REPORT

2019 Load Impact Evaluation of San Diego Gas and Electric's AC Saver Day Of Program

Prepared for:
San Diego Gas and Electric Company Co. (SDG&E)

Prepared by:
Candice A. Potter, *Principal*
George Jiang, *Managing Consultant*
Robert Gottlieb, *Project Analyst*

CALMAC Study ID SDG0323
April 1, 2020

Contents

1 Executive Summary

San Diego Gas and Electric Company's (SDG&E) AC Saver Day Of program is a demand response resource based on central air conditioner (CAC) load control that is implemented through an agreement between SDG&E and Itron, Inc. AC Saver Day Of was previously marketed to SDG&E customers as the Summer Saver program. The program name changed to AC Saver Day Of in 2018. This report provides ex post load impact estimates for the 2019 AC Saver Day Of program and ex ante load impact forecasts for 2020–2030.

The AC Saver Day Of program is available to residential and commercial customers with average monthly peak demand up to a maximum of 100 kW over a 12-month period. There are two enrollment options each for both residential and commercial customers. Residential customers can choose between 50% or 100% cycling and commercial customers can choose between 30% and 50% cycling. The incentive paid for each option varies and is based on the number of CAC tons under control at each premise. The AC Saver Day Of season runs from April 1 through October 31. An AC Saver Day Of event may be triggered by temperature or system load conditions and customers are not automatically notified when an event occurs; however, customers can sign up to receive event notification.

At the end of 2019, there were 13,724 customers enrolled in the program with a total cooling capacity of 73,449 tons. This represents a significant decrease in enrolled customers (11%) and cooling tons (12%) relative to 2018. For the 2019 program year, residential customers represented approximately 72% of AC Saver Day Of participants and accounted for about 54% of the program's total cooling tons. Among residential participants, 36% selected the highest cycling option (100% cycling); among commercial participants, 78% selected the 50% cycling option over the 30% option.

A total of 20 regular program events were called in 2019 with event hours ranging between 4 and 9 PM. Three of these events were called on weekends. Event hours varied but the most common event period was 6 to 8 PM, which comprised 12 of the 20 events. The event period from 6 to 8 PM is used for reporting Average Event Day load impacts. Ex post load impacts are estimated using two approaches—a randomized control trial (RCT) design for a sample of residential customers and a statistically-matched control group for the commercial customers. Table 1-1 shows the overall 2019 AC Saver Day Of residential ex post load impacts and event window temperatures. The average aggregate demand reduction for residential customers totaled 0.91 MW, and the largest load reduction was 1.7 MW on the September 6 event. As shown in Table 1-2, the aggregate load reduction for commercial customers on the Average Event Day was roughly 0.33 MW, or 0.09 kW per premise. The largest load reduction for commercial customers totaled 0.66 MW and occurred on the August 6 event.

Table 1-1: 2019 AC Saver Day Of Average Residential Ex Post Load Impacts

Date	Impact				Average Event Temperature (°F)
	per Ton (kW)	per CAC Unit (kW)	per Premise (kW)	Aggregate (MW)	
6/10/2019	0.01	0.02	0.03	0.20	73
6/23/2019	0.00	0.00	0.00	-0.02	67
7/12/2019	0.02	0.06	0.07	0.56	77
7/22/2019	0.02	0.07	0.08	0.69	77
7/23/2019	0.03	0.12	0.14	1.12	84
7/24/2019	0.03	0.12	0.14	1.12	80
7/29/2019	0.03	0.10	0.11	0.93	77
8/4/2019	0.04	0.13	0.15	1.15	78
8/5/2019	0.03	0.11	0.13	1.00	78
8/6/2019	0.02	0.06	0.07	0.52	74
8/11/2019	0.00	0.02	0.02	0.15	69
8/14/2019	0.03	0.11	0.12	0.97	79
8/15/2019	0.03	0.09	0.10	0.79	76
8/26/2019	0.05	0.16	0.18	1.40	81
8/27/2019	0.04	0.13	0.15	1.12	77
9/4/2019	0.05	0.16	0.18	1.44	84
9/5/2019	0.05	0.19	0.21	1.68	84
9/6/2019	0.05	0.19	0.21	1.69	83
10/21/2019	0.00	0.01	0.01	0.11	80
10/22/2019	0.01	0.03	0.04	0.29	83
Average*	**0.03**	**0.10**	**0.11**	**0.91**	**78**

* Reflects the average 6-8 PM weekday 2019 AC Saver Day of event

Table 1-2: 2019 AC Saver Day Of Average Commercial Ex Post Load Impacts

Date	Impact				Average Event Temperature (°F)
	per Ton (kW)	per CAC Unit (kW)	per Premise (kW)	Aggregate (MW)	
6/10/2019	0.01	0.04	0.10	0.36	71
6/23/2019	0.01	0.02	0.05	0.19	67
7/12/2019	0.00	0.01	0.02	0.09	75
7/22/2019	0.02	0.06	0.15	0.55	76
7/23/2019	0.02	0.06	0.14	0.54	83
7/24/2019	0.00	0.01	0.03	0.10	80
7/29/2019	0.00	0.02	0.04	0.16	76
8/4/2019	0.01	0.03	0.07	0.25	76
8/5/2019	0.01	0.05	0.12	0.44	76
8/6/2019	0.02	0.08	0.18	0.66	74
8/11/2019	0.00	0.00	-0.01	-0.04	69
8/14/2019	0.01	0.04	0.09	0.34	77
8/15/2019	0.01	0.03	0.07	0.25	75
8/26/2019	0.01	0.06	0.13	0.49	79
8/27/2019	0.01	0.03	0.06	0.24	76
9/4/2019	0.02	0.07	0.17	0.64	83
9/5/2019	0.02	0.06	0.14	0.51	83
9/6/2019	0.02	0.06	0.13	0.49	82
10/21/2019	0.01	0.02	0.05	0.20	80
10/22/2019	0.01	0.06	0.13	0.48	83
Average*	**0.01**	**0.04**	**0.09**	**0.33**	**77**

* Reflects the average 6-8 PM weekday 2019 AC Saver Day of event

Ex ante load impacts are intended to represent weather conditions under normal (1-in-2 year) and extreme (1-in-10 year) conditions, defined for two scenarios: one representing weather conditions expected when the SDG&E system peaks and another representing weather conditions when the California Independent System Operator (CAISO) system peaks.

In 2020, on a typical event day under 1-in-2 year SDG&E-specific peaking conditions, aggregate load impacts are forecasted to equal 1.2 MW for residential customers and 0.5 MW for commercial customers, for a total program load reduction of 1.7 MW. Based on ex post results, it is established that AC Saver Day Of load impacts increase with temperature. In the ex ante forecasts, the largest impacts are observed on the September monthly system peak days when the temperature scenarios are the hottest. In 2020, under 1-in-10 year SDG&E-specific peaking conditions, estimated impacts on the typical event day are forecasted to equal 1.9 MW and 0.6 MW for residential and commercial customers, respectively, or 2.5 MW in total. This is about 50% greater than on a typical event day under 1-in-2 year weather conditions. As in the case of ex post load impacts, the ex ante load impacts are lower in this evaluation relative to the prior load impact evaluation. In the case of the residential segment, August 2020 enrollments are forecasted to be 7,272 participants this year, but last year the forecast for August 2020 was 9,024 customers. In the case of the commercial segments, ex ante load impacts are somewhat lower as well, also influenced by a decline in the number of expected customers.

2 Introduction and Program Summary

San Diego Gas and Electric Company's (SDG&E) AC Saver Day Of program is a demand response resource based on central air conditioner (CAC) load control that is implemented through an agreement between SDG&E and Itron, Inc.[1] This report provides 2019 ex post load impact estimates and ex ante load impact estimates for an 11-year forecast horizon (2020–2030) as required by the California Public Utilities Commission (CPUC) Load Impact Protocols.[2]

The AC Saver Day Of program is classified as a day-of demand response program and is available to both residential and commercial customers, where eligible commercial customers are subject to a demand limit: only those commercial customers with average monthly peak demand up to a maximum of 100 kW over a 12-month period may participate. AC Saver Day Of events may only be called during the months of April through October. Under the current program, load control events may not run for more than four hours. Participants' air conditioners cannot be cycled less than two hours and no more than four consecutive hours in any event day and events can be triggered up to 80 hours per year, 24 hours per month, and three consecutive days at maximum. Load control events can occur on weekends but not on holidays and cannot be called more than three days in any calendar week. These program rules apply to both residential and commercial customers alike.

Relatively new to the program design is the current program event triggering mechanism. Previously, an event was triggered by system conditions, specifically when day-ahead forecasted system load reaches 4,000 MW. Under program design changes that took place in 2017, event triggers vary by month. During the program operational season, an AC Saver Day Of event can be triggered by any of the following criteria:

- Generator heat rates reaching or exceeding 35,000 Btu[3] per kWh in April, May, June, or October; or 25,000 Btu per kWh in July, August, or September;
- Imminent statewide or local emergencies, extreme conditions, and/or local distribution needs; or
- Upon the award of a bid into the California Independent System Operator (CAISO) wholesale market.

AC Saver Day Of events may be called between noon and 9 PM, and each event may last from two to four hours in duration. Prior to 2017, an AC Saver Day Of event could be called between noon and 8 PM, and each event could last one to four hours.

---

[1] AC Saver Day Of was previously marketed to SDG&E customers as the Summer Saver program. The program name changed to AC Saver Day Of in 2018.

[2] See CPUC Rulemaking 07-01-041 Decision (D.) 08-04-050, "Adopting Protocols for Estimating Demand Response Load Impacts" and Attachment A, "Protocols."

[3] British thermal unit, defined as the amount of heat required to raise the temperature of one pound of water by one degree Fahrenheit.

There are two enrollment options for both residential and commercial participants. Residential customers can choose to have their CAC units cycled 50% or 100% of the time during an event. The incentive paid for each option varies: the 50% cycling option pays $10.35 per ton per year of CAC capacity and the 100% cycling option pays $27 per ton per year. A residential customer with a four-ton CAC unit would be paid the following in the form of an annual credit on their SDG&E bill:

- $41.40 for 50% cycling; or
- $108 for 100% cycling.

Commercial customers have the option of choosing 30% or 50% cycling. The incentive payment for 30% cycling is $4.50 per ton per year and $7.50 per ton per year for the 50% cycling option. A commercial customer with five tons of air conditioning would be paid the following in the form of an annual credit on their SDG&E bill:

- $22.50 for 30% cycling; or
- $37.50 for 50% cycling.

Enrollment in the AC Saver Day Of program as of October 2019 is summarized in Table 2-1. Total enrollment—as measured by number of customers, number of devices, and CAC capacity (in tons)—has decreased since 2017 due to the program change to drop residential program participants with a net energy metering (NEM) agreement with SDG&E, as well as minimal marketing for the program. As of October 2019, there were 13,724 customers enrolled in the program, which in aggregate represents 73,449 tons of CAC capacity. This represents about a 12% decrease in enrolled customers and in enrolled tons relative to 2018. For the 2019 program year, residential customers represented approximately 72% of AC Saver Day Of participants and accounted for about 54% of the program's total cooling tons. About 64% of residential customers selected the 50% cycling option and approximately 22% of commercial customers chose the 30% cycling option, which represent the lower of the two cycling strategies offered to those customer segments. After five years of declining enrollment in the percentage of residential customers taking the 100% cycling option, in 2019 it held steady at 36%, compared to 35% in 2018. The same trend has been observed among commercial customers selecting the 50% option, with 79% of customers in 2019, compared to 79% in 2018.

Table 2-1: AC Saver Day Of Enrollment – October 2019

Customer Type	Cycling Option	Enrolled Customers	Enrolled Control Devices	Enrolled Tons
Commercial	30%	833	2,402	9,164
	50%	3,031	6,565	24,757
	Total	3,864	8,967	33,920
Residential	50%	6,341	7,206	24,755
	100%	3,519	4,158	14,774
	Total	9,860	11,364	39,529
Grand Total		**13,724**	**20,331**	**73,449**

2.1 Report Structure

The remainder of this report is organized as follows: 3 summarizes the data and methods that were used to develop ex post and ex ante load impact estimates and the validation tests that were applied to assess their accuracy. 4 contains the ex post load impact estimates. 5 presents the ex ante estimates and also provides details concerning the differences between the 2019 and the 2018 ex ante load impacts—in addition to differences between ex post and ex ante load impacts.

3 Data and Methodology

This section describes the datasets and analysis methods used to estimate load impacts for each event in 2019 and for ex ante weather and event conditions. Ex post results were calculated using control and treatment groups. The residential segment was evaluated with an RCT framework. With random assignment to treatment and control status and reasonably large sample sizes (approximately 1,600 residential participants), any differences in the average hourly electric loads of the treatment and control groups may be interpreted as being caused by AC Saver Day Of load control and representing an unbiased estimate of the effect of the program's load control devices' operations. In the case of the commercial segment, most of the commercial program participants were statistically matched to a control group of nonparticipants. Separate models are run for the residential and nonresidential segments. For residential customers, the ex post load impact estimates from 2018 and 2019 were used to estimate models relating temperature to load reductions that were then used in conjunction with ex ante weather data to predict ex ante load impacts. Only certain events with particular event hours were used to estimate the relationship between temperature and load reductions. Similarly, for commercial customers, the average load impacts from 2018 and 2019 were used to estimate models relating temperature to load reductions that were then used in conjunction with ex ante weather data to predict ex ante load impacts. A more detailed discussion is provided in Section 3.3.

3.1 Data

A total of 20 AC Saver Day Of events were called in 2019. Table 3-1 shows the date, day of week, and start and end times for each event. It also identifies if an event occurred during the weekend. All residential and commercial participants were called for each event, except for the residential control group customers that were held back for measurement and evaluation purposes. The event hours varied from 4 to 9 PM across the events in 2019.

Table 3-1: Summary of 2019 AC Saver Day Of Events

Date	Day of Week	Start Time	End Time	Weekend Event
6/10/2019	Monday	7:00 PM	9:00 PM	
6/23/2019	Sunday	7:00 PM	9:00 PM	X
7/12/2019	Friday	6:00 PM	8:00 PM	
7/22/2019	Monday	6:00 PM	8:00 PM	
7/23/2019	Tuesday	5:00 PM	8:00 PM	
7/24/2019	Wednesday	6:00 PM	8:00 PM	
7/29/2019	Monday	6:00 PM	8:00 PM	
8/4/2019	Sunday	6:00 PM	8:00 PM	X
8/5/2019	Monday	6:00 PM	8:00 PM	
8/6/2019	Tuesday	6:00 PM	8:00 PM	
8/11/2019	Sunday	7:00 PM	9:00 PM	X
8/14/2019	Wednesday	6:00 PM	8:00 PM	
8/15/2019	Thursday	6:00 PM	8:00 PM	
8/26/2019	Monday	6:00 PM	8:00 PM	
8/27/2019	Tuesday	6:00 PM	8:00 PM	
9/4/2019	Wednesday	4:00 PM	7:00 PM	
9/5/2019	Thursday	5:00 PM	8:00 PM	
9/6/2019	Friday	6:00 PM	8:00 PM	
10/21/2019	Monday	6:00 PM	8:00 PM	
10/22/2019	Tuesday	5:00 PM	8:00 PM	

Table 3-2 shows the distribution of CAC tonnage by cycling option and climate zone for the residential participant population as of October 2019. Due to the small populations of participants in in Climate Zones 2 and 3, they were combined into Climate Zones 1 and 4, respectively, for the purposes of this evaluation.

Table 3-2: Distribution of CAC Tonnage by Program Option and Climate Zone 2019 Residential Population

Group	Cycling Option	Climate Zone 1	Climate Zone 2	Climate Zone 3	Climate Zone 4	Total
Commercial	30%	13%	0.2%	0%	13%	27%
	50%	37%	0.3%	0%	35%	73%
	Total	**51%**	**0.5%**	**0%**	**49%**	**100%**
Residential	50%	7%	0.8%	0.04%	54%	63%
	100%	9%	0.3%	0.03%	28%	37%
	Total	**17%**	**1.1%**	**0.07%**	**82%**	**100%**

3.2 Methodology

The primary task in developing ex post load impacts is to estimate the reference load for each event. The reference load represents the counterfactual—a measure of what participant demand would have been in the absence of CAC cycling during an event. The primary task in estimating ex ante load impact forecasts—which is often of more practical concern—is to make the best use of historical data on loads and load impacts to predict future program performance. The data and models used to estimate ex post impacts are typically the key inputs to the ex ante analysis.

Two distinct approaches were used for estimating the ex post reference loads: a randomized controlled trial (RCT) design and a statistical matching design. Residential customer impacts were estimated using an RCT. The commercial customer impacts were estimated with a matching study. Under the RCT, random samples of residential AC Saver Day Of customers were selected from each cycling strategy. During each event, half of the control group sample did not have their CAC units cycled so that these customers could be used to provide a reference load for those who did have their units cycled. Under the matching design, a matched control was selected for all of the commercial AC Saver Day Of program participants. This approach was chosen for the commercial segment due to the smaller size of the program population and the larger relative effect of holding back a control group from program dispatch, compared to the residential segment.

3.2.1 Ex Post Methodology

3.2.1.1 RCT Framework

An RCT is a research approach in which customers are randomly assigned to treatment and control conditions so that the only difference between the two groups, other than random chance, is the existence of the treatment condition. In this context, roughly 1,600 customers in the residential sample served as the control group for each event while the remaining participants had their CAC units cycled. The group acting as the control group alternated from month to month throughout the course of the summer of 2019. This design has significant advantages in providing fast, reliable impact estimates if sample sizes are large enough.

3.2.1.2 Statistical Matching Framework

Consistent with the methodology used since the 2015 AC Saver Day Of evaluation, a matched control group was selected for the commercial program population whereby one nonparticipant was selected as a match for each participant on each event. The entire SDG&E small and medium business (SMB) customer population was made available for the statistical matching analysis. Each matched customer was chosen because they most closely resembled their matched participant in terms of the dissimilarity statistic described in Equation 3-1. The dissimilarity statistic measures how similar each match candidate is to any given participant customer based on how well (or not) their energy usage characteristics match those of the participant on both the event day and other hot non-event days in 2019, called proxy days. The characteristics used in the dissimilarity statistic are:

- Average demand during the event window hours on the average proxy day;
- Average demand from midnight to 10 AM on the event day; and
- Average demand from 10 AM to the start of the event for each event day.

Equation 3-1: Dissimilarity Statistic for Commercial Matching

$$Dissimilarity_i = (PeakProxy_i - PeakProxy_j)^2 + (EventMorn_i - EventMorn_j)^2 + (EventMidday_i - EventMidday_j)^2$$

Variable	Definition
$PeakProxy$	Average demand across the 2019 proxy days during the event window hours
$EventMorn$	Average demand on the event day from midnight to 10 AM
$EventMidday$	Average demand on the event day from 10 AM to the start of the event
$j\ j$	Commercial AC Saver Day Of participant to be matched
i	Index of the pool of control customers

This dissimilarity statistic was chosen as the optimal metric for matching among four alternately specified metrics and following an out-of-sample testing exercise with many alternative matching models. The best metric was chosen based on pre-treatment balance measures.

Matches were chosen such that only customers in the same industry and climate zone would be matched to one another. Likewise, NEM customers were only matched to other NEM customers. This approach minimizes the differences between participants and matched nonparticipants while allowing for good subgroup estimates.

The matching process proceeds, one commercial participant at a time, by selecting the non-participant with the same industry, climate zone, and NEM status with the smallest dissimilarity statistic. Individual non-participants may be selected more than once as a matched control customer.

3.2.1.3 Load Impact Estimation

Ex post event impacts were estimated for a broad collection of program segments including customer class, cycling strategy, NEM status, climate zone, industry, and status of dual-enrollment in other pricing and demand response programs at SDG&E.

Within each of these program segments, load impacts were estimated for each hour of each event day for both RCT and matched customers using two approaches:

First, we simply calculate the difference between the average demand for those customers who were cycled (the treatment group) and those who were not (the control group). We refer to this simple difference in average hourly load as the "unadjusted" load impact.

However, since randomization and matching both can leave some residual differences between the treatment and control groups that is not due to the CAC cycling, we also estimate what we refer to as the "adjusted" load impact that takes into account the small differences between the treatment and control group usages and thereby improves the accuracy and precision of the estimate. This adjusted estimate of load impacts is determined by a lagged dependent variable (LDV) regression model.

The regression, described in Equation 3-2, essentially uses variation among the group that was not cycled to establish the relationship between the demand before the event and on proxy days and the demand during the event window and afterward. The regression can then make a prediction for all of the cycled customers based on that simple model. This is very similar to how a ratio adjustment works. A ratio adjustment multiplies event day demand for the control group by the ratio between the cycled and control demands in the hours prior to the event window. An LDV model with one variable does the same thing, but it allows the adjustment to account for differences between the cycled and control group on proxy days as well.[4]

[4] Such an LDV model would be specified as

$$Demand_i = a_2 + t_2 * Cycled_i + h_2 * PreEvent_i + u_i$$

Equation 3-2: LDV Model for Estimating Impacts

$$Demand_i = a + t * Cycled_i + b * Proxy_i + c * ProxyWindow_i + d * ProxyEve_i + e * EventMorn1_i + f * EventMorn2_i + g * EventMorn3_i + h * PreEvent_i + u_i$$

Variable	Definition
$Demand$	Average demand in the event hour being studied
$Cycled$	An indicator for whether customer *i* was cycled
$Proxy$	Average demand in the hour being studied on the average proxy day
$ProxyWindow$	Average demand in the event window on the average proxy day
$ProxyEve$	Average demand after the event window on the average proxy day
$EventMorn1$	Average demand from midnight to 7 AM on the event day
$EventMorn2$	Average demand from 7 AM to 10 AM on the event day
$EventMorn3$	Average demand from 10 AM to four hours before the event on the event day
$PreEvent$	Average demand during the four hours before the event
i	Customer index
t	Estimated impact
$a - h$	Estimated regression coefficients
u	Error term

For estimating treatment effects, as we are doing in this setting, the adjustments from the LDV only change the estimate of the treatment effect if there are differences between the group that was cycled and the group that was not cycled on proxy days or in the hours leading up to the event. These differences should be relatively small for most of the important treatment effect estimates since the matching and RCT performed well. In cases such as this, where the matching and RCT perform well, the treatment effect estimates with and without the adjustment will look similar, but the confidence intervals will be much smaller for the adjusted version because the LDV model uses the data more efficiently.

Hourly impact estimates for the residential AC Saver Day Of population were calculated by taking a weighted average of the impact estimates for each cycling option, with weights determined by the number of tons enrolled on each cycling option and enrolled within each climate zone for each cycling option.

3.2.2 Ex Post Validation Analysis

Table 3-3 compares the sample size, average CAC tonnage, and cycling option for the randomly selected test groups of residential participants for the RCT. The two groups are very similar along two of these dimensions – the average tonnage per household is about 4.1 tons, and the share of customers on 50% cycling (versus 100%) is about the same. The sample sizes differ because, due to the method by which the samples were taken, there were customers who belonged to both groups A and B. These customers were considered during the event season as if they only belonged to group A, so they have been removed from the list of group B customers in this table.

Table 3-3: 2019 Residential A and B Group Comparison Sample Size, Tonnage, and Cycling Options

Group	Sample Size	Average CAC Tonnage per Household	% of Customers on 50% Cycling
A	1,562	4.1	50%
B	1,244	4.0	54%
Total/Average	**2,806**	**4.1**	**52%**

Even though random assignment and statistical matching should produce research groups with similar characteristics, it is still important to compare the two groups based on electricity consumption when AC Saver Day Of events are not in effect. In the absence of very large samples, differences in energy consumption between the groups can still occur—due to chance in an RCT and due to a heterogeneous control pool with statistical matching. In 2019, the absolute hourly differences between residential A group and the entire population, and between residential B group and the entire population, for both cycling strategies combined during event hours on hot, nonevent days, are 4% or less. For the commercial participants, matched nonparticipants were selected from the SDG&E SMB population. The absolute hourly differences between the commercial control and treatment (i.e., AC Saver Day Of participants) groups on hot, nonevent days are less than 1% during event hours.

Figure 3-1, Figure 3-2, and Figure 3-3 illustrate these differences on twenty-six hot nonevent days in 2019. As the figures show, the two residential samples are quite similar to the overall population, and the commercial matched control customers are quite similar to the treated customers, with respect to load shape, and the closeness of the plotted lines reflects the magnitude of hourly differences summarized above. Figure 3-4, Figure 3-5, and Figure 3-6 show the comparisons of groups A and B to the overall residential population, as well as treatment and matched control commercial customers, further segmented by cycling option. At the cycling level, residential A and B groups show approximately the same level of hourly differences for each cycling option compared to the differences between non-event loads when both cycles are combined. The commercial participant and matched control groups for the 50% and 30% cycling options also show approximately the same level of error as the combined groups. These differences are comparable to the small differences observed in 2018, and the small magnitude is a result of the large sample size afforded by the matching approach.

Figure 3-1: Residential Group A and All Comparison Average Load across All 2019 Proxy Days

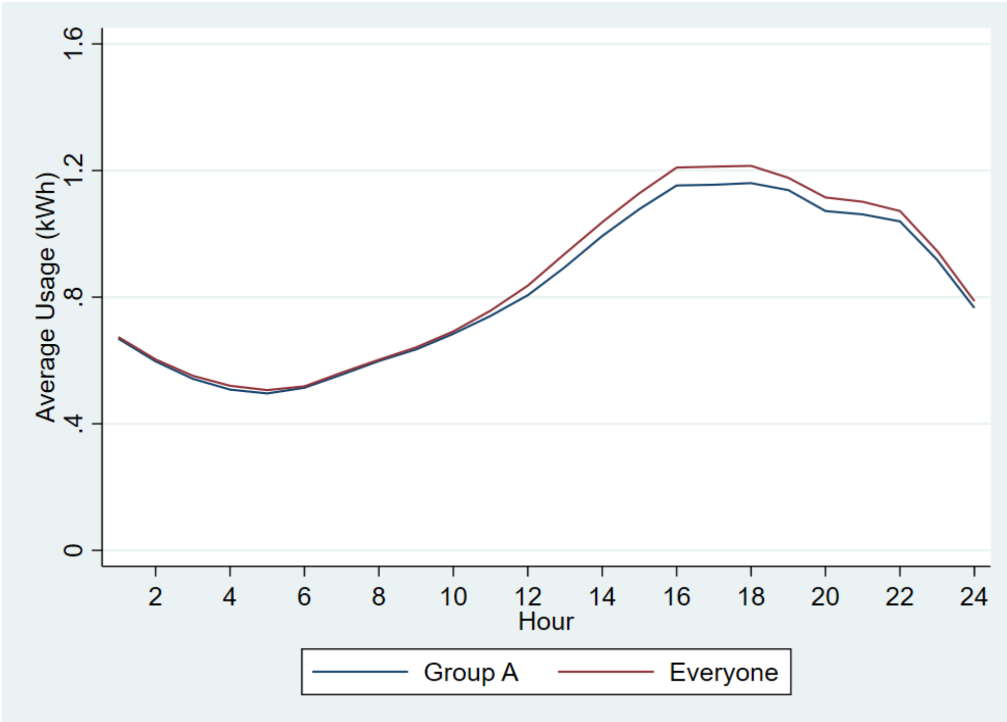


Figure 3-2: Residential Group B and All Comparison Average Load across All 2019 Proxy Days

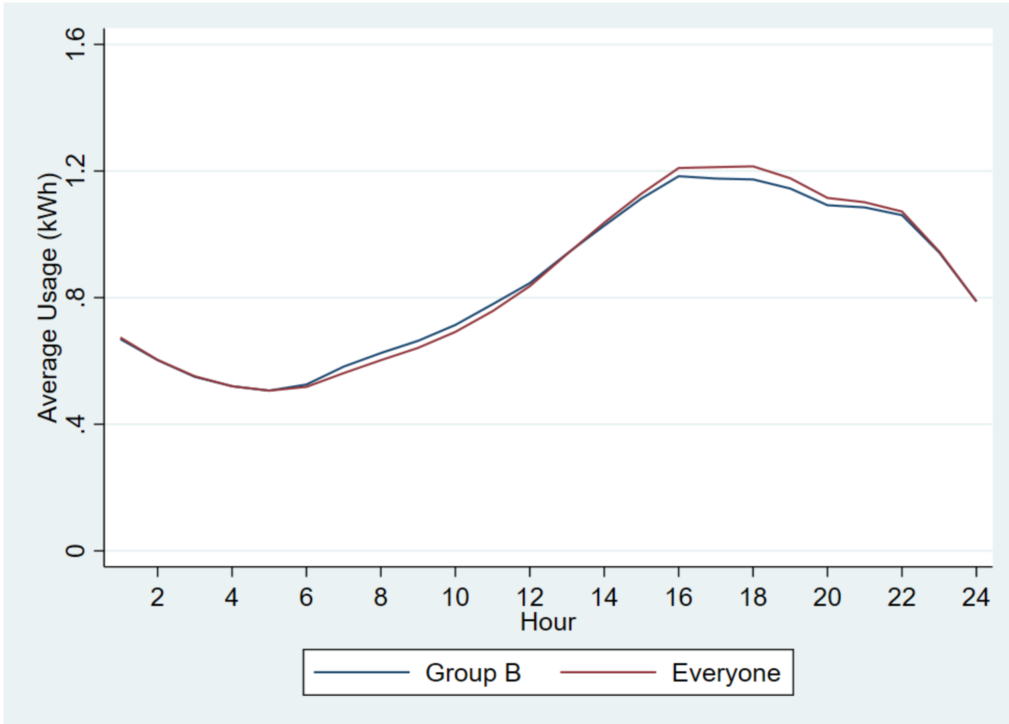


Figure 3-3: Commercial Matched Control and Treatment Group Comparison Average Load across All 2019 Proxy Days

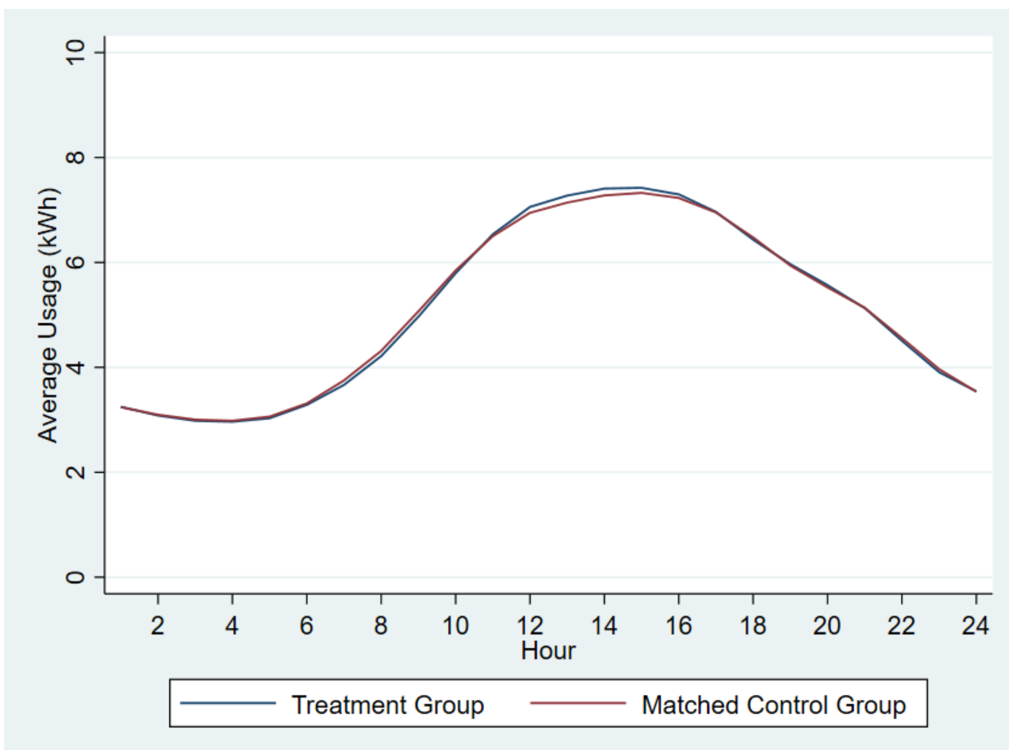


Figure 3-4: Residential Group A and All Comparison
Average Load across All 2019 Proxy Days by Cycling Option

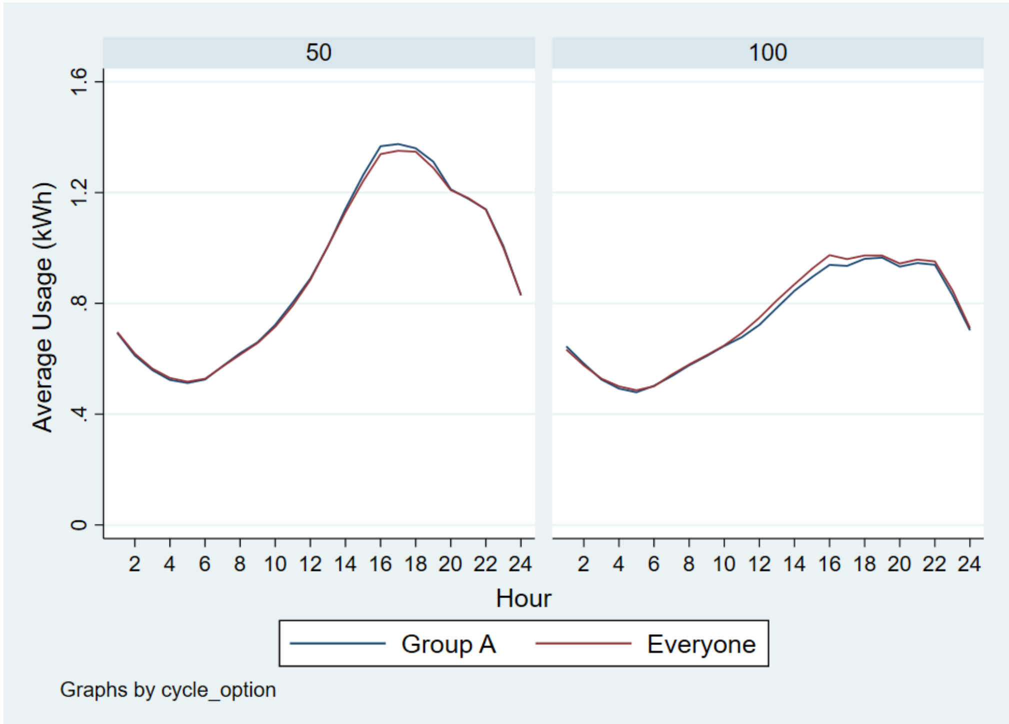


Figure 3-5: Residential Group B and All Comparison
Average Load across All 2019 Proxy Days by Cycling Option

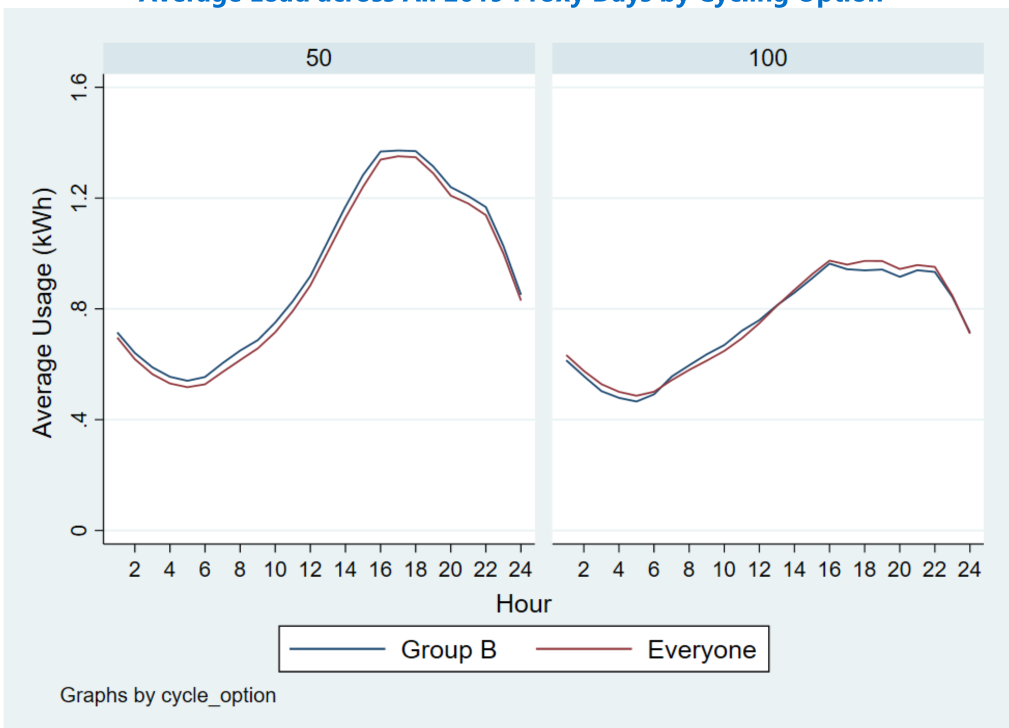
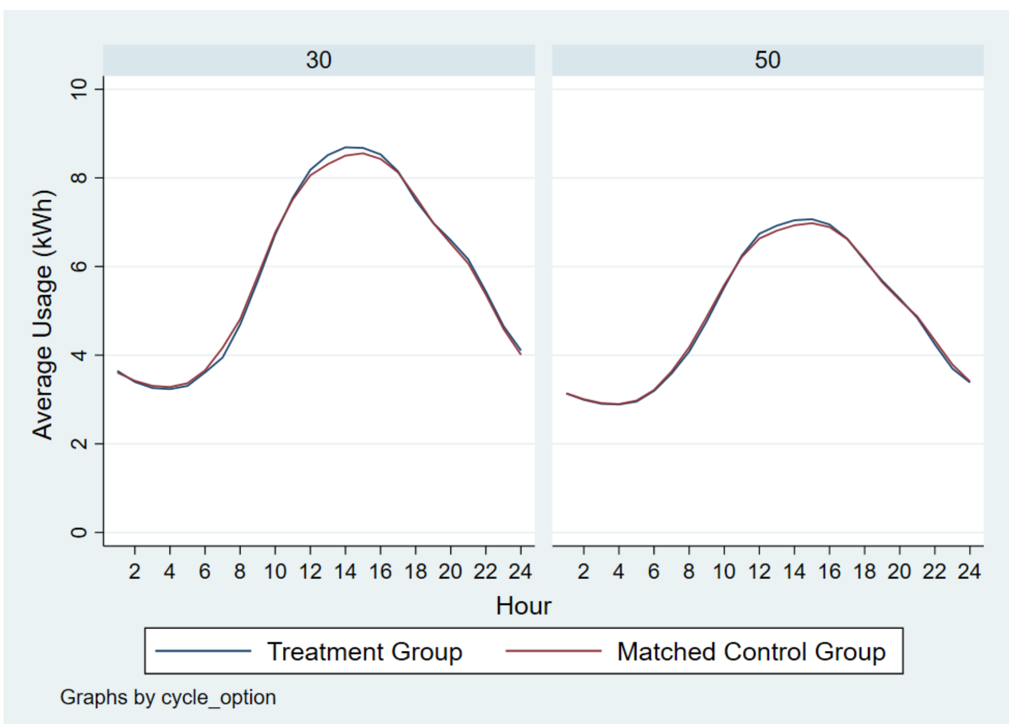


Figure 3-6: Commercial Matched Control and Treatment Group Comparison
Average Load Across all 2019 Proxy Days by Cycling Option



3.3 Ex Ante Impact Estimation Methodology

Ex ante load impacts were developed using relatively recent ex post load impacts. While reliably estimated load impacts are available going back ten years, the older load impact estimates are not likely to be as relevant as the most recent ones because that the program's fleet has been aging over the past ten years without any significant program efforts to refresh older equipment in the field. Ex post load impacts from 2018 and 2019 were used as the foundational data for developing the ex ante model that estimates the weather response of AC Saver Day Of load impacts.

In 2018 and 2019, the majority of events were called markedly later in the day than in previous years. In estimating ex ante load impacts, we fit a single model that estimates the weather responsiveness of average ex post load impacts. To ensure that similar events were used from both 2018 and 2019, the average load impacts are defined as the average load impact across the window of 6 to 8 PM, for all weekday events with the event window spanning this two-hour range. The benefit of this selection is that it results in the greatest amount of data points available for estimating the model – 12 of the 20 events in 2019 fit these criteria, as well as 12 of the 18 events in 2018. In the remainder of this section we refer to this set of average load impacts, the 6 to 8 PM average ex post impacts from 2018 and 2019, as the core ex post impacts.

Another important quality of the core ex post load impacts used in estimating ex ante load impacts is that all ex post impacts in the estimation dataset reflect important changes to the program: the drop of the bottom 30% of electricity users that occurred in 2017 and the drop of residential NEM customers in 2018. These program changes significantly affected the load shapes and impacts compared to previous program years and further justify using only recent ex post results.

The methodology for estimating ex ante impacts in 2019 is the same for residential and commercial participants. The core ex post load impacts are modeled as a function of the average temperature over the first 17 hours of each event day—midnight to 5 PM (mean17). This 17-hour average is used to capture the impact of heat buildup leading up to and including the event hours. Per ton load impacts have historically been used in the AC Saver Day Of load impact evaluation so that the load impacts would be scalable to ex ante scenarios where the tonnage and number of devices per premise may be different.

The regressions only include one explanatory variable; more complicated models were found to not perform better in prior AC Saver Day Of evaluations owing mostly to the relatively limited dataset of ex post load impacts that is available for ex ante estimation. Additionally, this model offers the added benefit of being easily interpretable and understandable. Equation 3-3 presents the model that is used to predict average ex post impacts as a function of weather. This model is estimated separately by customer class (residential and commercial) and cycling strategy. The estimated parameters from the models are used to predict load impacts under 1-in-2 and 1-in-10-year ex ante weather conditions.

Equation 3-3: Ex Ante Model for Predicting Ex Post Load Impacts' Weather Response

$$impact_d = b_0 + b_1 \cdot mean17_d + \varepsilon_d$$

Variable	Definition
$impact_d$	Core 2018-2019 ex post load impacts
b_0	Estimated constant
b_1	Estimated parameter coefficient
$mean17_d$	Average temperature over the first 17 hours of the day for each event day
ε_d	The error term for each day *d*

Figure 3-7 and Figure 3-8 show residential core ex post impacts from 2018 and 2019 (by cycling strategy) graphed against mean17; the core ex post load impacts (kW per ton) are represented by blue squares, with darker squares corresponding to 2018 impacts and lighter squares corresponding to 2019 impacts. The figures also show two lines, where the dark blue line represents the current ex ante estimate of the weather responsiveness of the ex post load impacts, as estimated by the model in Equation 3-3, and the gray line represents the ex ante model developed in the prior evaluation. The dark blue line in both figures shows a strong weather response – the hotter it is, the higher the average AC Saver Day Of load impacts.

Impact evaluations prior to 2017 did not have the benefit of ex post load impacts that occurred at lower temperatures between 65 and 75 °F (mean17). These impacts at lower temperatures serve as a lower bound for load impacts at cool temperatures. AC Saver Day Of load impacts will eventually become zero at even cooler temperatures, but that is only expected to occur during winter months when the program is not available for dispatch. With load impacts available at these temperatures in this evaluation and in the previous year, a clear weather response signature is seen for both cycling strategies for both evaluations: the weather response of the impact (i.e., the steepness of the slope of the regression line) is only slightly lower as estimated this year as compared to last.

Figure 3-7: Average 2018–2019 Ex Post Load Impacts and 2018 and 2019 Ex Ante Predictions for Residential 50% Cycling Participants

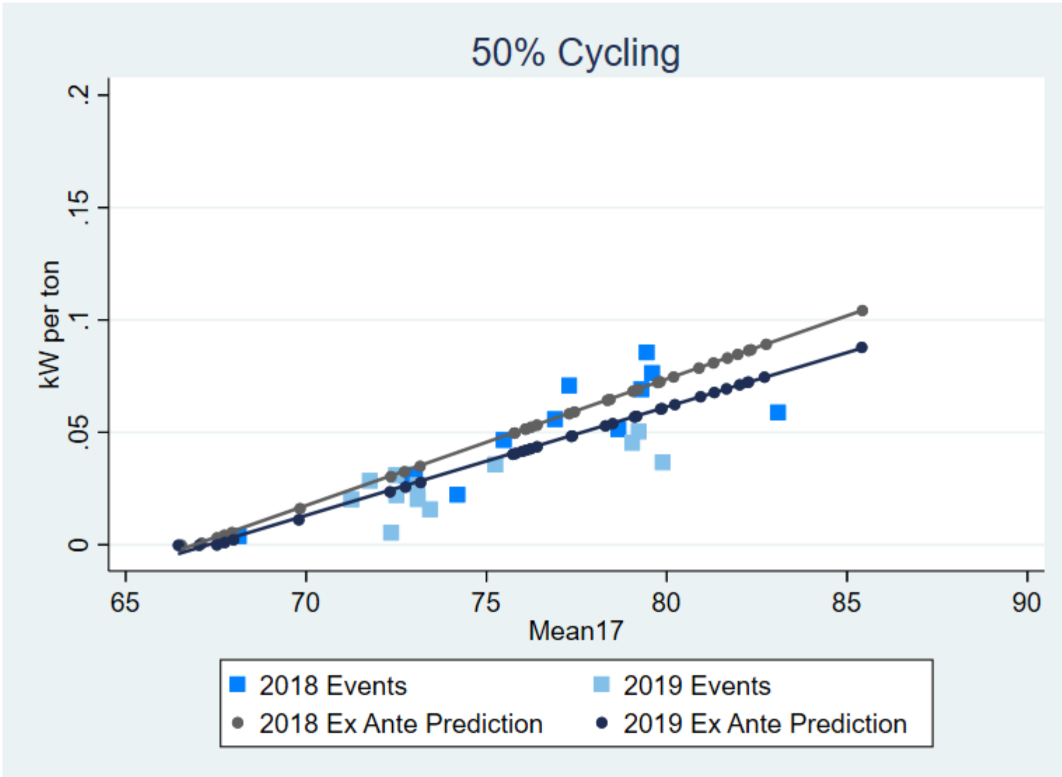


Figure 3-8: Average 2018–2019 Ex Post Load Impacts and 2018 and 2019 Ex Ante Predictions for Residential 100% Cycling Participants

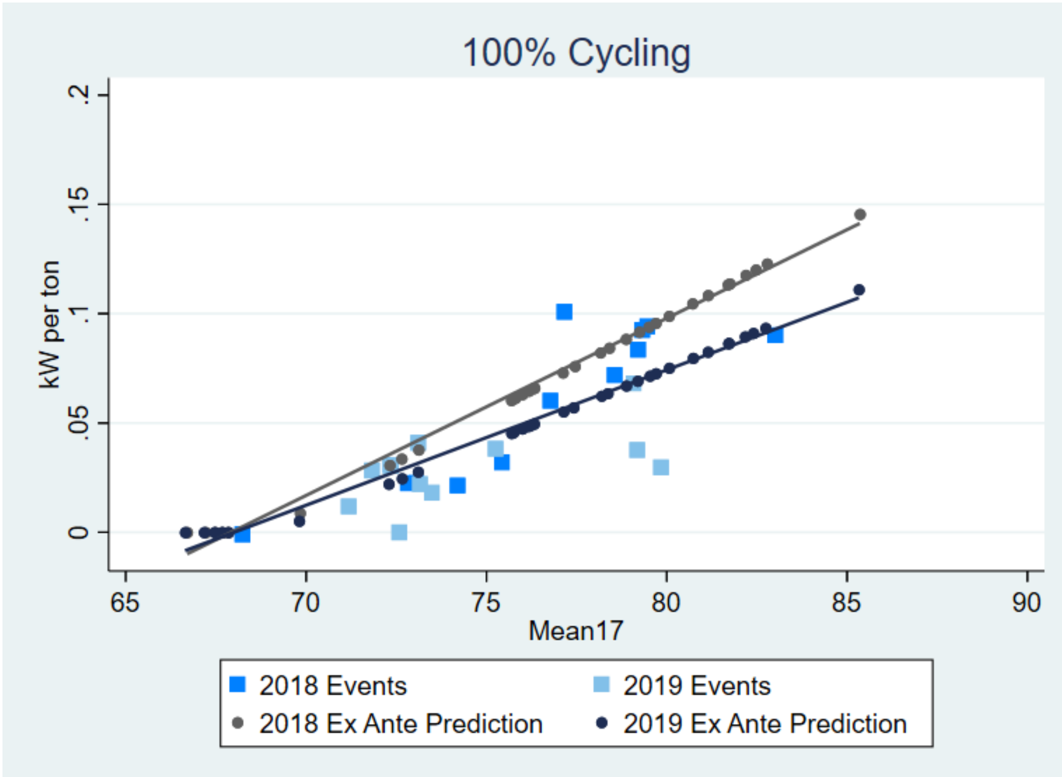


Figure 3-9 and Figure 3-10 show the commercial ex post impacts from 2018 and 2019 (by cycling strategy) as a function of mean17. Here again, the blue squares represent the core ex post load impacts with darker and lighter squares corresponding to 2018 and 2019 events, respectively. Also as in the previous graphs, the dark blue line represents the relationship of ex post load impacts to mean17 as estimated in the current evaluation and the gray line represents the ex ante relationship estimated by the prior load impact evaluation. As compared to the residential results, the weather response for the commercial participants appears to have decreased relative to the 2018 evaluation's results. This is due to the presence of more events with relatively low temperatures but high impacts in 2019 as compared to 2018, which lowered the overall weather responsiveness of the model.

Figure 3-9: Average 2018–2019 Ex Post Load Impacts and 2018 and 2019 Ex Ante Predictions for Commercial 30% Cycling Participants

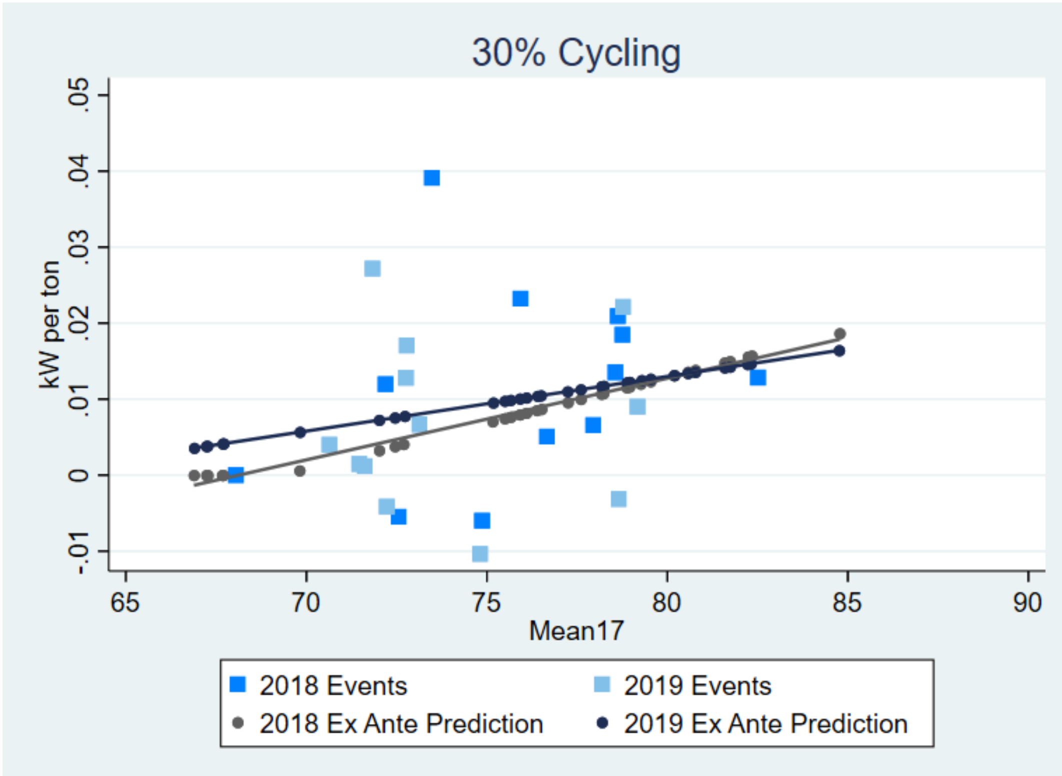
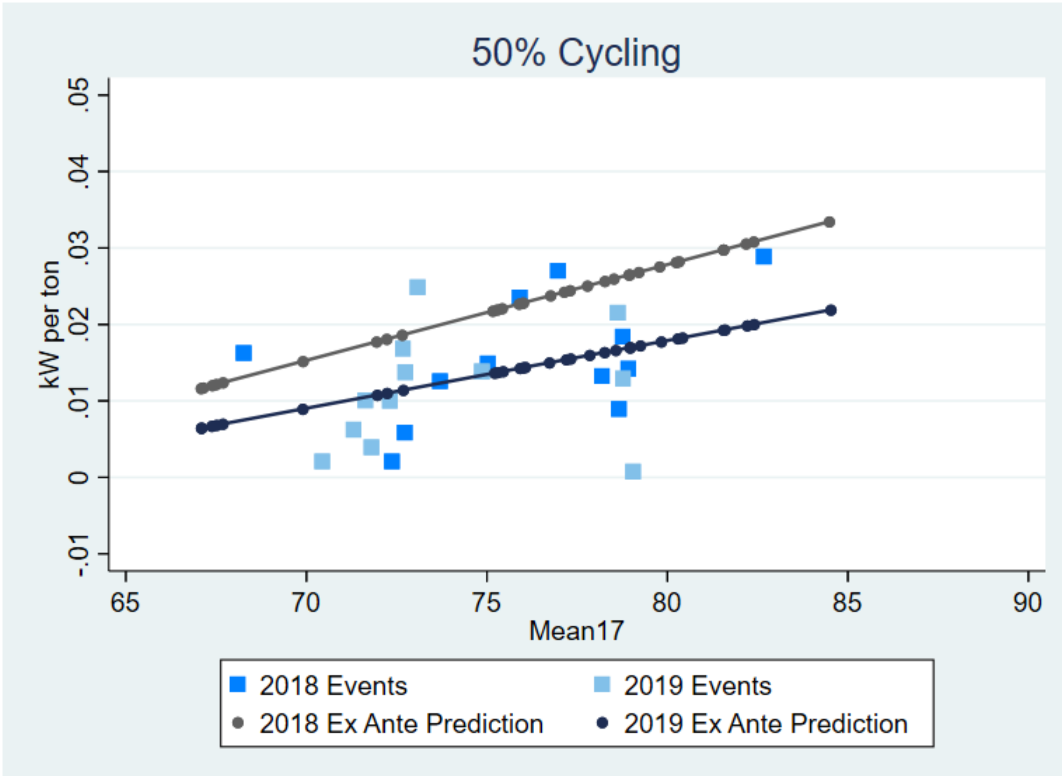


Figure 3-10: Average 2018–2019 Ex Post Load Impacts and 2018 and 2019 Ex Ante Predictions for Commercial 50% Cycling Participants



After the ex ante impacts have been estimated based on the average ex post load impacts, the next step is to predict impacts for each of the hours covered by the CPUC resource adequacy window of 4 to 9 PM, which is 5 hours in duration.

To estimate hourly ex ante load impacts, we use the load impacts from 4-hour events from 2017 and 2018 – as no events were longer than 3 hours in 2019 – to estimate the ratio of first hour, second hour, third hour, and fourth hour load impacts to the average load impacts in the middle two hours. These ratios are calculated separately for residential and commercial segments and for each cycling option. When applied to the predicted ex ante average load impact, they provide a consistent hourly shape to ex ante load impacts. Since there are no 5-hour AC Saver Day Of events, an additional hour is created between the second and third hours that is a linear interpolation of the ratios of the two surrounding hours.

This method constrains the relative size of event impacts across different hours to be the same for all ex ante estimates. The magnitude of event impacts varies with weather, but with this approach the ratio of the impact at 4 PM to the impact at 5 PM, for example, is always the same. The ratios for each customer type and cycling option are shown in Table 3-2.

Table 3-2: Ex Ante Shaping Ratios for Each Customer Type and Cycling Option

Hour of Event	Ratio: Hourly Impact / Core Impact			
	Residential 50%	Residential 100%	Commercial 30%	Commercial 50%
4-5 PM	0.97	0.77	3.13	1.59
5-6 PM	1.12	1.09	1.36	1.09
6-7 PM	1.00	1.00	1.00	1.00
7-8 PM	0.88	0.91	0.64	0.91
8-9 PM	0.56	0.79	0.43	0.61

An alternative method could be to use a separate ex ante model for each event hour. Such a strategy would have the virtue of independently identifying the effect of weather on event impacts at different times of day. However, when there are only a moderate number of events and, for some hours, many fewer events than for other hours, that strategy risks fitting spurious trends to individual hours or trends across hours that conflict with one another. Given the highly auto-correlated nature of the data, the differential impact of weather on different event hours is likely to be difficult to measure as compared to the primary effect of temperature on average event impacts.

Table 3-3 illustrates how the ratio approach for estimating the hourly shape of average load impacts works in estimating the ex ante load impacts for the RA window. For the case of residential 100% cycling, the load impacts for the 1-in-10 scenario are higher than those for 1-in-2, reflecting the model's prediction for higher average load impacts under hotter weather conditions, but the relationship between the hourly load impacts and the average load impacts are constant across the 1-in-2 and 1-in-10 load impacts.

Table 3-3: Hourly Load Impacts Compared to Average Impacts for Residential 100% Cycling

Hour of Event (RA Hours)	Ratio: Hourly Impact / Core Impact	Hourly Impact for Typical SDG&E Event Day, 1-in-2 Weather (kW/ton)	Hourly Impact for Typical SDG&E Event Day, 1-in-10 Weather (kW/Ton)
4-5 PM	0.77	0.04	0.06
5-6 PM	1.09	0.05	0.09
6-7 PM	1.00	0.05	0.08
7-8 PM	0.91	0.05	0.08
8-9 PM	0.79	0.04	0.07

As discussed previously, average ex ante load impacts were estimated directly based on ex post impacts. However, the CPUC Load Impact Protocols require that reference loads also be estimated to accompany ex ante load impacts even though they may not always be necessary for load impact estimation, as is true here. To meet this requirement, reference loads were estimated in a manner similar to the approach used for ex ante load impacts; models for estimating reference loads are estimated separately by customer type and cycling strategy. The following steps are taken to estimate reference loads:

- Average control group usage during the 6 to 8 PM time period for 2018 and 2019 weekday event days with event windows of 6 to 8 PM is modeled as a function of mean17;
- The parameters from this regression are used to predict average control group usage for the period of 6 to 8 PM under ex ante weather conditions;
- A ratio of the average control group load for each hour of the 4-hour events in 2017 and 2018 to the average control group load for the middle two event hours on those days is calculated; and
- Control group load (i.e., reference load) profiles are derived by applying the hourly ratios to the predicted average 6 to 8 PM loads under all the ex ante weather conditions.

Finally, estimates of the ex ante snapback effect were developed in a similar manner. Snapback refers to the increase in load following termination of a load control event as a result of the increased temperature that occurs in buildings when air conditioning is cycled. As with load impacts and reference loads, snapback for residential customers was calculated by cycling strategy. The calculation consisted of the following steps:

- Average the snapback values across the three hours after each ex post event;
- Develop a ratio between snapback in each hour and snapback in the first hour after the event;
- Multiply the snapback value in the first hour after the event by the ratio used to scale the ex post impact to ex ante weather conditions; and
- Multiply the adjusted snapback values for each set of ex ante weather conditions by the snapback ratios to get snapback values for the three hours after each ex ante event.

Commercial snapback is assumed to be zero as there is little prior evidence of CAC snapback after AC Saver Day Of events for commercial participants.

4 Ex Post Load Impact Estimates

This section contains the ex post load impact estimates for program year 2019. Residential load impacts are presented first, followed by commercial load impacts.

4.1 Residential Ex Post Load Impact Estimates

A total of 20 AC Saver Day Of events were called in 2019 including three weekend events. Table 4-1 presents ex post load impacts for the residential program segment for each event in program year 2019. The rows highlighted in green represent weekday events from 6-8 PM that are used in the calculation of the Average Event Day. The rows highlighted in orange represent the three weekend events.

Aggregate residential load impacts ranged from a low of -0.02 MW on June 23, 2019 to a high of 1.69 MW on September 6, 2019. This low result on June 23 could be explained by low temperatures. The "mean17" heat buildup – the average temperature from midnight to 5 PM – which was only 68 °F on that day – the lowest for any event in 2019, leading to lower cooling loads. The next lowest-impact event was on October 21, 2019, with an impact of 0.11 MW, which can again be explained in part by the low mean17 of 72 °F as compared to the average event's mean17 of 74 °F. The low impact of this event could also be attributed to the specific timing of this event. This event was called after an unusual spike in temperature a month and a half after the preceding event on September 6, during which the average mean17 was 68 °F. Given these factors, participants may have considered the summer event season to be over and have switched off their CAC units. Another event was called the following day, with larger impacts, presumably as more participants had turned on their CAC units due to the temperature increase. Conversely regarding the mean17 temperature, the highest impact event on September 6, 2019 saw a mean17 of 79 °F. This mean17 indicates that this event was one of the hottest events of the season, and the impact may also have been bolstered by this being the third event day in three consecutive days all with similar mean17 temperatures. All 2019 AC Saver Day Of residential impacts are statistically significant at the 90% confidence level with the exceptions of the two lowest-impact events mentioned.

For this ex post evaluation, "Average Event Day" load impacts are calculated using only events with the same event duration, at the same time of day, and only for weekday events. These criteria were selected because load impacts for the direct load control of residential CAC units may be sensitive to the hour in which the event was dispatched, so events with different event times should not be directly compared. In this case, the average event day load impacts are calculated using the events on July 12, 22, 24, and 29, August 5, 6, 14, 15, 26, and 27, September 6, and October 21. All twelve of these events were dispatched from 6 to 8 PM. The twelve 2019 AC Saver Day Of events included in the Average Event Day estimate yield an aggregate load reduction of 0.91 MW.

Table 4-1: AC Saver Day Of 2019 Residential Ex Post Load Impact Estimates

Date	Impact			Mean17 (°F)	Max Event Window Temperature (°F)	Event Hours	Statistically Significant at 90% Level
	Per CAC Unit (kW)	Per Premise (kW)	Aggregate (MW)				
6/10/2019	0.02	0.03	0.20	73	76	7pm - 9pm	Yes
6/23/2019	0.00	0.00	-0.02	68	68	7pm - 9pm	**NO**
7/12/2019	0.06	0.07	0.56	71	78	6pm - 8pm	Yes
7/22/2019	0.07	0.08	0.69	73	79	6pm - 8pm	Yes
7/23/2019	0.12	0.14	1.12	78	86	5pm - 8pm	Yes
7/24/2019	0.12	0.14	1.12	80	82	6pm - 8pm	Yes
7/29/2019	0.10	0.11	0.93	72	79	6pm - 8pm	Yes
8/4/2019	0.13	0.15	1.15	73	80	6pm - 8pm	Yes
8/5/2019	0.11	0.13	1.00	73	79	6pm - 8pm	Yes
8/6/2019	0.06	0.07	0.52	73	76	6pm - 8pm	Yes
8/11/2019	0.02	0.02	0.15	70	71	7pm - 9pm	Yes
8/14/2019	0.11	0.12	0.97	72	81	6pm - 8pm	Yes
8/15/2019	0.09	0.10	0.79	72	78	6pm - 8pm	Yes
8/26/2019	0.16	0.18	1.40	79	82	6pm - 8pm	Yes
8/27/2019	0.13	0.15	1.12	75	79	6pm - 8pm	Yes
9/4/2019	0.16	0.18	1.44	80	86	4pm - 7pm	Yes
9/5/2019	0.19	0.21	1.68	80	86	5pm - 8pm	Yes
9/6/2019	0.19	0.21	1.69	79	85	6pm - 8pm	Yes
10/21/2019	0.01	0.01	0.11	72	82	6pm - 8pm	**NO**
10/22/2019	0.03	0.04	0.29	75	89	5pm - 8pm	Yes
Average*	**0.10**	**0.11**	**0.91**	**74**	**80**	**6pm - 8pm**	**Yes**

The residential Average Event Day load impacts per premise in 2018 and 2019 were 0.18 kW and 0.11 kW, respectively. These averages were calculated using events with similarly timed event windows (6-8PM), but with hotter average mean17 temperatures in 2018 (77 °F) than in 2019 (74 °F), and hotter average event window temperatures in 2018 (82 °F) than in 2019 (80 °F). Figure 4-1 shows the relationship between mean17 and impact for all events in 2018 and 2019. The dark circles show the average event mean17 between the two program years. Besides the temperature difference, one key driver of the difference in aggregate ex post load impacts between 2017 and 2018 is the number of residential customers enrolled in the program: while 2018 saw 9,716 average participants per event, 2019 saw only 7,913. This drop in customers is due in part to normal attrition, and also due to the continued removal of residential NEM customers from the participant list.

Figure 4-1: 2018 and 2019 Ex Post Load Impacts vs. Temperature

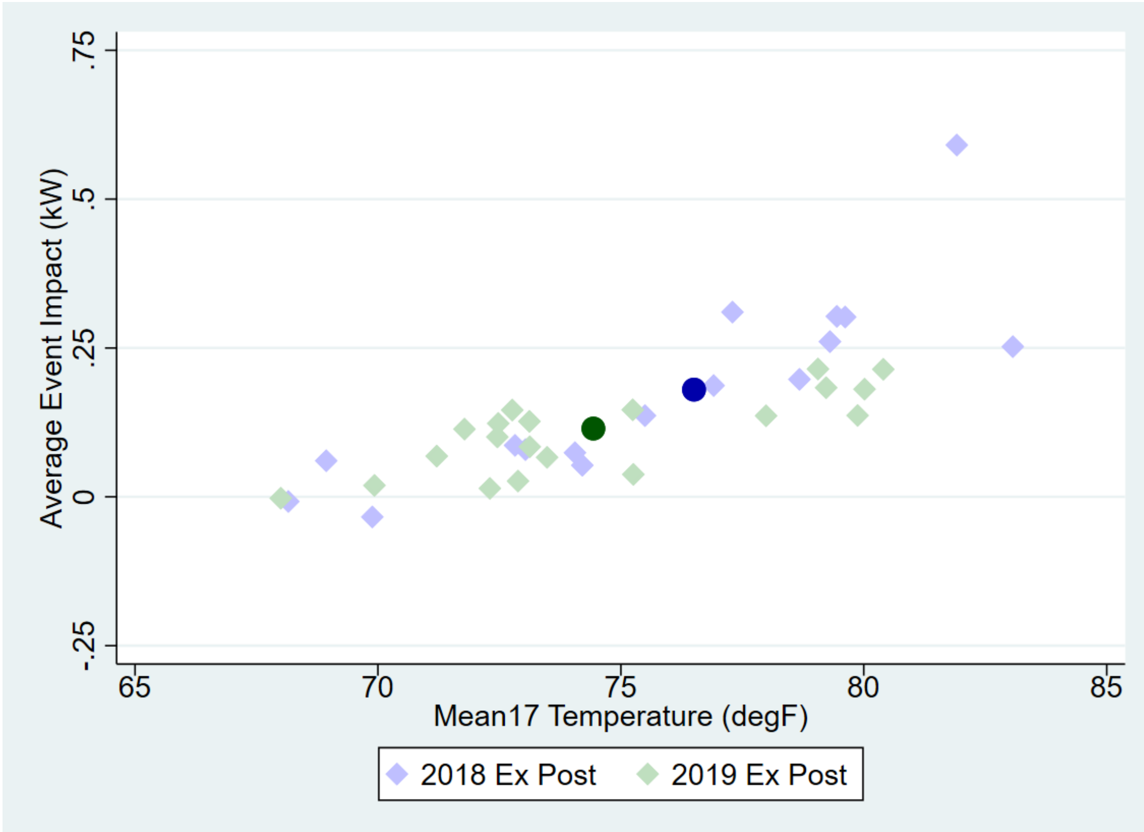


Table 4-2 shows the average per premise reference loads, load impacts, and percent impacts for residential customers by cycling option. On the average event day, the reference load for the 50% cycling group was approximately 25% higher than the reference load for the 100% cycling group, with reference loads of 1.41 and 1.06 kW per premise, respectively. This suggests that customers who use their CAC units more are less likely to select the 100% cycling option. This difference helps explain why, even though the 100% group is cycled twice as much as the 50% group, the load impacts for the 100% group (0.13 kW per premise) are only about 15% higher than those of the 50% cycling group (0.11 kW per premise): the 50% group has commensurately higher reference loads. Load impacts are at their highest for the 50% group on August 26 at 0.20 kW per premise, and highest for the 100% cycling participants on September 5 at 0.37 kW per premise.

Table 4-2: AC Saver Day Of 2019 Residential Average (per Premise) Reference Load, Impacts, and Percent Impacts by Cycling Option

Event Date	Average Reference Load per Premise (kW)		Average Load Impact per Premise (kW)		Average Percent Impact	
	50%	100%	50%	100%	50%	100%
6/10/2019	1.10	0.92	0.01	0.06	1%	6%
6/23/2019	0.83	0.75	-0.01	0.00	-1%	1%
7/12/2019	1.15	0.83	0.08	0.05	7%	6%
7/22/2019	1.24	0.96	0.08	0.09	6%	10%
7/23/2019	1.58	1.16	0.10	0.21	6%	18%
7/24/2019	1.52	1.13	0.14	0.12	9%	11%
7/29/2019	1.37	1.01	0.11	0.12	8%	12%
8/4/2019	1.49	1.11	0.14	0.16	9%	14%
8/5/2019	1.46	1.10	0.10	0.17	7%	16%
8/6/2019	1.28	0.97	0.06	0.08	5%	8%
8/11/2019	1.07	0.87	0.02	0.02	2%	2%
8/14/2019	1.46	1.06	0.12	0.13	8%	12%
8/15/2019	1.38	1.02	0.09	0.13	6%	13%
8/26/2019	1.73	1.23	0.20	0.16	11%	13%
8/27/2019	1.47	1.12	0.14	0.16	9%	14%
9/4/2019	1.66	1.28	0.12	0.29	7%	23%
9/5/2019	1.94	1.52	0.13	0.37	7%	24%
9/6/2019	1.86	1.43	0.18	0.29	9%	20%
10/21/2019	1.05	0.85	0.02	0.00	2%	0%
10/22/2019	1.20	0.91	0.03	0.05	3%	5%
Average*	**1.41**	**1.06**	**0.11**	**0.12**	**8%**	**12%**

*Reflects the average 6-8pm weekday 2019 AC Saver Day Of event

Aggregate ex post load impacts for the residential portion of AC Saver Day Of are presented in Table 4-3 for each event day, segmented by cycling option. Each cycling option contributes roughly half of the total residential load impacts. On the average event day, the 50% cycling participants deliver about 0.57 MW of load reduction while the 100% cycling participants contribute about 60% of that at 0.34 MW.

Table 4-3: AC Saver Day Of 2019 Residential Average (per Premise) and Aggregate Load Impacts by Cycling Option

Event Date	Average Load Impact per Premise (kW)		Aggregate Load Impact (MW)	
	50%	100%	50%	100%
6/10/2019	0.01	0.06	0.05	0.15
6/23/2019	-0.01	0.00	-0.03	0.01
7/12/2019	0.08	0.05	0.42	0.14
7/22/2019	0.08	0.09	0.42	0.27
7/23/2019	0.10	0.21	0.51	0.61
7/24/2019	0.14	0.12	0.76	0.36
7/29/2019	0.11	0.12	0.59	0.34
8/4/2019	0.14	0.16	0.73	0.42
8/5/2019	0.10	0.17	0.54	0.46
8/6/2019	0.06	0.08	0.32	0.20
8/11/2019	0.02	0.02	0.10	0.05
8/14/2019	0.12	0.13	0.63	0.34
8/15/2019	0.09	0.13	0.45	0.34
8/26/2019	0.20	0.16	1.00	0.40
8/27/2019	0.14	0.16	0.71	0.41
9/4/2019	0.12	0.29	0.64	0.80
9/5/2019	0.13	0.37	0.67	1.01
9/6/2019	0.18	0.29	0.90	0.78
10/21/2019	0.02	0.00	0.11	0.00
10/22/2019	0.03	0.05	0.17	0.12
Average*	**0.11**	**0.12**	**0.57**	**0.34**

* Reflects the average 6-8 PM 2018 AC Saver Day of event

Table 4-4 shows estimated event impacts for residential customers segmented by usage quintiles, and Table 4-5 shows the same but segmented by usage deciles. Each customer was placed into 1 of 5 quintiles (or 1 of 10 deciles, in the case of Table 4-5), based on their average usage during the peak hours from 11 AM to 6 PM on all proxy event days in 2019. Impact estimates were calculated separately for each quintile and decile for the average event hour of the 2019 Average Event Day to determine reference loads and load impacts. Load impacts by quintile largely increase with electricity usage, however given the smaller sample sizes associated with each individual quintile, there are relatively large standard errors, as compared to the impacts, associated with these estimates. In the case of the largest quintiles, per premise load impacts top out at 0.20 kW for 50% cycling and 0.31 kW for 100% cycling – both approximately double the overall average impacts for these cycling options of 0.11 kW and 0.12 kW, respectively. For the largest decile, 50% cycling load impacts peak at 0.20 kW and 100% cycling load impacts peak at 0.47 kW.

Table 4-4: AC Saver Day Of 2019 Residential Average (per Premise) Load Impacts by Usage Quintile and Cycling Option

Quintile	50% Cycling		100% Cycling	
	Average* Per Premise Load Impact (kW)	Load Impact Standard Error (kW)	Average* Per Premise Load Impact (kW)	Load Impact Standard Error (kW)
1	0.06	0.01	0.05	0.01
2	0.06	0.01	0.04	0.01
3	0.13	0.01	0.08	0.01
4	0.09	0.02	0.14	0.02
5	0.20	0.02	0.31	0.02

* Reflects the average 6-8 PM weekday 2019 AC Saver Day Of event

Table 4-5: AC Saver Day Of 2019 Residential Average (per Premise) Load Impacts by Usage Decile and Cycling Option

Decile	50% Cycling		100% Cycling	
	Average* Per Premise Load Impact (kW)	Load Impact Standard Error (kW)	Average* Per Premise Load Impact (kW)	Load Impact Standard Error (kW)
1	0.09	0.02	0.06	0.02
2	0.05	0.01	0.05	0.01
3	0.07	0.02	0.04	0.01
4	0.03	0.02	0.03	0.01
5	0.14	0.02	0.07	0.02
6	0.12	0.02	0.07	0.02
7	0.09	0.02	0.11	0.02
8	0.09	0.03	0.16	0.02
9	0.20	0.03	0.14	0.02
10	0.20	0.03	0.47	0.03

* Reflects the average 6-8 PM weekday 2019 AC Saver Day Of event

4.2 Commercial Ex Post Load Impact Estimates

Table 4-6 presents the ex post load impact estimates for commercial customers for each 2019 event day and the Average Event Day. Here again, the Average Event Day load impacts are calculated using July 12, 22, 24, and 29, August 5, 6, 14, 15, 26, and 27, September 6, and October 21. These rows highlighted in green represent weekday events from 6-8 PM that are used in the calculation of the Average Event Day. The rows highlighted in orange represent the three weekend events.

The commercial segment of AC Saver Day Of is smaller than the residential segment: commercial customers represent about 28% of the total AC Saver Day Of participants and about 46% of the enrolled CAC tonnage. In addition to the lower number of enrolled commercial customers and cooling tons, the per premise load impacts for commercial customers are smaller than those for residential customers. This is due in part to the fact that enrolled commercial CAC units are cycled less than the residential CAC units – commercial units have options of 30% or 50%, versus residential unit options of 50% or 100%. Additionally, commercial load impacts are lower than residential impacts due to the timing of the AC Saver Day Of events, which in 2019 were predominantly called when per premise load is ramping down towards the commercial daily minimum that occurs in the evening and overnight hours, as opposed to during the residential daily maximum period that occurs at the same time.

Weekday commercial aggregate impacts vary from a low of 0.09 MW (not statistically significant) on July 12 to a high of 0.66 MW on August 6. Generally, the commercial customers have lower sensitivity to weather, evidenced by the fact that the July 12 event had a maximum event window temperature of 76 °F while the August 6 event had a maximum of 75 °F.

The 2019 commercial per premise impacts are approximately 40% lower than those observed in 2018, as is also the case in the residential program segment. The Average Event Day load impact in 2018 (for 6-8 PM events) was 0.12 kW per premise, and the Average Event Day load impact in 2019 was 0.09 kW per premise. In the case of the commercial impacts, all per premise impacts at or below 0.03 kW are not statistically significant.

Table 4-6: AC Saver Day Of and 2019 Commercial Ex Post Load Impact Estimates

Date	Impact			Mean17 (°F)	Max Event Window Temperature (°F)	Event Hours	Statistically Significant at 90% Level
	Per CAC Unit (kW)	Per Premise (kW)	Aggregate (MW)				
6/10/2019	0.04	0.10	0.36	72	74	7pm - 9pm	Yes
6/23/2019	0.02	0.05	0.19	68	67	7pm - 9pm	Yes
7/12/2019	0.01	0.02	0.09	70	76	6pm - 8pm	**NO**
7/22/2019	0.06	0.15	0.55	73	77	6pm - 8pm	Yes
7/23/2019	0.06	0.14	0.54	77	84	5pm - 8pm	Yes
7/24/2019	0.01	0.03	0.10	79	81	6pm - 8pm	**NO**
7/29/2019	0.02	0.04	0.16	71	77	6pm - 8pm	Yes
8/4/2019	0.03	0.07	0.25	72	79	6pm - 8pm	Yes
8/5/2019	0.05	0.12	0.44	73	78	6pm - 8pm	Yes
8/6/2019	0.08	0.18	0.66	73	75	6pm - 8pm	Yes
8/11/2019	0.00	-0.01	-0.04	70	71	7pm - 9pm	**NO**
8/14/2019	0.04	0.09	0.34	72	79	6pm - 8pm	Yes
8/15/2019	0.03	0.07	0.25	72	76	6pm - 8pm	Yes
8/26/2019	0.06	0.13	0.49	79	81	6pm - 8pm	Yes
8/27/2019	0.03	0.06	0.24	75	78	6pm - 8pm	Yes
9/4/2019	0.07	0.17	0.64	80	84	4pm - 7pm	Yes
9/5/2019	0.06	0.14	0.51	80	85	5pm - 8pm	Yes
9/6/2019	0.06	0.13	0.49	79	84	6pm - 8pm	Yes
10/21/2019	0.02	0.05	0.20	72	82	6pm - 8pm	Yes
10/22/2019	0.06	0.13	0.48	75	88	5pm - 8pm	Yes
Average**	**0.04**	**0.09**	**0.33**	**74**	**79**	**6pm - 8pm**	**Yes**

A comparison of average impacts per CAC unit between Table 4-1 and Table 4-6 reveals that the Average Event Day impact per CAC unit for commercial customers is only 0.04 kW while it is 0.10 kW for residential customers. Much of this difference is due to the lower cycling options used by commercial customers, but load impacts per CAC unit can be directly compared across residential and commercial participants on the same cycling strategy to determine if there are other factors at play.

Table 4-7 shows a comparison of average load impact per CAC for 50% cycling residential and 50% cycling commercial customers. Looking at only the 50% cycling group for the commercial segment raises the Average Event Day load impact per CAC unit by a small amount, although with rounding it remains at 0.04 kW, which is still less than half as much as the 50% cycling residential CAC load impact on the Average Event Day of 0.10 kW.

Table 4-7: Comparison of 2019 Residential and Commercial AC Saver Day Of 50% Cycling Load Impacts

Event Date	Average Load Impact per CAC Unit (kW)	
	Residential 50%	Commercial 50%
6/10/2019	0.01	0.06
6/23/2019	-0.01	0.02
7/12/2019	0.07	0.01
7/22/2019	0.07	0.06
7/23/2019	0.08	0.05
7/24/2019	0.13	0.00
7/29/2019	0.10	0.02
8/4/2019	0.12	0.04
8/5/2019	0.09	0.05
8/6/2019	0.05	0.09
8/11/2019	0.02	0.00
8/14/2019	0.11	0.01
8/15/2019	0.08	0.04
8/26/2019	0.17	0.08
8/27/2019	0.12	0.05
9/4/2019	0.11	0.07
9/5/2019	0.12	0.08
9/6/2019	0.16	0.05
10/21/2019	0.02	0.04
10/22/2019	0.03	0.07
Average*	**0.10**	**0.04**

* Reflects the average 6-8 PM 2019 AC Saver Day Of Weekday event

Figure 4-2 shows the reference and observed loads for residential and commercial 50% cycling customers on the 2019 Average Event Day. The highlighted portions of the load represent the average event hours. Load impacts on the 2019 Average Event Day are nearly optimal for the residential customers due to the timing of the event, 6-8 PM, but the timing for the commercial customers is suboptimal, occurring when most occupancy and building processes are winding down. Another differentiating factor (which would need to be validated by a field study) may be that due to the advanced age of the AC Saver Day Of program, fewer commercial load control devices are still installed and functional. Many businesses have contracts with HVAC contractors for regular maintenance, and HVAC contractors may be inclined to remove or disconnect equipment such as load control devices that they may not recognize as legitimate equipment.

Figure 4-2: Reference and Observed Loads for the Average Event Day – 2019 Residential and Commercial 50% Cycling

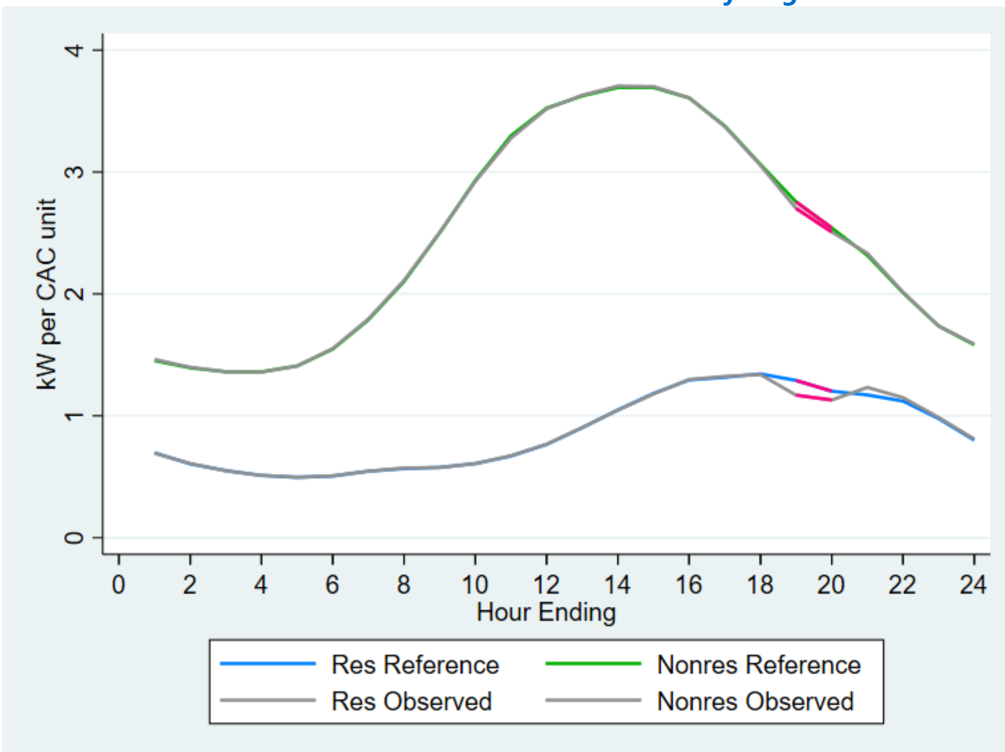


Table 4-8 presents the per premise and aggregate load impacts for commercial participants on each event day, segmented by cycling strategy. On a per premise basis, load impacts for the 50% cycling option range from 0.001 kW (weekend 7-9 PM event) to 0.21 kW (weekday 6-8 PM event). For weekday events, the lowest 50% cycling reduction was 0.006 kW. Per premise load impacts for the 30% cycling option are more broadly distributed, ranging from -0.11 kW to 0.30 kW (both weekday 6-8 PM events). Although the distributions of impacts vary between the groups, on the Average Event Day, load impacts for the 50% cycling group are approximately the same as those produced by the 30% cycling group.

Table 4-8: AC Saver Day Of 2019 Commercial Average (per Premise) and Aggregate Load Impacts by Cycling Option

Event Date	Average Load Impact per Premise (kW)		Aggregate Load Impact (MW)	
	30%	50%	30%	50%
6/10/2019	-0.04	0.14	-0.03	0.39
6/23/2019	0.05	0.05	0.04	0.15
7/12/2019	0.04	0.02	0.04	0.05
7/22/2019	0.19	0.14	0.15	0.40
7/23/2019	0.28	0.11	0.23	0.31
7/24/2019	0.10	0.01	0.08	0.02
7/29/2019	0.02	0.05	0.01	0.15
8/4/2019	0.03	0.08	0.03	0.23
8/5/2019	0.14	0.11	0.12	0.33
8/6/2019	0.07	0.21	0.06	0.60
8/11/2019	-0.05	0.00	-0.04	0.00
8/14/2019	0.30	0.03	0.24	0.09
8/15/2019	0.01	0.08	0.01	0.24
8/26/2019	-0.03	0.18	-0.03	0.52
8/27/2019	-0.11	0.11	-0.09	0.33
9/4/2019	0.25	0.15	0.20	0.44
9/5/2019	0.01	0.17	0.01	0.50
9/6/2019	0.24	0.10	0.19	0.30
10/21/2019	-0.04	0.08	-0.04	0.23
10/22/2019	0.09	0.14	0.07	0.41
Average*	**0.07**	**0.09**	**0.06**	**0.27**

*Reflects the average 6-8 PM weekday 2019 AC Saver Day Of Weekday event

Table 4-9 shows estimated event impacts for commercial customers segmented by usage quintiles, and Table 4-10 shows the same but segmented by usage deciles. Each customer was placed into 1 of 5 quintiles (or 1 of 10 deciles, in the case of Table 4-10), based on their average usage during the peak hours from 11 AM to 6 PM on all proxy event days in 2019. Impact estimates were calculated separately for each quintile and decile for the average event hour of the 2019 Average Event Day to determine reference loads and load impacts. Load impacts by quintile largely increase with electricity usage, however given the smaller sample sizes associated with each individual quintile, there are relatively large standard errors, as compared to the impacts, associated with these estimates. In the case of the largest quintiles, per premise load impacts top out at 0.17 kW for 30% cycling and 0.32 kW for 50% cycling – both approximately double the overall average impacts for these cycling options of 0.07 kW and 0.09 kW, respectively. For the largest decile, 30% cycling load impacts peak at 0.27 kW and 50% cycling load impacts peak at 0.44 kW. The first quintile and first few deciles show slight negative impacts, which can be attributed to Net Energy Metering (NEM) customers, whose negative loads during this time period lead to diminished impacts.

Table 4-9: AC Saver Day Of 2019 Commercial Average (per Premise) Load Impacts by Usage Quintile and Cycling Option

Quintile	30% Cycling		50% Cycling	
	Average* Per Premise Load Impact (kW)	Load Impact Standard Error (kW)	Average* Per Premise Load Impact (kW)	Load Impact Standard Error (kW)
1	-0.09	0.04	-0.05	0.02
2	0.00	0.02	0.01	0.01
3	0.22	0.03	0.11	0.02
4	0.11	0.05	0.05	0.02
5	0.17	0.11	0.32	0.05

* Reflects the average 6-8 PM weekday 2019 AC Saver Day Of event

Table 4-10: AC Saver Day Of 2019 Commercial Average (per Premise) Load Impacts by Usage Decile and Cycling Option

Decile	30% Cycling		50% Cycling	
	Average* Per Premise Load Impact (kW)	Load Impact Standard Error (kW)	Average* Per Premise Load Impact (kW)	Load Impact Standard Error (kW)
1	-0.13	0.06	-0.04	0.04
2	-0.05	0.02	-0.04	0.01
3	-0.03	0.04	0.02	0.01
4	0.03	0.03	0.01	0.02
5	0.16	0.04	0.13	0.02
6	0.25	0.05	0.09	0.02
7	0.02	0.06	0.04	0.03
8	0.16	0.08	0.07	0.03
9	0.09	0.11	0.20	0.04
10	0.27	0.18	0.44	0.09

* Reflects the average 6-8 PM weekday 2019 AC Saver Day Of event

5 Ex Ante Load Impact Estimates

This section presents ex ante load impact estimates for SDG&E's AC Saver Day Of program. Residential ex ante estimates are provided first, followed by estimates for commercial customers. These estimates are then compared to the ex ante estimates produced in the 2018 load impact evaluation and the relationship between the 2019 ex post impacts and the ex ante estimates is explained.

5.1 Ex Ante Estimates

The models described in Section 3 were used to estimate load impacts based on ex ante event weather conditions and enrollment projections for the years 2020–2030. Recent AC Saver Day Of evaluations have shown dramatic changes in projected program enrollment due to dropping underperforming (i.e., low usage) participants in 2017 and residential NEM customers in 2018. Forecasted enrollment now only features modest enrollment attrition throughout the forecast window.

The Load Impact Protocols require that ex ante load impacts are estimated assuming weather conditions associated with both normal and extreme utility operating conditions. Normal conditions are defined as those that would be expected to occur once every 2 years (1-in-2 conditions) and extreme conditions are defined as those that would be expected to occur once every 10 years (1-in-10 conditions). From 2008 to 2014, the California IOUs based their ex ante weather conditions on system operating conditions specific to each individual utility for estimating demand response load impacts. However, an alternative is to use ex ante weather conditions that reflect 1-in-2 and 1-in-10 year operating conditions for the CAISO rather than the operating conditions for each IOU. While the Protocols do not address this issue, a letter from the CPUC Energy Division to the IOUs dated October 21, 2014 directed the utilities to provide impact estimates under two sets of operating conditions starting with the April 1, 2015 filings: one reflecting operating conditions for each IOU and one reflecting operating conditions for the CAISO system.

In order to meet this new requirement, California's IOUs contracted with Nexant in 2014 to develop ex ante weather conditions based on the peaking conditions for each utility and for the CAISO system. Nexant subsequently updated these weather conditions for SDG&E in 2017.[5] The new ex ante weather dataset utilizes a shorter historical window of weather conditions that better reflect recent warming trends.

Ex ante weather conditions for CAISO peaking conditions and SDG&E peaking conditions may differ, and the extent to which that can happen largely depends on the correlation between individual utility and CAISO peak loads. Based on CAISO and SDG&E system peak loads for the top 25 CAISO

[5] The original ex ante weather conditions used in DR load impact evaluations were developed in 2009.

system load days each year from 2006 to 2013, the correlation coefficient for SDG&E is 0.56, indicating that there are many days on which the CAISO system loads are high while SDG&E loads are more modest, and vice-versa. This correlation for SDG&E tends to be weakest when CAISO loads are below 46,000 MW. CAISO loads often reach 43,000 MW when loads in the Los Angeles area are extreme but San Diego loads are moderate. However, whenever CAISO loads have exceeded 45,000 MW, loads typically have been high across all three IOUs, leading to a stronger correlation for SDG&E in these cases.

Table 5-1**Error! Reference source not found.** and Table 5-2**Error! Reference source not found.** show the AC Saver Day Of residential and commercial enrollment-weighted average mean17 (temperature buildup from midnight to 5 PM) for the typical event day and the monthly system peak days under the four sets of weather conditions for which load impacts are estimated. The differences in mean17 values based on SDG&E peak conditions and CAISO peak conditions, and also differences between normal and extreme weather conditions, can be significant. For example, the residential AC Saver Day Of enrollment-weighted temperature on a 1-in-10 SDG&E September peak day is 85°F, while on a CAISO 1-in-10 peak September day it is 82°F. There are also large differences across months. As seen in later tables in this section, even small differences in the value of mean17 can have large impacts on aggregate load impacts.

Table 5-1: Residential AC Saver Day Of Enrollment-weighted Ex Ante Weather Conditions (mean17)

Customer Type	Cycling	Day Type	CAISO System Mean17 Temperature (°F)		SDG&E System Mean17 Temperature (°F)	
			1-in-2	1-in-10	1-in-2	1-in-10
Residential	50%	Typical Event Day	76	80	76	81
		April Peak Day	67	72	66	76
		May Peak Day	68	76	70	77
		June Peak Day	68	82	68	79
		July Peak Day	73	77	76	78
		August Peak Day	81	80	80	82
		September Peak Day	83	82	82	85
		October Peak Day	73	78	76	79
	100%	Typical Event Day	76	80	76	81
		April Peak Day	67	72	67	76
		May Peak Day	67	76	70	77
		June Peak Day	68	82	68	79
		July Peak Day	73	77	76	78
		August Peak Day	81	80	80	82
		September Peak Day	83	82	82	85
		October Peak Day	73	78	76	79

Table 5-2: Commercial AC Saver Day Of Enrollment-weighted Ex Ante Weather Conditions (mean17)

Customer Type	Cycle	Day Type	CAISO System Mean17 Temperature (°F)		SDG&E System Mean17 Temperature (°F)	
			1-in-2	1-in-10	1-in-2	1-in-10
Commercial	30%	Typical Event Day	76	80	76	81
		April Peak Day	67	72	67	76
		May Peak Day	67	76	70	77
		June Peak Day	68	81	68	78
		July Peak Day	72	76	75	78
		August Peak Day	80	79	79	82
		September Peak Day	82	82	82	85
		October Peak Day	73	78	75	79
	50%	Typical Event Day	75	79	76	80
		April Peak Day	67	72	67	77
		May Peak Day	67	76	70	77
		June Peak Day	68	80	68	78
		July Peak Day	72	76	75	77
		August Peak Day	80	79	79	82
		September Peak Day	82	82	82	85
		October Peak Day	73	78	75	79

AC Saver Day Of enrollment is assumed to decrease over the forecast horizon. **Error! Reference source not found.** Table 5-3 shows the enrollment forecast for the two customer groups for the summer months of each year from 2020 to 2030. The forecast reflects an annual enrollment decrease from 2020-2022 of approximately 4% for residential customers and 3% for commercial customers.

Table 5-3: 2020–2030 AC Saver Day Of Program Enrollment Forecast Number of Enrolled Customers

Customer Type	Forecast Year	Forecast Month						
		April	May	June	July	August	September	October
Residential	2020	7,272	7,272	7,272	7,272	7,272	7,272	7,272
	2021	6,971	6,971	6,971	6,971	6,971	6,971	6,971
	2022	6,690	6,690	6,690	6,690	6,690	6,690	6,690
	2023	6,690	6,690	6,690	6,690	6,690	6,690	6,690
	2024-2030	6,690	6,690	6,690	6,690	6,690	6,690	6,690
Commercial	2020	3,558	3,558	3,558	3,558	3,558	3,558	3,558
	2021	3,452	3,452	3,452	3,452	3,452	3,452	3,452
	2022	3,349	3,349	3,349	3,349	3,349	3,349	3,349
	2023	3,349	3,349	3,349	3,349	3,349	3,349	3,349
	2024-2030	3,349	3,349	3,349	3,349	3,349	3,349	3,349

While AC Saver Day Of events can be called any time between noon and 9 PM, ex ante load impacts reported here represent the average load impact across the hours from 4 to 9 PM, reflecting the peak period as defined by the CPUC for determining resource adequacy requirements.

Table 5-4 and Table 5-5 summarize the average and aggregate load impact estimates per premise under SDG&E-specific peaking conditions and CAISO peaking conditions for 2020. The per premise load impacts are highest for the September monthly peak for both CAISO and SDG&E system conditions, for both residential and commercial, and for both 1-in-2 and 1-in-10 weather conditions, with the exception of CAISO 1-in-10 weather conditions which show the highest use for the June monthly peak. Similarly, the per premise impacts are lowest for the April monthly peak for all scenarios and customer types, except for CAISO 1-in-2 weather conditions which are lowest for the May monthly peak.

For a typical event day under SDG&E-specific weather conditions, the impact per premise in a 1-in-2 year is 0.17 kW for residential customers and 0.26 kW in a 1-in-10 year. The hottest weather conditions are expected in the month of September, where per premise load impacts peak at 0.28 kW under the SDG&E-specific 1-in-2 conditions and at 0.34 kW under 1-in-10 conditions. Differences between 1-in-2 and 1-in-10 load impacts are driven by differences in mean17, which vary by as much as 7 degrees for some months; a 7 degree temperature difference on average over 17 hours represents a very large difference in temperature conditions and air conditioning requirements.

Load impacts for commercial customers follow similar patterns. Under the SDG&E peaking scenarios, typical event day per premise load impacts are 0.13 kW under the 1-in-2 assumption and 0.16 kW under the 1-in-10 assumption. In September, commercial per premise load impacts peak at 0.18 kW under 1-in-2 conditions and 0.20 kW under 1-in-10 conditions. While the commercial load impacts are very similar to residential impacts, they on one hand reflect lower cycling strategies (30% and

50% compared to 50% and 100%) and on the other reflect more CAC units enrolled in the program per premise. The net effect is that commercial load impacts are similar, but somewhat lower, than residential. The milder cycling strategies also yield less weather-sensitive load impacts for commercial participants as compared to residential participants.

The aggregate program load reduction potential for residential customers is 1.2 MW for a typical event day under SDG&E-specific 1-in-2 year weather conditions in 2020 and 0.5 MW for commercial customers. Under SDG&E-specific 1-in-10 year weather conditions, the aggregate impacts for residential and commercial customers are 1.9 MW and 0.6 MW, respectively. The aggregate impacts under CAISO weather conditions are slightly lower for both weather year types.

Table 5-4: 2020 Residential Ex Ante Load Impact Estimates by CAISO and SDG&E-specific Weather and Day Type

Customer Type	Day Type	Per Premise Impact (kW)				Aggregate Impact (MW)			
		CAISO 1-in-2	SDGE 1-in-2	CAISO 1-in-10	SDGE 1-in-10	CAISO 1-in-2	SDGE 1-in-2	CAISO 1-in-10	SDGE 1-in-10
Residential	Typical Event Day	0.16	0.16	0.24	0.26	1.2	1.2	1.7	1.9
	April Monthly Peak	0.00	0.00	0.08	0.16	0.0	0.0	0.6	1.2
	May Monthly Peak	0.00	0.03	0.16	0.19	0.0	0.2	1.2	1.3
	June Monthly Peak	0.01	0.00	0.28	0.22	0.0	0.0	2.0	1.6
	July Monthly Peak	0.09	0.15	0.18	0.20	0.7	1.1	1.3	1.5
	August Monthly Peak	0.25	0.23	0.23	0.28	1.9	1.7	1.7	2.1
	September Monthly Peak	0.29	0.28	0.27	0.34	2.1	2.1	2.0	2.5
	October Monthly Peak	0.10	0.15	0.20	0.22	0.7	1.1	1.5	1.6

Table 5-5: 2020 Commercial Ex Ante Load Impact Estimates by CAISO and SDG&E-specific Weather and Day Type

Customer Type	Day Type	Per Premise Impact (kW)				Aggregate Impact (MW)			
		CAISO 1-in-2	SDGE 1-in-2	CAISO 1-in-10	SDGE 1-in-10	CAISO 1-in-2	SDGE 1-in-2	CAISO 1-in-10	SDGE 1-in-10
Commercial	Typical Event Day	0.12	0.13	0.15	0.16	0.4	0.5	0.6	0.6
	April Monthly Peak	0.06	0.05	0.09	0.13	0.2	0.2	0.3	0.5
	May Monthly Peak	0.06	0.08	0.13	0.14	0.2	0.3	0.5	0.5
	June Monthly Peak	0.06	0.06	0.16	0.14	0.2	0.2	0.6	0.5
	July Monthly Peak	0.10	0.12	0.13	0.14	0.3	0.4	0.5	0.5
	August Monthly Peak	0.16	0.15	0.15	0.17	0.6	0.5	0.5	0.6
	September Monthly Peak	0.18	0.18	0.17	0.20	0.6	0.6	0.6	0.7
	October Monthly Peak	0.10	0.12	0.15	0.15	0.4	0.4	0.5	0.5

5.1.1 Comparison of Ex Ante Load Impacts by Month

Table 5-5 and Table 5-6 provide ex ante impact estimates on an hourly basis for residential and commercial customers, respectively. The hours presented reflect the peak period as defined by the CPUC resource adequacy requirements of 4 to 9 PM. Residential impacts peak in the hour from 5 to 6 PM, and commercial impacts peak in the hour from 4 to 5 PM.

September ex ante conditions are much hotter than typical event day conditions and therefore have the highest impacts. In 2020, the residential program is estimated to provide an average impact of 2.5 MW over the 5-hour event window from 4 to 9 PM on a 1-in-10 September monthly system peak day and 2.1 MW on the September monthly system peak day under 1-in-2 year weather conditions for SDG&E-specific peaking conditions.

There is significant variation in load impacts across months and weather conditions for residential customers and commercial customers. Based on 1-in-2 year weather, the low temperatures in April, May, and June typically experienced in San Diego result in the smallest average and aggregate load impacts. The April, May, and June 1-in-2 year impacts for residential customers are each less than 0.5 MW while the remaining month estimates are each above 1.0 MW. The April 1-in-10 year estimate for residential customers is over 1 MW greater than the 1-in-2 year estimate as a result of the 1-in-10 year temperatures being much warmer than the 1-in-2 year temperatures for April. For commercial customers, the April 1-in-10 year estimate is only 0.3 MW greater than the 1-in-2 year estimate – about a quarter the size of the residential difference.

Table 5-5: 2020 AC Saver Day Of Ex Ante Load Impact Estimates by Weather Year, Day Type and Hour Residential Customers – SDG&E Peaking Conditions

Weather Year	Day Type	Hour of Day					Average (MW)
		4 to 5 PM (MW)	5 to 6 PM (MW)	6 to 7 PM (MW)	7 to 8 PM (MW)	8 to 9 PM (MW)	
1-in-2	Typical Event Day	1.2	1.5	1.3	1.2	0.8	1.2
	April Monthly Peak	0.0	0.0	0.0	0.0	0.0	0.0
	May Monthly Peak	0.3	0.3	0.3	0.2	0.2	0.2
	June Monthly Peak	0.0	0.0	0.0	0.0	0.0	0.0
	July Monthly Peak	1.1	1.4	1.2	1.1	0.8	1.1
	August Monthly Peak	1.7	2.1	1.9	1.7	1.2	1.7
	September Monthly Peak	2.0	2.5	2.3	2.0	1.5	2.1
	October Monthly Peak	1.1	1.4	1.2	1.1	0.8	1.1
1-in-10	Typical Event Day	1.9	2.3	2.1	1.9	1.4	1.9
	April Monthly Peak	1.1	1.4	1.3	1.1	0.8	1.2
	May Monthly Peak	1.3	1.6	1.5	1.3	1.0	1.3
	June Monthly Peak	1.6	1.9	1.7	1.6	1.1	1.6
	July Monthly Peak	1.5	1.8	1.6	1.5	1.1	1.5
	August Monthly Peak	2.0	2.5	2.3	2.0	1.5	2.1
	September Monthly Peak	2.5	3.1	2.8	2.5	1.8	2.5
	October Monthly Peak	1.6	2.0	1.8	1.6	1.1	1.6

Table 5-6: 2020 AC Saver Day Of Ex Ante Load Impact Estimates by Weather Year, Day Type and Hour Commercial Customers – SDG&E Peaking Conditions

Weather Year	Day Type	Hour of Day					Average (MW)
		4 to 5 PM (MW)	5 to 6 PM (MW)	6 to 7 PM (MW)	7 to 8 PM (MW)	8 to 9 PM (MW)	
1-in-2	Typical Event Day	0.8	0.5	0.4	0.4	0.2	0.5
	April Monthly Peak	0.3	0.2	0.2	0.2	0.1	0.2
	May Monthly Peak	0.5	0.3	0.3	0.2	0.1	0.3
	June Monthly Peak	0.4	0.2	0.2	0.2	0.1	0.2
	July Monthly Peak	0.8	0.5	0.4	0.3	0.2	0.4
	August Monthly Peak	0.9	0.6	0.5	0.4	0.3	0.5
	September Monthly Peak	1.1	0.7	0.6	0.5	0.3	0.6
	October Monthly Peak	0.7	0.5	0.4	0.3	0.2	0.4
1-in-10	Typical Event Day	1.0	0.6	0.5	0.4	0.3	0.6
	April Monthly Peak	0.8	0.5	0.4	0.4	0.2	0.5
	May Monthly Peak	0.9	0.5	0.4	0.4	0.3	0.5
	June Monthly Peak	0.9	0.5	0.5	0.4	0.3	0.5
	July Monthly Peak	0.9	0.5	0.4	0.4	0.3	0.5
	August Monthly Peak	1.1	0.6	0.6	0.5	0.3	0.6
	September Monthly Peak	1.2	0.7	0.6	0.5	0.4	0.7
	October Monthly Peak	0.9	0.6	0.5	0.4	0.3	0.5

Table 5-7 provides program-level ex ante aggregate estimates for each hour. In 2020, the program is expected to provide its highest impact under 1-in-10 year conditions in September. Under those conditions, the average impact over the event window is expected to be 3.2 MW, with an hourly peak of 3.8 MW between the hours of 5 and 6 PM.

Table 5-7: 2020 AC Saver Day Of Ex Ante Load Impact Estimates by Weather Year, Day Type and Hour – All Customers – SDG&E Peaking Conditions

Weather Year	Day Type	Hour of Day					Average (MW)
		4 to 5 PM (MW)	5 to 6 PM (MW)	6 to 7 PM (MW)	7 to 8 PM (MW)	8 to 9 PM (MW)	
1-in-2	Typical Event Day	2.0	1.9	1.7	1.5	1.1	1.7
	April Monthly Peak	0.3	0.2	0.2	0.2	0.1	0.2
	May Monthly Peak	0.7	0.6	0.5	0.5	0.3	0.5
	June Monthly Peak	0.4	0.2	0.2	0.2	0.1	0.2
	July Monthly Peak	1.9	1.8	1.6	1.4	1.0	1.5
	August Monthly Peak	2.6	2.6	2.3	2.1	1.5	2.2
	September Monthly Peak	3.1	3.2	2.9	2.5	1.8	2.7
	October Monthly Peak	1.8	1.8	1.6	1.4	1.0	1.5
1-in-10	Typical Event Day	2.9	2.9	2.6	2.3	1.7	2.5
	April Monthly Peak	2.0	1.9	1.7	1.5	1.1	1.6
	May Monthly Peak	2.2	2.2	1.9	1.7	1.2	1.8
	June Monthly Peak	2.5	2.5	2.2	1.9	1.4	2.1
	July Monthly Peak	2.3	2.3	2.1	1.8	1.3	2.0
	August Monthly Peak	3.1	3.1	2.8	2.5	1.8	2.7
	September Monthly Peak	3.7	3.8	3.4	3.0	2.2	3.2
	October Monthly Peak	2.5	2.5	2.3	2.0	1.4	2.1

5.2 Comparison of 2018 Ex Ante Load Impacts to 2019 Ex Ante Load Impacts

The 2018 AC Saver Day Of load impact evaluation estimated that the program's 2020 capacity load reduction is reached under September SDG&E-specific 1-in-10 weather conditions; residential load impacts peak at 5.1 MW, and 1.4 MW in the case of the commercial segment.

This current year's evaluation yields lower estimates of program capacity for the residential segment under these conditions – 2.5 MW vs. last year's estimate of 5.1 MW, and also lower estimates of program capacity for the commercial segment – 0.7 MW versus 1.4 MW last year. A full comparison of the 2018 estimates and 2019 estimates of the 2020 program year under different weather years and day types can be found in Table 5-8.

Table 5-8: 2020 AC Saver Day Of Estimates by Weather Year and Day Type – 2018 to 2019 Comparison – All Customers – SDG&E Peaking Conditions

Weather Year	Day Type	2018 Average Estimate for 2020 (MW)	2019 Average Estimate for 2020 (MW)
1-in-2	Typical Event Day	3.4	1.7
	April Monthly Peak	0.4	0.2
	May Monthly Peak	1.2	0.5
	June Monthly Peak	0.6	0.2
	July Monthly Peak	3.2	1.5
	August Monthly Peak	4.5	2.2
	September Monthly Peak	5.5	2.7
	October Monthly Peak	3.1	1.5
1-in-10	Typical Event Day	5.1	2.5
	April Monthly Peak	3.8	1.6
	May Monthly Peak	4.3	1.8
	June Monthly Peak	4.8	2.1
	July Monthly Peak	4.1	2.0
	August Monthly Peak	5.5	2.7
	September Monthly Peak	6.4	3.2
	October Monthly Peak	4.3	2.1

The differences between the 2020 ex ante load impact estimates are a composite net change reflecting differences in two key factors that influence ex ante load impacts:

Enrollment – Forecasted enrollment for 2020 has decreased substantially for the residential segment, from 8,994 enrolled residential customers to 7,272 enrolled residential customers. Forecasted commercial enrollment has decreased 17% from 4,277 customers to 3,558 customers.

Per premise load impacts – Peak residential per premise load impacts have seen a substantial decrease from 0.58 kW in the prior evaluation, for SDG&E peaking conditions on a 1-in-10 year for a September monthly peak, to 0.34 kW in the current load impact evaluation. Similarly, per premise load impacts have decreased by 38% for commercial participants, decreasing from 0.32 kW to 0.20 kW this year. These decreases may be due to more mild overall temperatures in 2019 compared to 2018 – the average event mean17 was 74 °F in 2019, compared to 77 °F in 2018. These cooler temperatures results in lower overall CAC use in customers, which directly results in lower impacts for programs that aim to reduce CAC usage. These lower impacts, which were used as the basis for the ex ante regressions, resulted in lower estimates of savings across all temperatures in the predictive weather sets.

5.3 Relationship between Ex Post and Ex Ante Load Impact Estimates

Table 5-7 facilitates a comparison of the ex post load impact estimates between each event and the ex ante estimates for 1-in-2 and 1-in-10 SDG&E weather conditions. Although ex ante estimates were created using only weekday 6 to 8 PM events, all events are included in this table for completeness.

The purpose of this table is to demonstrate the four important changes that are made to go from ex post results to ex ante predictions: enrollment numbers, predictions using a weather-dependent model, the event window, and weather. We will now step through the table to explain each of these changes, using the first event as an example:

1. First, 0.56 MW (Column D) was delivered by AC Saver Day Of on June 10, 2019, when the heat build-up (as measured by mean17) was 72.5 °F (Column B). This load impact was generated by 11,196 total AC Saver Day Of participants (Column C).

2. Given the mean17 observed on this date (Column B), the observed enrollment numbers (Column C), and the hours of the event (Column A), our ex ante model predicts that we would expect AC Saver Day Of to deliver 0.82 MW of load reduction (Column E). The impact scaling in this model is based on the impacts from 6-8pm weekday events from 2018 and 2019, and because our model is linear, this difference between ex post (Column D) and ex ante (Column E) implies that the load impact observed on June 10, 2019 was lower than average.

3. The next step is to perform the same ex ante model calculation as in Step 2, but to use the total predicted enrollment between residential and commercial (Column F) in place of the observed enrollment numbers (Column C). Note that as the total enrollment number changes, there may also be changes in the proportions of residential and commercial customers, and in the enrollments in different cycling options within each customer type, all of which is captured by the model. Using these new enrollment figures, our ex ante model predicts that we would expect AC Saver Day Of to deliver 0.79 MW of load reduction (Column G) on a day with a similar temperature profile (Column B) as June 10, 2019.

4. Another key difference in going from ex post to ex ante results is that ex ante results are designed to cover the RA window of 4 PM to 9 PM, which is longer than any AC Saver Day Of events. This is resolved by creating an approximate load shape that covers the RA window, which is used to convert the ex ante model output to an ex ante impact. Here, we take the observed ex post load impact (Column D), apply the predicted enrollment numbers from ex ante (Column F), and stretch the hourly impacts to fit the approximate RA window load shape. This gives an adjusted ex post load impact of 0.56 MW (Column H). Depending on the proportions of different groups of customers and the hours of the event, this new estimate may increase, decrease, or stay the same, as it did for this event.

5. We may now compare this adjusted ex post impact "apples-to-apples" with ex ante load impacts, since they now use the same enrollment (Column F) and RA window load shape. Our adjusted ex post load impact of 0.56 MW (Column H) occurs at a mean17 value of 72.5 °F (Column B). That temperature is between the 1-in-2 and 1-in-10 mean17 values for a June monthly system peak day of 67.7 °F (Column I) and 78.7 °F (Column K), respectively; therefore, we expect the adjusted ex post load impact to lie in between the 1-in-2 and 1-in-10 ex ante load impact estimates. Indeed, this is the case – the 1-in-2 ex ante load impact estimate is 0.23 MW (Column J), and the 1-in-10 ex ante load impact estimate is 2.09 MW (Column L), which are lower and higher, respectively, than the adjusted ex post load impact of 0.56 MW (Column H).

Table 5-9: Ex Post to Ex Ante Impacts by Analysis Step

Ex Post									SDG&E 1-in-2		SDG&E 1-in-10	
Date and Event Time		Mean 17 (°F)	Ex Post Enrollment	Ex Post Estimate (MW)	Ex Ante Estimate Using 2018 Enrollment (MW)	Ex Ante Enrollment	Ex Ante Estimate Using 2019 Enrollment (MW)	Ex Post Estimate Using 2019 Enrollment and Adjusted to RA Window (MW)	Mean 17 (°F)	Ex Ante Estimate Using 2019 Enrollment and Adjusted to RA Window (MW)	Mean 17 (°F)	Ex Ante Estimate Using 2019 Enrollment and Adjusted to RA Window (MW)
A		B	C	D	E	F	G	H	I	J	K	L
10-Jun-19	7 - 9pm	72.5	11,196	0.56	0.82	10,830	0.79	0.56	67.7	0.23	78.7	2.09
23-Jun-19	7 - 9pm	68.0	11,977	0.17	0.19		0.18	0.21				
12-Jul-19	6 - 8pm	71.0	11,937	0.65	0.78	10,830	0.71	0.55	75.6	1.54	78.0	1.98
22-Jul-19	6 - 8pm	73.0	11,934	1.25	1.17		1.06	1.14				
23-Jul-19	5 - 8pm	77.7	11,925	1.66	2.26		2.02	1.46				
24-Jul-19	6 - 8pm	79.6	11,912	1.22	2.50		2.23	1.02				
29-Jul-19	6 - 8pm	71.6	11,859	1.09	0.90		0.82	0.91				
4-Aug-19	6 - 8pm	72.5	11,570	1.40	1.06	10,830	0.99	1.21	79.4	2.22	82.0	2.67
5-Aug-19	6 - 8pm	73.0	11,562	1.44	1.13		1.06	1.29				
6-Aug-19	6 - 8pm	73.3	11,563	1.18	1.20		1.12	1.10				
11-Aug-19	7 - 9pm	69.9	11,590	0.11	0.42		0.40	0.13				
14-Aug-19	6 - 8pm	72.2	11,587	1.31	1.00		0.94	1.21				
15-Aug-19	6 - 8pm	72.2	11,567	1.04	0.99		0.93	0.91				
26-Aug-19	6 - 8pm	79.0	11,373	1.89	2.24		2.13	1.72				
27-Aug-19	6 - 8pm	75.1	11,372	1.36	1.51		1.43	1.29				
4-Sep-19	4 - 7pm	79.9	11,649	2.07	2.81	10,830	2.59	1.84	82.3	2.70	85.1	3.21
5-Sep-19	5 - 8pm	80.2	11,525	2.19	2.67		2.48	1.88				
6-Sep-19	6 - 8pm	78.9	11,516	2.18	2.26		2.10	1.94				
21-Oct-19	6 - 8pm	72.3	11,261	0.31	0.96	10,830	0.93	0.33	75.6	1.54	79.1	2.15
22-Oct-19	5 - 8pm	75.3	11,261	0.76	1.61		1.54	0.75				

6 Findings and Recommendations

This section presents findings and recommendations from the 2019 AC Saver Day Of load impact evaluation.

Finding 1

Average load impacts from the 2019 summer season were lower than those from the previous summers. This can partially be attributed to differences in weather – the average heat buildup (mean17) during events in 2019 was 74 °F while the average in 2018 was 77 °F. However, another cause may be the age and responsiveness of the device fleet. As of the last event in 2019, 44.5% of customers (4,192) have a device with an enrollment date before 2010. Seventy-five percent of customers (7,021) have a device with an enrollment date before 2015. The average age of customers' oldest devices is 8 years and 8 months (July 2011). Devices that have been installed for a long period of time could be nonfunctional or have been inadvertently disconnected during CAC upgrades or maintenance.

Recommendation 1

In order to ensure that the program's direct load control devices are dispatching during events and producing load reductions, a field study should be conducted that examines the fleet of devices for functionality, prioritizing those that have been installed for the longest period of time. Alternatively, a data-based analysis could be designed that uses clustering or similar techniques to identify specific devices that do not exhibit evidence of cycling during program events.

Finding 2

As discussed in Section **Error! Reference source not found.**, the residential weekday event with the lowest impacts occurred on October 21, 2019, with an aggregate impact of 0.11 MW and an average per premise impact of 0.01 kW. The low impacts are partially explained by the lower mean17 of 72 °F, but the main cause may be the fact that the event was called after a long spell of cool weather, during which the average mean17 was 68 °F. Participants may have turned off their CAC units by this time in the year and after a long period of time with cool weather. This is further supported by the event that was called the very next day, where impacts rose to 0.04 kW per premise at similar temperature conditions.

Recommendation 2

The possibility of low or negative impacts should be considered when calling events after a long period of cool weather.

Finding 3

At the end of summer 2019, there were 3,864 commercial participants and 9,860 residential participants. This represents about a 12% decrease in enrolled customers and in enrolled tons relative to 2018. Exploring the incidence of de-enrollment throughout the 2019 control season, there appeared to be large increases in de-enrollment that coincided with events being called on three consecutive days. On July 25, 71 customers de-enrolled following events on July 22-24, with another 104 customers de-enrolling on July 29. On September 5, 322 customers de-enrolled in the middle of consecutive events being called on September 4-6. On August 7, 207 customers de-enrolled following consecutive events on August 4-6. These de-enrollments represent almost 40% of the total de-enrollments in summer 2019.

Recommendation 3

The possibility of large-scale de-enrollments should be considered when calling AC Saver Day Of events on consecutive days.

Finding 4

Twelve out of 20 events in 2019 were two-hour events that occurred between 6 and 8 PM. In the ex ante analysis, to ensure that similar events were used from both 2018 and 2019, the average load impacts are defined as the average load impact across the window of 6 to 8 PM, for all weekday events with the event window spanning this two-hour range. The benefit of this is that it resulted in the greatest amount of data points available for estimating the model – 12 of the 20 events in 2019 fit these criteria, as well as 12 of the 18 events in 2018. However, the CPUC Load Impact Protocols require that ex ante load impacts be reported for the Resource Adequacy window of 4 to 9 PM. Only using two-hour events to estimate impacts for a five-hour window requires developing techniques such as the shaping ratios described in Section 3.3.

Recommendation 4

In order to facilitate a less tenuous connection between ex post and ex ante, SDG&E should call three to four events that are the maximum of four hours in duration each season, between the hours of 4 PM to 9 PM. The results from these events will help to better construct the ex ante impacts for the Resource Adequacy window.

Headquarters

49 Stevenson Street, Suite 700

San Francisco CA 94105-3651

Tel: (415) 369-1000

Fax: (415) 369-9700

www.nexant.com