following figures.

Figure 7-4
Event day: July 18, 2008

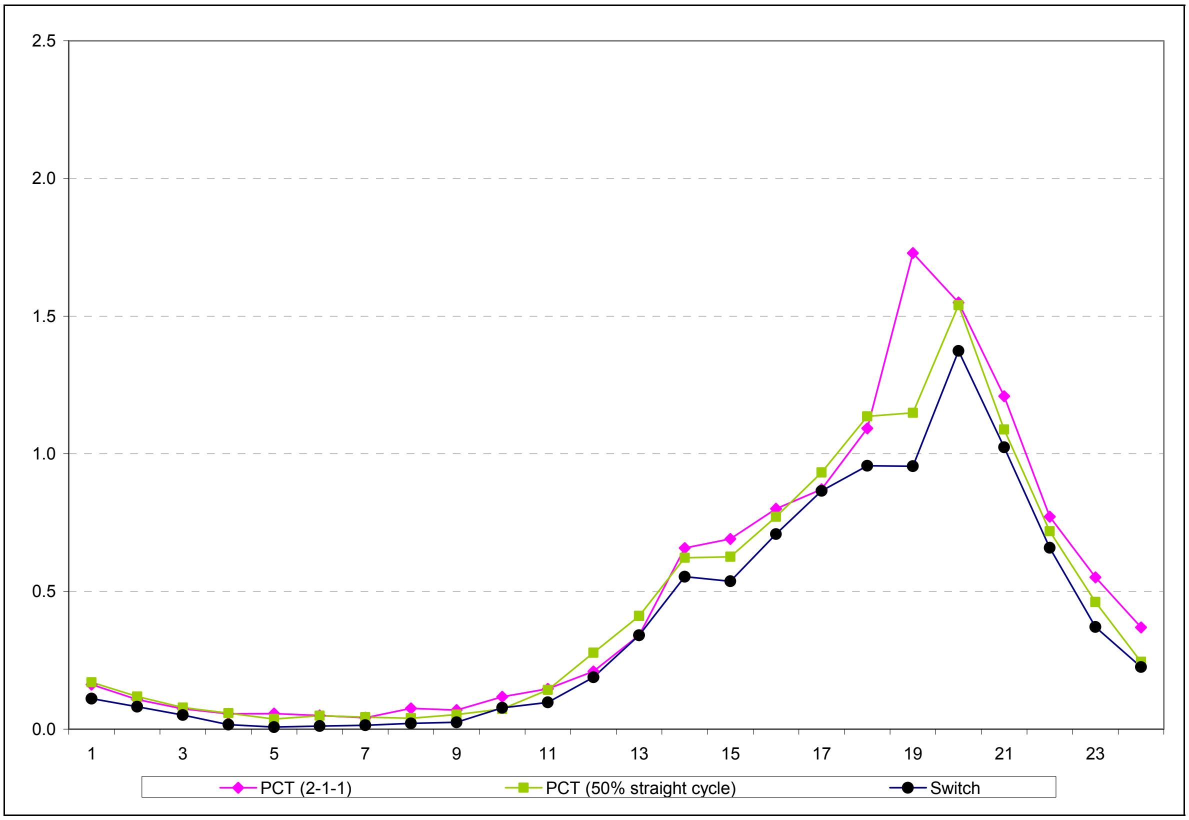


In this particular example (July 18, from 1:30 to 5:30 in the afternoon)[41], both PCT groups reflect a maximum outdoor temperature of 103 degrees, at 5 PM. Adaptive switches experienced a lower maximum temperature, of about 101 degrees.

[41] Event hours are reported on a scale that is equivalent to 0 to 23 hours. Note that the hours shown on the graph run from 1 to 24, rather than from 0 to 23.

Both the adaptive switch and the straight 50% cycling had a drop in the first hour of the event, followed by a gradual rise until the time the control was released. The ramped PCT dropped in each of the first 2 hours, but then increased more rapidly than the duty cycle control even before the end of the event, producing negative savings in the last hour of the event.

Figure 7-5
Event day: August 11, 2008



On August 11, the event took place from 2 to 7 PM. The PCT ramp sample group experienced a high temperature of about 101 degrees, whereas the PCT 50% and the adaptive switch experienced a high temperature of about 97 degrees. This is a substantial temperature difference that is evident in the large amount of snapback experienced by the PCT ramp group.

The temperature differential between the two PCT groups is an unfortunate result of the “luck of the draw” of the sample on that day. PCT sample participants were randomly assigned to both groups, and on this particular day, the temperatures that each group experienced were not the same.

This temperature difference makes direct comparisons between the load impacts in the ramp group and the 50% group invalid. However, it is again apparent that the load in the ramp group increases before the end of the event, producing negative savings in the last hour of the event.

Appendix E.
SmartAC 2008 System Peak *Ex Post* Estimates by AC Unit (kW)

Table 7-1
SmartAC Peak Day Average Unit Impact Estimates: Program Level

Date	Hour Ending	Estimated Reference Load (kW per AC Unit)	Event Day Load (kW per AC Unit)	Estimated Load Impact (kW per AC Unit)	Weighted Average Temperature (ºF)	Uncertainty Adjusted Load Impact (kW per AC Unit)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul	1:00 AM	0.53	0.50	0.04	82.94	-0.01	0.02	0.04	0.06	0.08
8-Jul	2:00 AM	0.35	0.35	0.01	80.63	-0.03	-0.01	0.01	0.02	0.04
8-Jul	3:00 AM	0.25	0.25	0.01	78.68	-0.03	-0.01	0.01	0.02	0.04
8-Jul	4:00 AM	0.19	0.20	-0.01	76.98	-0.03	-0.02	-0.01	0.00	0.02
8-Jul	5:00 AM	0.15	0.14	0.01	76.26	-0.02	0.00	0.01	0.02	0.03
8-Jul	6:00 AM	0.12	0.14	-0.02	75.01	-0.04	-0.03	-0.02	-0.01	0.00
8-Jul	7:00 AM	0.10	0.14	-0.04	73.52	-0.07	-0.05	-0.04	-0.03	-0.02
8-Jul	8:00 AM	0.12	0.16	-0.04	76.41	-0.06	-0.05	-0.04	-0.03	-0.02
8-Jul	9:00 AM	0.22	0.24	-0.01	81.54	-0.05	-0.03	-0.01	0.00	0.02
8-Jul	10:00 AM	0.40	0.36	0.04	86.81	0.00	0.03	0.04	0.06	0.08
8-Jul	11:00 AM	0.60	0.58	0.02	92.10	-0.03	0.00	0.02	0.04	0.07
8-Jul	12:00 PM	0.90	0.90	0.00	96.49	-0.06	-0.02	0.00	0.03	0.06
8-Jul	1:00 PM	1.24	1.26	-0.02	99.61	-0.10	-0.06	-0.02	0.01	0.06
8-Jul	2:00 PM	1.49	0.97	0.51	102.31	0.45	0.49	0.51	0.54	0.58
8-Jul	3:00 PM	1.76	1.14	0.62	104.36	0.55	0.59	0.62	0.65	0.70
8-Jul	4:00 PM	2.07	1.25	0.81	105.68	0.74	0.78	0.81	0.84	0.89
8-Jul	5:00 PM	2.20	1.34	0.86	106.65	0.79	0.83	0.86	0.90	0.94
8-Jul	6:00 PM	2.32	1.42	0.91	105.85	0.82	0.87	0.91	0.94	0.99
8-Jul	7:00 PM	2.31	1.45	0.87	103.74	0.79	0.84	0.87	0.90	0.94
8-Jul	8:00 PM	1.98	2.37	-0.40	100.25	-0.48	-0.43	-0.40	-0.37	-0.32
8-Jul	9:00 PM	1.71	2.17	-0.46	95.16	-0.54	-0.49	-0.46	-0.43	-0.38
8-Jul	10:00 PM	1.44	1.79	-0.35	91.61	-0.42	-0.38	-0.35	-0.31	-0.27
8-Jul	11:00 PM	1.03	1.30	-0.27	88.21	-0.34	-0.30	-0.27	-0.24	-0.20
8-Jul	12:00 AM	0.74	0.93	-0.19	86.05	-0.25	-0.21	-0.19	-0.17	-0.13
Date	Daily Summary	Estimated Reference Load (kW per AC Unith)	Event Day Load (kW per AC Unith)	Estimated Load Impact (kW per AC Unith)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (kW per AC Unith)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul		24.24	21.34	2.90	371.30	1.58	2.36	2.90	3.43	4.21

Event Information			
Sample Size	623		
Population Count	64,023		
Event Duration	6 hrs		
Event Start and End Times:	1:00 PM	to	7:00 PM
High Temp (ºF)	106.6 (ºF)		

*

[*] Blue shading represents event hours.

Table 7-2
SmartAC Peak Day Average Unit Impact Estimates: Control Switch

Date	Hour Ending	Estimated Reference Load (kW per AC Unit)	Event Day Load (kW per AC Unit)	Estimated Load Impact (kW per AC Unit)	Weighted Average Temperature (ºF)	Uncertainty Adjusted Load Impact (kW per AC Unit)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul	1:00 AM	0.52	0.47	0.05	82.56	-0.01	0.03	0.05	0.07	0.11
8-Jul	2:00 AM	0.34	0.32	0.02	80.19	-0.03	0.00	0.02	0.04	0.07
8-Jul	3:00 AM	0.25	0.22	0.03	78.22	0.00	0.02	0.03	0.05	0.07
8-Jul	4:00 AM	0.19	0.18	0.01	76.58	-0.03	-0.01	0.01	0.02	0.04
8-Jul	5:00 AM	0.15	0.14	0.01	75.88	-0.02	0.00	0.01	0.02	0.04
8-Jul	6:00 AM	0.11	0.14	-0.03	74.66	-0.05	-0.04	-0.03	-0.01	0.00
8-Jul	7:00 AM	0.09	0.14	-0.05	73.25	-0.08	-0.06	-0.05	-0.04	-0.02
8-Jul	8:00 AM	0.11	0.15	-0.04	76.13	-0.06	-0.05	-0.04	-0.03	-0.01
8-Jul	9:00 AM	0.22	0.23	-0.01	81.31	-0.05	-0.03	-0.01	0.00	0.02
8-Jul	10:00 AM	0.39	0.35	0.05	86.65	0.00	0.03	0.05	0.07	0.09
8-Jul	11:00 AM	0.60	0.57	0.03	92.06	-0.03	0.01	0.03	0.06	0.09
8-Jul	12:00 PM	0.92	0.90	0.02	96.50	-0.05	-0.01	0.02	0.06	0.10
8-Jul	1:00 PM	1.27	1.25	0.02	99.60	-0.08	-0.02	0.02	0.06	0.12
8-Jul	2:00 PM	1.51	0.94	0.57	102.31	0.49	0.54	0.57	0.60	0.65
8-Jul	3:00 PM	1.79	1.10	0.69	104.35	0.60	0.66	0.69	0.73	0.78
8-Jul	4:00 PM	2.11	1.21	0.89	105.69	0.80	0.86	0.89	0.93	0.99
8-Jul	5:00 PM	2.20	1.29	0.91	106.56	0.81	0.87	0.91	0.95	1.00
8-Jul	6:00 PM	2.31	1.37	0.94	105.68	0.84	0.90	0.94	0.98	1.04
8-Jul	7:00 PM	2.30	1.41	0.89	103.43	0.80	0.85	0.89	0.93	0.98
8-Jul	8:00 PM	1.95	2.38	-0.43	99.91	-0.53	-0.47	-0.43	-0.38	-0.32
8-Jul	9:00 PM	1.72	2.17	-0.45	94.86	-0.55	-0.49	-0.45	-0.42	-0.36
8-Jul	10:00 PM	1.45	1.81	-0.36	91.32	-0.46	-0.40	-0.36	-0.32	-0.27
8-Jul	11:00 PM	1.02	1.30	-0.28	87.91	-0.37	-0.32	-0.28	-0.24	-0.19
8-Jul	12:00 AM	0.72	0.90	-0.18	85.73	-0.25	-0.21	-0.18	-0.15	-0.11
Date	Daily Summary	Estimated Reference Load (kW per AC Unith)	Event Day Load (kW per AC Unith)	Estimated Load Impact (kW per AC Unith)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (kW per AC Unith)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul		24.25	20.93	3.31	365.72	1.69	2.65	3.31	3.98	4.94

Event Information			
Sample Size	339		
Population Count	48,996		
Event Duration	6 hrs		
Event Start and End Times:	1:00 PM	to	7:00 PM
High Temp (ºF)	106.6 (ºF)		

*

* Blue shading represents event hours.

Table 7-3
SmartAC Peak Day Average Unit Impact Estimates: Control: PCT

Date	Hour Ending	Estimated Reference Load (kW per AC Unit)	Event Day Load (kW per AC Unit)	Estimated Load Impact (kW per AC Unit)	Weighted Average Temperature (ºF)	Uncertainty Adjusted Load Impact (kW per AC Unit)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul	1:00 AM	0.58	0.59	-0.01	84.17	-0.08	-0.04	-0.01	0.01	0.05
8-Jul	2:00 AM	0.39	0.43	-0.04	82.06	-0.10	-0.06	-0.04	-0.01	0.02
8-Jul	3:00 AM	0.26	0.34	-0.08	80.17	-0.15	-0.11	-0.08	-0.06	-0.02
8-Jul	4:00 AM	0.19	0.24	-0.05	78.30	-0.09	-0.07	-0.05	-0.03	-0.01
8-Jul	5:00 AM	0.17	0.17	0.00	77.51	-0.03	-0.01	0.00	0.02	0.04
8-Jul	6:00 AM	0.15	0.14	0.00	76.16	-0.02	-0.01	0.00	0.02	0.03
8-Jul	7:00 AM	0.13	0.14	-0.02	74.40	-0.06	-0.03	-0.02	0.00	0.02
8-Jul	8:00 AM	0.15	0.19	-0.03	77.33	-0.07	-0.05	-0.03	-0.02	0.00
8-Jul	9:00 AM	0.24	0.26	-0.02	82.29	-0.07	-0.04	-0.02	0.00	0.02
8-Jul	10:00 AM	0.42	0.39	0.03	87.32	-0.03	0.00	0.03	0.05	0.08
8-Jul	11:00 AM	0.58	0.61	-0.03	92.24	-0.10	-0.06	-0.03	0.00	0.04
8-Jul	12:00 PM	0.85	0.92	-0.07	96.47	-0.15	-0.10	-0.07	-0.04	0.01
8-Jul	1:00 PM	1.13	1.28	-0.16	99.61	-0.24	-0.19	-0.16	-0.12	-0.07
8-Jul	2:00 PM	1.39	1.07	0.33	102.30	0.25	0.29	0.33	0.36	0.40
8-Jul	3:00 PM	1.67	1.27	0.40	104.40	0.31	0.36	0.40	0.43	0.49
8-Jul	4:00 PM	1.94	1.39	0.55	105.65	0.45	0.51	0.55	0.59	0.64
8-Jul	5:00 PM	2.22	1.51	0.72	106.91	0.61	0.67	0.72	0.76	0.82
8-Jul	6:00 PM	2.35	1.56	0.80	106.39	0.69	0.75	0.80	0.84	0.90
8-Jul	7:00 PM	2.36	1.58	0.78	104.75	0.68	0.74	0.78	0.82	0.88
8-Jul	8:00 PM	2.05	2.37	-0.32	101.36	-0.42	-0.36	-0.32	-0.27	-0.21
8-Jul	9:00 PM	1.69	2.17	-0.48	96.15	-0.59	-0.52	-0.48	-0.43	-0.37
8-Jul	10:00 PM	1.44	1.73	-0.29	92.58	-0.39	-0.33	-0.29	-0.25	-0.19
8-Jul	11:00 PM	1.06	1.31	-0.25	89.18	-0.35	-0.29	-0.25	-0.21	-0.15
8-Jul	12:00 AM	0.79	1.01	-0.22	87.12	-0.31	-0.26	-0.22	-0.19	-0.14
Date	Daily Summary	Estimated Reference Load (kW per AC Unith)	Event Day Load (kW per AC Unith)	Estimated Load Impact (kW per AC Unith)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (kW per AC Unith)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul		24.22	22.69	1.53	377.96	-0.25	0.80	1.53	2.26	3.31

Event Information			
Sample Size	284		
Population Count	15,027		
Event Duration	6 hrs		
Event Start and End Times:	1:00 PM	to	7:00 PM
High Temp (ºF)	106.9 (ºF)		

*

* Blue shading represents event hours.

Table 7-4
SmartAC Peak Day Average Unit Impact Estimates: LCA: Greater Bay Area

Date	Hour Ending	Estimated Reference Load (kW per AC Unit)	Event Day Load (kW per AC Unit)	Estimated Load Impact (kW per AC Unit)	Weighted Average Temperature (ºF)	Uncertainty Adjusted Load Impact (kW per AC Unit)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul	1:00 AM	0.41	0.45	-0.04	77.32	-0.11	-0.07	-0.04	-0.01	0.04
8-Jul	2:00 AM	0.23	0.29	-0.06	73.93	-0.14	-0.09	-0.06	-0.03	0.01
8-Jul	3:00 AM	0.14	0.19	-0.05	71.25	-0.11	-0.07	-0.05	-0.02	0.02
8-Jul	4:00 AM	0.12	0.12	0.00	70.85	-0.05	-0.02	0.00	0.02	0.05
8-Jul	5:00 AM	0.08	0.07	0.01	70.14	-0.02	0.00	0.01	0.02	0.04
8-Jul	6:00 AM	0.06	0.07	-0.01	69.18	-0.03	-0.02	-0.01	0.00	0.01
8-Jul	7:00 AM	0.06	0.07	-0.01	69.28	-0.04	-0.02	-0.01	0.01	0.02
8-Jul	8:00 AM	0.04	0.08	-0.03	71.86	-0.06	-0.04	-0.03	-0.02	-0.01
8-Jul	9:00 AM	0.15	0.18	-0.02	78.53	-0.07	-0.04	-0.02	-0.01	0.02
8-Jul	10:00 AM	0.37	0.29	0.08	85.56	0.02	0.05	0.08	0.10	0.14
8-Jul	11:00 AM	0.66	0.54	0.12	93.80	0.03	0.08	0.12	0.15	0.21
8-Jul	12:00 PM	0.99	0.86	0.14	99.11	0.02	0.09	0.14	0.19	0.26
8-Jul	1:00 PM	1.33	1.16	0.17	101.79	-0.01	0.09	0.17	0.24	0.34
8-Jul	2:00 PM	1.55	0.84	0.71	104.57	0.58	0.66	0.71	0.76	0.84
8-Jul	3:00 PM	1.84	0.98	0.87	106.34	0.74	0.81	0.87	0.92	0.99
8-Jul	4:00 PM	2.27	1.15	1.12	108.01	0.98	1.06	1.12	1.17	1.25
8-Jul	5:00 PM	2.22	1.22	1.01	107.45	0.86	0.95	1.01	1.06	1.15
8-Jul	6:00 PM	2.37	1.25	1.12	104.93	0.95	1.05	1.12	1.18	1.28
8-Jul	7:00 PM	2.27	1.27	1.00	100.02	0.87	0.95	1.00	1.06	1.14
8-Jul	8:00 PM	1.76	2.25	-0.48	96.38	-0.64	-0.55	-0.48	-0.42	-0.33
8-Jul	9:00 PM	1.60	2.10	-0.50	91.42	-0.65	-0.56	-0.50	-0.43	-0.34
8-Jul	10:00 PM	1.36	1.77	-0.41	86.92	-0.56	-0.47	-0.41	-0.35	-0.25
8-Jul	11:00 PM	0.98	1.20	-0.23	83.18	-0.36	-0.28	-0.23	-0.17	-0.09
8-Jul	12:00 AM	0.65	0.82	-0.16	80.96	-0.28	-0.21	-0.16	-0.12	-0.05
Date	Daily Summary	Estimated Reference Load (kW per AC Unith)	Event Day Load (kW per AC Unith)	Estimated Load Impact (kW per AC Unith)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (kW per AC Unith)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul		23.52	19.19	4.33	318.89	1.94	3.35	4.33	5.31	6.72

Event Information			
Sample Size	191		
Population Count	25,394		
Event Duration	6 hrs		
Event Start and End Times:	1:00 PM	to	7:00 PM
High Temp (ºF)	108 (ºF)		

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* Blue shading represents event hours.

Table 7-5
SmartAC Peak Day Average Unit Impact Estimates: LCA: Greater Fresno

Date	Hour Ending	Estimated Reference Load (kW per AC Unit)	Event Day Load (kW per AC Unit)	Estimated Load Impact (kW per AC Unit)	Weighted Average Temperature (ºF)	Uncertainty Adjusted Load Impact (kW per AC Unit)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul	1:00 AM	0.72	0.60	0.13	87.97	0.05	0.10	0.13	0.16	0.20
8-Jul	2:00 AM	0.50	0.40	0.10	85.59	0.04	0.08	0.10	0.13	0.16
8-Jul	3:00 AM	0.41	0.32	0.08	84.08	0.03	0.06	0.08	0.11	0.14
8-Jul	4:00 AM	0.29	0.26	0.03	81.56	-0.01	0.01	0.03	0.05	0.07
8-Jul	5:00 AM	0.24	0.25	-0.01	80.60	-0.07	-0.03	-0.01	0.02	0.06
8-Jul	6:00 AM	0.22	0.23	-0.02	78.68	-0.08	-0.04	-0.02	0.01	0.05
8-Jul	7:00 AM	0.19	0.31	-0.12	77.84	-0.19	-0.15	-0.12	-0.09	-0.05
8-Jul	8:00 AM	0.24	0.26	-0.02	80.45	-0.07	-0.04	-0.02	-0.01	0.02
8-Jul	9:00 AM	0.37	0.35	0.01	85.35	-0.05	-0.01	0.01	0.04	0.08
8-Jul	10:00 AM	0.56	0.55	0.01	90.24	-0.06	-0.02	0.01	0.04	0.08
8-Jul	11:00 AM	0.72	0.79	-0.08	94.18	-0.17	-0.11	-0.08	-0.04	0.02
8-Jul	12:00 PM	1.08	1.15	-0.07	97.76	-0.18	-0.11	-0.07	-0.02	0.04
8-Jul	1:00 PM	1.31	1.58	-0.27	100.42	-0.38	-0.31	-0.27	-0.22	-0.16
8-Jul	2:00 PM	1.65	1.37	0.28	103.80	0.19	0.25	0.28	0.32	0.38
8-Jul	3:00 PM	1.97	1.54	0.43	106.28	0.32	0.38	0.43	0.47	0.54
8-Jul	4:00 PM	2.23	1.61	0.62	106.88	0.50	0.57	0.62	0.67	0.74
8-Jul	5:00 PM	2.41	1.74	0.68	109.30	0.55	0.63	0.68	0.73	0.80
8-Jul	6:00 PM	2.52	1.79	0.73	109.35	0.61	0.68	0.73	0.78	0.85
8-Jul	7:00 PM	2.48	1.82	0.67	108.03	0.55	0.62	0.67	0.71	0.78
8-Jul	8:00 PM	2.29	2.59	-0.31	105.36	-0.42	-0.35	-0.31	-0.26	-0.20
8-Jul	9:00 PM	1.93	2.40	-0.46	101.14	-0.58	-0.51	-0.46	-0.42	-0.35
8-Jul	10:00 PM	1.68	1.98	-0.29	97.71	-0.41	-0.34	-0.29	-0.25	-0.18
8-Jul	11:00 PM	1.26	1.59	-0.34	93.82	-0.45	-0.38	-0.34	-0.29	-0.22
8-Jul	12:00 AM	0.96	1.23	-0.27	92.21	-0.37	-0.31	-0.27	-0.23	-0.17
Date	Daily Summary	Estimated Reference Load (kW per AC Unith)	Event Day Load (kW per AC Unith)	Estimated Load Impact (kW per AC Unith)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (kW per AC Unith)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul		28.22	26.70	1.51	438.75	-0.66	0.62	1.51	2.40	3.69

Event Information			
Sample Size	200		
Population Count	18,001		
Event Duration	6 hrs		
Event Start and End Times:	1:00 PM	to	7:00 PM
High Temp (ºF)	109.3 (ºF)		

*

* Blue shading represents event hours

Table 7-6
SmartAC Peak Day Average Unit Impact Estimates: LCA: Stockton

Date	Hour Ending	Estimated Reference Load (kW per AC Unit)	Event Day Load (kW per AC Unit)	Estimated Load Impact (kW per AC Unit)	Weighted Average Temperature (ºF)	Uncertainty Adjusted Load Impact (kW per AC Unit)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul	1:00 AM	0.51	0.50	0.01	84.98	-0.07	-0.03	0.01	0.04	0.09
8-Jul	2:00 AM	0.38	0.38	-0.01	83.98	-0.07	-0.03	-0.01	0.02	0.06
8-Jul	3:00 AM	0.26	0.26	0.00	82.48	-0.05	-0.02	0.00	0.02	0.05
8-Jul	4:00 AM	0.20	0.25	-0.05	79.98	-0.10	-0.07	-0.05	-0.03	0.01
8-Jul	5:00 AM	0.16	0.14	0.02	79.48	-0.02	0.00	0.02	0.04	0.06
8-Jul	6:00 AM	0.11	0.14	-0.03	78.48	-0.06	-0.04	-0.03	-0.02	0.00
8-Jul	7:00 AM	0.09	0.10	-0.01	74.48	-0.05	-0.03	-0.01	0.00	0.02
8-Jul	8:00 AM	0.12	0.16	-0.03	77.98	-0.07	-0.05	-0.03	-0.01	0.01
8-Jul	9:00 AM	0.18	0.22	-0.04	81.48	-0.09	-0.06	-0.04	-0.02	0.02
8-Jul	10:00 AM	0.31	0.31	0.00	84.98	-0.07	-0.03	0.00	0.03	0.07
8-Jul	11:00 AM	0.43	0.45	-0.02	87.98	-0.11	-0.06	-0.02	0.02	0.07
8-Jul	12:00 PM	0.63	0.72	-0.08	91.98	-0.17	-0.12	-0.08	-0.05	0.00
8-Jul	1:00 PM	1.07	1.09	-0.02	95.98	-0.12	-0.06	-0.02	0.03	0.09
8-Jul	2:00 PM	1.30	0.77	0.53	97.98	0.41	0.48	0.53	0.58	0.65
8-Jul	3:00 PM	1.53	0.98	0.55	99.98	0.41	0.49	0.55	0.60	0.68
8-Jul	4:00 PM	1.75	1.07	0.68	101.48	0.55	0.63	0.68	0.73	0.80
8-Jul	5:00 PM	2.04	1.14	0.90	102.98	0.77	0.85	0.90	0.95	1.03
8-Jul	6:00 PM	2.12	1.31	0.81	103.48	0.68	0.75	0.81	0.86	0.94
8-Jul	7:00 PM	2.24	1.35	0.89	103.98	0.75	0.83	0.89	0.94	1.02
8-Jul	8:00 PM	1.95	2.37	-0.42	99.98	-0.57	-0.48	-0.42	-0.36	-0.27
8-Jul	9:00 PM	1.65	2.09	-0.45	93.98	-0.56	-0.49	-0.45	-0.40	-0.33
8-Jul	10:00 PM	1.37	1.71	-0.34	91.48	-0.46	-0.39	-0.34	-0.29	-0.21
8-Jul	11:00 PM	0.95	1.19	-0.24	88.98	-0.37	-0.29	-0.24	-0.19	-0.12
8-Jul	12:00 AM	0.69	0.83	-0.14	86.48	-0.24	-0.18	-0.14	-0.10	-0.04
Date	Daily Summary	Estimated Reference Load (kW per AC Unith)	Event Day Load (kW per AC Unith)	Estimated Load Impact (kW per AC Unith)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (kW per AC Unith)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul		22.03	19.54	2.50	356.00	0.31	1.60	2.50	3.39	4.69

Event Information			
Sample Size	206		
Population Count	6,613		
Event Duration	6 hrs		
Event Start and End Times:	1:00 PM	to	7:00 PM
High Temp (ºF)	104 (ºF)		

*

* Blue shading represents event hours.

Table 7-7
SmartAC Peak Day Average Unit Impact Estimates:Year Built: pre-1975

Date	Hour Ending	Estimated Reference Load (kW per AC Unit)	Event Day Load (kW per AC Unit)	Estimated Load Impact (kW per AC Unit)	Weighted Average Temperature (ºF)	Uncertainty Adjusted Load Impact (kW per AC Unit)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul	1:00 AM	0.49	0.44	0.05	82.13	-0.03	0.02	0.05	0.09	0.13
8-Jul	2:00 AM	0.34	0.26	0.09	79.71	0.02	0.06	0.09	0.11	0.15
8-Jul	3:00 AM	0.25	0.16	0.09	77.79	0.03	0.06	0.09	0.11	0.14
8-Jul	4:00 AM	0.20	0.17	0.03	76.14	-0.01	0.01	0.03	0.05	0.07
8-Jul	5:00 AM	0.16	0.12	0.04	75.39	0.01	0.02	0.04	0.05	0.07
8-Jul	6:00 AM	0.14	0.11	0.04	74.11	0.02	0.03	0.04	0.04	0.06
8-Jul	7:00 AM	0.11	0.14	-0.03	72.96	-0.07	-0.04	-0.03	-0.01	0.01
8-Jul	8:00 AM	0.12	0.17	-0.04	75.72	-0.07	-0.06	-0.04	-0.03	-0.01
8-Jul	9:00 AM	0.21	0.21	0.01	80.92	-0.04	-0.01	0.01	0.02	0.05
8-Jul	10:00 AM	0.39	0.33	0.06	86.26	0.00	0.03	0.06	0.08	0.12
8-Jul	11:00 AM	0.57	0.55	0.03	91.62	-0.07	-0.01	0.03	0.06	0.12
8-Jul	12:00 PM	0.93	0.89	0.05	95.95	-0.06	0.00	0.05	0.09	0.15
8-Jul	1:00 PM	1.30	1.32	-0.02	98.92	-0.18	-0.09	-0.02	0.04	0.13
8-Jul	2:00 PM	1.57	1.07	0.51	101.74	0.40	0.46	0.51	0.55	0.62
8-Jul	3:00 PM	1.88	1.21	0.67	103.81	0.56	0.62	0.67	0.72	0.78
8-Jul	4:00 PM	2.13	1.36	0.77	105.02	0.66	0.73	0.77	0.82	0.89
8-Jul	5:00 PM	2.24	1.45	0.78	105.95	0.66	0.73	0.78	0.84	0.91
8-Jul	6:00 PM	2.39	1.47	0.92	105.05	0.79	0.86	0.92	0.97	1.05
8-Jul	7:00 PM	2.29	1.47	0.82	102.71	0.70	0.77	0.82	0.86	0.93
8-Jul	8:00 PM	2.03	2.30	-0.28	99.32	-0.40	-0.33	-0.28	-0.22	-0.15
8-Jul	9:00 PM	1.67	2.12	-0.45	94.45	-0.57	-0.50	-0.45	-0.39	-0.32
8-Jul	10:00 PM	1.33	1.78	-0.45	90.89	-0.57	-0.50	-0.45	-0.40	-0.33
8-Jul	11:00 PM	0.94	1.28	-0.34	87.47	-0.45	-0.39	-0.34	-0.30	-0.23
8-Jul	12:00 AM	0.65	0.81	-0.16	85.42	-0.25	-0.20	-0.16	-0.13	-0.07
Date	Daily Summary	Estimated Reference Load (kW per AC Unith)	Event Day Load (kW per AC Unith)	Estimated Load Impact (kW per AC Unith)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (kW per AC Unith)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul		24.35	21.19	3.16	373.41	1.06	2.30	3.16	4.02	5.27

Event Information			
Sample Size	212		
Population Count	-		
Event Duration	6 hrs		
Event Start and End Times:	1:00 PM	to	7:00 PM
High Temp (ºF)	105.9 (ºF)		

*

* Blue shading represents event hours.

Table 7-8

SmartAC Peak Day Average Unit Impact Estimates: Year Built: 1975 to 1995

Date	Hour Ending	Estimated Reference Load (kW per AC Unit)	Event Day Load (kW per AC Unit)	Estimated Load Impact (kW per AC Unit)	Weighted Average Temperature (ºF)	Uncertainty Adjusted Load Impact (kW per AC Unit)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul	1:00 AM	0.57	0.54	0.04	83.06	-0.04	0.01	0.04	0.07	0.11
8-Jul	2:00 AM	0.37	0.41	-0.04	80.69	-0.10	-0.06	-0.04	-0.01	0.03
8-Jul	3:00 AM	0.28	0.32	-0.04	78.79	-0.09	-0.06	-0.04	-0.01	0.02
8-Jul	4:00 AM	0.20	0.21	-0.01	76.98	-0.05	-0.03	-0.01	0.01	0.04
8-Jul	5:00 AM	0.16	0.17	-0.01	76.37	-0.06	-0.03	-0.01	0.01	0.04
8-Jul	6:00 AM	0.11	0.18	-0.07	75.16	-0.11	-0.09	-0.07	-0.05	-0.02
8-Jul	7:00 AM	0.10	0.13	-0.04	73.55	-0.08	-0.05	-0.04	-0.02	0.01
8-Jul	8:00 AM	0.13	0.14	-0.01	76.51	-0.04	-0.02	-0.01	0.00	0.02
8-Jul	9:00 AM	0.23	0.28	-0.05	81.52	-0.10	-0.07	-0.05	-0.03	0.00
8-Jul	10:00 AM	0.42	0.37	0.06	86.70	-0.01	0.03	0.06	0.08	0.12
8-Jul	11:00 AM	0.59	0.61	-0.01	91.80	-0.09	-0.04	-0.01	0.02	0.07
8-Jul	12:00 PM	0.87	0.95	-0.08	96.16	-0.18	-0.12	-0.08	-0.04	0.01
8-Jul	1:00 PM	1.21	1.29	-0.08	99.35	-0.19	-0.13	-0.08	-0.03	0.03
8-Jul	2:00 PM	1.48	1.01	0.46	102.03	0.36	0.42	0.46	0.51	0.57
8-Jul	3:00 PM	1.75	1.19	0.56	104.06	0.44	0.51	0.56	0.61	0.68
8-Jul	4:00 PM	2.05	1.25	0.80	105.41	0.68	0.75	0.80	0.85	0.92
8-Jul	5:00 PM	2.20	1.35	0.85	106.50	0.72	0.80	0.85	0.90	0.98
8-Jul	6:00 PM	2.34	1.46	0.89	105.81	0.75	0.83	0.89	0.94	1.02
8-Jul	7:00 PM	2.38	1.51	0.87	103.85	0.75	0.82	0.87	0.92	0.99
8-Jul	8:00 PM	2.08	2.47	-0.38	100.33	-0.52	-0.44	-0.38	-0.33	-0.25
8-Jul	9:00 PM	1.81	2.18	-0.37	95.37	-0.48	-0.41	-0.37	-0.33	-0.26
8-Jul	10:00 PM	1.59	1.81	-0.22	92.05	-0.34	-0.27	-0.22	-0.16	-0.09
8-Jul	11:00 PM	1.18	1.39	-0.21	88.67	-0.33	-0.26	-0.21	-0.16	-0.09
8-Jul	12:00 AM	0.82	1.09	-0.27	86.39	-0.36	-0.31	-0.27	-0.24	-0.18
Date	Daily Summary	Estimated Reference Load (kW per AC Unith)	Event Day Load (kW per AC Unith)	Estimated Load Impact (kW per AC Unith)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (kW per AC Unith)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul		24.94	22.30	2.64	372.90	0.52	1.77	2.64	3.50	4.76

Event Information			
Sample Size	271		
Population Count	-		
Event Duration	6 hrs		
Event Start and End Times:	1:00 PM	to	7:00 PM
High Temp (ºF)	106.5 (ºF)		

*

* Blue shading represents event hours.

Table 7-9

SmartAC Peak Day Average Unit Impact Estimates: Year Built: post-1995

Date	Hour Ending	Estimated Reference Load (kW per AC Unit)	Event Day Load (kW per AC Unit)	Estimated Load Impact (kW per AC Unit)	Weighted Average Temperature (ºF)	Uncertainty Adjusted Load Impact (kW per AC Unit)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul	1:00 AM	0.51	0.51	0.00	81.29	-0.08	-0.03	0.00	0.04	0.09
8-Jul	2:00 AM	0.32	0.40	-0.07	79.43	-0.14	-0.10	-0.07	-0.05	-0.01
8-Jul	3:00 AM	0.20	0.26	-0.06	77.41	-0.12	-0.08	-0.06	-0.04	0.00
8-Jul	4:00 AM	0.15	0.23	-0.08	75.91	-0.14	-0.10	-0.08	-0.06	-0.02
8-Jul	5:00 AM	0.12	0.13	-0.01	75.03	-0.05	-0.03	-0.01	0.00	0.03
8-Jul	6:00 AM	0.09	0.12	-0.03	73.80	-0.06	-0.04	-0.03	-0.01	0.01
8-Jul	7:00 AM	0.08	0.17	-0.08	71.91	-0.14	-0.11	-0.08	-0.06	-0.03
8-Jul	8:00 AM	0.09	0.16	-0.07	74.79	-0.12	-0.09	-0.07	-0.05	-0.02
8-Jul	9:00 AM	0.21	0.19	0.01	79.83	-0.04	-0.01	0.01	0.04	0.07
8-Jul	10:00 AM	0.33	0.35	-0.01	84.85	-0.08	-0.04	-0.01	0.01	0.05
8-Jul	11:00 AM	0.61	0.55	0.06	90.19	-0.03	0.03	0.06	0.10	0.15
8-Jul	12:00 PM	0.87	0.78	0.10	94.55	-0.02	0.05	0.10	0.14	0.21
8-Jul	1:00 PM	1.10	1.00	0.10	97.70	-0.02	0.05	0.10	0.15	0.23
8-Jul	2:00 PM	1.27	0.66	0.60	100.12	0.44	0.53	0.60	0.67	0.76
8-Jul	3:00 PM	1.48	0.85	0.63	102.11	0.48	0.57	0.63	0.70	0.79
8-Jul	4:00 PM	1.87	0.99	0.88	103.51	0.72	0.81	0.88	0.94	1.04
8-Jul	5:00 PM	2.03	1.03	1.00	104.28	0.87	0.95	1.00	1.06	1.13
8-Jul	6:00 PM	2.03	1.16	0.87	103.51	0.70	0.80	0.87	0.94	1.04
8-Jul	7:00 PM	2.13	1.21	0.92	101.71	0.75	0.85	0.92	0.98	1.08
8-Jul	8:00 PM	1.58	2.22	-0.64	98.24	-0.81	-0.71	-0.64	-0.57	-0.47
8-Jul	9:00 PM	1.55	2.16	-0.61	92.63	-0.79	-0.68	-0.61	-0.54	-0.43
8-Jul	10:00 PM	1.33	1.67	-0.35	88.74	-0.48	-0.40	-0.35	-0.29	-0.21
8-Jul	11:00 PM	0.86	1.10	-0.24	85.49	-0.39	-0.30	-0.24	-0.17	-0.08
8-Jul	12:00 AM	0.73	0.79	-0.07	83.46	-0.22	-0.13	-0.07	0.00	0.08
Date	Daily Summary	Estimated Reference Load (kW per AC Unith)	Event Day Load (kW per AC Unith)	Estimated Load Impact (kW per AC Unith)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (kW per AC Unith)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul		21.55	18.69	2.86	364.06	0.23	1.79	2.86	3.94	5.49

Event Information			
Sample Size	136		
Population Count	-		
Event Duration	6 hrs		
Event Start and End Times:	1:00 PM	to	7:00 PM
High Temp (ºF)	104.3 (ºF)		

*

* Blue shading represents event hours.

Table 7-10
SmartAC Peak Day Average Unit Impact Estimates: Sq. Ft.: 1,000-2,000

Date	Hour Ending	Estimated Reference Load (kW per AC Unit)	Event Day Load (kW per AC Unit)	Estimated Load Impact (kW per AC Unit)	Weighted Average Temperature (ºF)	Uncertainty Adjusted Load Impact (kW per AC Unit)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul	1:00 AM	0.60	0.53	0.07	83.82	0.00	0.04	0.07	0.09	0.13
8-Jul	2:00 AM	0.40	0.34	0.06	81.71	0.00	0.04	0.06	0.08	0.12
8-Jul	3:00 AM	0.31	0.26	0.05	79.90	0.00	0.03	0.05	0.07	0.10
8-Jul	4:00 AM	0.21	0.23	-0.01	78.01	-0.05	-0.03	-0.01	0.00	0.02
8-Jul	5:00 AM	0.19	0.18	0.01	77.26	-0.03	-0.01	0.01	0.02	0.05
8-Jul	6:00 AM	0.15	0.17	-0.02	75.97	-0.06	-0.04	-0.02	-0.01	0.01
8-Jul	7:00 AM	0.13	0.20	-0.06	74.28	-0.10	-0.08	-0.06	-0.05	-0.02
8-Jul	8:00 AM	0.15	0.20	-0.05	77.18	-0.08	-0.07	-0.05	-0.04	-0.02
8-Jul	9:00 AM	0.23	0.25	-0.02	82.07	-0.06	-0.04	-0.02	0.00	0.02
8-Jul	10:00 AM	0.39	0.33	0.06	87.04	0.01	0.04	0.06	0.08	0.10
8-Jul	11:00 AM	0.58	0.55	0.03	91.88	-0.03	0.01	0.03	0.06	0.09
8-Jul	12:00 PM	0.94	0.93	0.01	96.12	-0.07	-0.03	0.01	0.04	0.09
8-Jul	1:00 PM	1.27	1.29	-0.02	99.30	-0.11	-0.06	-0.02	0.02	0.07
8-Jul	2:00 PM	1.57	1.03	0.55	102.01	0.46	0.51	0.55	0.58	0.63
8-Jul	3:00 PM	1.85	1.21	0.64	104.14	0.55	0.60	0.64	0.68	0.73
8-Jul	4:00 PM	2.09	1.36	0.72	105.36	0.63	0.69	0.72	0.76	0.82
8-Jul	5:00 PM	2.26	1.43	0.84	106.49	0.74	0.80	0.84	0.88	0.94
8-Jul	6:00 PM	2.38	1.47	0.91	105.94	0.80	0.87	0.91	0.95	1.02
8-Jul	7:00 PM	2.33	1.50	0.83	104.22	0.74	0.79	0.83	0.87	0.92
8-Jul	8:00 PM	2.10	2.40	-0.30	100.74	-0.39	-0.34	-0.30	-0.26	-0.20
8-Jul	9:00 PM	1.77	2.22	-0.45	95.61	-0.55	-0.49	-0.45	-0.41	-0.36
8-Jul	10:00 PM	1.47	1.85	-0.38	92.18	-0.47	-0.42	-0.38	-0.34	-0.29
8-Jul	11:00 PM	1.05	1.38	-0.33	88.87	-0.41	-0.36	-0.33	-0.29	-0.24
8-Jul	12:00 AM	0.77	0.99	-0.22	86.75	-0.29	-0.25	-0.22	-0.19	-0.15
Date	Daily Summary	Estimated Reference Load (kW per AC Unith)	Event Day Load (kW per AC Unith)	Estimated Load Impact (kW per AC Unith)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (kW per AC Unith)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul		25.22	22.32	2.89	376.79	1.20	2.20	2.89	3.58	4.58

Event Information			
Sample Size	330		
Population Count	33,814		
Event Duration	6 hrs		
Event Start and End Times:	1:00 PM	to	7:00 PM
High Temp (ºF)	106.5 (ºF)		

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* Blue shading represents event hours.

Table 7-11
SmartAC Peak Day Average Unit Impact Estimates: Sq. Ft.: 2,000-5,000

Date	Hour Ending	Estimated Reference Load (kW per AC Unit)	Event Day Load (kW per AC Unit)	Estimated Load Impact (kW per AC Unit)	Weighted Average Temperature (ºF)	Uncertainty Adjusted Load Impact (kW per AC Unit)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul	1:00 AM	0.49	0.52	-0.03	81.97	-0.10	-0.05	-0.03	0.00	0.05
8-Jul	2:00 AM	0.32	0.40	-0.08	79.53	-0.14	-0.10	-0.08	-0.06	-0.02
8-Jul	3:00 AM	0.18	0.25	-0.07	77.35	-0.12	-0.09	-0.07	-0.05	-0.02
8-Jul	4:00 AM	0.16	0.18	-0.02	75.97	-0.07	-0.04	-0.02	0.00	0.03
8-Jul	5:00 AM	0.10	0.10	0.00	75.21	-0.02	-0.01	0.00	0.01	0.03
8-Jul	6:00 AM	0.07	0.09	-0.02	74.00	-0.04	-0.03	-0.02	-0.01	0.00
8-Jul	7:00 AM	0.04	0.08	-0.04	72.64	-0.06	-0.04	-0.04	-0.03	-0.01
8-Jul	8:00 AM	0.08	0.09	-0.02	75.51	-0.04	-0.03	-0.02	-0.01	0.01
8-Jul	9:00 AM	0.24	0.22	0.02	81.00	-0.02	0.01	0.02	0.04	0.07
8-Jul	10:00 AM	0.43	0.38	0.05	86.61	-0.01	0.02	0.05	0.08	0.11
8-Jul	11:00 AM	0.67	0.65	0.02	92.60	-0.07	-0.02	0.02	0.05	0.11
8-Jul	12:00 PM	0.95	0.90	0.05	97.20	-0.06	0.01	0.05	0.09	0.16
8-Jul	1:00 PM	1.31	1.25	0.06	100.25	-0.11	-0.01	0.06	0.13	0.23
8-Jul	2:00 PM	1.44	0.86	0.58	102.88	0.45	0.52	0.58	0.63	0.70
8-Jul	3:00 PM	1.69	1.03	0.67	104.84	0.53	0.61	0.67	0.72	0.80
8-Jul	4:00 PM	2.09	1.13	0.97	106.29	0.83	0.91	0.97	1.02	1.10
8-Jul	5:00 PM	2.21	1.23	0.99	106.98	0.85	0.93	0.99	1.05	1.13
8-Jul	6:00 PM	2.28	1.29	0.99	105.85	0.85	0.94	0.99	1.05	1.14
8-Jul	7:00 PM	2.29	1.34	0.96	103.30	0.82	0.90	0.96	1.02	1.10
8-Jul	8:00 PM	1.80	2.38	-0.58	99.81	-0.74	-0.65	-0.58	-0.51	-0.42
8-Jul	9:00 PM	1.68	2.17	-0.48	94.52	-0.63	-0.54	-0.48	-0.42	-0.34
8-Jul	10:00 PM	1.42	1.78	-0.36	90.61	-0.50	-0.42	-0.36	-0.30	-0.21
8-Jul	11:00 PM	0.95	1.24	-0.29	87.11	-0.43	-0.35	-0.29	-0.24	-0.16
8-Jul	12:00 AM	0.72	0.86	-0.14	84.96	-0.26	-0.19	-0.14	-0.09	-0.02
Date	Daily Summary	Estimated Reference Load (kW per AC Unith)	Event Day Load (kW per AC Unith)	Estimated Load Impact (kW per AC Unith)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (kW per AC Unith)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul		23.63	20.40	3.23	362.29	0.91	2.28	3.23	4.18	5.56

Event Information			
Sample Size	239		
Population Count	19,590		
Event Duration	6 hrs		
Event Start and End Times:	1:00 PM	to	7:00 PM
High Temp (ºF)	107 (ºF)		

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* Blue shading represents event hours.

Table 7-12
SmartAC Peak Day Average Unit Impact Estimates: Climate Zone R

Date	Hour Ending	Estimated Reference Load (kW per AC Unit)	Event Day Load (kW per AC Unit)	Estimated Load Impact (kW per AC Unit)	Weighted Average Temperature (ºF)	Uncertainty Adjusted Load Impact (kW per AC Unit)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul	1:00 AM	0.73	0.60	0.13	88.01	0.05	0.10	0.13	0.16	0.20
8-Jul	2:00 AM	0.50	0.40	0.10	85.64	0.04	0.08	0.10	0.13	0.16
8-Jul	3:00 AM	0.41	0.32	0.08	84.12	0.03	0.06	0.08	0.11	0.14
8-Jul	4:00 AM	0.29	0.26	0.03	81.60	-0.01	0.01	0.03	0.05	0.07
8-Jul	5:00 AM	0.24	0.25	-0.01	80.64	-0.07	-0.03	-0.01	0.02	0.06
8-Jul	6:00 AM	0.22	0.23	-0.02	78.72	-0.08	-0.04	-0.02	0.01	0.05
8-Jul	7:00 AM	0.19	0.31	-0.12	77.88	-0.19	-0.15	-0.12	-0.09	-0.05
8-Jul	8:00 AM	0.24	0.26	-0.02	80.50	-0.07	-0.04	-0.02	-0.01	0.02
8-Jul	9:00 AM	0.37	0.35	0.01	85.39	-0.05	-0.01	0.01	0.04	0.08
8-Jul	10:00 AM	0.56	0.55	0.01	90.29	-0.06	-0.02	0.01	0.04	0.08
8-Jul	11:00 AM	0.72	0.79	-0.08	94.23	-0.17	-0.11	-0.08	-0.04	0.02
8-Jul	12:00 PM	1.08	1.15	-0.07	97.81	-0.18	-0.11	-0.07	-0.02	0.04
8-Jul	1:00 PM	1.32	1.58	-0.27	100.47	-0.38	-0.31	-0.27	-0.22	-0.16
8-Jul	2:00 PM	1.65	1.37	0.29	103.86	0.19	0.25	0.29	0.32	0.38
8-Jul	3:00 PM	1.97	1.54	0.43	106.33	0.32	0.38	0.43	0.47	0.54
8-Jul	4:00 PM	2.23	1.61	0.62	106.93	0.50	0.57	0.62	0.67	0.74
8-Jul	5:00 PM	2.41	1.74	0.68	109.36	0.55	0.63	0.68	0.73	0.80
8-Jul	6:00 PM	2.52	1.79	0.73	109.41	0.61	0.68	0.73	0.78	0.85
8-Jul	7:00 PM	2.48	1.82	0.67	108.09	0.55	0.62	0.67	0.71	0.78
8-Jul	8:00 PM	2.29	2.59	-0.31	105.42	-0.42	-0.35	-0.31	-0.26	-0.20
8-Jul	9:00 PM	1.94	2.40	-0.46	101.19	-0.58	-0.51	-0.46	-0.42	-0.35
8-Jul	10:00 PM	1.68	1.98	-0.29	97.76	-0.41	-0.34	-0.29	-0.25	-0.18
8-Jul	11:00 PM	1.26	1.59	-0.34	93.87	-0.45	-0.38	-0.34	-0.29	-0.22
8-Jul	12:00 AM	0.96	1.23	-0.27	92.26	-0.37	-0.31	-0.27	-0.23	-0.17
Date	Daily Summary	Estimated Reference Load (kW per AC Unith)	Event Day Load (kW per AC Unith)	Estimated Load Impact (kW per AC Unith)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (kW per AC Unith)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul		28.23	26.72	1.51	438.75	-0.66	0.62	1.51	2.41	3.69

Event Information			
Sample Size	200		
Population Count	18,330		
Event Duration	6 hrs		
Event Start and End Times:	1:00 PM	to	7:00 PM
High Temp (ºF)	109.4 (ºF)		

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* Blue shading represents event hours.

Table 7-13
SmartAC Peak Day Average Unit Impact Estimates: Climate Zone S

Date	Hour Ending	Estimated Reference Load (kW per AC Unit)	Event Day Load (kW per AC Unit)	Estimated Load Impact (kW per AC Unit)	Weighted Average Temperature (ºF)	Uncertainty Adjusted Load Impact (kW per AC Unit)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul	1:00 AM	0.54	0.50	0.03	84.15	-0.05	0.00	0.03	0.07	0.12
8-Jul	2:00 AM	0.37	0.39	-0.02	82.79	-0.07	-0.04	-0.02	0.01	0.04
8-Jul	3:00 AM	0.25	0.27	-0.02	81.24	-0.07	-0.04	-0.02	0.00	0.03
8-Jul	4:00 AM	0.19	0.25	-0.06	78.87	-0.11	-0.08	-0.06	-0.04	-0.01
8-Jul	5:00 AM	0.16	0.14	0.02	78.44	-0.02	0.01	0.02	0.03	0.06
8-Jul	6:00 AM	0.12	0.14	-0.02	77.48	-0.05	-0.03	-0.02	-0.01	0.00
8-Jul	7:00 AM	0.09	0.12	-0.03	73.98	-0.06	-0.04	-0.03	-0.01	0.01
8-Jul	8:00 AM	0.12	0.19	-0.07	77.41	-0.11	-0.09	-0.07	-0.06	-0.03
8-Jul	9:00 AM	0.20	0.25	-0.05	81.21	-0.10	-0.07	-0.05	-0.03	0.01
8-Jul	10:00 AM	0.34	0.31	0.03	85.07	-0.03	0.01	0.03	0.06	0.10
8-Jul	11:00 AM	0.51	0.48	0.03	88.54	-0.05	-0.01	0.03	0.06	0.11
8-Jul	12:00 PM	0.73	0.79	-0.06	92.66	-0.15	-0.10	-0.06	-0.02	0.03
8-Jul	1:00 PM	1.15	1.14	0.00	96.56	-0.09	-0.04	0.00	0.04	0.10
8-Jul	2:00 PM	1.35	0.81	0.54	98.68	0.43	0.50	0.54	0.58	0.64
8-Jul	3:00 PM	1.58	1.00	0.58	100.66	0.46	0.53	0.58	0.62	0.70
8-Jul	4:00 PM	1.78	1.11	0.67	102.20	0.56	0.62	0.67	0.72	0.78
8-Jul	5:00 PM	2.08	1.17	0.91	103.57	0.79	0.86	0.91	0.96	1.03
8-Jul	6:00 PM	2.15	1.30	0.86	103.79	0.74	0.81	0.86	0.91	0.98
8-Jul	7:00 PM	2.24	1.34	0.90	103.72	0.78	0.85	0.90	0.95	1.02
8-Jul	8:00 PM	1.96	2.39	-0.43	99.73	-0.56	-0.48	-0.43	-0.37	-0.29
8-Jul	9:00 PM	1.65	2.12	-0.47	94.05	-0.58	-0.51	-0.47	-0.42	-0.36
8-Jul	10:00 PM	1.35	1.74	-0.39	91.51	-0.50	-0.44	-0.39	-0.34	-0.28
8-Jul	11:00 PM	0.90	1.24	-0.34	88.80	-0.45	-0.38	-0.34	-0.29	-0.23
8-Jul	12:00 AM	0.69	0.87	-0.18	86.17	-0.27	-0.22	-0.18	-0.14	-0.09
Date	Daily Summary	Estimated Reference Load (kW per AC Unith)	Event Day Load (kW per AC Unith)	Estimated Load Impact (kW per AC Unith)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (kW per AC Unith)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul		22.51	20.07	2.44	355.53	0.43	1.62	2.44	3.27	4.46

Event Information			
Sample Size	251		
Population Count	23,142		
Event Duration	6 hrs		
Event Start and End Times:	1:00 PM	to	7:00 PM
High Temp (ºF)	103.8 (ºF)		

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* Blue shading represents event hours.

Table 7-14
SmartAC Peak Day Average Unit Impact Estimates: Climate Zone X

Date	Hour Ending	Estimated Reference Load (kW per AC Unit)	Event Day Load (kW per AC Unit)	Estimated Load Impact (kW per AC Unit)	Weighted Average Temperature (ºF)	Uncertainty Adjusted Load Impact (kW per AC Unit)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul	1:00 AM	0.38	0.41	-0.03	77.66	-0.11	-0.07	-0.03	0.00	0.05
8-Jul	2:00 AM	0.21	0.26	-0.05	74.41	-0.12	-0.08	-0.05	-0.02	0.03
8-Jul	3:00 AM	0.13	0.16	-0.03	71.70	-0.09	-0.05	-0.03	0.00	0.04
8-Jul	4:00 AM	0.11	0.10	0.02	71.35	-0.03	0.00	0.02	0.04	0.06
8-Jul	5:00 AM	0.07	0.06	0.01	70.53	-0.03	-0.01	0.01	0.02	0.04
8-Jul	6:00 AM	0.05	0.06	-0.01	69.52	-0.03	-0.02	-0.01	-0.01	0.00
8-Jul	7:00 AM	0.04	0.04	0.00	69.59	-0.02	-0.01	0.00	0.02	0.03
8-Jul	8:00 AM	0.03	0.04	-0.01	72.13	-0.03	-0.02	-0.01	0.00	0.01
8-Jul	9:00 AM	0.14	0.14	-0.01	78.85	-0.04	-0.02	-0.01	0.01	0.03
8-Jul	10:00 AM	0.33	0.26	0.08	85.86	0.02	0.05	0.08	0.11	0.14
8-Jul	11:00 AM	0.59	0.52	0.08	94.15	-0.01	0.04	0.08	0.11	0.17
8-Jul	12:00 PM	0.94	0.82	0.13	99.46	0.01	0.08	0.13	0.17	0.24
8-Jul	1:00 PM	1.27	1.12	0.15	102.12	-0.04	0.07	0.15	0.22	0.33
8-Jul	2:00 PM	1.49	0.82	0.67	104.89	0.53	0.61	0.67	0.72	0.81
8-Jul	3:00 PM	1.78	0.95	0.83	106.69	0.70	0.78	0.83	0.89	0.96
8-Jul	4:00 PM	2.23	1.11	1.12	108.33	0.97	1.06	1.12	1.17	1.26
8-Jul	5:00 PM	2.16	1.19	0.97	107.72	0.81	0.90	0.97	1.03	1.12
8-Jul	6:00 PM	2.34	1.24	1.10	105.18	0.92	1.03	1.10	1.17	1.27
8-Jul	7:00 PM	2.25	1.25	1.00	100.31	0.85	0.94	1.00	1.05	1.14
8-Jul	8:00 PM	1.74	2.19	-0.45	96.69	-0.61	-0.51	-0.45	-0.38	-0.28
8-Jul	9:00 PM	1.60	2.05	-0.45	91.54	-0.61	-0.51	-0.45	-0.38	-0.29
8-Jul	10:00 PM	1.36	1.70	-0.34	86.84	-0.50	-0.41	-0.34	-0.28	-0.18
8-Jul	11:00 PM	0.98	1.13	-0.15	83.11	-0.29	-0.21	-0.15	-0.10	-0.01
8-Jul	12:00 AM	0.61	0.75	-0.14	80.99	-0.25	-0.18	-0.14	-0.09	-0.02
Date	Daily Summary	Estimated Reference Load (kW per AC Unith)	Event Day Load (kW per AC Unith)	Estimated Load Impact (kW per AC Unith)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (kW per AC Unith)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul		22.84	18.37	4.47	315.89	1.98	3.45	4.47	5.49	6.96

Event Information			
Sample Size	172		
Population Count	22,551		
Event Duration	6 hrs		
Event Start and End Times:	1:00 PM	to	7:00 PM
High Temp (ºF)	108.3 (ºF)		

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* Blue shading represents event hours.

Appendix F.
SmartAC 2008 System Peak
Ex Post Population Estimates (MW)

Table 7-15
SmartAC Peak Day Population Impact Estimates: Program Level

Date	Hour Ending	Estimated Reference Load (MW)	Event Day Load (MW)	Estimated Load Impact (MW)	Weighted Average Temperature (ºF)	Uncertainty Adjusted Load Impact (MW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul	1:00 AM	34.21	31.91	2.30	82.94	-0.70	1.07	2.30	3.52	5.29
8-Jul	2:00 AM	22.54	22.11	0.42	80.63	-2.00	-0.57	0.42	1.42	2.85
8-Jul	3:00 AM	16.26	15.79	0.47	78.68	-1.68	-0.41	0.47	1.34	2.61
8-Jul	4:00 AM	12.13	12.56	-0.43	76.98	-2.18	-1.15	-0.43	0.29	1.32
8-Jul	5:00 AM	9.75	9.22	0.53	76.26	-1.10	-0.14	0.53	1.20	2.17
8-Jul	6:00 AM	7.63	8.79	-1.16	75.01	-2.53	-1.72	-1.16	-0.60	0.21
8-Jul	7:00 AM	6.51	9.26	-2.76	73.52	-4.34	-3.40	-2.76	-2.11	-1.17
8-Jul	8:00 AM	7.84	10.21	-2.37	76.41	-3.71	-2.92	-2.37	-1.83	-1.04
8-Jul	9:00 AM	14.40	15.35	-0.96	81.54	-2.90	-1.75	-0.96	-0.16	0.98
8-Jul	10:00 AM	25.65	22.96	2.69	86.81	0.23	1.68	2.69	3.69	5.15
8-Jul	11:00 AM	38.33	37.27	1.06	92.10	-2.21	-0.28	1.06	2.39	4.32
8-Jul	12:00 PM	57.89	57.74	0.15	96.49	-3.81	-1.47	0.15	1.77	4.11
8-Jul	1:00 PM	79.18	80.64	-1.46	99.61	-6.65	-3.58	-1.46	0.67	3.73
8-Jul	2:00 PM	95.11	62.27	32.83	102.31	28.54	31.08	32.83	34.59	37.13
8-Jul	3:00 PM	112.73	72.79	39.94	104.36	35.36	38.06	39.94	41.81	44.52
8-Jul	4:00 PM	132.27	80.23	52.04	105.68	47.31	50.10	52.04	53.97	56.76
8-Jul	5:00 PM	141.11	85.77	55.34	106.65	50.43	53.33	55.34	57.35	60.25
8-Jul	6:00 PM	148.66	90.66	57.99	105.85	52.72	55.84	57.99	60.15	63.26
8-Jul	7:00 PM	148.03	92.55	55.48	103.74	50.71	53.53	55.48	57.43	60.24
8-Jul	8:00 PM	126.46	152.04	-25.58	100.25	-30.84	-27.73	-25.58	-23.43	-20.33
8-Jul	9:00 PM	109.61	139.06	-29.45	95.16	-34.35	-31.45	-29.45	-27.44	-24.54
8-Jul	10:00 PM	92.50	114.61	-22.11	91.61	-27.03	-24.12	-22.11	-20.10	-17.19
8-Jul	11:00 PM	65.84	83.29	-17.45	88.21	-21.97	-19.30	-17.45	-15.61	-12.94
8-Jul	12:00 AM	47.24	59.39	-12.15	86.05	-16.00	-13.72	-12.15	-10.58	-8.31
Date	Daily Summary	Estimated Reference Load (MWh)	Event Day Load (MWh)	Estimated Load Impact (MWh)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (MWh)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul		1551.86	1366.51	185.35	371.30	101.31	150.96	185.35	219.74	269.40

Event Information			
Sample Size	623		
Population Count	64,023		
Event Duration	6 hrs		
Event Start and End Times:	1:00 PM	to	7:00 PM
High Temp (ºF)	106.6 (ºF)		

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* Blue shading represents event hours.

Table 7-16
SmartAC Peak Day Population Impact Estimates: Control: Switch

Date	Hour Ending	Estimated Reference Load (MW)	Event Day Load (MW)	Estimated Load Impact (MW)	Weighted Average Temperature (°F)	Uncertainty Adjusted Load Impact (MW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul	1:00 AM	25.53	23.06	2.47	82.56	-0.36	1.31	2.47	3.63	5.31
8-Jul	2:00 AM	16.61	15.59	1.01	80.19	-1.23	0.10	1.01	1.93	3.26
8-Jul	3:00 AM	12.34	10.63	1.71	78.22	-0.19	0.93	1.71	2.49	3.62
8-Jul	4:00 AM	9.26	8.93	0.33	76.58	-1.31	-0.34	0.33	1.00	1.96
8-Jul	5:00 AM	7.18	6.68	0.50	75.88	-1.05	-0.14	0.50	1.13	2.04
8-Jul	6:00 AM	5.39	6.62	-1.23	74.66	-2.54	-1.77	-1.23	-0.69	0.08
8-Jul	7:00 AM	4.57	7.09	-2.52	73.25	-3.99	-3.12	-2.52	-1.92	-1.06
8-Jul	8:00 AM	5.57	7.43	-1.86	76.13	-3.05	-2.35	-1.86	-1.37	-0.66
8-Jul	9:00 AM	10.81	11.44	-0.63	81.31	-2.44	-1.37	-0.63	0.11	1.18
8-Jul	10:00 AM	19.35	17.04	2.31	86.65	0.00	1.37	2.31	3.25	4.61
8-Jul	11:00 AM	29.58	28.05	1.53	92.06	-1.57	0.26	1.53	2.80	4.64
8-Jul	12:00 PM	45.07	43.87	1.20	96.50	-2.55	-0.34	1.20	2.73	4.95
8-Jul	1:00 PM	62.26	61.37	0.88	99.60	-4.15	-1.17	0.88	2.94	5.92
8-Jul	2:00 PM	74.14	46.20	27.95	102.31	23.81	26.26	27.95	29.64	32.08
8-Jul	3:00 PM	87.66	53.73	33.93	104.35	29.53	32.13	33.93	35.73	38.32
8-Jul	4:00 PM	103.16	59.33	43.83	105.69	39.33	41.99	43.83	45.67	48.33
8-Jul	5:00 PM	107.69	63.12	44.58	106.56	39.93	42.67	44.58	46.48	49.22
8-Jul	6:00 PM	113.29	67.29	46.00	105.68	40.98	43.94	46.00	48.05	51.02
8-Jul	7:00 PM	112.60	68.87	43.73	103.43	39.20	41.88	43.73	45.58	48.25
8-Jul	8:00 PM	95.61	116.44	-20.83	99.91	-25.84	-22.88	-20.83	-18.78	-15.83
8-Jul	9:00 PM	84.15	106.41	-22.27	94.86	-26.89	-24.16	-22.27	-20.37	-17.64
8-Jul	10:00 PM	70.83	88.54	-17.72	91.32	-22.41	-19.64	-17.72	-15.80	-13.03
8-Jul	11:00 PM	49.90	63.61	-13.71	87.91	-17.98	-15.46	-13.71	-11.96	-9.44
8-Jul	12:00 AM	35.42	44.21	-8.79	85.73	-12.43	-10.28	-8.79	-7.30	-5.15
Date	Daily Summary	Estimated Reference Load (MWh)	Event Day Load (MWh)	Estimated Load Impact (MWh)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (MWh)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul		1187.98	1025.58	162.40	365.72	82.80	129.82	162.40	194.97	241.99

Event Information			
Sample Size	339		
Population Count	48,996		
Event Duration	6 hrs		
Event Start and End Times:	1:00 PM	to	7:00 PM
High Temp (°F)	106.6 (°F)		

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* Blue shading represents event hours.

Table 7-17
SmartAC Peak Day Population Impact Estimates: Control: PCT

Date	Hour Ending	Estimated Reference Load (MW)	Event Day Load (MW)	Estimated Load Impact (MW)	Weighted Average Temperature (ºF)	Uncertainty Adjusted Load Impact (MW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul	1:00 AM	8.68	8.85	-0.17	84.17	-1.14	-0.57	-0.17	0.22	0.79
8-Jul	2:00 AM	5.93	6.52	-0.59	82.06	-1.52	-0.97	-0.59	-0.21	0.34
8-Jul	3:00 AM	3.92	5.16	-1.25	80.17	-2.23	-1.65	-1.25	-0.84	-0.26
8-Jul	4:00 AM	2.87	3.63	-0.76	78.30	-1.38	-1.01	-0.76	-0.50	-0.14
8-Jul	5:00 AM	2.57	2.54	0.04	77.51	-0.49	-0.18	0.04	0.25	0.56
8-Jul	6:00 AM	2.24	2.17	0.07	76.16	-0.33	-0.10	0.07	0.24	0.47
8-Jul	7:00 AM	1.94	2.18	-0.23	74.40	-0.84	-0.48	-0.23	0.02	0.38
8-Jul	8:00 AM	2.27	2.79	-0.52	77.33	-1.10	-0.75	-0.52	-0.28	0.07
8-Jul	9:00 AM	3.58	3.91	-0.33	82.29	-1.03	-0.61	-0.33	-0.04	0.37
8-Jul	10:00 AM	6.30	5.92	0.38	87.32	-0.49	0.02	0.38	0.73	1.25
8-Jul	11:00 AM	8.75	9.22	-0.48	92.24	-1.49	-0.89	-0.48	-0.07	0.53
8-Jul	12:00 PM	12.82	13.87	-1.05	96.47	-2.31	-1.57	-1.05	-0.53	0.22
8-Jul	1:00 PM	16.92	19.26	-2.34	99.61	-3.63	-2.87	-2.34	-1.82	-1.06
8-Jul	2:00 PM	20.96	16.07	4.89	102.30	3.70	4.40	4.89	5.37	6.07
8-Jul	3:00 PM	25.07	19.06	6.01	104.40	4.71	5.48	6.01	6.54	7.30
8-Jul	4:00 PM	29.11	20.91	8.20	105.65	6.76	7.61	8.20	8.79	9.64
8-Jul	5:00 PM	33.41	22.65	10.76	106.91	9.17	10.11	10.76	11.41	12.35
8-Jul	6:00 PM	35.36	23.37	12.00	106.39	10.39	11.34	12.00	12.65	13.60
8-Jul	7:00 PM	35.43	23.68	11.75	104.75	10.24	11.13	11.75	12.37	13.26
8-Jul	8:00 PM	30.85	35.60	-4.75	101.36	-6.34	-5.40	-4.75	-4.10	-3.16
8-Jul	9:00 PM	25.47	32.65	-7.18	96.15	-8.81	-7.85	-7.18	-6.51	-5.55
8-Jul	10:00 PM	21.68	26.07	-4.39	92.58	-5.86	-4.99	-4.39	-3.79	-2.92
8-Jul	11:00 PM	15.94	19.68	-3.74	89.18	-5.19	-4.34	-3.74	-3.15	-2.29
8-Jul	12:00 AM	11.82	15.19	-3.36	87.12	-4.61	-3.87	-3.36	-2.86	-2.12
Date	Daily Summary	Estimated Reference Load (MWh)	Event Day Load (MWh)	Estimated Load Impact (MWh)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (MWh)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul		363.89	340.93	22.95	377.96	-3.80	12.01	22.95	33.90	49.70

Event Information			
Sample Size	284		
Population Count	15,027		
Event Duration	6 hrs		
Event Start and End Times:	1:00 PM	to	7:00 PM
High Temp (ºF)	106.9 (ºF)		

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* Blue shading represents event hours.

Table 7-18
SmartAC Peak Day Population Impact Estimates: LCA: Greater Bay Area

Date	Hour Ending	Estimated Reference Load (MW)	Event Day Load (MW)	Estimated Load Impact (MW)	Weighted Average Temperature (ºF)	Uncertainty Adjusted Load Impact (MW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul	1:00 AM	10.44	11.39	-0.96	77.32	-2.89	-1.75	-0.96	-0.16	0.98
8-Jul	2:00 AM	5.84	7.46	-1.62	73.93	-3.43	-2.36	-1.62	-0.87	0.20
8-Jul	3:00 AM	3.52	4.70	-1.19	71.25	-2.84	-1.86	-1.19	-0.51	0.46
8-Jul	4:00 AM	2.95	2.95	0.00	70.85	-1.18	-0.48	0.00	0.48	1.18
8-Jul	5:00 AM	1.97	1.75	0.22	70.14	-0.54	-0.09	0.22	0.53	0.99
8-Jul	6:00 AM	1.43	1.71	-0.28	69.18	-0.74	-0.47	-0.28	-0.09	0.19
8-Jul	7:00 AM	1.51	1.69	-0.17	69.28	-0.97	-0.50	-0.17	0.15	0.63
8-Jul	8:00 AM	1.13	1.94	-0.81	71.86	-1.48	-1.08	-0.81	-0.53	-0.13
8-Jul	9:00 AM	3.85	4.48	-0.62	78.53	-1.67	-1.05	-0.62	-0.20	0.42
8-Jul	10:00 AM	9.27	7.25	2.02	85.56	0.46	1.38	2.02	2.65	3.57
8-Jul	11:00 AM	16.80	13.78	3.02	93.80	0.81	2.12	3.02	3.93	5.23
8-Jul	12:00 PM	25.21	21.73	3.48	99.11	0.44	2.24	3.48	4.72	6.52
8-Jul	1:00 PM	33.79	29.56	4.22	101.79	-0.26	2.39	4.22	6.06	8.71
8-Jul	2:00 PM	39.29	21.26	18.02	104.57	14.70	16.66	18.02	19.39	21.35
8-Jul	3:00 PM	46.82	24.83	21.99	106.34	18.78	20.68	21.99	23.30	25.20
8-Jul	4:00 PM	57.52	29.10	28.42	108.01	25.00	27.02	28.42	29.82	31.84
8-Jul	5:00 PM	56.42	30.87	25.55	107.45	21.95	24.08	25.55	27.02	29.14
8-Jul	6:00 PM	60.21	31.86	28.35	104.93	24.23	26.66	28.35	30.03	32.46
8-Jul	7:00 PM	57.75	32.30	25.45	100.02	22.01	24.04	25.45	26.85	28.88
8-Jul	8:00 PM	44.77	57.07	-12.29	96.38	-16.16	-13.87	-12.29	-10.71	-8.42
8-Jul	9:00 PM	40.76	53.38	-12.62	91.42	-16.50	-14.21	-12.62	-11.03	-8.74
8-Jul	10:00 PM	34.58	44.94	-10.36	86.92	-14.24	-11.95	-10.36	-8.77	-6.47
8-Jul	11:00 PM	24.82	30.54	-5.72	83.18	-9.16	-7.13	-5.72	-4.31	-2.27
8-Jul	12:00 AM	16.54	20.72	-4.18	80.96	-7.00	-5.33	-4.18	-3.03	-1.36
Date	Daily Summary	Estimated Reference Load (MWh)	Event Day Load (MWh)	Estimated Load Impact (MWh)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (MWh)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul		597.18	487.25	109.93	318.89	49.31	85.13	109.93	134.74	170.55

Event Information			
Sample Size	191		
Population Count	25,394		
Event Duration	6 hrs		
Event Start and End Times:	1:00 PM	to	7:00 PM
High Temp (ºF)	108 (ºF)		

*

* Blue shading represents event hours.

Table 7-19

SmartAC Peak Day Population Impact Estimates: LCA: Greater Fresno

Date	Hour Ending	Estimated Reference Load (MW)	Event Day Load (MW)	Estimated Load Impact (MW)	Weighted Average Temperature (ºF)	Uncertainty Adjusted Load Impact (MW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul	1:00 AM	13.05	10.78	2.27	87.97	0.95	1.73	2.27	2.81	3.59
8-Jul	2:00 AM	9.03	7.20	1.83	85.59	0.72	1.38	1.83	2.28	2.93
8-Jul	3:00 AM	7.32	5.82	1.50	84.08	0.53	1.10	1.50	1.89	2.46
8-Jul	4:00 AM	5.15	4.60	0.55	81.56	-0.23	0.23	0.55	0.86	1.32
8-Jul	5:00 AM	4.40	4.49	-0.09	80.60	-1.29	-0.58	-0.09	0.40	1.10
8-Jul	6:00 AM	3.87	4.19	-0.32	78.68	-1.46	-0.79	-0.32	0.15	0.83
8-Jul	7:00 AM	3.35	5.55	-2.20	77.84	-3.41	-2.69	-2.20	-1.70	-0.98
8-Jul	8:00 AM	4.27	4.70	-0.43	80.45	-1.24	-0.76	-0.43	-0.10	0.37
8-Jul	9:00 AM	6.58	6.33	0.25	85.35	-0.96	-0.24	0.25	0.75	1.46
8-Jul	10:00 AM	9.99	9.83	0.16	90.24	-1.16	-0.38	0.16	0.70	1.48
8-Jul	11:00 AM	12.90	14.26	-1.36	94.18	-3.07	-2.06	-1.36	-0.66	0.35
8-Jul	12:00 PM	19.51	20.75	-1.24	97.76	-3.24	-2.06	-1.24	-0.42	0.76
8-Jul	1:00 PM	23.67	28.49	-4.83	100.42	-6.85	-5.66	-4.83	-4.00	-2.80
8-Jul	2:00 PM	29.73	24.60	5.13	103.80	3.47	4.45	5.13	5.80	6.78
8-Jul	3:00 PM	35.43	27.74	7.69	106.28	5.67	6.87	7.69	8.52	9.71
8-Jul	4:00 PM	40.14	28.98	11.16	106.88	8.96	10.26	11.16	12.06	13.36
8-Jul	5:00 PM	43.45	31.27	12.17	109.30	9.95	11.26	12.17	13.08	14.39
8-Jul	6:00 PM	45.32	32.20	13.12	109.35	10.92	12.22	13.12	14.02	15.33
8-Jul	7:00 PM	44.69	32.71	11.99	108.03	9.86	11.12	11.99	12.86	14.11
8-Jul	8:00 PM	41.15	46.68	-5.54	105.36	-7.53	-6.35	-5.54	-4.72	-3.54
8-Jul	9:00 PM	34.82	43.17	-8.35	101.14	-10.35	-9.17	-8.35	-7.53	-6.35
8-Jul	10:00 PM	30.27	35.55	-5.28	97.71	-7.35	-6.13	-5.28	-4.43	-3.21
8-Jul	11:00 PM	22.60	28.67	-6.07	93.82	-8.11	-6.90	-6.07	-5.24	-4.03
8-Jul	12:00 AM	17.23	22.09	-4.86	92.21	-6.73	-5.63	-4.86	-4.09	-2.98
Date	Daily Summary	Estimated Reference Load (MWh)	Event Day Load (MWh)	Estimated Load Impact (MWh)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (MWh)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul		507.92	480.67	27.24	438.75	-11.96	11.20	27.24	43.28	66.44

Event Information	
Sample Size	200
Population Count	18,001
Event Duration	6 hrs
Event Start and End Times:	1:00 PM to 7:00 PM
High Temp (ºF)	109.3 (ºF)

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* Blue shading represents event hours.

Table 7-20
SmartAC Peak Day Population Impact Estimates: LCA: Stockton

Date	Hour Ending	Estimated Reference Load (MW)	Event Day Load (MW)	Estimated Load Impact (MW)	Weighted Average Temperature (ºF)	Uncertainty Adjusted Load Impact (MW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul	1:00 AM	3.35	3.31	0.04	84.98	-0.48	-0.17	0.04	0.26	0.57
8-Jul	2:00 AM	2.50	2.54	-0.04	83.98	-0.46	-0.21	-0.04	0.13	0.37
8-Jul	3:00 AM	1.71	1.72	-0.02	82.48	-0.34	-0.15	-0.02	0.12	0.31
8-Jul	4:00 AM	1.30	1.62	-0.32	79.98	-0.68	-0.47	-0.32	-0.17	0.04
8-Jul	5:00 AM	1.08	0.94	0.14	79.48	-0.12	0.03	0.14	0.24	0.39
8-Jul	6:00 AM	0.76	0.95	-0.19	78.48	-0.40	-0.28	-0.19	-0.11	0.02
8-Jul	7:00 AM	0.59	0.66	-0.08	74.48	-0.31	-0.17	-0.08	0.02	0.16
8-Jul	8:00 AM	0.81	1.03	-0.21	77.98	-0.49	-0.33	-0.21	-0.10	0.07
8-Jul	9:00 AM	1.22	1.48	-0.25	81.48	-0.61	-0.40	-0.25	-0.11	0.10
8-Jul	10:00 AM	2.07	2.05	0.01	84.98	-0.46	-0.18	0.01	0.21	0.49
8-Jul	11:00 AM	2.84	2.97	-0.13	87.98	-0.73	-0.38	-0.13	0.11	0.46
8-Jul	12:00 PM	4.20	4.75	-0.55	91.98	-1.11	-0.78	-0.55	-0.32	0.01
8-Jul	1:00 PM	7.08	7.20	-0.11	95.98	-0.80	-0.39	-0.11	0.17	0.57
8-Jul	2:00 PM	8.60	5.11	3.49	97.98	2.68	3.16	3.49	3.81	4.29
8-Jul	3:00 PM	10.09	6.48	3.61	99.98	2.70	3.24	3.61	3.99	4.52
8-Jul	4:00 PM	11.56	7.07	4.49	101.48	3.66	4.15	4.49	4.83	5.32
8-Jul	5:00 PM	13.50	7.56	5.94	102.98	5.09	5.59	5.94	6.29	6.79
8-Jul	6:00 PM	14.00	8.64	5.36	103.48	4.46	4.99	5.36	5.72	6.25
8-Jul	7:00 PM	14.80	8.93	5.86	103.98	4.96	5.49	5.86	6.23	6.77
8-Jul	8:00 PM	12.87	15.66	-2.80	99.98	-3.78	-3.20	-2.80	-2.39	-1.81
8-Jul	9:00 PM	10.88	13.83	-2.95	93.98	-3.71	-3.26	-2.95	-2.64	-2.19
8-Jul	10:00 PM	9.09	11.31	-2.22	91.48	-3.03	-2.55	-2.22	-1.89	-1.41
8-Jul	11:00 PM	6.27	7.89	-1.62	88.98	-2.42	-1.95	-1.62	-1.29	-0.82
8-Jul	12:00 AM	4.54	5.49	-0.95	86.48	-1.61	-1.22	-0.95	-0.68	-0.29
Date	Daily Summary	Estimated Reference Load (MWh)	Event Day Load (MWh)	Estimated Load Impact (MWh)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (MWh)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul		145.70	129.19	16.51	356.00	2.03	10.59	16.51	22.44	30.99

Event Information			
Sample Size	206		
Population Count	6,613		
Event Duration	6 hrs		
Event Start and End Times:	1:00 PM	to	7:00 PM
High Temp (ºF)	104 (ºF)		

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* Blue shading represents event hours.

Table 7-21

SmartAC Peak Day Population Impact Estimates: Year Built: pre-1975

Date	Hour Ending	Estimated Reference Load (MW)	Event Day Load (MW)	Estimated Load Impact (MW)	Weighted Average Temperature (°F)	Uncertainty Adjusted Load Impact (MW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul	1:00 AM	0.11	0.10	0.01	82.13	-0.01	0.00	0.01	0.02	0.03
8-Jul	2:00 AM	0.08	0.06	0.02	79.71	0.01	0.01	0.02	0.02	0.03
8-Jul	3:00 AM	0.06	0.04	0.02	77.79	0.01	0.01	0.02	0.02	0.03
8-Jul	4:00 AM	0.04	0.04	0.01	76.14	0.00	0.00	0.01	0.01	0.02
8-Jul	5:00 AM	0.04	0.03	0.01	75.39	0.00	0.01	0.01	0.01	0.01
8-Jul	6:00 AM	0.03	0.02	0.01	74.11	0.00	0.01	0.01	0.01	0.01
8-Jul	7:00 AM	0.03	0.03	-0.01	72.96	-0.01	-0.01	-0.01	0.00	0.00
8-Jul	8:00 AM	0.03	0.04	-0.01	75.72	-0.02	-0.01	-0.01	-0.01	0.00
8-Jul	9:00 AM	0.05	0.05	0.00	80.92	-0.01	0.00	0.00	0.01	0.01
8-Jul	10:00 AM	0.09	0.07	0.01	86.26	0.00	0.01	0.01	0.02	0.03
8-Jul	11:00 AM	0.13	0.12	0.01	91.62	-0.01	0.00	0.01	0.01	0.03
8-Jul	12:00 PM	0.21	0.20	0.01	95.95	-0.01	0.00	0.01	0.02	0.03
8-Jul	1:00 PM	0.29	0.29	-0.01	98.92	-0.04	-0.02	-0.01	0.01	0.03
8-Jul	2:00 PM	0.35	0.24	0.11	101.74	0.09	0.10	0.11	0.12	0.14
8-Jul	3:00 PM	0.42	0.27	0.15	103.81	0.12	0.14	0.15	0.16	0.17
8-Jul	4:00 PM	0.47	0.30	0.17	105.02	0.15	0.16	0.17	0.18	0.20
8-Jul	5:00 PM	0.50	0.32	0.17	105.95	0.15	0.16	0.17	0.19	0.20
8-Jul	6:00 PM	0.53	0.33	0.20	105.05	0.17	0.19	0.20	0.22	0.23
8-Jul	7:00 PM	0.51	0.33	0.18	102.71	0.16	0.17	0.18	0.19	0.21
8-Jul	8:00 PM	0.45	0.51	-0.06	99.32	-0.09	-0.07	-0.06	-0.05	-0.03
8-Jul	9:00 PM	0.37	0.47	-0.10	94.45	-0.13	-0.11	-0.10	-0.09	-0.07
8-Jul	10:00 PM	0.30	0.40	-0.10	90.89	-0.13	-0.11	-0.10	-0.09	-0.07
8-Jul	11:00 PM	0.21	0.28	-0.08	87.47	-0.10	-0.09	-0.08	-0.07	-0.05
8-Jul	12:00 AM	0.14	0.18	-0.04	85.42	-0.06	-0.04	-0.04	-0.03	-0.02
Date	Daily Summary	Estimated Reference Load (MWh)	Event Day Load (MWh)	Estimated Load Impact (MWh)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (MWh)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul		5.41	4.70	0.70	373.41	0.23	0.51	0.70	0.89	1.17

Event Information			
Sample Size	212		
Population Count	-		
Event Duration	6 hrs		
Event Start and End Times:	1:00 PM	to	7:00 PM
High Temp (°F)	105.9 (°F)		

*

[*] Blue shading represents event hours.

Table 7-22
SmartAC Peak Day Population Impact Estimates: Year Built: 1975-1995

Date	Hour Ending	Estimated Reference Load (MW)	Event Day Load (MW)	Estimated Load Impact (MW)	Weighted Average Temperature (ºF)	Uncertainty Adjusted Load Impact (MW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul	1:00 AM	0.16	0.15	0.01	83.06	-0.01	0.00	0.01	0.02	0.03
8-Jul	2:00 AM	0.11	0.12	-0.01	80.69	-0.03	-0.02	-0.01	0.00	0.01
8-Jul	3:00 AM	0.08	0.09	-0.01	78.79	-0.03	-0.02	-0.01	0.00	0.01
8-Jul	4:00 AM	0.06	0.06	0.00	76.98	-0.01	-0.01	0.00	0.00	0.01
8-Jul	5:00 AM	0.05	0.05	0.00	76.37	-0.02	-0.01	0.00	0.00	0.01
8-Jul	6:00 AM	0.03	0.05	-0.02	75.16	-0.03	-0.02	-0.02	-0.01	-0.01
8-Jul	7:00 AM	0.03	0.04	-0.01	73.55	-0.02	-0.02	-0.01	-0.01	0.00
8-Jul	8:00 AM	0.04	0.04	0.00	76.51	-0.01	-0.01	0.00	0.00	0.01
8-Jul	9:00 AM	0.07	0.08	-0.01	81.52	-0.03	-0.02	-0.01	-0.01	0.00
8-Jul	10:00 AM	0.12	0.11	0.02	86.70	0.00	0.01	0.02	0.02	0.03
8-Jul	11:00 AM	0.17	0.17	0.00	91.80	-0.03	-0.01	0.00	0.01	0.02
8-Jul	12:00 PM	0.25	0.27	-0.02	96.16	-0.05	-0.04	-0.02	-0.01	0.00
8-Jul	1:00 PM	0.35	0.37	-0.02	99.35	-0.06	-0.04	-0.02	-0.01	0.01
8-Jul	2:00 PM	0.42	0.29	0.13	102.03	0.10	0.12	0.13	0.14	0.16
8-Jul	3:00 PM	0.50	0.34	0.16	104.06	0.13	0.15	0.16	0.17	0.19
8-Jul	4:00 PM	0.59	0.36	0.23	105.41	0.19	0.21	0.23	0.24	0.26
8-Jul	5:00 PM	0.63	0.39	0.24	106.50	0.21	0.23	0.24	0.26	0.28
8-Jul	6:00 PM	0.67	0.42	0.25	105.81	0.22	0.24	0.25	0.27	0.29
8-Jul	7:00 PM	0.68	0.43	0.25	103.85	0.22	0.24	0.25	0.26	0.28
8-Jul	8:00 PM	0.60	0.71	-0.11	100.33	-0.15	-0.13	-0.11	-0.09	-0.07
8-Jul	9:00 PM	0.52	0.63	-0.11	95.37	-0.14	-0.12	-0.11	-0.09	-0.08
8-Jul	10:00 PM	0.46	0.52	-0.06	92.05	-0.10	-0.08	-0.06	-0.05	-0.03
8-Jul	11:00 PM	0.34	0.40	-0.06	88.67	-0.09	-0.07	-0.06	-0.05	-0.03
8-Jul	12:00 AM	0.24	0.31	-0.08	86.39	-0.10	-0.09	-0.08	-0.07	-0.05
Date	Daily Summary	Estimated Reference Load (MWh)	Event Day Load (MWh)	Estimated Load Impact (MWh)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (MWh)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul		7.16	6.40	0.76	372.90	0.15	0.51	0.76	1.01	1.36

Event Information			
Sample Size	271		
Population Count	-		
Event Duration	6 hrs		
Event Start and End Times:	1:00 PM	to	7:00 PM
High Temp (ºF)	106.5 (ºF)		

*

* Blue shading represents event hours.

Table 7-23
SmartAC Peak Day Population Impact Estimates: Year Built: post-1995

Date	Hour Ending	Estimated Reference Load (MW)	Event Day Load (MW)	Estimated Load Impact (MW)	Weighted Average Temperature (°F)	Uncertainty Adjusted Load Impact (MW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul	1:00 AM	0.07	0.07	0.00	81.29	-0.01	0.00	0.00	0.01	0.01
8-Jul	2:00 AM	0.05	0.06	-0.01	79.43	-0.02	-0.01	-0.01	-0.01	0.00
8-Jul	3:00 AM	0.03	0.04	-0.01	77.41	-0.02	-0.01	-0.01	-0.01	0.00
8-Jul	4:00 AM	0.02	0.03	-0.01	75.91	-0.02	-0.01	-0.01	-0.01	0.00
8-Jul	5:00 AM	0.02	0.02	0.00	75.03	-0.01	0.00	0.00	0.00	0.00
8-Jul	6:00 AM	0.01	0.02	0.00	73.80	-0.01	-0.01	0.00	0.00	0.00
8-Jul	7:00 AM	0.01	0.02	-0.01	71.91	-0.02	-0.01	-0.01	-0.01	0.00
8-Jul	8:00 AM	0.01	0.02	-0.01	74.79	-0.02	-0.01	-0.01	-0.01	0.00
8-Jul	9:00 AM	0.03	0.03	0.00	79.83	0.00	0.00	0.00	0.00	0.01
8-Jul	10:00 AM	0.05	0.05	0.00	84.85	-0.01	-0.01	0.00	0.00	0.01
8-Jul	11:00 AM	0.09	0.08	0.01	90.19	0.00	0.00	0.01	0.01	0.02
8-Jul	12:00 PM	0.12	0.11	0.01	94.55	0.00	0.01	0.01	0.02	0.03
8-Jul	1:00 PM	0.15	0.14	0.01	97.70	0.00	0.01	0.01	0.02	0.03
8-Jul	2:00 PM	0.18	0.09	0.08	100.12	0.06	0.07	0.08	0.09	0.11
8-Jul	3:00 PM	0.21	0.12	0.09	102.11	0.07	0.08	0.09	0.10	0.11
8-Jul	4:00 PM	0.26	0.14	0.12	103.51	0.10	0.11	0.12	0.13	0.15
8-Jul	5:00 PM	0.28	0.14	0.14	104.28	0.12	0.13	0.14	0.15	0.16
8-Jul	6:00 PM	0.28	0.16	0.12	103.51	0.10	0.11	0.12	0.13	0.15
8-Jul	7:00 PM	0.30	0.17	0.13	101.71	0.11	0.12	0.13	0.14	0.15
8-Jul	8:00 PM	0.22	0.31	-0.09	98.24	-0.11	-0.10	-0.09	-0.08	-0.07
8-Jul	9:00 PM	0.22	0.30	-0.09	92.63	-0.11	-0.10	-0.09	-0.08	-0.06
8-Jul	10:00 PM	0.19	0.23	-0.05	88.74	-0.07	-0.06	-0.05	-0.04	-0.03
8-Jul	11:00 PM	0.12	0.15	-0.03	85.49	-0.05	-0.04	-0.03	-0.02	-0.01
8-Jul	12:00 AM	0.10	0.11	-0.01	83.46	-0.03	-0.02	-0.01	0.00	0.01
Date	Daily Summary	Estimated Reference Load (MWh)	Event Day Load (MWh)	Estimated Load Impact (MWh)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (MWh)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul		3.02	2.62	0.40	364.06	0.03	0.25	0.40	0.55	0.77

Event Information			
Sample Size	136		
Population Count	-		
Event Duration	6 hrs		
Event Start and End Times:	1:00 PM	to	7:00 PM
High Temp (°F)	104.3 (°F)		

*

* Blue shading represents event hours.

Table 7-24
SmartAC Peak Day Population Impact Estimates: Sq. Ft.: 1,000-2,000

Date	Hour Ending	Estimated Reference Load (MW)	Event Day Load (MW)	Estimated Load Impact (MW)	Weighted Average Temperature (°F)	Uncertainty Adjusted Load Impact (MW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul	1:00 AM	20.20	18.00	2.20	83.82	-0.13	1.25	2.20	3.15	4.53
8-Jul	2:00 AM	13.50	11.43	2.07	81.71	0.15	1.29	2.07	2.86	3.99
8-Jul	3:00 AM	10.42	8.73	1.69	79.90	0.01	1.00	1.69	2.37	3.36
8-Jul	4:00 AM	7.23	7.73	-0.51	78.01	-1.77	-1.02	-0.51	0.01	0.76
8-Jul	5:00 AM	6.37	6.15	0.23	77.26	-1.17	-0.35	0.23	0.80	1.63
8-Jul	6:00 AM	5.09	5.88	-0.79	75.97	-1.94	-1.26	-0.79	-0.32	0.36
8-Jul	7:00 AM	4.49	6.60	-2.11	74.28	-3.49	-2.68	-2.11	-1.54	-0.73
8-Jul	8:00 AM	5.17	6.92	-1.75	77.18	-2.87	-2.21	-1.75	-1.29	-0.63
8-Jul	9:00 AM	7.88	8.52	-0.64	82.07	-2.05	-1.22	-0.64	-0.06	0.77
8-Jul	10:00 AM	13.10	11.21	1.89	87.04	0.28	1.23	1.89	2.55	3.50
8-Jul	11:00 AM	19.77	18.69	1.08	91.88	-1.05	0.21	1.08	1.95	3.21
8-Jul	12:00 PM	31.82	31.61	0.21	96.12	-2.53	-0.91	0.21	1.34	2.96
8-Jul	1:00 PM	42.99	43.69	-0.70	99.30	-3.78	-1.96	-0.70	0.56	2.37
8-Jul	2:00 PM	53.14	34.70	18.44	102.01	15.63	17.29	18.44	19.60	21.26
8-Jul	3:00 PM	62.59	40.94	21.65	104.14	18.68	20.44	21.65	22.87	24.63
8-Jul	4:00 PM	70.60	46.13	24.47	105.36	21.38	23.20	24.47	25.73	27.56
8-Jul	5:00 PM	76.57	48.25	28.32	106.49	25.02	26.97	28.32	29.67	31.62
8-Jul	6:00 PM	80.50	49.74	30.76	105.94	27.14	29.28	30.76	32.24	34.38
8-Jul	7:00 PM	78.92	50.84	28.08	104.22	25.08	26.85	28.08	29.31	31.09
8-Jul	8:00 PM	71.01	81.07	-10.06	100.74	-13.34	-11.40	-10.06	-8.72	-6.78
8-Jul	9:00 PM	59.88	75.22	-15.34	95.61	-18.62	-16.68	-15.34	-14.00	-12.06
8-Jul	10:00 PM	49.73	62.61	-12.88	92.18	-16.04	-14.17	-12.88	-11.59	-9.72
8-Jul	11:00 PM	35.60	46.64	-11.04	88.87	-14.03	-12.27	-11.04	-9.82	-8.06
8-Jul	12:00 AM	26.09	33.53	-7.44	86.75	-9.86	-8.43	-7.44	-6.45	-5.02
Date	Daily Summary	Estimated Reference Load (MWh)	Event Day Load (MWh)	Estimated Load Impact (MWh)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (MWh)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul		852.67	754.83	97.84	376.79	40.70	74.46	97.84	121.21	154.97

Event Information			
Sample Size	330		
Population Count	33,814		
Event Duration	6 hrs		
Event Start and End Times:	1:00 PM	to	7:00 PM
High Temp (°F)	106.5 (°F)		

*

* Blue shading represents event hours.

Table 7-25

SmartAC Peak Day Population Impact Estimates: Sq. Ft.: 2,000-5,000

Date	Hour Ending	Estimated Reference Load (MW)	Event Day Load (MW)	Estimated Load Impact (MW)	Weighted Average Temperature (ºF)	Uncertainty Adjusted Load Impact (MW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul	1:00 AM	9.67	10.16	-0.50	81.97	-1.90	-1.07	-0.50	0.08	0.91
8-Jul	2:00 AM	6.33	7.89	-1.56	79.53	-2.70	-2.03	-1.56	-1.09	-0.42
8-Jul	3:00 AM	3.55	4.92	-1.37	77.35	-2.31	-1.76	-1.37	-0.98	-0.43
8-Jul	4:00 AM	3.06	3.46	-0.40	75.97	-1.35	-0.79	-0.40	-0.01	0.54
8-Jul	5:00 AM	2.02	1.99	0.03	75.21	-0.45	-0.16	0.03	0.23	0.52
8-Jul	6:00 AM	1.38	1.79	-0.41	74.00	-0.86	-0.59	-0.41	-0.23	0.04
8-Jul	7:00 AM	0.88	1.57	-0.69	72.64	-1.11	-0.86	-0.69	-0.52	-0.27
8-Jul	8:00 AM	1.55	1.85	-0.30	75.51	-0.78	-0.50	-0.30	-0.11	0.18
8-Jul	9:00 AM	4.69	4.23	0.46	81.00	-0.37	0.12	0.46	0.80	1.29
8-Jul	10:00 AM	8.48	7.51	0.97	86.61	-0.29	0.46	0.97	1.49	2.23
8-Jul	11:00 AM	13.11	12.72	0.38	92.60	-1.29	-0.30	0.38	1.07	2.06
8-Jul	12:00 PM	18.55	17.58	0.96	97.20	-1.13	0.11	0.96	1.82	3.06
8-Jul	1:00 PM	25.61	24.40	1.21	100.25	-2.15	-0.17	1.21	2.59	4.58
8-Jul	2:00 PM	28.21	16.94	11.27	102.88	8.79	10.26	11.27	12.29	13.76
8-Jul	3:00 PM	33.12	20.09	13.03	104.84	10.43	11.97	13.03	14.09	15.63
8-Jul	4:00 PM	40.98	22.05	18.93	106.29	16.24	17.83	18.93	20.03	21.61
8-Jul	5:00 PM	43.37	24.01	19.36	106.98	16.63	18.24	19.36	20.47	22.08
8-Jul	6:00 PM	44.72	25.23	19.48	105.85	16.68	18.34	19.48	20.63	22.29
8-Jul	7:00 PM	44.94	26.18	18.76	103.30	16.01	17.64	18.76	19.89	21.52
8-Jul	8:00 PM	35.24	46.62	-11.37	99.81	-14.59	-12.69	-11.37	-10.06	-8.16
8-Jul	9:00 PM	32.97	42.45	-9.49	94.52	-12.36	-10.66	-9.49	-8.31	-6.61
8-Jul	10:00 PM	27.86	34.84	-6.97	90.61	-9.83	-8.14	-6.97	-5.81	-4.12
8-Jul	11:00 PM	18.55	24.30	-5.76	87.11	-8.43	-6.85	-5.76	-4.66	-3.08
8-Jul	12:00 AM	14.11	16.87	-2.75	84.96	-5.12	-3.72	-2.75	-1.78	-0.39
Date	Daily Summary	Estimated Reference Load (MWh)	Event Day Load (MWh)	Estimated Load Impact (MWh)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (MWh)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul		462.95	399.66	63.29	362.29	17.75	44.66	63.29	81.92	108.82

Event Information			
Sample Size		239	
Population Count		19,590	
Event Duration		6 hrs	
Event Start and End Times:	1:00 PM	to	7:00 PM
High Temp (ºF)		107 (ºF)	

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* Blue shading represents event hours.

Table 7-26

SmartAC Peak Day Population Impact Estimates: Climate Zone R

Date	Hour Ending	Estimated Reference Load (MW)	Event Day Load (MW)	Estimated Load Impact (MW)	Weighted Average Temperature (ºF)	Uncertainty Adjusted Load Impact (MW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul	1:00 AM	13.29	10.98	2.31	88.01	0.97	1.76	2.31	2.86	3.65
8-Jul	2:00 AM	9.20	7.34	1.86	85.64	0.74	1.40	1.86	2.32	2.99
8-Jul	3:00 AM	7.45	5.93	1.52	84.12	0.54	1.12	1.52	1.93	2.51
8-Jul	4:00 AM	5.24	4.69	0.56	81.60	-0.23	0.23	0.56	0.88	1.34
8-Jul	5:00 AM	4.48	4.57	-0.09	80.64	-1.31	-0.59	-0.09	0.40	1.12
8-Jul	6:00 AM	3.95	4.27	-0.32	78.72	-1.49	-0.80	-0.32	0.15	0.84
8-Jul	7:00 AM	3.42	5.65	-2.24	77.88	-3.47	-2.74	-2.24	-1.73	-1.00
8-Jul	8:00 AM	4.35	4.79	-0.44	80.50	-1.26	-0.78	-0.44	-0.11	0.38
8-Jul	9:00 AM	6.71	6.45	0.26	85.39	-0.98	-0.25	0.26	0.76	1.49
8-Jul	10:00 AM	10.18	10.02	0.16	90.29	-1.18	-0.39	0.16	0.71	1.51
8-Jul	11:00 AM	13.14	14.53	-1.39	94.23	-3.13	-2.10	-1.39	-0.68	0.35
8-Jul	12:00 PM	19.88	21.14	-1.26	97.81	-3.30	-2.10	-1.26	-0.43	0.77
8-Jul	1:00 PM	24.11	29.03	-4.92	100.47	-6.98	-5.76	-4.92	-4.07	-2.85
8-Jul	2:00 PM	30.28	25.06	5.22	103.86	3.54	4.53	5.22	5.91	6.91
8-Jul	3:00 PM	36.10	28.26	7.84	106.33	5.78	6.99	7.84	8.68	9.90
8-Jul	4:00 PM	40.90	29.52	11.37	106.93	9.13	10.46	11.37	12.29	13.61
8-Jul	5:00 PM	44.26	31.86	12.40	109.36	10.14	11.48	12.40	13.33	14.66
8-Jul	6:00 PM	46.18	32.81	13.37	109.41	11.12	12.45	13.37	14.29	15.62
8-Jul	7:00 PM	45.54	33.32	12.21	108.09	10.05	11.33	12.21	13.10	14.38
8-Jul	8:00 PM	41.92	47.56	-5.64	105.42	-7.67	-6.47	-5.64	-4.81	-3.60
8-Jul	9:00 PM	35.47	43.98	-8.51	101.19	-10.55	-9.34	-8.51	-7.68	-6.47
8-Jul	10:00 PM	30.84	36.22	-5.38	97.76	-7.49	-6.24	-5.38	-4.52	-3.27
8-Jul	11:00 PM	23.03	29.21	-6.19	93.87	-8.26	-7.03	-6.19	-5.34	-4.11
8-Jul	12:00 AM	17.55	22.50	-4.95	92.26	-6.86	-5.73	-4.95	-4.17	-3.04
Date	Daily Summary	Estimated Reference Load (MWh)	Event Day Load (MWh)	Estimated Load Impact (MWh)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (MWh)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul		517.47	489.72	27.75	438.75	-12.19	11.41	27.75	44.10	67.69

Event Information			
Sample Size	200		
Population Count	18,330		
Event Duration	6 hrs		
Event Start and End Times:	1:00 PM	to	7:00 PM
High Temp (ºF)	109.4 (ºF)		

*

* Blue shading represents event hours.

Table 7-27
SmartAC Peak Day Population Impact Estimates: Climate Zone S

Date	Hour Ending	Estimated Reference Load (MW)	Event Day Load (MW)	Estimated Load Impact (MW)	Weighted Average Temperature (ºF)	Uncertainty Adjusted Load Impact (MW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul	1:00 AM	12.43	11.66	0.77	84.15	-1.21	-0.04	0.77	1.58	2.75
8-Jul	2:00 AM	8.59	8.94	-0.35	82.79	-1.63	-0.88	-0.35	0.17	0.92
8-Jul	3:00 AM	5.87	6.33	-0.46	81.24	-1.61	-0.93	-0.46	0.01	0.69
8-Jul	4:00 AM	4.39	5.71	-1.33	78.87	-2.44	-1.78	-1.33	-0.87	-0.22
8-Jul	5:00 AM	3.72	3.26	0.46	78.44	-0.37	0.12	0.46	0.80	1.29
8-Jul	6:00 AM	2.69	3.22	-0.53	77.48	-1.16	-0.79	-0.53	-0.28	0.09
8-Jul	7:00 AM	2.17	2.82	-0.65	73.98	-1.42	-0.96	-0.65	-0.33	0.12
8-Jul	8:00 AM	2.83	4.49	-1.66	77.41	-2.61	-2.05	-1.66	-1.27	-0.71
8-Jul	9:00 AM	4.68	5.76	-1.08	81.21	-2.29	-1.57	-1.08	-0.58	0.13
8-Jul	10:00 AM	7.98	7.26	0.72	85.07	-0.75	0.12	0.72	1.33	2.20
8-Jul	11:00 AM	11.84	11.19	0.65	88.54	-1.27	-0.14	0.65	1.43	2.56
8-Jul	12:00 PM	16.86	18.28	-1.41	92.66	-3.50	-2.27	-1.41	-0.56	0.68
8-Jul	1:00 PM	26.51	26.43	0.07	96.56	-2.18	-0.85	0.07	0.99	2.32
8-Jul	2:00 PM	31.31	18.84	12.48	98.68	10.03	11.47	12.48	13.48	14.92
8-Jul	3:00 PM	36.57	23.25	13.32	100.66	10.55	12.19	13.32	14.46	16.09
8-Jul	4:00 PM	41.21	25.71	15.51	102.20	12.94	14.46	15.51	16.56	18.08
8-Jul	5:00 PM	48.22	27.15	21.07	103.57	18.39	19.97	21.07	22.17	23.76
8-Jul	6:00 PM	49.85	29.98	19.88	103.79	17.09	18.74	19.88	21.02	22.67
8-Jul	7:00 PM	51.85	31.08	20.77	103.72	18.04	19.66	20.77	21.89	23.51
8-Jul	8:00 PM	45.37	55.23	-9.86	99.73	-13.00	-11.14	-9.86	-8.57	-6.71
8-Jul	9:00 PM	38.23	49.05	-10.82	94.05	-13.40	-11.88	-10.82	-9.76	-8.23
8-Jul	10:00 PM	31.16	40.18	-9.02	91.51	-11.63	-10.09	-9.02	-7.95	-6.41
8-Jul	11:00 PM	20.79	28.61	-7.82	88.80	-10.31	-8.84	-7.82	-6.80	-5.32
8-Jul	12:00 AM	15.92	20.07	-4.16	86.17	-6.30	-5.03	-4.16	-3.28	-2.01
Date	Daily Summary	Estimated Reference Load (MWh)	Event Day Load (MWh)	Estimated Load Impact (MWh)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (MWh)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul		521.04	464.47	56.57	355.53	9.96	37.49	56.57	75.64	103.18

Event Information	
Sample Size	251
Population Count	23,142
Event Duration	6 hrs
Event Start and End Times:	1:00 PM to 7:00 PM
High Temp (ºF)	103.8 (ºF)

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* Blue shading represents event hours.

Table 7-28
SmartAC Peak Day Population Impact Estimates: Climate Zone X

Date	Hour Ending	Estimated Reference Load (MW)	Event Day Load (MW)	Estimated Load Impact (MW)	Weighted Average Temperature (ºF)	Uncertainty Adjusted Load Impact (MW)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul	1:00 AM	8.54	9.30	-0.76	77.66	-2.55	-1.49	-0.76	-0.02	1.04
8-Jul	2:00 AM	4.79	5.84	-1.05	74.41	-2.78	-1.76	-1.05	-0.35	0.68
8-Jul	3:00 AM	2.98	3.55	-0.57	71.70	-2.09	-1.19	-0.57	0.05	0.94
8-Jul	4:00 AM	2.52	2.16	0.36	71.35	-0.73	-0.08	0.36	0.81	1.46
8-Jul	5:00 AM	1.57	1.42	0.16	70.53	-0.57	-0.14	0.16	0.46	0.89
8-Jul	6:00 AM	1.02	1.33	-0.30	69.52	-0.71	-0.47	-0.30	-0.14	0.10
8-Jul	7:00 AM	0.94	0.84	0.10	69.59	-0.54	-0.16	0.10	0.37	0.75
8-Jul	8:00 AM	0.70	0.95	-0.25	72.13	-0.71	-0.44	-0.25	-0.07	0.20
8-Jul	9:00 AM	3.06	3.18	-0.12	78.85	-1.01	-0.48	-0.12	0.24	0.77
8-Jul	10:00 AM	7.55	5.75	1.80	85.86	0.36	1.21	1.80	2.38	3.23
8-Jul	11:00 AM	13.41	11.64	1.77	94.15	-0.22	0.96	1.77	2.59	3.76
8-Jul	12:00 PM	21.25	18.43	2.82	99.46	0.13	1.72	2.82	3.93	5.52
8-Jul	1:00 PM	28.61	25.30	3.31	102.12	-0.90	1.59	3.31	5.03	7.52
8-Jul	2:00 PM	33.60	18.53	15.07	104.89	11.97	13.80	15.07	16.34	18.18
8-Jul	3:00 PM	40.18	21.43	18.75	106.69	15.73	17.51	18.75	19.98	21.76
8-Jul	4:00 PM	50.30	25.14	25.15	108.33	21.88	23.81	25.15	26.49	28.43
8-Jul	5:00 PM	48.74	26.92	21.81	107.72	18.38	20.41	21.81	23.22	25.25
8-Jul	6:00 PM	52.75	28.02	24.72	105.18	20.84	23.14	24.72	26.31	28.60
8-Jul	7:00 PM	50.73	28.29	22.44	100.31	19.20	21.11	22.44	23.77	25.68
8-Jul	8:00 PM	39.27	49.33	-10.06	96.69	-13.72	-11.56	-10.06	-8.56	-6.40
8-Jul	9:00 PM	36.01	46.13	-10.12	91.54	-13.75	-11.61	-10.12	-8.64	-6.49
8-Jul	10:00 PM	30.60	38.29	-7.69	86.84	-11.27	-9.16	-7.69	-6.22	-4.10
8-Jul	11:00 PM	22.13	25.58	-3.45	83.11	-6.58	-4.73	-3.45	-2.17	-0.32
8-Jul	12:00 AM	13.85	16.92	-3.07	80.99	-5.62	-4.11	-3.07	-2.03	-0.53
Date	Daily Summary	Estimated Reference Load (MWh)	Event Day Load (MWh)	Estimated Load Impact (MWh)	Cooling Degree Hours	Uncertainty Adjusted Load Impact (MWh)				
						10th percentile	30th percentile	50th percentile	70th percentile	90th percentile
8-Jul		515.11	414.29	100.82	315.89	44.72	77.86	100.82	123.77	156.92

Event Information			
Sample Size	172		
Population Count	22,551		
Event Duration	6 hrs		
Event Start and End Times:	1:00 PM	to	7:00 PM
High Temp (ºF)	108.3 (ºF)		

*

* Blue shading represents event hours.

Appendix G. Regression Output Example

This Appendix includes the results of one of the individual regressions performed for this evaluation. For illustration purposes, we include the variance-covariance matrix for hour 17 only.

KEMAid	68441857
RMSE:	0.4445
R^2	0.78034
Adj R^2	0.76258

	Cooling Degree Days at Hour X (cool_daily_hourX)			Lagged Cooling Degree Day at Hour X (cool_lag_hourX)			June-Blended Cooling Degree Days at Hour X (month6_cool_hourX)			July-Blended Cooling Degree Days at Hour X (month7_cool_hourX)			August-Blended Cooling Degree Days at Hour X (month8_cool_hourX)		
Hour	coef	stderr	tval	coef	stderr	tval	coef	stderr	tval	coef	stderr	tval	coef	stderr	tval
1	0.091491	0.037938	2.411567	0.004049	0.000767	5.278943	-0.083149	0.049212	-1.689614	-0.067827	0.032698	-2.074339	-0.127517	0.036108	-3.531579
2	0.006501	0.037583	0.172971	0.00263	0.000794	3.310132	-0.024373	0.049273	-0.494658	0.038759	0.032702	1.185225	-0.024057	0.036098	-0.66642
3	-0.003583	0.037563	-0.095391	0.001993	0.000839	2.373954	-0.00213	0.04942	-0.043106	0.027014	0.032797	0.823683	-0.00707	0.036202	-0.195295
4	0.036753	0.037592	0.977705	0.001209	0.000892	1.354431	-0.047337	0.049843	-0.949716	-0.020507	0.032965	-0.622097	-0.040974	0.036387	-1.126065
5	0.007605	0.037633	0.20209	0.001576	0.000959	1.643176	-0.011918	0.050135	-0.237714	0.00349	0.03306	0.10555	-0.010742	0.036672	-0.292921
6	-0.008931	0.037799	-0.236278	0.001205	0.001105	1.090175	0.009014	0.050386	0.17889	0.010242	0.033186	0.308619	0.006509	0.036906	0.176379
7	-0.004518	0.037401	-0.120793	0.000719	0.001177	0.610604	0.002089	0.049888	0.041882	0.002922	0.032929	0.088741	0.002332	0.036673	0.063592
8	0.057497	0.03758	1.529991	0.002989	0.00105	2.846939	-0.078689	0.049349	-1.594539	-0.038348	0.03295	-1.163835	-0.055231	0.036488	-1.513676
9	0.029068	0.038263	0.759677	0.004831	0.000957	5.045413	-0.104469	0.049154	-2.125315	-0.007304	0.032948	-0.221679	-0.050414	0.036304	-1.388675
10	0.111667	0.03905	2.859578	0.00085	0.00089	0.955671	-0.127493	0.049108	-2.596187	-0.025256	0.032876	-0.768237	-0.100224	0.036181	-2.770111
11	0.111008	0.040025	2.773429	-6.51E-05	0.000906	-0.071854	-0.11075	0.049077	-2.256657	0.017504	0.03281	0.533497	-0.096997	0.036082	-2.688289
12	0.095444	0.040921	2.33237	0.002354	0.000894	2.633754	-0.13531	0.048999	-2.761482	-0.045942	0.032728	-1.403742	-0.142177	0.036002	-3.949109
13	0.084663	0.041576	2.03633	0.003341	0.000868	3.850344	-0.129898	0.048933	-2.654603	-0.023806	0.03269	-0.728252	-0.170968	0.035958	-4.754615
14	0.197947	0.041598	4.758561	0.003468	0.000823	4.213271	-0.206091	0.048891	-4.215317	-0.095349	0.03268	-2.917657	-0.281332	0.035954	-7.824801
15	0.311185	0.041785	7.44732	0.000661	0.000818	0.808114	-0.239353	0.048887	-4.895998	-0.125814	0.032711	-3.846182	-0.334739	0.035977	-9.304129
16	0.320978	0.041847	7.670314	0.001223	0.00077	1.589832	-0.2399	0.048889	-4.907002	-0.125708	0.032736	-3.840014	-0.353019	0.035975	-9.812946
17	0.208993	0.042405	4.928543	0.001184	0.000778	1.520726	-0.160691	0.048898	-3.286226	0.009466	0.032756	0.288996	-0.248856	0.035969	-6.918552
18	0.325024	0.043776	7.424643	0.000365	0.000852	0.428102	-0.21168	0.048949	-4.324511	-0.080932	0.032729	-2.472781	-0.342242	0.035959	-9.517476
19	0.292382	0.043745	6.683738	-0.000677	0.000901	-0.750679	-0.139484	0.048929	-2.850721	-0.036887	0.032745	-1.126508	-0.273853	0.035967	-7.614096
20	0.258301	0.042465	6.082716	-0.001769	0.00093	-1.901735	-0.131655	0.048891	-2.692844	-0.01679	0.032836	-0.511324	-0.24322	0.036019	-6.752634
21	0.162686	0.042014	3.872192	0.002811	0.000984	2.857685	-0.159629	0.048914	-3.263465	-0.015766	0.032782	-0.480933	-0.223668	0.035984	-6.215781
22	0.100647	0.041329	2.435274	0.003234	0.000991	3.264007	-0.07974	0.04906	-1.62535	-0.013289	0.0327	-0.406405	-0.185955	0.035956	-5.171696
23	0.166324	0.040429	4.113946	0.000541	0.001003	0.539441	-0.117075	0.049111	-2.383909	-0.024121	0.032691	-0.737824	-0.178131	0.035962	-4.95335
24	0.065791	0.038674	1.701187	0.002428	0.000919	2.642684	-0.035123	0.049015	-0.716579	-0.005929	0.032696	-0.181332	-0.115041	0.035961	-3.199077

	September-Blended Cooling Degree at Hour X (month9_cool_hourX)			October-Blended Cooling Degree at Hour X (month10_cool_hourX)			Monday Cooling Degree Days at Hour X (weekday1_cool_hourX)			Tuesday Cooling Degree Days at Hour X (weekday2_cool_hourX)			Wednesday Cooling Degree Days at Hour X (weekday3_cool_hourX)		
Hour	coef	stderr	tval	coef	stderr	tval	coef	stderr	tval	coef	stderr	tval	coef	stderr	tval
1	-0.140825	0.035132	-4.008513	-0.117673	0.038855	-3.028538	-0.006621	0.010792	-0.613477	-0.008217	0.013154	-0.624673	0.03738	0.013685	2.731477
2	-0.029601	0.035148	-0.842174	-0.013487	0.038899	-0.34673	-0.006652	0.010803	-0.615712	-0.004404	0.013148	-0.334948	0.010604	0.013687	0.774727
3	-0.012409	0.035226	-0.352269	0.002134	0.039164	0.054484	0.000733	0.010816	0.067746	-0.006793	0.013149	-0.516605	0.00549	0.013691	0.400976
4	-0.041354	0.035413	-1.167768	-0.036692	0.039489	-0.929157	-0.0027	0.01088	-0.248143	-0.003903	0.013149	-0.296816	-0.000954	0.013687	-0.069696
5	-0.013465	0.03552	-0.379094	-0.005685	0.039589	-0.143605	-0.001609	0.010849	-0.148274	-0.001664	0.01315	-0.126544	-0.004003	0.013701	-0.292153
6	0.004803	0.035673	0.134631	0.009686	0.039777	0.243512	-0.002079	0.010763	-0.193123	-0.001905	0.013163	-0.14473	-0.000897	0.013723	-0.065344
7	0.001273	0.035497	0.035864	0.003106	0.039293	0.079044	-0.00066	0.010744	-0.061386	0.000295	0.013168	0.022436	0.000422	0.013719	0.030733
8	-0.057531	0.035514	-1.61995	-0.047367	0.039455	-1.200541	-0.016829	0.010758	-1.564258	-0.000895	0.013233	-0.067635	-0.01236	0.013731	-0.900142
9	-0.048356	0.035456	-1.363828	-0.019604	0.039883	-0.491543	-0.024821	0.010715	-2.316354	0.014185	0.013233	1.071932	-0.008502	0.013866	-0.613196
10	-0.09508	0.03527	-2.695787	-0.093396	0.039401	-2.370374	-0.020583	0.010708	-1.922117	-0.032271	0.013176	-2.449231	-0.030276	0.013859	-2.184623
11	-0.09645	0.035162	-2.743001	-0.105986	0.039047	-2.71431	-0.007684	0.010764	-0.713881	-0.025442	0.013154	-1.934199	0.011748	0.01384	0.848827
12	-0.156076	0.035079	-4.449205	-0.141837	0.038763	-3.65905	0.011787	0.010727	1.098834	0.003437	0.013152	0.261306	0.039115	0.013855	2.823078
13	-0.159527	0.035068	-4.549131	-0.147551	0.038595	-3.823012	-0.004981	0.010727	-0.464386	0.005152	0.013149	0.391864	0.012811	0.013833	0.926112
14	-0.260574	0.0351	-7.423701	-0.250297	0.038414	-6.515811	-0.038202	0.010757	-3.551288	-0.034038	0.013163	-2.585803	-0.011965	0.013755	-0.869917
15	-0.311935	0.035175	-8.868089	-0.323225	0.038287	-8.442066	-0.024551	0.010774	-2.278617	-0.030014	0.013169	-2.279053	0.021616	0.01375	1.572129
16	-0.336047	0.035159	-9.557949	-0.341031	0.038315	-8.900611	-0.023721	0.010737	-2.209238	-0.032547	0.013166	-2.472088	-0.003324	0.013741	-0.241935
17	-0.225646	0.035138	-6.421652	-0.235318	0.03835	-6.136002	-0.019098	0.010712	-1.782806	-0.009049	0.013155	-0.687862	-0.004693	0.013761	-0.341021
18	-0.319411	0.035129	-9.092455	-0.337298	0.038491	-8.762914	-0.014145	0.010697	-1.322383	-0.010154	0.013153	-0.772012	0.014234	0.013833	1.028976
19	-0.256456	0.035131	-7.299907	-0.282493	0.038549	-7.328185	-0.019194	0.010694	-1.7949	-0.026313	0.013148	-2.001263	0.008407	0.013886	0.605431
20	-0.218299	0.035164	-6.20796	-0.245579	0.038537	-6.372488	0.011409	0.0107	1.06627	0.011316	0.013148	0.860654	-0.002213	0.013923	-0.15892
21	-0.212992	0.035096	-6.068787	-0.210166	0.038526	-5.455106	-0.016246	0.010695	-1.519023	-0.019353	0.013149	-1.471861	0.009472	0.014004	0.676367
22	-0.166932	0.035069	-4.760047	-0.157188	0.038657	-4.066276	0.006292	0.010689	0.588671	0.003465	0.013149	0.26354	0.025137	0.014069	1.786733
23	-0.160444	0.03508	-4.573667	-0.16816	0.038707	-4.344395	-0.014762	0.010687	-1.381299	-0.005792	0.01315	-0.440478	-0.003688	0.014226	-0.259212
24	-0.101204	0.035076	-2.885241	-0.099071	0.038493	-2.573769	0.006055	0.010691	0.566335	0.021996	0.013151	1.672664	0.018286	0.014086	1.298126

	Thursday Cooling Degree Days at Hour X (weekday4_cool_hourX)			Friday Cooling Degree Days at Hour X (weekday5_cool_hourX)			Hourly Relative Humidity (humi)		
Hour	coef	stderr	tval	coef	stderr	tval	coef	stderr	tval
1	-0.002034	0.01338	-0.152043	-0.008707	0.012256	-0.710445	0.000241	0.000222	1.082717
2	-0.00591	0.013364	-0.442203	-0.003941	0.012274	-0.321086			
3	-0.007761	0.01337	-0.58049	-0.004543	0.012307	-0.36915			
4	-0.002305	0.013344	-0.172772	-0.010012	0.01239	-0.808085			
5	-0.004473	0.013355	-0.334901	-0.00691	0.012447	-0.555206			
6	-0.000959	0.013391	-0.071639	-0.000158	0.012446	-0.012711			
7	0.000531	0.013408	0.0396	0.001931	0.012458	0.154983			
8	-0.011246	0.013439	-0.836872	-0.01439	0.01241	-1.159568			
9	-0.011004	0.013506	-0.814774	-0.008726	0.012295	-0.709737			
10	-0.038596	0.013501	-2.858855	-0.041696	0.012302	-3.389434			
11	-0.023487	0.013442	-1.747256	-0.044335	0.012303	-3.603581			
12	0.009368	0.013449	0.696569	0.00053	0.012229	0.043314			
13	0.009572	0.013442	0.71208	-0.009399	0.012188	-0.771156			
14	-0.016626	0.013398	-1.240948	-0.012495	0.012196	-1.024505			
15	-0.015862	0.013387	-1.184861	-0.002395	0.01219	-0.19646			
16	-0.01298	0.013387	-0.969575	-0.021433	0.012203	-1.756307			
17	-0.00103	0.013437	-0.076644	-0.0284	0.01219	-2.329753			
18	-0.007657	0.01346	-0.568889	-0.030355	0.012161	-2.496027			
19	0.021462	0.013428	1.598277	-0.036629	0.012158	-3.012805			
20	0.039858	0.01341	2.972201	0.007575	0.012162	0.622869			
21	0.017698	0.013376	1.323178	-0.033333	0.01216	-2.741163			
22	0.009742	0.013355	0.729501	0.002411	0.012183	0.197861			
23	-0.014982	0.01336	-1.121409	-0.010251	0.012163	-0.842817			
24	0.005028	0.01336	0.376366	0.002012	0.012162	0.165414			

name	cool_daily_hour17	cool_lag_hour17	month6_cool_hour17	month7_cool_hour17	month8_cool_hour17	month9_cool_hour17	month10_cool_hour17	weekday1_cool_hour17	weekday2_cool_hour17	weekday3_cool_hour17	weekday4_cool_hour17	weekday5_cool_hour17
Cooling Degree Days at Hour 17 (cool_daily_hour17)	0.001798	-1.69E-05	-0.001672	-0.0010699	-0.0012186	-0.0011513	-0.0013142	-0.0001158	-0.0001148	-0.0001483	-0.000145	-0.0001224
Lagged Cooling Degree Day at Hour 17 (cool_lag_hour17)	-1.69E-05	6.06E-07	8.532E-07	-1.737E-06	-8.485E-07	-1.764E-06	2.503E-06	-5.884E-07	-3.382E-07	1.201E-06	1.253E-06	-6.947E-07
June-Blended Cooling Degree Days at Hour 17 (month6_cool_hour17)	-0.001672	8.53E-07	0.0023911	0.0014246	0.0016432	0.0015768	0.0016387	5.841E-05	4.156E-05	4.039E-05	4.337E-05	8.532E-05
July-Blended Cooling Degree Days at Hour 17 (month7_cool_hour17)	-0.00107	-1.74E-06	0.0014246	0.0010729	0.001093	0.001086	0.0010982	4.41E-05	3.194E-05	2.607E-05	1.935E-05	4.819E-05
August-Blended Cooling Degree Days at Hour 17 (month8_cool_hour17)	-0.001219	-8.49E-07	0.0016432	0.001093	0.0012938	0.0011751	0.0012318	5.116E-05	4.547E-05	3.105E-05	2.428E-05	5.457E-05
September-Blended Cooling Degree at Hour 17 (month9_cool_hour17)	-0.001151	-1.76E-06	0.0015768	0.001086	0.0011751	0.0012347	0.0011546	4.201E-05	4.234E-05	2.283E-05	1.698E-05	5.665E-05
October-Blended Cooling Degree at Hour 17 (month10_cool_hour17)	-0.001314	2.5E-06	0.0016387	0.0010982	0.0012318	0.0011546	0.0014707	5.339E-05	3.751E-05	2.459E-05	2.546E-05	7.003E-05
Monday Cooling Degree Days at Hour 17 (weekday1_cool_hour17)	-0.000116	-5.88E-07	5.841E-05	4.41E-05	5.116E-05	4.201E-05	5.339E-05	0.0001148	8.686E-05	8.477E-05	8.452E-05	8.786E-05
Tuesday Cooling Degree Days at Hour 17 (weekday2_cool_hour17)	-0.000115	-3.38E-07	4.156E-05	3.194E-05	4.547E-05	4.234E-05	3.751E-05	8.686E-05	0.0001731	8.499E-05	8.413E-05	8.647E-05
Wednesday Cooling Degree Days at Hour 17 (weekday3_cool_hour17)	-0.000148	1.2E-06	4.039E-05	2.607E-05	3.105E-05	2.283E-05	2.459E-05	8.477E-05	8.499E-05	0.0001894	8.846E-05	8.363E-05
Thursday Cooling Degree Days at Hour 17 (weekday4_cool_hour17)	-0.000145	1.25E-06	4.337E-05	1.935E-05	2.428E-05	1.698E-05	2.546E-05	8.452E-05	8.413E-05	8.846E-05	0.0001805	8.44E-05
Friday Cooling Degree Days at Hour 17 (weekday5_cool_hour17)	-0.000122	-6.95E-07	8.532E-05	4.819E-05	5.457E-05	5.665E-05	7.003E-05	8.786E-05	8.647E-05	8.363E-05	8.44E-05	0.0001486
Hourly Relative Humidity (humi)	-2.45E-07	4.69E-09	7.747E-08	3.747E-08	4.952E-08	4.348E-08	2.822E-08	9.464E-10	-2.625E-09	-8.137E-09	-3.862E-10	5.395E-09

Appendix H. Electronic Appendices

This report includes the following electronic appendices:

Ex post estimates FINAL SmartAC 2008 ex post impacts per AC unit.xls

This file contains ex post estimates for 19 events conducted in 2008 and an average, per AC unit (kW) and for all program participants (MW), for the following groups:

- Program Level
- Control: Switch
- Control: PCT
- LCA: Greater Bay Area
- LCA: Greater Fresno
- LCA: Stockton
- Year Built: pre-1975
- Year Built: 1975 to 1995
- Year Built: post-1995
- SQFT: 1000 to 2000
- SQFT: 2000 to 5000
- Climate Zone R
- Climate Zone S
- Climate Zone X
- Ramp (not available for all days)

Ex ante estimates FINAL SmartAC 2008 ex ante impacts per SAID.xls

This file contains ex ante estimates for 6 peaks and an average, per premise (equivalent to SAID), for combinations of the following groups:

- Climate Zone
- Year type (1-in-2 and 1-in-10)
- Device type (Switch or PCT)

Tool to compare the effect of two types of thermostat control and adaptive switch control

SmartAC 2008 Ramp Vs Cycling worksheet.xls

This tool was provided to illustrate theoretical examples of the circumstances when thermostats utilizing a ramped temperature set-back may achieve higher load impacts than adaptive and legacy switches.

SAS files with results of individual regressions, supplied in compliance of Protocol 10

SmartAC load impact 2008 kw_model_stats.sas7bdat
SmartAC load impact 2008 kw_model_coef.sas7bdat
SmartAC load impact 2008 kw_model_varcov.sas7bdat

Ex Post load impact tables PG&E SmartAC 2008 Ex Post Tables.doc

A total of 200 tables dictated by the Protocols, for the combinations of:

- SmartAC Program and each of four Load Control Areas
- Each of 19 events and an annual average
- Unit and Population estimates