2021 Load Impact Evaluation of San Diego Gas and Electric's AC Saver Day Of Program

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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 2021 AC Saver Day Of program and ex ante load impact forecasts for 2022–2032.

The AC Saver Day Of program is available to residential and commercial customers in the SDG&E territory. There are two enrollment options 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. Load control is enabled through devices installed on enrolled CAC units that receive dispatch signals from the program's control system, delivered through a public paging network. 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 2021, there were 12,073 customers enrolled in the program with a total cooling capacity of 61,514 tons. These counts represent all the customers that were enrolled at some point during the 2021 season. For the 2021 program year, there were 9,418 residential customers, representing approximately 78% of AC Saver Day Of participants, and 37,266 cooling tons, accounting for about 61% of the program's total tonnage. In the commercial customer class, there were 2,655 participants and 24,248 cooling tons enrolled. Among residential participants, 29% selected the highest cycling option (100% cycling); among commercial participants, 77% selected the 50% cycling option over the 30% option.

In 2020, the COVID-19 pandemic resulted in higher residential reference loads and subsequently higher load impacts due to increased home occupancy as a result of stay-at-home orders. Similarly, the pandemic caused commercial customer reference loads and load impact estimates to be lower because of decreased occupancy and operations. In 2021, residential reference loads decreased compared to 2020, but remained higher than 2019. On the other hand, commercial reference loads returned to 2019 levels. Both residential and commercial absolute kW impacts were more similar to those observed in 2019 than 2020.

A total of seven regular program events were called in 2021 with event hours ranging between 5 PM and 9 PM. There were no events called on weekends. Event hours varied but the most common event period was 6 to 8 PM, which comprised 4 of the 7 events. The event period from 6 to 8 PM is used for reporting Average Event Day load impacts. Load impacts were 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 2021 AC Saver Day Of residential ex post load impacts and maximum event window temperatures. The average aggregate demand reduction for residential customers totaled 0.43 MW, or 0.06 kW per premise. The largest load reduction was 1.28 MW on the last event of the season, held on September 10. As shown in Table 1-2, the aggregate load reduction for commercial customers was roughly 0.22 MW, or 0.09 kW per premise. The largest load reduction for commercial customers totaled 0.31 MW and occurred on the first event of the season, June 15, which also had the highest event window temperature of the seven events called this season.

Table 1-1: 2021 AC Saver Day Of Average Residential Ex Post Load Impacts

Date	Impact				Max Event Window Temperature (°F)
	Per Ton (kW)	Per Device (kW)	Per Premise (kW)	Aggregate (MW)	
6/15/2021	0.02	0.09	0.10	0.77	89
6/16/2021	0.00	0.00	0.00	0.03	76
6/17/2021	0.00	0.01	0.01	0.06	75
7/12/2021	0.00	0.00	0.00	0.01	74
7/29/2021	0.02	0.07	0.09	0.66	80
9/9/2021	0.03	0.11	0.12	0.93	84
9/10/2021	0.04	0.15	0.17	1.28	84
Average*	**0.01**	**0.05**	**0.06**	**0.43**	**81**

* Reflects the average 6 PM to 8 PM weekday 2021 AC Saver Day of event

Table 1-2: 2021 AC Saver Day Of Average Commercial Ex Post Load Impacts

Date	Impact				Max Event Window Temperature (°F)
	Per Ton (kW)	Per Device (kW)	Per Premise (kW)	Aggregate (MW)	
6/15/2021	0.01	0.06	0.14	0.31	88
6/16/2021	0.01	0.02	0.05	0.11	75
6/17/2021	0.00	0.01	0.02	0.04	73
7/12/2021	0.01	0.03	0.08	0.16	73
7/29/2021	0.00	0.02	0.04	0.09	79
9/9/2021	0.01	0.04	0.11	0.28	83
9/10/2021	0.01	0.03	0.08	0.21	82
Average*	**0.01**	**0.04**	**0.09**	**0.22**	**80**

* Reflects the average 6 PM to 8 PM weekday 2021 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. 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.

As shown in Table 1-3, on a typical event day in 2022 under 1-in-2 year SDG&E-specific peaking conditions, aggregate load impacts are forecasted to equal 1.1 MW for residential customers and 0.3 MW for commercial customers, for a total program load reduction of 1.4 MW. In 2022, 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 0.3 MW for residential and commercial customers, respectively, or 2.2 MW in total. This is about 55% greater than on a typical event day under 1-in-2 year weather conditions.

Table 1-3: 2022 AC Saver Day Of Typical Event Day Aggregate Ex Ante Impacts

Customer Type	Day Type	Aggregate Impact (MW)	
		SDGE 1-in-2	SDGE 1-in-10
Residential	Typical Event Day	1.1	1.9
Commercial	Typical Event Day	0.3	0.3
Total	**Typical Event Day**	**1.4**	**2.2**

In the case of the residential segment, August 2022 enrollments are forecasted to be 7,160 participants. In the case of the commercial segments, August 2022 enrollments are forecasted to be 1,963 participants. Over the next five years, the residential population is projected to decrease by 6.5% per year while the commercial population is projected to decrease by 3.2% per year.

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 2021 ex post load impact estimates and ex ante load impact estimates for an 11-year forecast horizon (2022–2032) 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. AC Saver Day Of events may only be called during the months of April through October. Under the current program framework, events can be triggered up to 80 hours per year, 24 hours per month, and three consecutive days at maximum with a total of no more than 20 events per year. 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.

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 12 PM and 9 PM, and each event may last from a minimum of two to a maximum of four hours in duration. Prior to 2017, an AC Saver Day Of event could be called between 12 PM and 8 PM, and each event could last one to four hours.

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.

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[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.

For example, 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.

For instance, 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.

Customer enrollment in the AC Saver Day Of program is summarized in Table 2-1. The table includes all customers who were enrolled at any point during the 2021 season. There were 12,073 customers enrolled in the program, representing 61,514 tons of CAC capacity in aggregate. For the 2021 program year, residential customers represented approximately 78% of AC Saver Day Of participants and accounted for about 61% of the program's total cooling tons. About 71% of residential customers selected the 50% cycling option and approximately 77% of commercial customers chose the 50% cycling option, which represent the higher of the two cycling strategies offered to those customer segments. Total enrollment—as measured by number of customers, number of devices, and CAC capacity (in tons)—has generally decreased for residential and commercial customers since 2017 due to minimal marketing to attract new participants to the program.

Table 2-1: AC Saver Day Of Enrollment

Customer Type	Cycling Option	Enrolled Customers	Enrolled Control Devices	Enrolled Tons
Residential	50%	6,692	7,561	25,771
	100%	2,726	3,216	11,495
	Total	9,418	10,777	37,266
Commercial	30%	603	1,732	6,420
	50%	2,052	4,693	17,829
	Total	2,655	6,425	24,248
Grand Total		**12,073**	**17,202**	**61,514**

The global COVID-19 pandemic had less impact on customers in 2021 than 2020. The SDG&E service territory was subject to stay-at-home orders and other state-mandated social distancing measures during the entirety of the 2020 load control season. These measures were mostly lifted in time for the 2021 event season. In terms of program operations, there were no COVID-19 related changes to the AC Saver Day Of program. However, there were observable changes in hourly energy usage profiles for both commercial and residential participants compared to 2020. Residential reference loads are lower than what was observed in 2020 but higher than pre-pandemic loads in 2019. This could reflect people continuing to work from home since the start of the pandemic. In the future, residential reference loads may not return to 2019 levels if people work from in the long-term. Commercial reference loads returned to 2019 levels. Usage profiles decreased during 2020 from businesses facing operational restrictions that lowered load. Since COVID-19 had less effect on society in 2021 than 2020, the methodologies used in this evaluation more closely follow those used in 2019. Additionally, impacts calculated for 2020 are excluded from the ex ante methodology.

2.1. Report Structure

The remainder of this report is organized as follows: Section 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. Section 4 contains the ex post load impact estimates. Section 5 presents the ex ante estimates and provides details concerning the differences between the 2021 and the 2019 ex ante load impacts—in addition to differences between ex post and ex ante load impacts. Section 6 presents the key findings from this evaluation and recommendations for future program years.

3. Data and Methodology

This section describes the datasets and analysis methods used to estimate load impacts for each event in 2021 and for ex ante weather and event conditions. Ex post results were calculated using control and treatment groups. The residential segment was evaluated with a randomized controlled trial (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, 2019, and 2021 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, 2019, and 2021 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 3.2.3.

3.1. Data

A total of seven AC Saver Day Of events were called in 2021. Table 3-1 shows the date, day of week, start time, end time, and temperature metrics for each event. The event hours varied from 12 PM to 9 PM across the events in 2021. There were no events called on weekends.

Table 3-1: Summary of 2021 AC Saver Day Of Events

Date	Day of Week	Start Time	End Time	Mean17 (°F)	Max. Event Window Temperature (°F)
6/15/2021	Tuesday	6:00 PM	8:00 PM	74	89
6/16/2021	Wednesday	6:00 PM	8:00 PM	71	76
6/17/2021	Thursday	6:00 PM	9:00 PM	70	75
7/12/2021	Monday	6:00 PM	8:00 PM	71	74
7/29/2021	Thursday	6:00 PM	9:00 PM	73	80
9/9/2021	Thursday	6:00 PM	8:00 PM	75	84
9/10/2021	Friday	5:00 PM	8:00 PM	76	84

Table 3-2 shows the distribution of CAC tonnage by cycling option and climate zone for the residential participant population as of October 2021. Due to the small populations of participants in the

Mountain and Desert Climate Zones, they are combined into the Coastal and Inland Climate Zones, respectively, in the ex post and ex ante analyses.

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

Group	Cycling Option	Group	Climate Zone				Total
			Coastal	Inland	Desert	Mountain	
Residential	50%	Population	9%	59%	0.1%	0.9%	71%
	100%	Population	8%	23%	0.0%	0.2%	29%
	Total	**Population**	**17.3%**	**81.5%**	**0.1%**	**1.1%**	**100%**
Commercial	30%	Population	13%	13%	0.0%	0.2%	25%
	50%	Population	36%	37%	0.0%	0.1%	75%
	Total	**Population**	**48.9%**	**50.8%**	**0.0%**	**0.3%**	**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 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 2021. 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 2021, 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

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

Variable	Definition
$\boldsymbol{PeakProxy}$	Average demand across the 2021 proxy days during the event window hours
$\boldsymbol{EventMorn}$	Average demand on the event day from midnight to 10 AM
$\boldsymbol{EventMidday}$	Average demand on the event day from 10 AM to the start of the event
$\boldsymbol{j}$	Commercial AC Saver Day Of participant to be matched
$\boldsymbol{i}$	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 (for commercial customers) and climate zone would be matched to one another. Likewise, NEM customers were only matched to other NEM customers (for commercial customers). This approach minimizes the differences between participants and matched nonparticipants while allowing for good estimates for program subsegments of interest.

The matching process proceeds, one participant at a time, by selecting the non-participant with the same industry (commercial only), climate zone, and NEM status (commercial only) 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 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

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

Variable	Definition
$\boldsymbol{Demand}$	Average demand in the event hour being studied
$\boldsymbol{Cycled}$	An indicator for whether customer i was cycled
$\boldsymbol{Proxy}$	Average demand in the hour being studied on the average proxy day
$\boldsymbol{ProxyWindow}$	Average demand in the event window on the average proxy day
$\boldsymbol{ProxyEve}$	Average demand after the event window on the average proxy day
$\boldsymbol{EventMorn1}$	Average demand from midnight to 7 AM on the event day
$\boldsymbol{EventMorn2}$	Average demand from 7 AM to 10 AM on the event day
$\boldsymbol{EventMorn3}$	Average demand from 10 AM to four hours before the event on the event day
$\boldsymbol{PreEvent}$	Average demand during the four hours before the event
$\boldsymbol{PreProxy}$[5]	Average demand during the four hours before the event on proxy day
$\boldsymbol{i}$	Customer index
$\boldsymbol{t}$	Estimated impact
$\boldsymbol{a - j}$	Estimated regression coefficients
$\boldsymbol{u}$	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 performed well (we discuss our matching validation in the next section of this report). In cases such as this, where the matching performs 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 entire residential AC Saver Day Of population were calculated by taking a weighted average of the impact estimates for each cycling option, with weights determined

[5] This term was included only for residential customers to account for control group B having generally lower usage on proxy days than the rest of the treatment customers. See Section 3.2.2. for more details.

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 groups are similar in terms of sample size and average CAC when comparing A and B groups within each cycling strategy. The 100% cycling strategy has a slightly higher average CAC tonnage per household than the 50% group. The differences in sample sizes are reflective of naturally occurring program attrition. All groups started with 800 customers at the beginning of the program season.

Table 3-3: 2021 Residential A and B Group Comparison
Sample Size, Tonnage, and Cycling Options

Cycling Strategy	Group	Sample Size	Average CAC Tonnage per Household
50%	A	729	3.8
	B	729	3.9
100%	A	723	4.2
	B	714	4.3
Total/Average		**2,895**	**4.0**

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. Additionally, it is possible the ongoing COVID-19 pandemic affected usage patterns differently for customers throughout the course of 2020 and 2021. Since the control groups were sampled using usage data from 2020, customer load may have changed significantly between 2020 and 2021 depending on challenges they faced from COVID. Subsequently, it is not surprising that the control groups show some separation from the rest of the customer population on proxy days. In 2021, 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 nonevent days, are 8% 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 nonevent days are less than 1% during event hours.

Figure 3-1, Figure 3-2, and Figure 3-3 illustrate these differences on 17 nonevent days in 2021. As the figures show, average load of the two residential samples is close to the overall population. Both group A and B have slightly lower usage than the general population of residential customers on proxy days, with group B having a little lower usage than group A. 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, the residential A group shows 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 50% cycling B group shows lower usage than the general population of customers. This difference was controlled for in Equation 3-2 by adding an additional variable that accounts for pre-event usage on proxy days. 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 previous evaluations, and the small magnitude is a result of the large sample size afforded by the matching approach for commercial customers.

Figure 3-1: Residential Group A and All Comparison Average Load across All 2021 Proxy Days

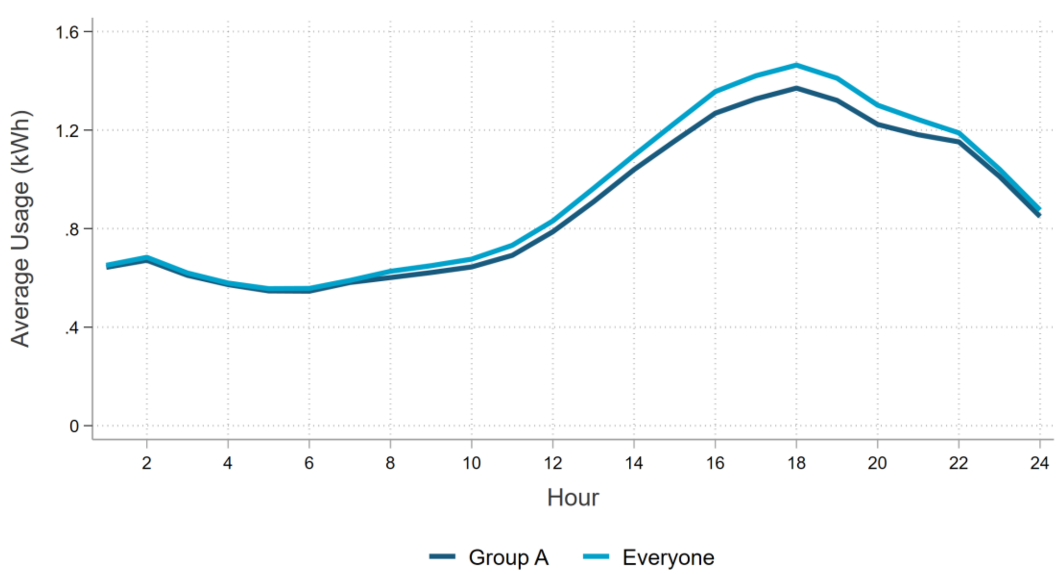


Figure 3-2: Residential Group B and All Comparison Average Load across All 2021 Proxy Days

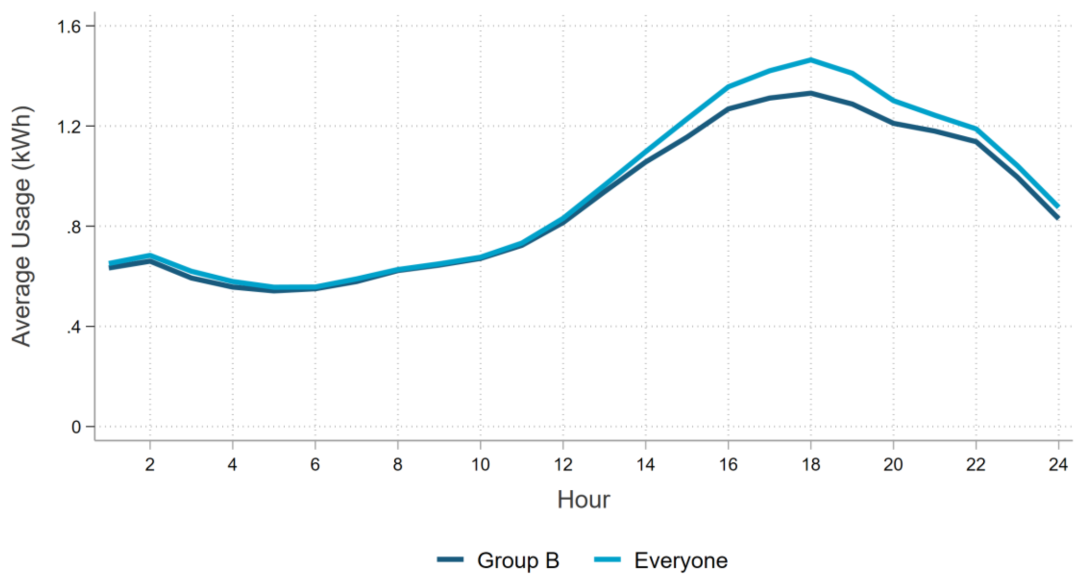


Figure 3-3: Commercial Matched Control and Treatment Group Comparison Average Load across All 2021 Proxy Days

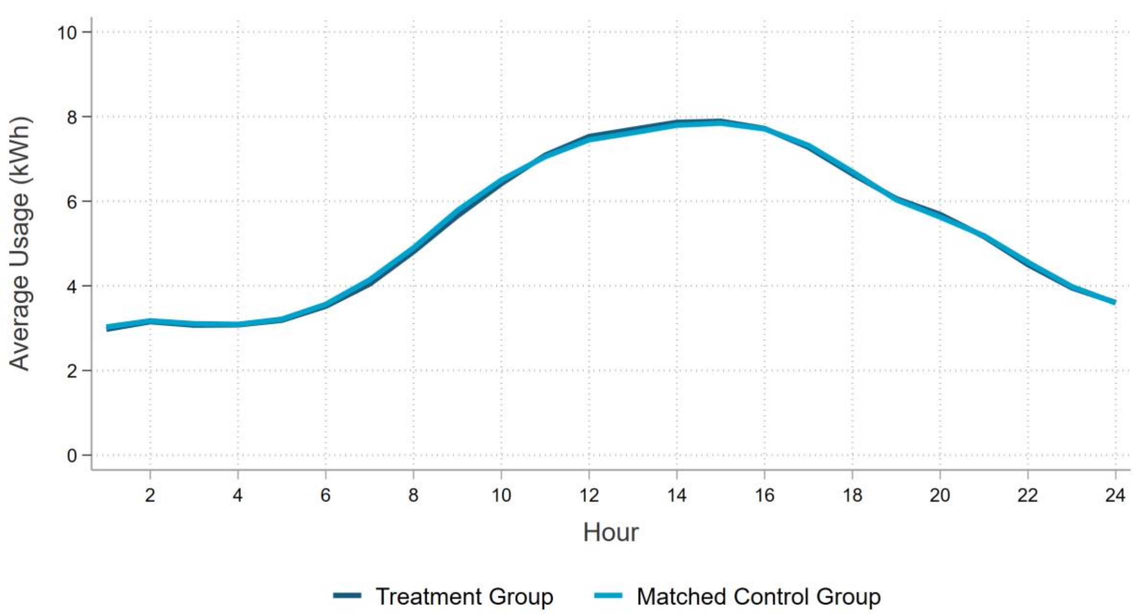


Figure 3-4: Residential Group A and All Comparison Average Load across All 2021 Proxy Days by Cycling Option

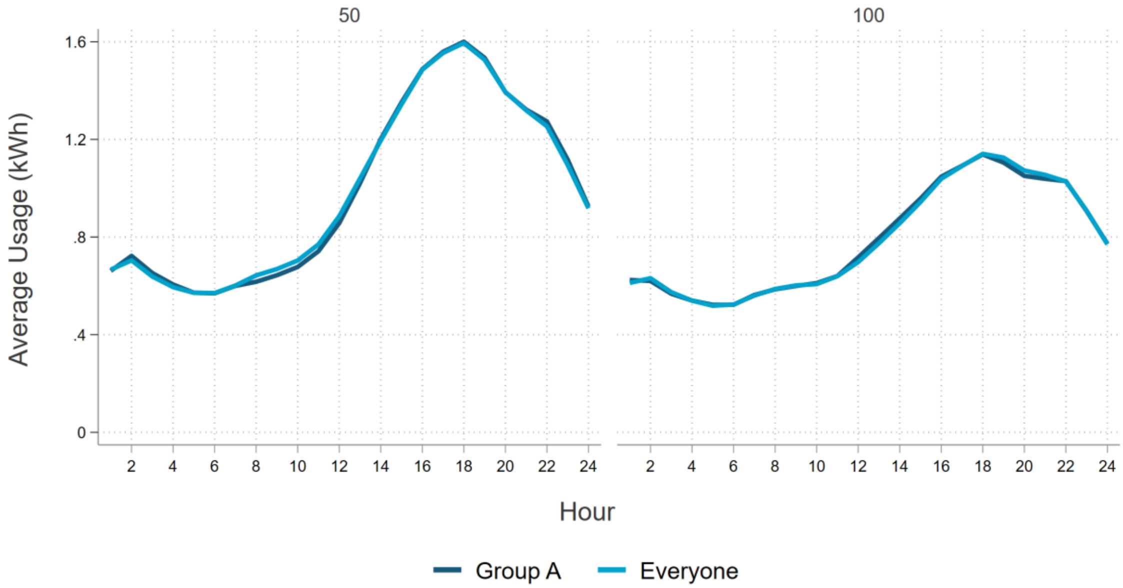


Figure 3-5: Residential Group B and All Comparison Average Load across All 2021 Proxy Days by Cycling Option

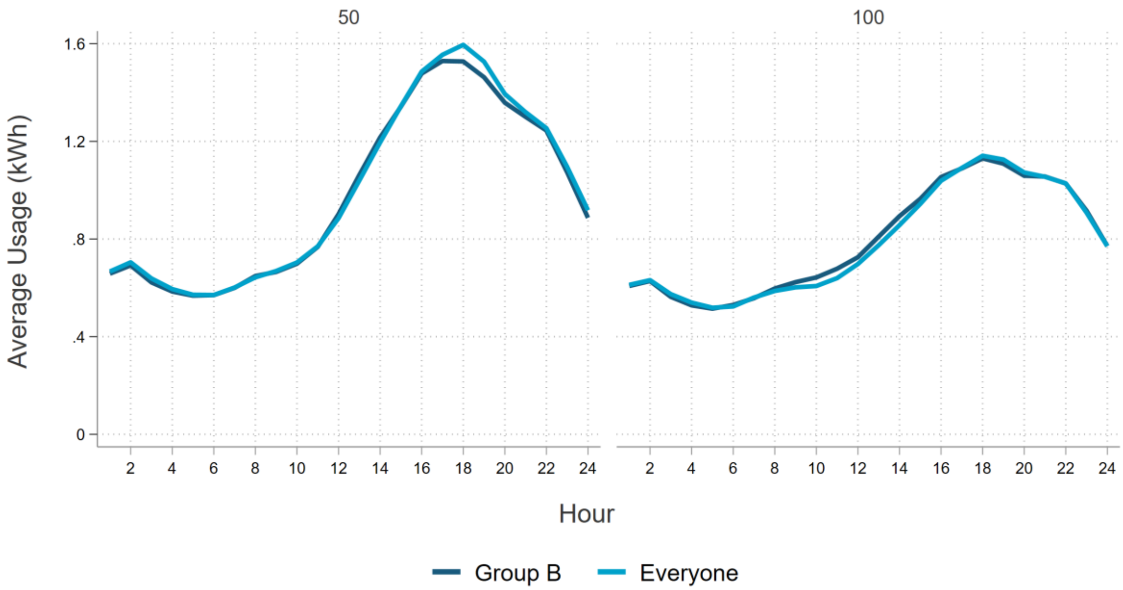
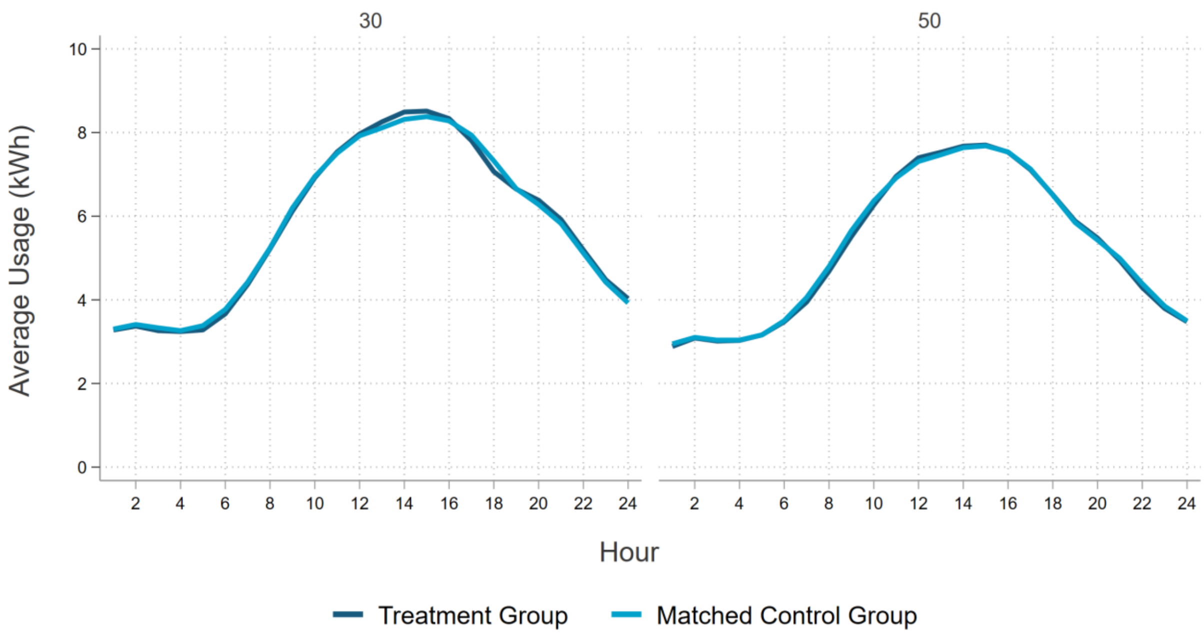


Figure 3-6: Commercial Matched Control and Treatment Group Comparison Average Load Across All 2021 Proxy Days by Cycling Option



3.2.3. Ex Ante Impact Estimation Methodology

The ex ante load impacts were developed using 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 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 ante impacts have traditionally been developed using two years of historical ex post load impacts, where ex post results from the current evaluation (2021) and prior evaluation (2020) are used to model reference loads and kW impacts. However, for the current evaluation, ex post load impacts for 2020 were not included because the COVID-19 pandemic caused the residential and commercial reference loads and impacts to shift considerably compared to other years. Further, fewer program events were called in 2021 than previous years and over a narrower event day temperature range, limiting the amount and range of ex post impact data available to estimate ex ante load impacts. To account for this, ex post load impacts from 2018, 2019, and 2021 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 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, 2019, and 2021, 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 – 4 of the 7 events in 2021 fit these criteria, as well as 12 of 20 events and 12 of 18 events in 2019 and 2018, respectively. 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, 2019, and 2021) as the core ex post impacts.

The methodology for estimating ex ante impacts in 2021 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 and 2021 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, 2019, and 2021 (by cycling strategy) graphed against mean17. The figures also show two lines, where the orange 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 dark blue line represents the ex ante model developed in the 2019 evaluation (we chose not to compare to 2020 due to the impact from the COVID-19 pandemic). The lines in both figures shows a strong weather response – the hotter it is, the higher the average AC Saver Day Of load impacts. Including three years' worth of data allows for the model to predict impacts at a wide range of temperatures. The 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 cooler temperatures. With load impacts available at these temperatures from 2021 and impacts at hotter temperatures from 2018 and 2019, a clear weather response signature is seen for both cycling strategies for both evaluations. Additionally, the weather response of the impact (i.e., the steepness of the slope of the regression line) is very similar as estimated this year when compared to 2019.

Figure 3-7: Average 2018, 2019, and 2021 Ex Post Load Impacts and Ex Ante Predictions for Residential 50% Cycling Participants

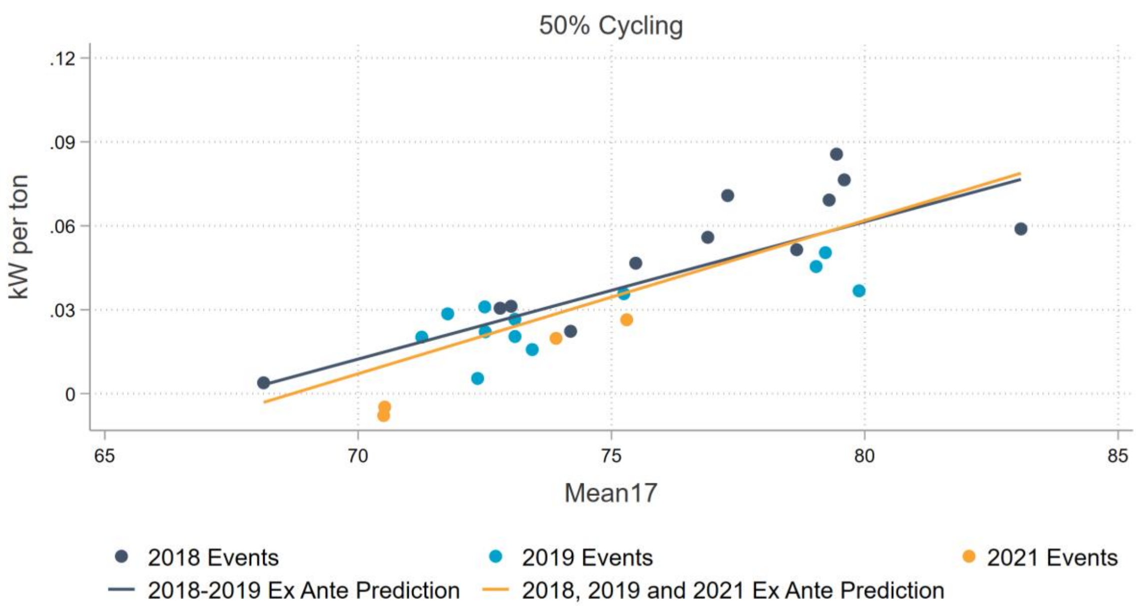


Figure 3-8: Average 2018, 2019, and 2021 Ex Post Load Impacts and Ex Ante Predictions for Residential 100% Cycling Participants

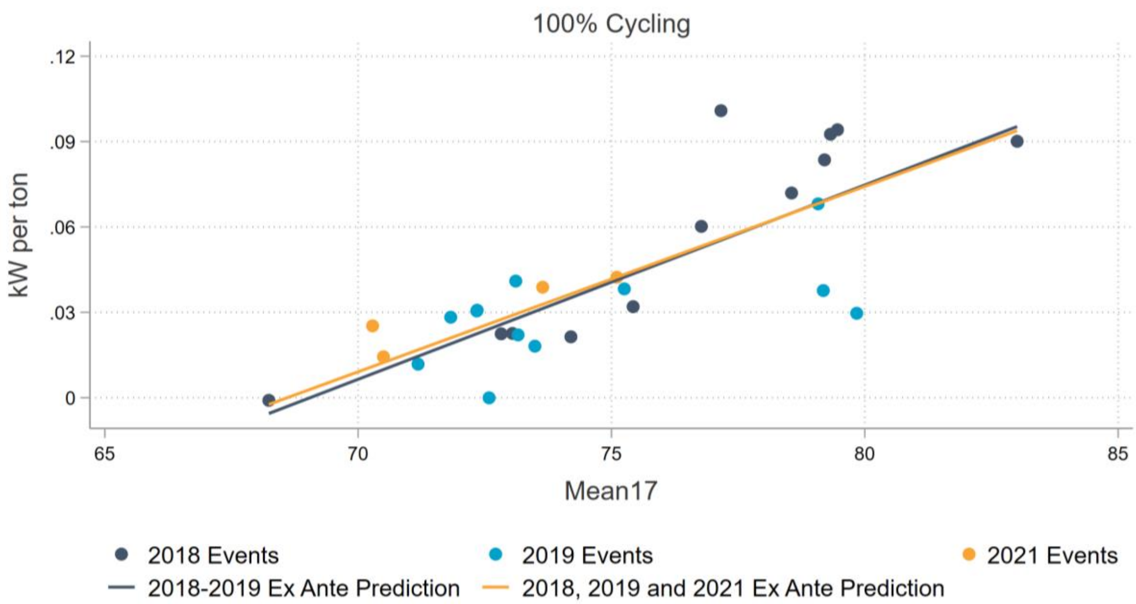


Figure 3-9 and Figure 3-10 show the commercial ex post impacts from 2018, 2019, and 2021 (by cycling strategy) as a function of mean17. Here again, the orange line represents the relationship of ex post load impacts to mean17 as estimated in the current evaluation and the dark blue line represents the ex ante relationship estimated by the 2019 load impact evaluation. As compared to the residential results, the weather response for the commercial participants is less sensitive. The ex ante relationship between the 2019 and 2021 evaluation is nearly the same for both 30% and 50% commercial cycling.

Figure 3-9: Average 2018, 2019, and 2021 Ex Post Load Impacts and Ex Ante Predictions for Commercial 30% Cycling Participants

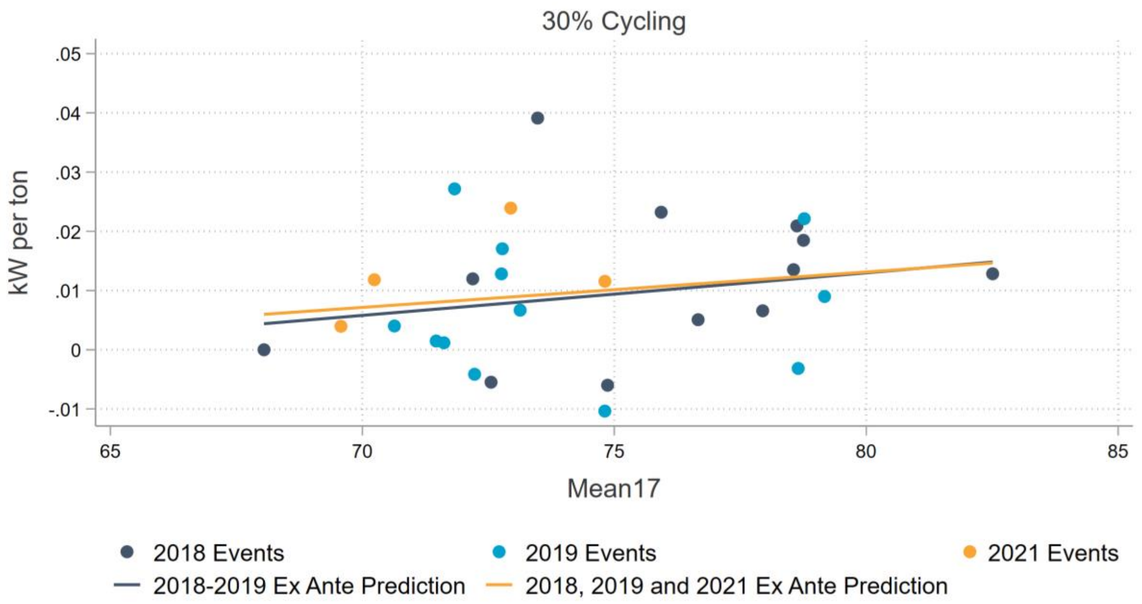
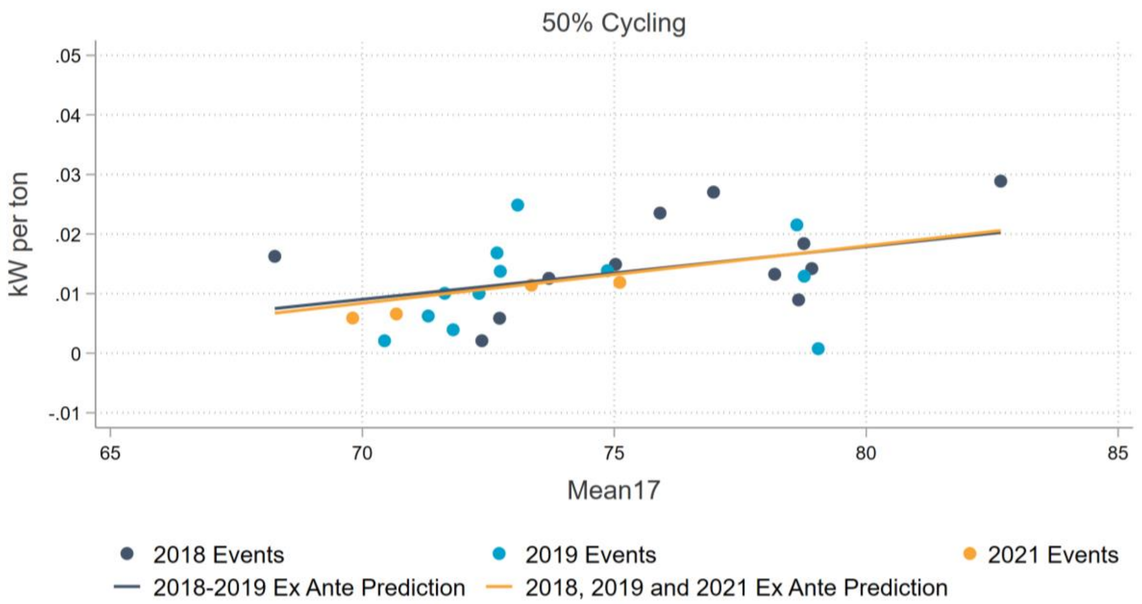


Figure 3-10: Average 2018, 2019, and 2021 Ex Post Load Impacts and Ex Ante Predictions for Commercial 50% Cycling Participants



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 since 2018 have been longer than 3 hours – 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 3-4.

Table 3-4: Ex Ante Shaping Ratios for Each Customer Type and Cycling Option

Hour of the 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 3-5 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 3-5: 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	0.07
8-9 PM	0.79	0.04	0.06

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:

- Model the average control group usage during the 6 to 8 PM time period for 2018, 2019, and 2021 weekday event days with event windows of 6 to 8 PM as a function of mean17;
- Predict average control group usage for the period of 6 to 8 PM under ex ante weather conditions using the parameters from this regression;
- Calculate 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; and
- Derive the control group load (i.e., reference load) profiles 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 2021. Residential load impacts are presented first, followed by commercial load impacts. Ex post impacts are compared to 2019 and 2020 levels to illustrate how the ongoing COVID-19 pandemic has affected program performance.

4.1. Residential Ex Post Load Impact Estimates

A total of seven AC Saver Day Of events were called in 2021 with event hours ranging between 5 PM and 9 PM. There were no events called on weekends. Table 4-1 presents ex post load impacts for the residential program segment for each event in program year 2021. The rows highlighted in blue represent events from 6 to 8 PM that are used in the calculation of the Average Event Day.

Aggregate residential load impacts ranged from a low of 0.01 MW on July 12, 2021 to a high of 1.28 MW on September 10, 2021. This low result on July 12 could be explained by low temperatures. The "mean17" heat buildup – the average temperature from midnight to 5 PM – which was only 71 °F on that day – one of the lowest for events in 2021, leading to lower cooling loads. The next lowest-impact event was on June 16, 2021, with an impact of 0.03 MW, which can again be explained in part by the low mean17 of 71 °F as compared to the average event's mean17 of 73 °F. Conversely regarding this metric, the highest impact event on September 10, 2021 saw a mean17 of 76 °F. This mean17 indicates that this event was the hottest events of the season, and the impact may also have been bolstered by this being the second event day in two consecutive days with similar mean17 temperatures. Ex post impacts for the four 2021 AC Saver Day Of residential event days with the highest mean17 temperatures are statistically significant at the 90% confidence level. Conversely, the other three event days with the lowest mean17 temperatures do not have statistically significant impacts.

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 June 15 and 16, July 12, and September 9. All four of these events were dispatched from 6 to 8 PM. The four 2021 AC Saver Day Of events included in the Average Event Day estimate yield an aggregate load reduction of 0.43 MW.

Table 4-1: AC Saver Day Of 2021 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 Site (kW)	Aggregate (MW)				
6/15/2021	0.09	0.10	0.77	74	89	6–8 PM	Yes
6/16/2021	0.00	0.00	0.03	71	76	6–8 PM	No
6/17/2021	0.01	0.01	0.06	70	75	6–9 PM	No
7/12/2021	0.00	0.00	0.01	71	74	6–8 PM	No
7/29/2021	0.07	0.09	0.66	73	80	6–9 PM	Yes
9/9/2021	0.11	0.12	0.93	75	84	6–8 PM	Yes
9/10/2021	0.15	0.17	1.28	76	84	5–8 PM	Yes
Average*	**0.05**	**0.06**	**0.43**	**73**	**81**	**6–8 PM**	**Yes**

*Reflects the average 6 to 8 PM weekday 2021 AC Saver Day Of event (blue rows)

The residential Average Event Day load impacts per premise in 2018, 2019, and 2021 were 0.18 kW, 0.11 kW, and 0.06 kW, respectively. These averages were calculated using events with similarly timed event windows (6 to 8 PM), but with varying average mean17 temperatures (77 °F in 2018, 74 °F in 2019, and 74 °F in 2021) and average event window temperatures (82 °F in 2018, 80 °F in 2019, and 81 °F in 2021). Figure 4-1 shows the relationship between mean17 and impact for all events in 2018, 2019, and 2021. Impacts from 2020 are not included in this comparison because performance was significantly affected by the COVID-19 pandemic. The dark circles show the average event mean17 between the three program years. Besides the temperature difference, one key driver of the difference in aggregate ex post load impacts between 2018, 2019, and 2021 is the number of residential customers enrolled in the program: with 2018 seeing 9,716 average participants per event, 2019 seeing 7,913 average participants per event, and 2021 seeing 7,798 average participants per event. This drop in customers is due in part to normal attrition, and also due to the lack of marketing to new customers.

Figure 4-1: 2018, 2019, and 2021 Ex Post Load Impacts vs. Temperature

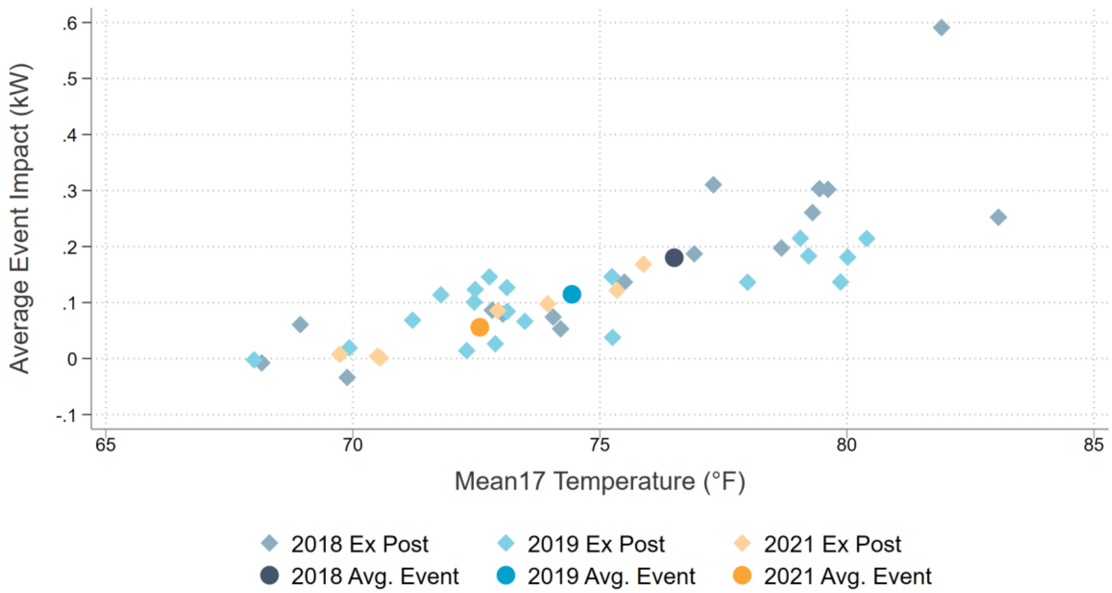


Table 4-2 shows the average per-premise reference loads, load impacts, and percent impacts for residential customers by cycling option. On the average event day, the reference load for the 50% cycling group was approximately 33% higher than the reference load for the 100% cycling group, with reference loads of 1.46 and 1.10 kW per premise, respectively. When comparing average percent impacts across event days, the 100% cycling customers provide larger percentage impacts. This is particularly true on the three coolest event days: June 16, June 17, and July 17. On these days the max event window temperatures were 76 °F, 75 °F, and 74 °F, respectively. It is possible the small impacts from the 50% cycling customers on these days are the result of customers not using their air conditioners because of low temperatures. As such, the three event days with negative impacts for residential 50% customers should not be interpreted as these customers increasing load. Rather, the negative impacts should be view as a function of noise in the data. These days provided no discernable impacts nor were these results statistically significant in either direction.

Table 4-2: AC Saver Day Of 2021 Residential Average Per-Premise Reference Load, Impacts, and Percent Impacts by Cycling Option

Event Date	Average Reference Load per Site (kW)		Average Load Impact per Site (kW)		Average Percent Impact	
	50%	100%	50%	100%	50%	100%
6/15/2021	1.72	1.22	0.08	0.16	4%	13%
6/16/2021	1.17	0.95	-0.03	0.11	-3%	11%
6/17/2021	1.11	0.88	-0.01	0.06	-1%	7%
7/12/2021	1.12	0.90	-0.02	0.06	-2%	7%
7/29/2021	1.52	1.11	0.08	0.11	5%	10%
9/9/2021	1.83	1.33	0.10	0.18	6%	13%
9/10/2021	1.84	1.41	0.13	0.29	7%	20%
Average*	**1.46**	**1.10**	**0.03**	**0.13**	**2%**	**12%**

*Reflects the average 6 to 8 PM weekday 2021 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. The 100% cycling option contributes roughly 58% of the total residential load impacts. On the average event day, the 50% cycling participants deliver about 0.18 MW of load reduction while the 100% cycling participants contribute about 40% more at 0.25 MW.

Table 4-3: AC Saver Day Of 2021 Residential Average Per-Premise and Aggregate Load Impacts by Cycling Option

Event Date	Average Load Impact per Site (kW)		Aggregate Load Impact (MW)	
	50%	100%	50%	100%
6/15/2021	0.08	0.16	0.45	0.32
6/16/2021	-0.03	0.11	-0.18	0.21
6/17/2021	-0.01	0.06	-0.07	0.13
7/12/2021	-0.02	0.06	-0.11	0.12
7/29/2021	0.08	0.11	0.44	0.22
9/9/2021	0.10	0.18	0.58	0.35
9/10/2021	0.13	0.29	0.72	0.56
***Average**	**0.03**	**0.13**	**0.18**	**0.25**

* Reflects the average 6 to 8 PM 2021 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 2021. Impact estimates were calculated separately for each quintile and decile for the average event hour of the 2021 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 0.06 kW for 50% cycling and 0.32 kW for 100% cycling – both approximately double the overall average impacts for these cycling options of 0.03 kW and 0.13 kW, respectively. For the largest decile, 50% cycling load impacts peak at 0.07 kW and 100% cycling load impacts peak at 0.40 kW.

Table 4-4: Residential Average Per-Premise Load Impacts by Usage Quintile and Cycling Option

Quintile	50% Cycling		100% Cycling	
	Average* Load Impact per Premise (kW)	Load Impact Standard Error (kW)	Average* Load Impact per Premise (kW)	Load Impact Standard Error (kW)
1	-0.04	0.02	0.01	0.01
2	0.03	0.02	0.04	0.02
3	0.06	0.03	0.11	0.02
4	0.05	0.03	0.13	0.03
5	0.06	0.04	0.32	0.04

* Reflects the average 6 to 8 PM 2021 AC Saver Day of event

Table 4-5: Residential Average Per-Premise Load Impacts by Usage Decile and Cycling Option

Decile	50% Cycling		100% Cycling	
	Average* Load Impact per Premise (kW)	Load Impact Standard Error (kW)	Average* Load Impact per Premise (kW)	Load Impact Standard Error (kW)
1	-0.03	0.03	0.01	0.02
2	-0.05	0.02	0.01	0.02
3	-0.04	0.03	0.00	0.02
4	0.10	0.04	0.08	0.02
5	0.00	0.04	0.11	0.03
6	0.10	0.04	0.11	0.03
7	0.04	0.04	0.03	0.04
8	0.06	0.05	0.21	0.04
9	0.04	0.05	0.23	0.04
10	0.07	0.05	0.40	0.07

* Reflects the average 6 to 8 PM 2021 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 2021 event day and the Average Event Day. Here again, the Average Event Day load impacts are calculated using June 15 and 16, July 12, and September 9. These rows highlighted in blue represent weekday events from 6 to 8 PM that are used in the calculation of the Average Event Day.

Weekday commercial aggregate impacts vary from a low of 0.04 MW on June 17 to a high of 0.31 MW on June 15. On average, cooler event days produced lower impacts but one warm event day, July 29, produced the second lowest impacts. The event on July 29 was one of two events from 6-9 PM. These two events went later than the other events and overlapped with times when most business are closed. During nighttime hours most businesses are unable to provide noticeable load reductions.

Generally, the timing of events affects impacts for commercial customers more than residential customers since people are usually at home during the evening hours. Besides event timing, there is another large difference between commercial and residential customers – commercial customers have lower weather sensitivity. This can be seen on cooler event days (June 16, June 17, and July 12) when commercial customers still provide load reductions and residential customers have almost no impacts. Alternately, residential customers generally provide larger per-premise impacts on hot event days. In 2021, commercial customers provided more consistent impacts than residential customers regardless of weather.

Table 4-6: AC Saver Day Of 2021 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 Site (kW)	Aggregate (MW)				
6/15/2021	0.06	0.14	0.31	73	88	6–8 PM	Yes
6/16/2021	0.02	0.05	0.11	70	75	6–8 PM	No
6/17/2021	0.01	0.02	0.04	69	73	6–9 PM	No
7/12/2021	0.03	0.08	0.16	71	73	6–8 PM	Yes
7/29/2021	0.02	0.04	0.09	73	79	6–9 PM	Yes
9/9/2021	0.04	0.11	0.28	75	83	6–8 PM	Yes
9/10/2021	0.03	0.08	0.21	76	82	5–8 PM	Yes
Average*	**0.04**	**0.09**	**0.22**	**72**	**80**	**6–8 PM**	**Yes**

*Reflects the average 6 to 8 PM weekday 2021 AC Saver Day Of event (blue rows)

Figure 4-2 shows the relationship between mean17 and impact for all commercial events in 2018, 2019, and 2021. The dark circles show the average event mean17 between the three program years. The commercial Average Event Day (6 to 8 PM events) load impacts per premise in 2018, 2019, and 2021 were 0.14 kW, 0.09 kW, and 0.09 kW, respectively. As displayed in Figure 4-2, the mean17 temperature was higher in 2018 than both 2019 and 2021. The hotter events in 2018 were the main driver of higher impacts compared to the other two years. As mentioned previously, commercial impacts remain relatively consistent regardless of the temperature, especially when the mean17 is lower than 75 °F.

Figure 4-2: Commercial 2018, 2019, 2021 Ex Post Load Impacts vs. Temperature

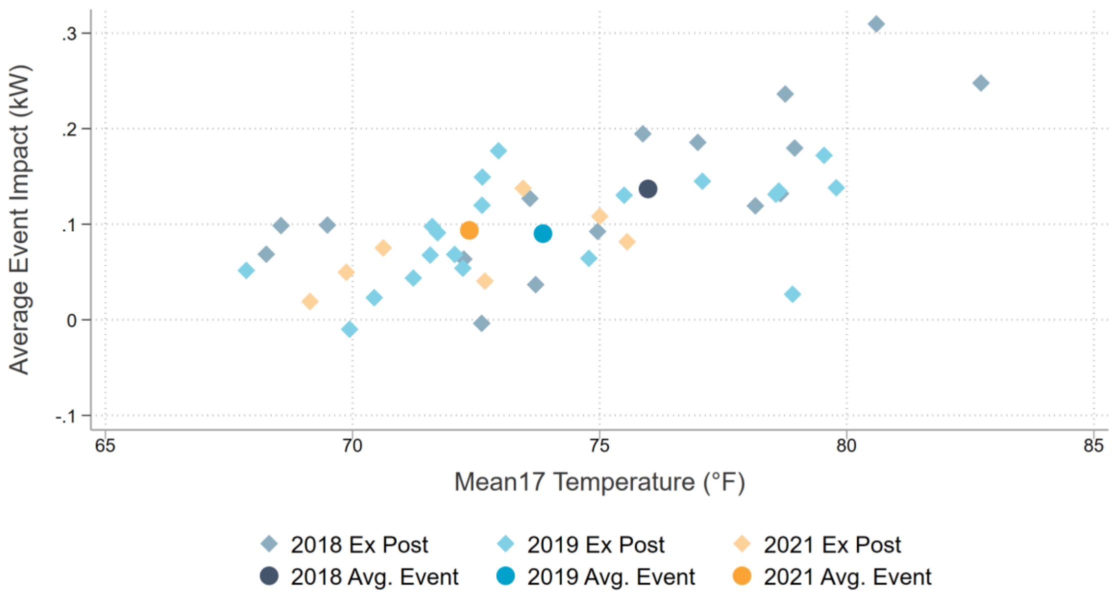


Table 4-7 presents the per-premise and aggregate load impacts for commercial participants on each event day, segmented by cycling strategy. On a per-premise basis, load impacts for the 50% cycling option range from 0.04 kW on June 29 to 0.10 kW on September 9. Per-premise load impacts for the 30% cycling option are more broadly distributed, ranging from -0.14 kW to 0.26 kW. Although the distributions of impacts vary between the groups, on the Average Event Day, load impacts for the 50% cycling group are 0.08 kW, while the 30% group has an average 0.14 kW. The difference in aggregate impacts reflects the differences in customer enrollment between the two cycling strategies. There were 534 premises in the 30% cycling group and 1,778 in the 50% cycling group.

Table 4-7: 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%
6/15/2021	0.26	0.10	0.14	0.17
6/16/2021	0.04	0.05	0.02	0.09
6/17/2021	-0.14	0.07	-0.07	0.11
7/12/2021	0.13	0.06	0.07	0.10
7/29/2021	0.06	0.04	0.03	0.06
9/9/2021	0.12	0.10	0.07	0.21
9/10/2021	0.12	0.07	0.07	0.14
Average*	**0.14**	**0.08**	**0.08**	**0.14**

*Reflects the average 6 to 8 PM weekday 2021 AC Saver Day Of Weekday event

Table 4-8 shows estimated event impacts for commercial customers segmented by usage quintiles, and Table 4-9 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 4-9), based on their average usage during the peak hours from 11 AM to 6 PM on all proxy event days in 2021. Impact estimates were calculated separately for each quintile and decile for the average event hour of the Average Event Day to determine reference loads and load impacts.

Load impacts by quintile and decile largely increase with electricity usage for 30% and 50% cycling customers. There are a couple instances where a decrease in impacts is seen when comparing quintiles or deciles. There are approximately 530 commercial 30% cycling customers in total and dividing this group further produces a limited amount of data to evaluate. Given the smaller sample sizes associated with each individual decile for 30% cycling, there are relatively large standard errors associated with these estimates. For example, in the 6th decile for 30% cycling there is a per-premise load impact of -0.01 kW with standard error of 0.10.

Table 4-8: Commercial Average Per-Premise Load Impacts by Usage Quintile and Cycle Option

Quintile	30% Cycling		50% Cycling	
	Average* Load Impact per Premise (kW)	Load Impact Standard Error (kW)	Average* Load Impact per Premise (kW)	Load Impact Standard Error (kW)
1	0.01	0.07	-0.09	0.05
2	0.08	0.04	-0.03	0.03
3	0.05	0.07	0.05	0.03
4	0.16	0.09	0.11	0.05
5	0.32	0.23	0.58	0.14

*Reflects the average 6 to 8 PM weekday 2021 AC Saver Day Of Weekday event

Table 4-9: Commercial Average Per-Premise Load Impacts by Usage Decile and Cycle Option

Decile	30% Cycling		50% Cycling	
	Average* Load Impact per Premise (kW)	Load Impact Standard Error (kW)	Average* Load Impact per Premise (kW)	Load Impact Standard Error (kW)
1	-0.02	0.12	-0.20	0.09
2	0.04	0.05	-0.02	0.02
3	0.09	0.06	0.07	0.03
4	0.09	0.06	-0.10	0.04
5	0.09	0.08	0.04	0.04
6	-0.01	0.10	0.07	0.04
7	0.03	0.11	0.04	0.07
8	0.35	0.14	0.21	0.07
9	0.23	0.19	0.18	0.10
10	0.32	0.42	0.98	0.25

*Reflects the average 6 to 8 PM weekday 2021 AC Saver Day Of Weekday event

4.3. Ex Post Load Impact Comparison to 2019 and 2020

In 2020, the COVID-19 pandemic had a large effect on impacts for both residential and commercial customers. This section illustrates the differences in impacts between 2019, 2020, and 2021. It also provides context for why 2020 impacts were excluded from ex ante calculations.

In addition to the COVID-19 pandemic, varying weather conditions in 2019, 2020, and 2021 contributed to a change in load impacts across program years. Figure 4-3, Figure 4-4, and Figure 4-5 show the daily mean17 temperature (average daily temperature between midnight and 5 PM) from May 1 through October 31 for 2019, 2020, and 2021, respectively. Each graph has a horizontal line at 75 °F and red circles to represent each event day that season. In 2019, 6 of the 20 events were called with a mean17 over 75 °F. In 2020, 9 of the 20 events called were on days with a mean17 over 75 °F. There was also a significant heat wave in September 2020 with mean17 temperatures exceeding 80 °F. Comparatively, in 2021, only 2 of 7 events were called with a mean17 over 75 °F. With so few 2021 events being called on higher temperature days, there is less available air conditioning load to shed, leading to lower overall impacts.

Figure 4-3: 2019 AC Saver Day Of Event Days and Mean17 Temperatures

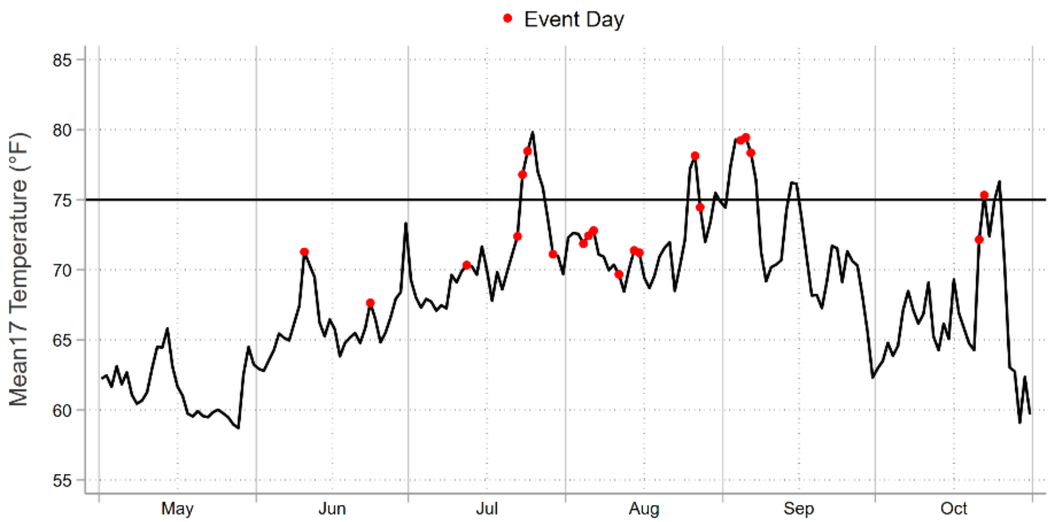


Figure 4-4: 2020 AC Saver Day Of Event Days and Mean17 Temperatures

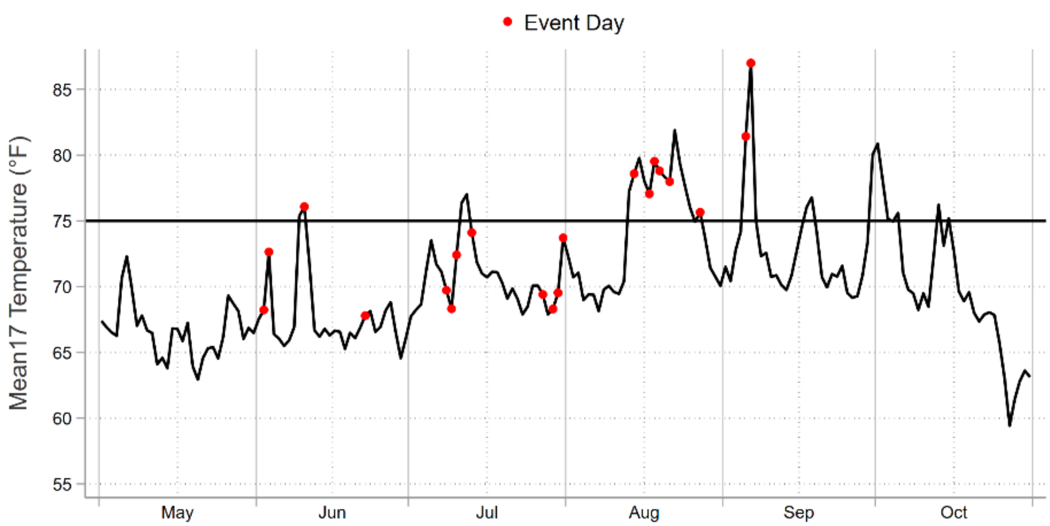


Figure 4-5: 2021 AC Saver Day Of Event Days and Mean17 Temperatures

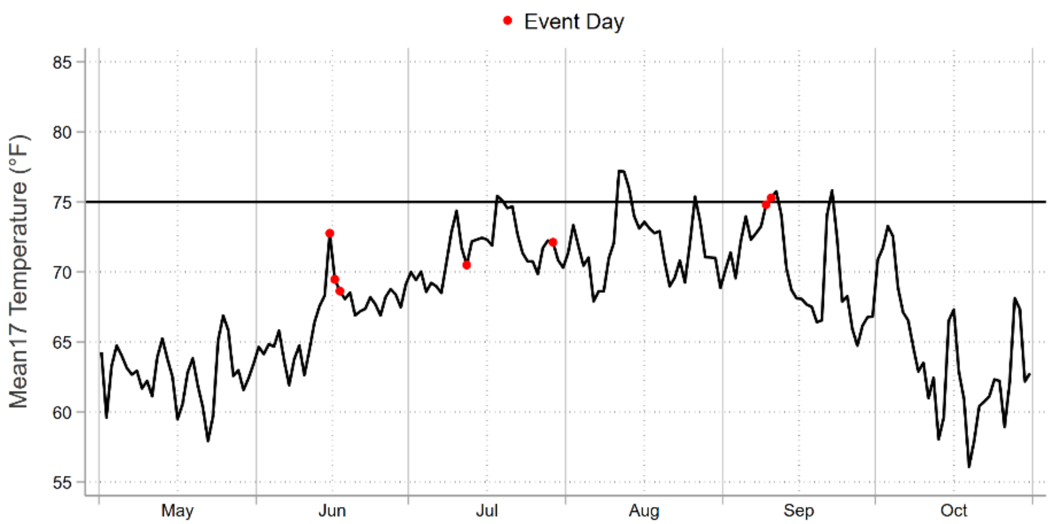


Table 4-10 and Table 4-6 show the residential Average Event Day (6 to 8 PM) impacts for 2019, 2020, and 2021. Impacts were the higher in 2020 in both absolute and percentage terms compared to the other two years. Additionally, in 2020 reference loads for residential customers were higher, presumably because people were spending more time at home, increasing electricity use, due to stay-at-home orders. Generally, customers with higher reference loads will produce larger kW impacts because they have more load to shed. As seen in Table 4-6, program year 2020 had higher impacts across a broad range of similar temperatures compared to 2019 and 2021. At cooler temperatures around a mean17 of 70 °F, event days in 2020 produced larger impacts than 2021. This is one reason why the Average Event Day impacts are lower in 2021. Another reason is that only four 6 to 8 PM events were called in 2021, compared to 12 in both 2019 and 2020.

Table 4-10: Residential 2019, 2020, and 2021 Ex Post Impacts

Year	Avg. Event Hours	Mean17 Avg. Temp. (°F)	Avg. Reference Load (kW)	Avg. Load w/DR (kW)	Impact (kW)	Impact (%)
2019 Average Event Day	6PM - 8PM	74	1.29	1.18	0.11	8.9%
2020 Average Event Day	6PM - 8PM	73	1.44	1.31	0.13	9.3%
2021 Average Event Day	6PM - 8PM	73	1.37	1.31	0.06	4.1%

Figure 4-6: Residential 2019, 2020, and 2021 Ex Post Impacts

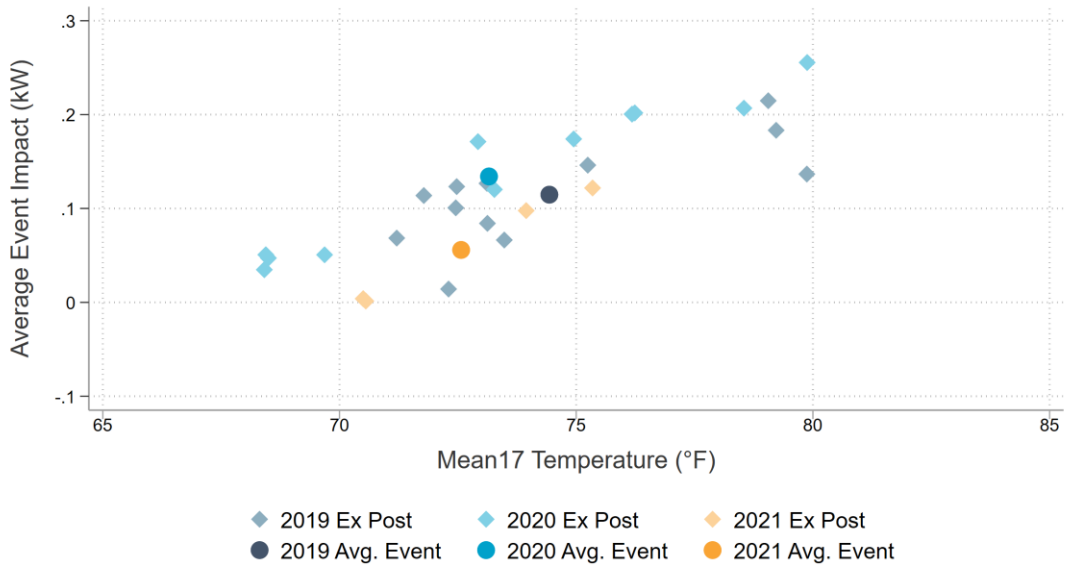
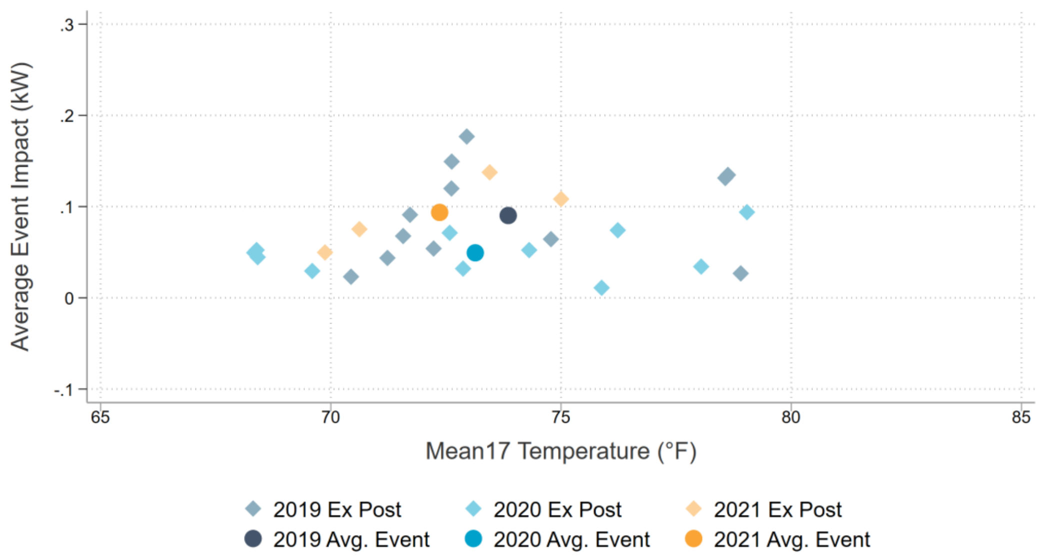


Table 4-11 and Figure 4-7 display the commercial Average Event Day (6 to 8 PM) impacts for 2019, 2020, and 2021. The effects of COVID on commercial customers were opposite of what was seen with the residential customers. In 2020, commercial customers had small impacts compared to the other years. Also, commercial customers had smaller reference loads because many businesses were shut down or running partial operations because of COVID. Impacts and reference loads in 2021 are similar to those in 2019, indicating the impact of COVID was less pronounced in 2021.

Table 4-11: Commercial 2019, 2020, and 2021 Ex Post Impacts

Year	Avg. Event Hours	Mean17 Avg. Temp. (°F)	Avg. Reference Load (kW)	Avg. Load w/DR (kW)	Impact (kW)	Impact (%)
2019 Average Event Day	6PM - 8PM	74	6.09	6.00	0.09	1.5%
2020 Average Event Day	6PM - 8PM	73	4.98	4.93	0.05	1.0%
2021 Average Event Day	6PM - 8PM	72	5.85	5.75	0.09	1.6%

Figure 4-7: Commercial 2019, 2020, and 2021 Ex Post Impacts



As shown in the tables and figures above, COVID-19 had a major influence on the results of the program in 2020. Accordingly, the results in 2020 are viewed more as an anomaly than the norm. The ex ante methodology reflects this by not including 2020 results in the analysis, but using 2018, 2019, and 2021 results instead, representing years in which the effects of the pandemic on electricity usage are either nonexistent or diminished.

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 2019 load impact evaluation and the relationship between the 2021 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 2022–2032. Recent AC Saver Day Of evaluations have shown a steady decrease in enrollment forecasts because the program is no longer actively marketed. This trend continues in 2021 with predicted enrollments decreasing about 7% per year for residential and 25% per year for commercial customers.

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 Resource Innovations (formerly Nexant) in 2014 to develop ex ante weather conditions based on the peaking conditions for each utility and for the CAISO system. Resource Innovations subsequently updated these weather conditions for SDG&E in 2017[6]. 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 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

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

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 and Table 5-2 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 Enrollment-Weighted Ex Ante Weather Conditions

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
Residential	50%	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
	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	79	82
		September Peak Day	83	82	82	85
		October Peak Day	73	78	76	79

Table 5-2: Commercial Enrollment-Weighted Ex Ante Weather Conditions

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	79	76	80
		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	77
		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	84
		October Peak Day	73	78	75	79

AC Saver Day Of enrollment is assumed to decrease over the forecast horizon. Table 5-3 shows the enrollment forecast for the two customer groups for the summer months of each year from 2022 to 2032. The forecast reflects an annual enrollment change from 2022-2026 of an approximately 24% decrease for residential customers and 70% decrease for commercial customers.

Table 5-3: Program Enrollment Forecast

Customer Type	Forecast Year	Forecast Month						
		April	May	June	July	August	Sept.	October
Residential	2022	7,160	7,160	7,160	7,160	7,160	7,160	7,160
	2023	6,683	6,683	6,683	6,683	6,683	6,683	6,683
	2024	6,240	6,240	6,240	6,240	6,240	6,240	6,240
	2025	5,828	5,828	5,828	5,828	5,828	5,828	5,828
	2026	5,446	5,446	5,446	5,446	5,446	5,446	5,446
	2027-2032	5,091	5,091	5,091	5,091	5,091	5,091	5,091
Commercial	2022	1,963	1,963	1,963	1,963	1,963	1,963	1,963
	2023	1,450	1,450	1,450	1,450	1,450	1,450	1,450
	2024	1,072	1,072	1,072	1,072	1,072	1,072	1,072
	2025	792	792	792	792	792	792	792
	2026	585	585	585	585	585	585	585
	2027-2032	432	432	432	432	432	432	432

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 (RA) 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 2022. 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. Similarly, the per-premise impacts are generally lowest for the April monthly peak for all scenarios and customer types. Those scenarios that have a predicted value of zero represented cooler weather months where the program is not expected to provide noticeable impacts.

For a typical event day under SDG&E-specific weather conditions, the impact per premise in a 1-in-2 year is 0.16 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 11 degrees for some months; a 11-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, the typical event day per-premise load impact is 0.13 kW under the 1-in-2 assumption and 0.17 kW under the 1-in-10 assumption. In September, commercial per-premise load impacts peak at

0.19 kW under 1-in-2 conditions and 0.21 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 lower 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 1.1 MW for a typical event day under SDG&E-specific 1-in-2 year weather conditions in 2022 and 0.3 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 0.3 MW, respectively. The aggregate impacts under CAISO weather conditions are slightly lower for both weather year types.

Table 5-4: 2022 Residential Ex Ante Load Impact Estimates by CAISO and SDG&E-specific Weather and Day Type

Customer Type	Day Type	Impact per Premise (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	0.15	0.16	0.24	0.26	1.1	1.1	1.7	1.9
	April Monthly Peak	0.00	0.00	0.08	0.15	0.0	0.0	0.5	1.1
	May Monthly Peak	0.00	0.02	0.16	0.18	0.0	0.2	1.1	1.3
	June Monthly Peak	0.00	0.00	0.27	0.21	0.0	0.0	1.9	1.5
	July Monthly Peak	0.08	0.15	0.18	0.20	0.6	1.0	1.3	1.4
	August Monthly Peak	0.25	0.23	0.23	0.28	1.8	1.6	1.6	2.0
	Sept. Monthly Peak	0.29	0.28	0.27	0.34	2.1	2.0	1.9	2.5
	October Monthly Peak	0.09	0.15	0.20	0.22	0.7	1.0	1.4	1.6

Table 5-5: 2022 Commercial Ex Ante Load Impact Estimates by CAISO and SDG&E-specific Weather and Day Type

Customer Type	Day Type	Impact per Premise (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	0.13	0.13	0.16	0.17	0.3	0.3	0.3	0.3
	April Monthly Peak	0.06	0.06	0.10	0.14	0.1	0.1	0.2	0.3
	May Monthly Peak	0.06	0.08	0.13	0.14	0.1	0.2	0.3	0.3
	June Monthly Peak	0.06	0.06	0.17	0.15	0.1	0.1	0.3	0.3
	July Monthly Peak	0.10	0.13	0.13	0.14	0.2	0.2	0.3	0.3
	August Monthly Peak	0.17	0.16	0.16	0.18	0.3	0.3	0.3	0.4
	Sept. Monthly Peak	0.19	0.19	0.18	0.21	0.4	0.4	0.4	0.4
	October Monthly Peak	0.10	0.13	0.15	0.16	0.2	0.2	0.3	0.3

5.1.1. Comparison of Ex Ante Load Impacts by Month

Table 5-6 and Table 5-7 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 2022, 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 2.0 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 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 and June 1-in-2 year impacts for residential customers are 0.0 MW while impacts in May are 0.2 MW. As shown in Table 5-1, May has a slightly higher 1-in-2 mean17 than April and June. For commercial customers, the estimates are much more stable given the lack of weather sensitivity for these customers. The average aggregate impacts range from 0.1 MW or 0.4 MW regardless of month of weather.

Table 5-6: 2022 Residential AC Saver Day Of Ex Ante Load Impact Estimates by Weather Year, Day Type and Hour, 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	1.1	1.4	1.3	1.1	0.8	1.1
	April Monthly Peak	0.0	0.0	0.0	0.0	0.0	0.0
	May Monthly Peak	0.2	0.2	0.2	0.2	0.1	0.2
	June Monthly Peak	0.0	0.0	0.0	0.0	0.0	0.0
	July Monthly Peak	1.0	1.3	1.2	1.0	0.7	1.0
	August Monthly Peak	1.6	2.0	1.8	1.6	1.1	1.6
	Sept. Monthly Peak	2.0	2.5	2.2	2.0	1.4	2.0
	October Monthly Peak	1.0	1.3	1.1	1.0	0.7	1.0
1-in-10	Typical Event Day	1.9	2.3	2.0	1.8	1.3	1.9
	April Monthly Peak	1.1	1.4	1.2	1.1	0.8	1.1
	May Monthly Peak	1.3	1.6	1.4	1.3	0.9	1.3
	June Monthly Peak	1.5	1.9	1.7	1.5	1.1	1.5
	July Monthly Peak	1.4	1.7	1.6	1.4	1.0	1.4
	August Monthly Peak	2.0	2.4	2.2	2.0	1.4	2.0
	Sept. Monthly Peak	2.5	3.0	2.7	2.4	1.7	2.5
	October Monthly Peak	1.6	1.9	1.7	1.5	1.1	1.6

Table 5-7: 2022 Commercial AC Saver Day Of Ex Ante Load Impact Estimates by Weather Year, Day Type and Hour, 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	0.5	0.3	0.2	0.2	0.1	0.3
	April Monthly Peak	0.2	0.1	0.1	0.1	0.1	0.1
	May Monthly Peak	0.3	0.2	0.1	0.1	0.1	0.2
	June Monthly Peak	0.2	0.1	0.1	0.1	0.1	0.1
	July Monthly Peak	0.4	0.3	0.2	0.2	0.1	0.2
	August Monthly Peak	0.5	0.3	0.3	0.2	0.2	0.3
	Sept. Monthly Peak	0.6	0.4	0.3	0.3	0.2	0.4
	October Monthly Peak	0.4	0.3	0.2	0.2	0.1	0.2
1-in-10	Typical Event Day	0.6	0.3	0.3	0.3	0.2	0.3
	April Monthly Peak	0.5	0.3	0.2	0.2	0.1	0.3
	May Monthly Peak	0.5	0.3	0.3	0.2	0.1	0.3
	June Monthly Peak	0.5	0.3	0.3	0.2	0.2	0.3
	July Monthly Peak	0.5	0.3	0.3	0.2	0.1	0.3
	August Monthly Peak	0.6	0.4	0.3	0.3	0.2	0.4
	Sept. Monthly Peak	0.7	0.4	0.4	0.3	0.2	0.4
	October Monthly Peak	0.5	0.3	0.3	0.2	0.2	0.3

Table 5-8 provides program-level ex ante aggregate estimates for each hour. In 2022, the program is expected to provide its highest impact under 1-in-10 conditions in September. Under those conditions, the average impact over the event window is expected to be 2.9 MW, with an hourly peak of 3.4 MW between the hours of 5 and 6 PM.

Table 5-8: 2022 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	1.6	1.7	1.5	1.3	0.9	1.4
	April Monthly Peak	0.2	0.1	0.1	0.1	0.1	0.1
	May Monthly Peak	0.4	0.4	0.3	0.3	0.2	0.3
	June Monthly Peak	0.2	0.1	0.1	0.1	0.1	0.1
	July Monthly Peak	1.5	1.5	1.4	1.2	0.9	1.3
	August Monthly Peak	2.2	2.3	2.1	1.8	1.3	1.9
	Sept. Monthly Peak	2.7	2.9	2.6	2.3	1.6	2.4
	October Monthly Peak	1.5	1.5	1.4	1.2	0.9	1.3
1-in-10	Typical Event Day	2.4	2.6	2.3	2.1	1.5	2.2
	April Monthly Peak	1.6	1.6	1.5	1.3	0.9	1.4
	May Monthly Peak	1.8	1.9	1.7	1.5	1.1	1.6
	June Monthly Peak	2.0	2.2	1.9	1.7	1.2	1.8
	July Monthly Peak	1.9	2.0	1.8	1.6	1.1	1.7
	August Monthly Peak	2.6	2.8	2.5	2.2	1.6	2.4
	Sept. Monthly Peak	3.2	3.4	3.1	2.7	1.9	2.9
	October Monthly Peak	2.1	2.2	2.0	1.8	1.2	1.9

5.2. Comparison of 2019 Ex Ante Load Impacts to 2021 Ex Ante Load Impacts

The following section compares ex ante impacts for a common year, 2022, between this year's evaluation and the 2019 evaluation. As previously discussed, the results from 2020 are not included because of the effects of the COVID-19 pandemic on the results. The 2019 AC Saver Day Of load impact evaluation estimated that the program's 2022 capacity load reduction is reached under September SDG&E-specific 1-in-10 weather conditions with a combined load impact peak of 2.9 MW. This current year's evaluation yields the same estimate of program capacity for the residential segment under these conditions – 2.9 MW. A full comparison of the 2019 estimates and 2021 estimates of the 2022 program year under different weather years and day types can be found in Table 5-9.

Table 5-9: 2022 AC Saver Day Of Estimates by Weather Year and Day Type – 2019 to 2021 Comparison – All Customers – SDG&E Peaking Conditions

Weather Year	Day Type	2019 Average Estimate for 2022 (MW)	2021 Average Estimate for 2022 (MW)
1-in-2	Typical Event Day	1.5	1.4
	April Monthly Peak	0.2	0.1
	May Monthly Peak	0.5	0.3
	June Monthly Peak	0.2	0.1
	July Monthly Peak	1.4	1.3
	August Monthly Peak	2.0	1.9
	Sept. Monthly Peak	2.5	2.4
	October Monthly Peak	1.4	1.3
1-in-10	Typical Event Day	2.3	2.2
	April Monthly Peak	1.5	1.4
	May Monthly Peak	1.7	1.6
	June Monthly Peak	1.9	1.8
	July Monthly Peak	1.8	1.7
	August Monthly Peak	2.4	2.4
	Sept. Monthly Peak	2.9	2.9
	October Monthly Peak	2.0	1.9

The differences between the 2022 ex ante load impact estimates are small and are a composite net change that are largely attributable to decreases in enrollment. The total forecasted enrollment in 2019 for 2022 was 10,039 while the 2021 forecasted enrollment for 2022 is 9,123.

5.3. Relationship between Ex Post and Ex Ante Load Impact Estimates

Table 5-10 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, 1.08 MW (Column D) was delivered by AC Saver Day Of on June 15, 2021, when the heat build-up (as measured by mean17) was 74 °F (Column B). This load impact was generated by 10,142 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 1.10 MW of load reduction (Column E). The impact scaling in this model is based on the impacts from 6 to 8 PM weekday events from 2018, 2019, and 2021, 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 15, 2021 was slightly 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 0.99 MW of load reduction (Column G) on a day with a similar temperature profile (Column B) as June 15, 2021.

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 0.95 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.

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 0.95 MW (Column H) occurs at a mean17 value of 74 °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 68 °F (Column I) and 79 °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 0.12 MW (Column J), and the 1-in-10 ex ante load impact estimate is 1.81 MW (Column L), which are lower and higher, respectively, than the adjusted ex post load impact of 0.95 MW (Column H).

Table 5-10: Ex Post to Ex Ante Impacts Analysis Step

Ex Post									SDG&E 1-in-2		SDG&E 1-in-10	
Date and Event Time		Mean17 (°F)	Ex Post Enrollment	Ex Post Estimate (MW)	Ex Ante Estimate Using 2021 Enrollment (MW)	Ex Ante Enrollment	Ex Ante Estimate Using 2022 Enrollment (MW)	Ex Post Estimate Using 2022 Enrollment and Adjusted to RA Window (MW)	Mean17 (°F)	Ex Ante Estimate Using 2022 Enrollment and Adjusted to RA Window (MW)	Mean17 (°F)	Ex Ante Estimate Using 2022 Enrollment and Adjusted to RA Window (MW)
A		B	C	D	E	F	G	H	I	J	K	L
6/15/2021	6-8 PM	74	10,142	1.08	1.10	9,123	0.99	0.95	68	0.12	79	1.81
6/16/2021	6-8 PM	70	10,097	0.14	0.45		0.41	0.29	68			
6/17/2021	6-9 PM	70	10,061	0.10	0.27		0.25	0.22	68			
7/12/2021	6-8 PM	71	9,975	0.18	0.47	9,123	0.43	0.27	76	1.30	78	1.71
7/29/2021	6-9 PM	73	9,928	0.75	0.79		0.73	0.65	76			
9/9/2021	6-8 PM	75	10,226	1.21	1.36	9,123	1.23	1.03	82	2.39	85	2.87
9/10/2021	5-8 PM	76	10,209	1.49	1.55		1.41	1.28	82			

6. Findings and Recommendations

This section presents findings and recommendations from the 2021 AC Saver Day Of load impact evaluation.

Finding 1

In previous program years, the implementation of the randomized control trial (RCT) design has encountered various difficulties. For example, in Program Year 2020, paging issues prevented the program from delivering load reductions to full program capacity; customer cycling strategies and control groups were not properly readdressed due to incomplete paging messaging to the load control devices. Also, the RCT design of withholding control groups from cycling was not correctly implemented, resulting in more groups being held back than was necessary for each event.

Recommendation 1

Change the methodology for estimating the residential ex post reference loads from a RCT design to a statistical matching framework for upcoming program years. While the RCT design is more statistically robust than the matched control group approach, this change in methodology would provide multiple benefits. First, it would eliminate the risk of future paging issues like those experienced in 2020, as well as prevent sampling error due to changes in customer load between the two control groups from one season to the next (as seen between 2020 and 2021). Further, this would allow the entire enrolled residential population to provide load impacts without the need to hold back approximately 800 customers per cycling segment, which represents about 10% of the residential 50% cycling group and about 30% of the residential 100% cycling group.

Finding 2

Another cause of sub-optimal performance may be the age and responsiveness of the device fleet. As of the evaluation in Program Year 2021, some of the installed devices are over 15 years old. 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 2

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. This is particularly important if new residential customers continue to be re-added to the program using legacy AC Saver switches. 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 3

Commercial customers produced relatively small impacts when compared to residential customers, but the days when events were called earlier in the day during standard business hours produced larger impacts. There were five weekday events that were called before 6 PM in 2020 and commercial customers had average aggregate impacts of 0.42 MW on these days. This is much larger than the average event day impacts (6 PM to 8 PM) of 0.22 MW in 2021.

Recommendation 3

Consider calling events for commercial participants that include hours before 6 PM to achieve larger commercial impacts.

Finding 4

Four out of seven events in 2021 were two-hour events that occurred between 6 PM and 8 PM. In the ex ante analysis, to ensure that similar events were used from 2018, 2019, and 2021, the average load impacts are defined as the average load impact across the window of 6 PM 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 – 4 of the 7 events in 2021 fit these criteria, as well as 12 of 20 events and 12 of 18 events in 2019 and 2018, respectively. 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 3.2.3.

Recommendation 4

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

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