Demand Side Analytics
DATA DRIVEN RESEARCH AND INSIGHTS

FINAL REPORT

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# 2023 Load Impact Evaluation for San Diego Gas and Electric's Residential Technology Deployment Program

Prepared for SD&GE
By Demand Side Analytics, LLC
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## *ACKNOWLEDGEMENTS*

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## ABSTRACT


This study quantifies the demand impacts of residential thermostats. The study focuses on two primary research questions: What were the 2023 demand reductions due to dispatch operations? What is the magnitude of dispatchable load reduction capability for 1-in-2 and 1-in-10 weather planning conditions?

AC Saver Day Ahead (ACSDA) participants receive event dispatch signals via either free thermostats or Bring Your Own Thermostat (BYOT) thermostats. The thermostats can also help reduce electricity consumption when a residence is unoccupied. The program began in 2018 with a BYOT option and a Free option that was transitioned from the prior SCTD program. Prior to the PY 2019 event season, SDG&E closed its free thermostat program to new enrollments and ramped up enrollment of BYOT thermostats, adding over three thousand thermostats to the program. In addition, before the beginning of the PY 2019 event season SDG&E closed its Peak Time Rebate program (another program open to smart thermostats) and transferred around four thousand participants to ACSDA, mostly of these transfers were from the Free Programmable Thermostat program. In PY 2023, nearly 30 thousand participants were enrolled, double the PY 2022 enrollment.

Events are most commonly dispatched on summer weekdays from 6pm to 8pm. The average PY 2023 weekday 6pm to 8pm event produced 0.79 MW of reduction for free thermostats and a reduction of 13.27 MW for BYOT thermostats.

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# 1 EXECUTIVE SUMMARY

The residential AC Saver Day Ahead (ACSDA) program is a smart thermostat enabled demand response program that has been in place since 2018, though smart thermostat demand response has been available to residential customers since 2014. The current participant population also includes participants that received a free thermostat prior to 2018 and participants previously enrolled in the discontinued Reduce Your Use Peak Time Rebate program (RYU-PTR). Residential ACSDA participants receive event dispatch signals via smart thermostats which can also help reduce electricity consumption when a residence is unoccupied.

SDG&E's residential smart thermostat demand program was initially designed around an offer of a free ecobee thermostat[1] as part of the SCTD program (Small Customer Technology Deployment). In 2018, the program changed from a free thermostat model to a rebate model and was broadened to include additional thermostat models. The impacts of the free and rebated Bring-Your-Own-Thermostat (BYOT) components were evaluated separately and continue to be reported separately for this study.

During 2018, SDG&E began its Default TOU Pilot[2] which transitioned residential customers from rates that did not vary by time of day onto time varying pricing[3]. At the end of the PY 2019 demand response season, approximately 50% of residential ACSDA customers were on TOU rates, but nearly 20% of participants were still not on TOU rates at the end of PY 2022. By PY 2023, only 12% of participants were not on TOU rates, and 88% were on TOU rates. The study segmentation has been simplified relative to prior years, with a non-TOU group and a TOU group including sites that were on a TOU at any time during the study period. In practice the latter group is largely comprised of the several thousand sites that were on a TOU rate for the duration of the study period plus the few dozen that moved onto a TOU rate at some time during the study period. Essentially, unlike in prior years the group that transitioned during the study period was too small for separate analysis and was therefore analyzed along with the TOU group. This segmentation structure still isolates any differential effects across groups who transitioned before or during the PY 2023 season or did not experience the TOU transition.

A more recent notable change in the program population is the substantial increase in enrollment in PY 2023 relative to PY 2022. In PY 2022, around 19,000 devices were enrolled at around 18,000 sites across

[1] The RYU-PTR program provided participants with free ecobee thermostats from 2014 to 2017. After 2017, a BYOT option was offered and the list of eligible models expanded.
[2] SDG&E's Residential Default TOU rate is being evaluated separately.
[3] SDG&E began to implement default Time-of-Use in March of 2018. This first phase targeted about 144,000 randomly selected customers. A control group of about 150,000 customers was withheld from the default rollout for evaluation purposes. The control group continued to stay on the residential tiered rate until the end of 2019. The second phase roll out began in 2019. Customers who were expected to benefit from the TOU rates were defaulted first, followed by customers whose rate impacts were expected to be neutral. Finally, the program was rolled out to customers with non-benefiting profiles. Because of the targeted deployment phase, populations from different rollout phases are not equivalent in their underlying energy usage patterns.

the free and BYOT programs. In PY 2023, however, around 34,000 devices were enrolled at around 32,000 sites across the free and BYOT programs. The ~78% increase in the total enrolled devices was largely concentrated among Nest thermostats. This growth is likely related to the launch of the Golden State Energy Efficiency rebate for thermostats which launched in 2023.

The study analyzes two primary research questions:

- What were the 2023 demand reductions due to dispatch operations?
- What is the magnitude of dispatchable load reduction capability for 1-in-2 and 1-in-10 weather planning conditions?

Table 1-1 summarizes the estimated ex post demand reductions for each of the interventions and distinguishes between free and BYOT resources. The two categories were dispatched identically on the same dates. There are fewer sites in the free thermostats category, resulting in lower aggregate load and lower aggregate reduction.

**Table 1-1: Summary of Average 2023 Ex Post Demand Reductions[4]**

| Technology Intervention | Sites | Load without DR (MW) | Load reduction (MW) | % Reduction |
|---|---|---|---|---|
| ACSDA Free devices (Avg weekday 6-8 pm event) | 2,351 | 3.65 | 0.79 | 21.6% |
| ACSDA BYOT devices (Avg weekday 6-8 pm event) | 29,929 | 51.91 | 13.27 | 25.6% |
| ***ACSDA All devices (Avg weekday 6-8 pm event)*** | ***32,280*** | ***55.56*** | ***14.02*** | ***25.3%*** |

On December 14, 2023, Decision (D.) 23-12-005 OP28 ordered SDG&E to terminate the current Smart Energy Program (SEP) formerly named as AC Saver program at the end of 2023 and decline to fund the SEP for future years. As such ex ante load impacts are no included in this report.

[4] Five of nine weekday events were called from 6 to 8 pm. The two hottest events were called from 5 to 7 pm

# 2 INTRODUCTION

The residential AC Saver Day Ahead (ACSDA) program is a smart thermostat enabled demand response program in place since 2018. The participant population includes participants previously enrolled in the now discontinued Reduce Your Use Peak Time Rebate program (RYU-PTR). Residential ACSDA participants receive event dispatch signals via smart thermostats which can also help reduce electricity consumption when a residence is unoccupied. Smart thermostats allow for optimized energy use by shifting use towards off peak times. ACSDA customers participate in demand response events, where thermostat setpoints are adjusted slightly across a region to decrease aggregate AC runtime during peak times.

Two key transitions that occurred in PY 2019 have the potential to produce differences in load impacts for residential ACSDA. First, the default transition of most residential customers onto TOU rates began in 2019 and was phased in progressively to over 800 thousand of SDG&E's roughly 1.3 million residential accounts[5]. The transition to time varying rates encourages customers to consider when they consume power in addition to how much they consume. Customers can save by modifying when they use energy and by reducing energy use. The rates also better align the prices customers face with the cost of supplying power. Prior to and over the course of the transition, SDG&E implemented an outreach and education campaign designed to increase awareness and improve understanding of the new rate. The second key transition for ACSDA was to the participant and technology mix, as described below.

On December 14, 2023, Decision (D.) 23-12-005 OP28 ordered SDG&E to terminate the current Smart Energy Program (SEP) formerly named as AC Saver program at the end of 2023 and decline to fund the SEP for future years.

[5] Preceding the 2019 residential default time of use rollout was a pilot known as the Residential Default TOU Pilot. The first phase in 2018 targeted about 144,000 customers who were randomly selected to participate in the pilot along with a randomly selected control group. Once the pilot was over, SDG&E continued to roll out its default TOU rate to those customers who would benefit most from the TOU rates offered. The subsequent phase rolled out TOU rates to customers for which impacts were expected to be neutral, and finally to customers with non-benefiting profiles. A control group of about 150,000 customers is being withheld from the default rollout for evaluation purposes.

## 2.1 TECHNOLOGIES AND PROGRAMS EVALUATED

Smart thermostats are the delivery method through which the ACSDA program is dispatched. The program includes ecobee, Nest, Honeywell Home, and Honeywell Total Connect thermostats. In addition to receiving event dispatch signals, the thermostats also can help reduce electricity consumption when a residence is unoccupied. ACSDA thermostats can be dispatched at any time between 12 pm to 9 pm (on-peak hours) for a maximum of 4 consecutive hours and for up to 20 events per season. ACSDA devices are curtailed by raising the thermostat temperature set point 4 degrees during the event window.



SDG&E's residential smart thermostat demand program was initially designed around an offer of a free ecobee thermostat[6] as part of the SCTD program (Small Customer Technology Deployment). In 2018, the program changed from a free thermostat model to a rebate model and was broadened to include additional thermostat models. The current Bring Your Own Thermostat (BYOT) rebate model allows customers to use their existing smart thermostats to receive the ACSDA program signals. Before the PY 2018 event season, SDG&E closed the free thermostat program to new enrollments and ramped up enrollment of BYOT thermostats, adding over three thousand thermostats to the program. In addition, before the beginning of the PY 2019 event season SDG&E closed the Peak Time Rebate program (another smart thermostat enabled program in existence since 2016) and transferred around four thousand participants to the ACSDA program. These factors substantially changed the participant mix. The Free and BYOT channels are evaluated in this report as two distinct programs and most of the transitioned PTR participants are included in the Free program population.

## 2.2 STUDY RESEARCH QUESTIONS

Table 2-1 summarizes the key research questions for each intervention. Thermostats are dispatchable resources that also can lead to daily changes in energy use.

[6] The RYU-PTR program provided participants with free ecobee thermostats from 2014 to 2017. After 2017, a BYOT option was offered and the list of eligible models expanded.

Table 2-1: Key Research Questions

| | Research Question |
|---|---|
| 1 | What were the demand reductions due to program operations and interventions in 2023 – for each event day and hour? |
| 2 | How does weather influence the magnitude of demand response? |
| 3 | How do load impacts differ for customers who were transitioned onto TOU rates during PY 2023? |
| 4 | How do load impacts vary for different thermostat segments-free vs BYOT? |
| 5 | What are the ex ante load reduction capabilities for 1-in-2 and 1-in-10 weather conditions? And how well does it align with ex post results? |
| 6 | What concrete steps or experimental tests can be undertaken to improve program performance? |

## 2.3 OVERVIEW OF METHODS

The primary challenge of impact evaluation is the need to accurately detect changes in energy consumption while systematically eliminating plausible alternative explanations for those changes, including random chance. Did the introduction of smart thermostats cause a change in critical peak period demand? Or can the differences be explained by other factors? To estimate energy savings, it is necessary to estimate what energy consumption would have been in the absence of the intervention—the counterfactual or reference load.

The change in energy use patterns was estimated using difference-in-differences with a control site matched to each participant. Key modeling design components are as follows:

- **Matched control tournament:** In order to identify the control pool sites that best matched each participant's energy use patterns on event-like proxy days (similar in weather and system conditions to event days), several matching methods were tested. These methods included different matching algorithms (e.g. Euclidean and propensity matching) and different site characteristics to be used in the matching. Matching methods included different combinations of proxy day load characteristics such as load factor, load shape, and site weather sensitivity. Control candidates were also "hard-matched" on climate zone, net metering status, and Residential ELRP eligibility group.

- **Difference in-differences model with event and non-event days and participants and matched controls:** The data was structured with participant and control group loads on event days and non-event days side by side. Per site load impacts were estimated with difference-in-differences to net out exogenous differences between treatment and control that existed even on non-event days. This approach was used as the primary method for event impacts for critical peak events delivered by AC Saver Day Ahead thermostat participants.

Figure 2-1 summarizes the out of sample testing process used to select the matched controls to be used for modeling. Essentially, the out of sample process is an iterative approach whereby data is systematically left out of the matching model then used to assess matching method performance—a well performing model should produce matches for loads on days which were not used for the model. The final model is identified based on least bias (% Bias) and best fit (Relative RMSE) metrics.

**Figure 2-1: Out of Sample Process for Control Group Selection**

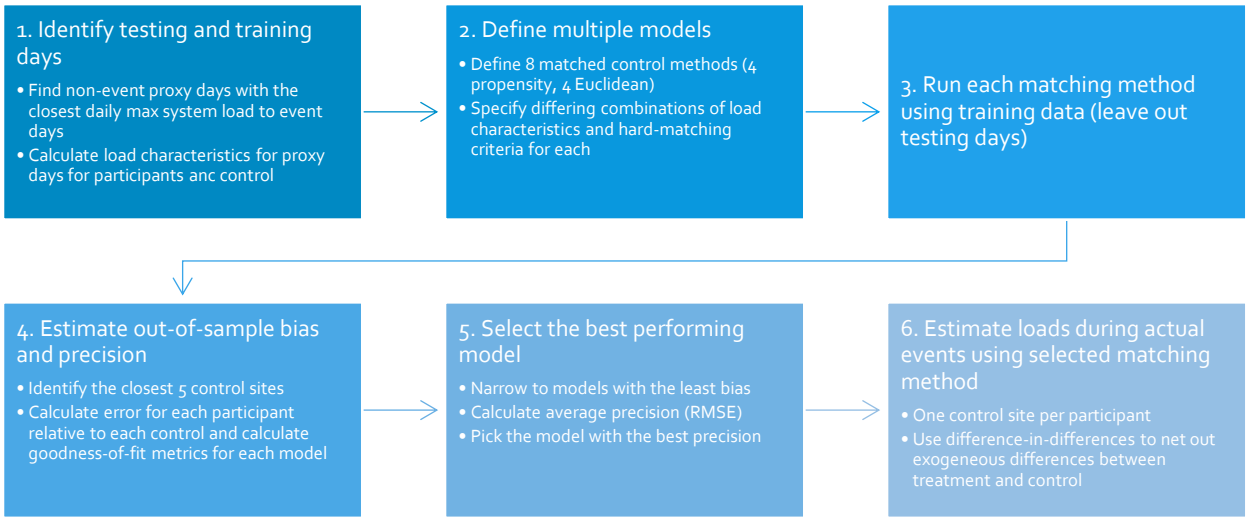



Figure 2-2 below demonstrates the mechanics of a difference in difference calculation. In the first panel, average observed loads on proxy days are shown for participants and for their matched controls. The difference between these two is the first "difference" and quantifies underlying differences between participants and their controls not attributable to event participation. Note that this first difference is very small, indicative of a high-quality match and sufficient sample size to neutralize the noise inherent in individual customer loads. The second panel shows the average observed participant and matched control loads on event days. The gap between these two is the second difference which includes both the difference due to event participation as well as the underlying first difference observable on non-event days. The third panel shows the average event day loads after netting out the proxy day difference from the event day control load. The result is the difference in difference impact.

## Figure 2-2: Difference-in-Differences Calculation Example

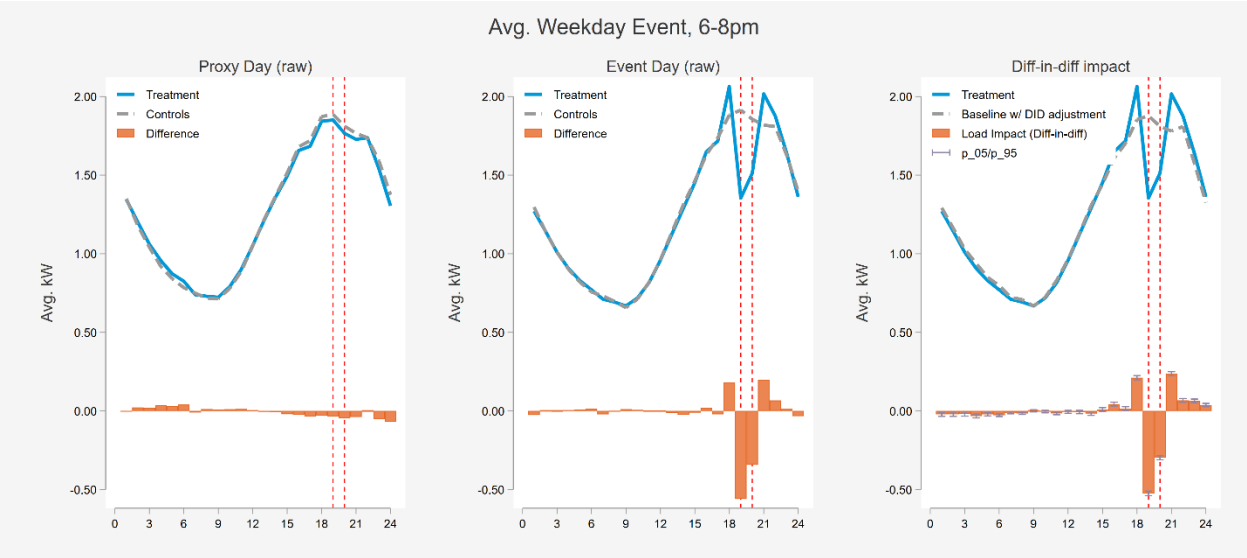



Table 2-2 summarizes the data sources, segmentation, and estimation methods used for each program. The segmentation was defined in advance of the analysis and is of particular importance because the evaluation used a bottom-up approach to estimate impacts and to ensure that aggregate impacts across segments equaled the sum of the parts. Because impacts for each segment were added together, the segmentation was structured to be mutually exclusive and completely exhaustive. In other words, every customer was assigned to exactly one segment. By design, the segmentation differentiated customers who were expected to deliver greater demand reductions– such as customers in the inland climate zone where cooling loads are higher– from customers who were expected to deliver lower demand reductions. This program year, segmentation by TOU status was simplified as the TOU transition has stabilized. As such, the TOU segments consist of those who were not on TOU at any point during the study period and those who transitioned onto TOU prior to or during the study period. Segmentation by solar/net metering status was also added for this program year. Additional segments were analyzed, after the fact, as part of exploratory analysis, but the core results presented are based on the segmentation detailed below.

## Table 2-2: Evaluation Methods

| Evaluation Element | TD Programs |
|---|---|
| **Data sources / samples** | ▪ All event season data for the past program year for ~32k Residential ACSDA participants |
| **Segmentation** | ▪ Rate<br>✓ Not on TOU rate<br>✓ Transitioned to TOU rate during or prior to PY2023<br>▪ Climate zone (Coastal vs Inland) |

| Evaluation Element | TD Programs |
|---|---|
| | ▪ Thermostat type and program<br>✓ Free<br>✓ BYOT<br>▪ Solar/NEM status |
| **Estimation method: Ex-post** | ▪ Difference-in-differences with matched control sites |

# 3 RESIDENTIAL THERMOSTAT EVENT DAY IMPACTS

AC Saver Day Ahead (ACSDA) participants receive event dispatch signals via either free or BYOT thermostats. The thermostats can also help reduce electricity consumption when a residence is unoccupied. In 2018, the program changed from a free thermostat to a rebate model and was broadened to include additional thermostat models. Figure 3-1 summarizes the program development since 2017[7]. ACSDA events are typically called from 6 to 8 pm. ACSDA thermostats can be dispatched at any time between 12 pm to 9 pm (on-peak hours) for a maximum of 4 consecutive hours and most events in 2019 were called from 6-8pm. For both ACSDA programs, devices are curtailed by raising the thermostat temperature set point 4 degrees during the event window.

**Figure 3-1: Summary of Residential Technology Deployment Program Taxonomy**

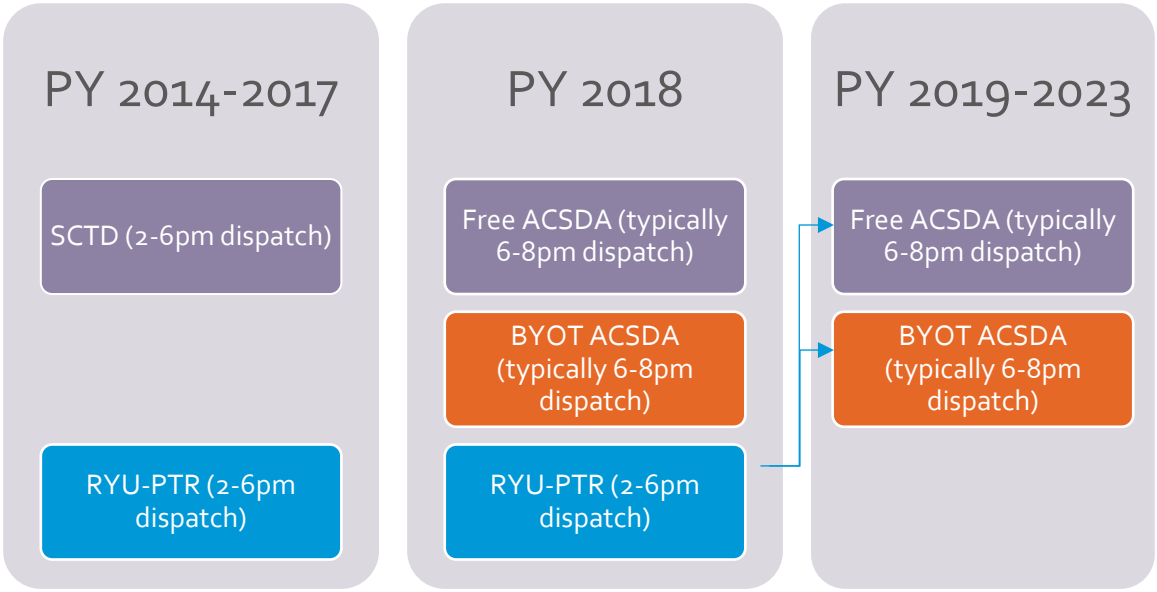



Table 3-1 shows the customer site counts and aggregate percent reduction for the previous four program years for each of the Residential TD programs.

**Table 3-1: Historical Program Overview**

| | Count of Sites (Aggregate Percent Reductions) | | | | |
|---|---|---|---|---|---|
| Program | 2019 | 2020 | 2021 | 2022 | 2023 |
| ACSDA Free | 6,916 (13.3%) | 4,714 (13.5%) | 3,114 (23.0%) | 2,732 (26.6%) | 2,351 (21.6%) |
| ACSDA BYOT | 10,281 (20.4%) | 10,423 (24.1%) | 11,725 (25.2%) | 14,796 (26.0%) | 29,929 (25.6%) |

[7] The RYU-PTR program provided participants with free ecobee thermostats from 2014 to 2017. After 2017, a BYOT option was offered and the list of eligible thermostats was expanded.

There are over 32,000 devices enrolled at over 32,000 residential sites. Reductions for residential ACSDA sites were statistically significant on average and almost exclusively positive across events, with average weekday 6-8pm event savings of 21.6% and 25.6% for free and BYOT thermostats, respectively.

For residential thermostats, connectivity rates are relatively high. Ninety-six percent of the enrolled free thermostats are connected and 93% of the BYOT devices are connected. Because only connected devices can receive signals and curtail AC load this lack of connectivity has direct implication for load impacts delivered by the Technology Deployment programs. Over time, connectivity rates decrease and future efforts to maintain and reconnect disconnected devices, particularly among programs or customer segments delivering greater reductions, are critical to maintaining an effective program.

## 3.1 TECHNOLOGY AND EVENT CHARACTERISTICS

The thermostats used as the enabling device receive a signal from SDG&E to curtail usage during events. For all PY 2023 events, thermostats were controlled by raising the setpoint temperature by 4 degrees. This approach is intended to reduce energy usage by air conditioning units. However, to receive the curtailment signals, the devices must be connected to the internet and registered in the SDG&E dispatch portal. This is initially set up during the device installation process, but connectivity can be affected by internet reliability. Once connected, the device can receive and execute curtailment signals, and it can also communicate event notifications to users before the beginning of an event. Participating, connected devices were sent event notifications 24 hours prior to an event.

The PY 2019 evaluation highlighted the issue of disconnected devices and the dampening effect this had on average "per-site" and "per-device" impacts. The failure rate described in the past incorporated two threads of failure-site attrition and thermostat failure. Site attrition occurs when a site, or customer, un-enrolls from a program or moves out of a service address. Thermostat failure occurs when a customer changes a setting that disconnects their thermostat from the internet. This could be caused by a change in the internet router, a new password, a new internet service provider or any other simple disconnection where the customer does not reconnect their device.

For PY 2023, as for evaluations since PY 2021, site attrition and thermostat disconnections were disaggregated. In part, this helped distinguish between disenrollments, presumably due to move-outs and device disconnections, which may be remedied through participant outreach. This was important for modeling enrollment since historically customers moving into an enrolled site were automatically enrolled in the program, but in practice the device was no longer connected or receiving dispatch signals. Functionally this artificially lowered the observed thermostat survival rate because it was conflated with site move-outs. A new policy in PY 2022 disenrolled thermostats which had been disconnected for the past 365 days, which boosted connectivity rates. Table 3-2 shows the failure rates as a percentage of sites or devices that are no longer enrolled or connected. Figure 3-2 shows the reverse of the failure rate, the survival rates. The figure shows survival trends for enrolled sites and

thermostat connectivity based on years since enrollment and years since installation, respectively. Note that thermostat survival only includes thermostats for enrolled sites. Essentially, the site survival reflects the rate at which sites remain enrolled over time while the thermostat survival shows the rate over time at which thermostats at enrolled sites remain connected. The drop in enrollment after 7 years reflects the bulk unenrollment in the summer of PY 2022 of a large portion of the cohort of sites which enrolled in 2015 and 2016.

**Table 3-2: Failure Rates by Cause**

| Program | Site Attrition | | | Tstat Disconnection | | |
|---|---|---|---|---|---|---|
| | Expected | Lower bound | Upper bound | Expected | Lower bound | Upper bound |
| Res ACSDA | 3.2% | 3.1% | 3.3% | 2.2% | 2.1% | 2.4% |

**Figure 3-2: Survival Trends Over Time**

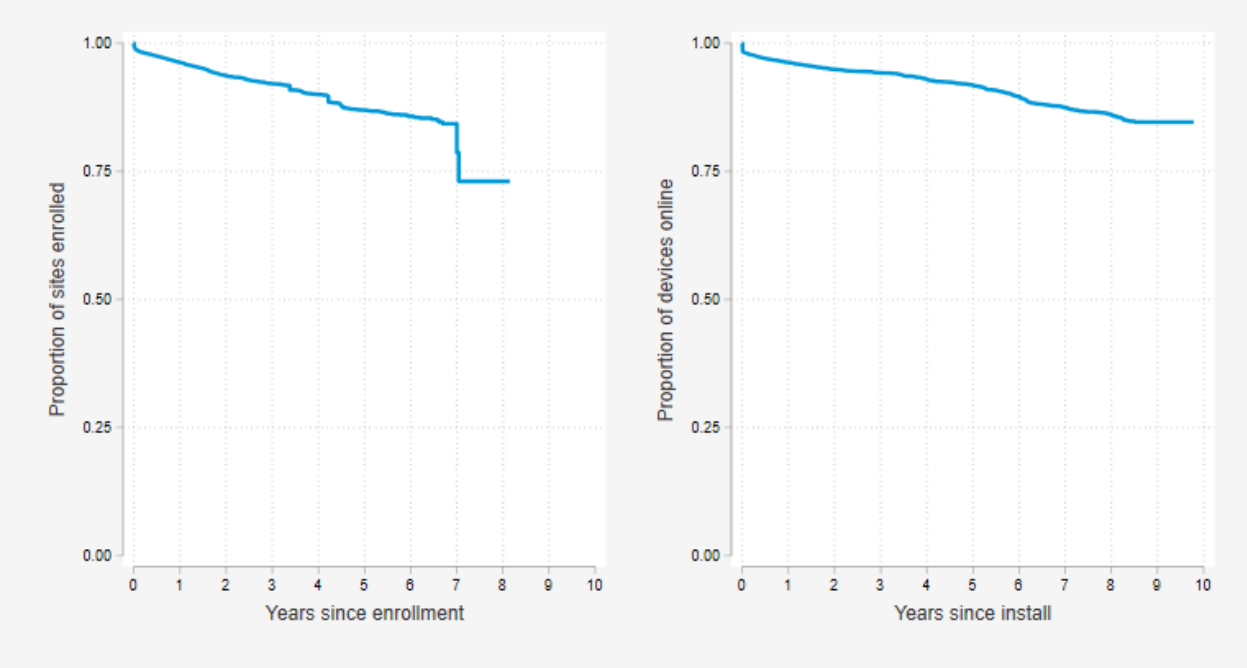



Table 3-3 shows program counts for enrolled sites, enrolled thermostats, and connected thermostats during the average PY 2023 weekday 6-8pm event. Among all enrolled devices, about 3% were no longer connected to the SDG&E dispatch portal during PY 2022 and therefore could not be curtailed during events. There are multiple reasons why a thermostat can become disconnected: a change in routers, a change in Wi-Fi passwords, deliberate disconnection (opt-outs), replacement of the thermostat, etc. When router or Wi-Fi passwords change, a thermostat may not be reconnected by the customers. Understanding the reason why thermostats become disconnected and how to effectively encourage customers to reconnect is critical to the long-term success of the program.

PY 2023 saw a substantial increase in enrollment over PY 2022. In PY 2022, around 19,000 devices were enrolled at around 18,000 sites across the free and BYOT programs. In PY 2023, however, around 34,000 devices were enrolled at around 32,000 sites across the free and BYOT programs. The ~78% increase in the total enrolled devices was largely concentrated among Nest thermostats. This growth is likely related to the launch of the Golden State Energy Efficiency rebate for thermostats which launched in 2023.

Residential thermostat event impacts were assessed by site (premise and service point combination). Sites were grouped together into segments to assess potential differences in impacts for various groups. The segmentation, summarized in Table 3-3, was developed based on thermostat category, brand, TOU status, climate zone, and net metering status which may influence impacts. The analysis was performed at the segment level so these granular impacts could therefore be summed, yielding aggregate impacts in addition to the segment specific impacts.

The segmentation criteria were defined as follows:

- **Program:** was the thermostat provided for free by SDG&E or through the BYOT program?
- **TOU Status:** was the site on a TOU rate at any time during the study period or is it not yet on a TOU rate?
- **Climate zone:** in which SDG&E climate zone was the site located?
- **NEM status**: did the site have net metering?

**Table 3-3: Thermostat Programs and Populations**

| Program Rate | TOU Status | Climate zone | NEM | Total sites | Sites in event analysis | Total enrolled devices | Total connected devices |
|---|---|---|---|---|---|---|---|
| ACSDARES (Free) | Non-TOU | Coastal | No | 229 | 212 | 260 | 251 |
| | | Inland | No | 408 | 395 | 448 | 435 |
| | TOU | Coastal | No | 502 | 489 | 607 | 584 |
| | | | Yes | 223 | 221 | 271 | 260 |
| | | Inland | No | 582 | 574 | 659 | 638 |
| | | | Yes | 407 | 391 | 493 | 472 |
| ACSDARES (BYOT) | Non-TOU | Coastal | No | 1,297 | 1,151 | 1,336 | 1,260 |
| | | | Yes | 238 | 199 | 238 | 238 |
| | | Inland | No | 1,295 | 1,167 | 1,319 | 1,260 |
| | | | Yes | 472 | 366 | 519 | 478 |
| | TOU | Coastal | No | 8,746 | 7,554 | 9,085 | 8,558 |
| | | | Yes | 5,752 | 5,104 | 6,336 | 5,855 |
| | | Inland | No | 5,653 | 4,850 | 5,794 | 5,448 |

| Program Rate | TOU Status | Climate zone | NEM | Total sites | Sites in event analysis | Total enrolled devices | Total connected devices |
|---|---|---|---|---|---|---|---|
| | | | Yes | 6,476 | 5,160 | 7,117 | 6,486 |
| **TOTAL** | | | | **32,280** | **27,833** | **34,482** | **32,222** |

Table 3-3 also summarizes the total number of sites in each segment and the final number of sites used for the ex post event analysis once data cleaning was completed. BYOT makes up the majority of sites and thermostats. The majority of BYOT sites (54%) are in the coastal climate zone where cooling loads and therefore impacts per thermostat are expected to be lower. In contrast, a smaller portion of free sites (41%) are in the coastal zone. About 14.2k sites (44% of all sites) across both programs were net-metered, but it was important to estimate impacts separately for this segment given the difference in underlying load shapes typical of solar customers.

Table 3-4: shows the 18 PY 2023 Residential ACSDA event days. The ACSDA season started in July and ended in October, covering a longer period than the 2022 event season (August to September). In 2023, eleven events occurred on weekdays and seven occurred on weekends or holidays. 2023 event days were cooler than 2022 event days, with daily maximum temperatures ranging from 77.7 to 89.7 F. The SDG&E system peak occurred on August 28th at 5:38pm and SDG&E triggered a residential ACSDA event from 6:00 PM to 8:00 PM on the system peak day.

**Table 3-4: Residential Thermostat ACSDA Events in 2023**

| Event day | Day of week | Event start | Event end | Max daily temp (F) | SDG&E system load (MW) |
|---|---|---|---|---|---|
| 7/14/2023 | Friday | 7:00 PM | 9:00 PM | 83.3 | 3,261 |
| 7/15/2023 | Saturday | 7:00 PM | 9:00 PM | 78.5 | 2,803 |
| 7/16/2023 | Sunday | 7:00 PM | 9:00 PM | 79.6 | 2,941 |
| 7/20/2023 | Thursday | 7:00 PM | 9:00 PM | 83.7 | 3,434 |
| 7/21/2023 | Friday | 7:00 PM | 9:00 PM | 80.5 | 3,129 |
| 7/22/2023 | Saturday | 7:00 PM | 9:00 PM | 78.1 | 2,778 |
| 7/25/2023 | Tuesday | 7:00 PM | 9:00 PM | 84.4 | 3,521 |
| 7/26/2023 | Wednesday | 7:00 PM | 9:00 PM | 87.2 | 3,703 |
| 8/14/2023 | Monday | 6:00 PM | 8:00 PM | 78.6 | 3,159 |
| 8/15/2023 | Tuesday | 5:00 PM | 9:00 PM | 81.0 | 3,309 |
| 8/16/2023 | Wednesday | 5:00 PM | 9:00 PM | 83.4 | 3,636 |
| 8/28/2023 | Monday | 6:00 PM | 8:00 PM | 89.7 | 4,008 |
| 8/30/2023 | Wednesday | 6:00 PM | 8:00 PM | 83.0 | 3,706 |
| 9/9/2023 | Saturday | 6:00 PM | 8:00 PM | 87.1 | 3,618 |
| 9/10/2023 | Sunday | 6:00 PM | 8:00 PM | 86.1 | 3,476 |

| Event day | Day of week | Event start | Event end | Max daily temp (F) | SDG&E system load (MW) |
|---|---|---|---|---|---|
| 10/7/2023 | Saturday | 5:00 PM | 9:00 PM | 86.1 | 2,915 |
| 10/8/2023 | Sunday | 5:00 PM | 9:00 PM | 81.4 | 3,009 |
| 10/9/2023 | Monday | 5:00 PM | 9:00 PM | 77.3 | 2,906 |

## 3.2 DATA SOURCES AND ANALYSIS METHOD

Table 3-5 summarizes the five data sources used to conduct the residential thermostat event impact analysis. The analysis was done by site on hourly load data. Various data sources were used to classify sites into the study segments. While different segments were developed for the various analyses in this report, the characteristic definitions used to build segments were consistent across analyses.

**Table 3-5: Residential Thermostat Event Impact Evaluation Data Sources**

| Source | Comments |
|---|---|
| Hourly interval data | ▪ Summer 2023<br>▪ All analysis done by site (premise id-service point id pair) |
| Outage information | ▪ PSPS and emergency outage data details which customers and what timeframes were impacted by outages |
| Customer characteristics | ▪ Treatment: All residential thermostat participants<br>▪ Control: All residential sites not in other DR programs (except for Residential ELRP defaults)<br>▪ Residential ELRP eligibility group, NEM status, climate zones used in matched control selection |
| Thermostat installation data | ▪ Installation and last connected dates |
| SDG&E hourly system loads | ▪ Summer 2023<br>▪ Used to identify non-event high system load days |
| Ex post weather data by weather station | ▪ Used to derive cooling degree hours for impact evaluation modeling |

The primary analysis method was difference-in-differences with matched controls. The distance matching approach selected one matched control site for each of the more than 32,000 residential thermostat sites among a control candidate pool of roughly 15,000 sampled residential sites who were not enrolled in CPP or other DR programs (except for Residential ELRP defaults) which might influence

energy use. Non-typical, or very large customers tend to be more difficult to match because there are fewer other customers with similar load patterns. To ensure there would be sufficient control candidates for every type of participant, the control pool was constructed within bins by TOU status, NEM status, Residential ELRP eligibility group, and size (annual usage for non-NEM and system capacity for NEM sites). Once the matches were selected for each participant, the difference-in-differences model was used to assess impacts and standard errors for each event and each study segment.

## 3.3 EX POST LOAD IMPACTS

### 3.3.1 AC SAVER DAY AHEAD: RESIDENTIAL WITH TECHNOLOGY

The residential SCTD program was rebranded as ACSDA in 2018 and transitioned from a free thermostat channel and a Bring Your Own Thermostat (BYOT) rebate channel. The BYOT channel allows customers to use their existing smart thermostats, or those newly purchased and qualified for a rebate, to receive the ACSDA program signals. The program is only open to specific smart thermostat models and brands including Nest, ecobee, Honeywell Home. Before the PY 2019 event season, SDG&E closed the free thermostat program to new enrollments and substantially ramped up enrollment of BYOT thermostats, adding over three thousand thermostats to the program and also substantially changing the participant mix compared to PY 2018 and prior years. In addition, before the beginning of the PY 2019 event season SDG&E closed the Peak Time Rebate program (another program open to smart thermostats in existence since 2012) and transferred around four thousand participants to the ACSDA program, substantially changing the participant mix. The Free and BYOT channels are evaluated in this report as two distinct programs and most of the transitioned PTR participants are included in the Free program population.

There were 18 residential events called during PY 2023. The Residential ACSDA events were most often called starting at 7 pm and ending at 9 pm, though the earliest call time was 5pm, and some ended at 8 pm. Because events have diminishing impacts with each subsequent hour, comparing average impacts between events of different durations is not comparable. Load reductions were significant for all events. The average weekday 6-8pm event window and average weekday 7-9pm window were significant with an average aggregate reduction of 14.02 MW and 11.06 MW, respectively. The average weekend 6-8pm window was also significant with an average aggregate reduction of 12.02 MW.

Load reductions are a function of the reference load. When there is lower load, specifically lower cooling load, demand response programs have less opportunity for reduction. However, there are limitations to the differences that can be identified by comparing ex post loads across years given multiple changing variables such as weather and participant population. Most notably, the population of customers and thermostats changed meaningfully during the past three seasons due to the removal of disconnected sites and thermostats. Controlling for these external factors such as population variability and weather helps isolate the effect of demand response programs on loads.

Table 3-6, Table 3-7, and Table 3-8 summarize the load reductions for Residential ACSDA sites for the 18 events and the three average event windows: the average 6-8 pm weekday, the average 7-9 pm weekday event, and the average 6-8 pm weekend event. The full event hours for the non-standard event days are provided below the average event impacts.

The combined impacts for the BYOT and free thermostats are detailed in Table 3-6. The average aggregate load reduction for weekday events from 6 to 8 pm was 14.02 MW across all 32,249 enrolled sites and the average reduction per site was 0.43 kW. Though 32,249 devices were enrolled at enrolled sites, only 30,536 devices on average were connected during the PY 2023 event season. Because only connected devices can be dispatched, all reductions are delivered by these connected devices. The average reduction per connected device was 0.44 kW. Impacts tended to be larger for events where the average event temperature was higher.

Aggregate reductions for significant events range from 4.46 MW (December 9) to 16.74 MW (August 28). The August 28 event, shown in Table 3-7 exhibited the highest average reductions with a maximum reduction of 0.52 kW per site and 0.52 kW per connected thermostat. In the tables, the orange bars show a visual comparison of the reductions that are numerically labeled on the left of the bars. Weekend event days rows are highlighted in light grey, and average weekend events are highlighted in dark grey.

### Table 3-6: ACSDA Residential Program Event Reductions (BYOT + Free)

| Event Date | Event Window | Avg Event Temp (F) | Sites Enrolled | Enrolled Devices | Connect-ed Devices | Reduction | | | t-stat | Significant (90% CI) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Aggregate (MW) | Average Site (kw) | Average Connected Tstat (kw) | | |
| 7/14/2023 | 7 to 9 pm | 70.2 | 30,101 | 32,221 | 30,659 | 10.19 | 0.34 | 0.33 | 38.67 | Yes |
| 7/20/2023 | 7 to 9 pm | 70.7 | 30,115 | 32,236 | 30,527 | 10.68 | 0.35 | 0.35 | 43.92 | Yes |
| 7/21/2023 | 7 to 9 pm | 67.6 | 30,108 | 32,226 | 30,503 | 9.07 | 0.30 | 0.30 | 37.46 | Yes |
| 7/25/2023 | 7 to 9 pm | 71.4 | 30,168 | 32,291 | 30,509 | 12.22 | 0.40 | 0.40 | 47.02 | Yes |
| 7/26/2023 | 7 to 9 pm | 71.7 | 30,149 | 32,270 | 30,479 | 13.20 | 0.44 | 0.43 | 47.75 | Yes |
| **Avg Weekday Event** | **7 to 9 pm** | **70.3** | **30,128** | **32,249** | **30,536** | **11.06** | **0.37** | **0.36** | **76.95** | **Yes** |
| 8/14/2023 | 6 to 8 pm | 68.4 | 32,325 | 34,530 | 32,403 | 9.75 | 0.30 | 0.30 | 36.87 | Yes |
| 8/28/2023 | 6 to 8 pm | 74.8 | 32,185 | 34,377 | 32,069 | 16.74 | 0.52 | 0.52 | 57.16 | Yes |
| 8/30/2023 | 6 to 8 pm | 72.8 | 32,329 | 34,538 | 32,192 | 15.51 | 0.48 | 0.48 | 52.58 | Yes |
| **Avg Weekday Event** | **6 to 8 pm** | **72.0** | **32,280** | **34,482** | **32,222** | **14.02** | **0.43** | **0.44** | **75.98** | **Yes** |
| 8/15/2023 | 5 to 9 pm | 71.3 | 32,279 | 34,482 | 32,339 | 8.45 | 0.26 | 0.26 | 37.01 | Yes |
| 8/16/2023 | 5 to 9 pm | 72.5 | 32,269 | 34,463 | 32,312 | 9.82 | 0.30 | 0.30 | 41.39 | Yes |
| 10/9/2023 | 5 to 9 pm | 65.0 | 32,138 | 34,321 | 31,913 | 4.46 | 0.14 | 0.14 | 22.06 | Yes |
| 7/15/2023 | 7 to 9 pm | 67.3 | 30,169 | 32,292 | 30,723 | 7.35 | 0.24 | 0.24 | 28.66 | Yes |
| 7/16/2023 | 7 to 9 pm | 69.3 | 30,087 | 32,210 | 30,643 | 8.50 | 0.28 | 0.28 | 33.62 | Yes |
| 7/22/2023 | 7 to 9 pm | 67.5 | 30,161 | 32,286 | 30,541 | 7.01 | 0.23 | 0.23 | 28.36 | Yes |
| 9/9/2023 | 6 to 8 pm | 75.7 | 32,208 | 34,405 | 32,032 | 11.63 | 0.36 | 0.36 | 37.07 | Yes |
| 9/10/2023 | 6 to 8 pm | 74.4 | 32,223 | 34,425 | 32,050 | 12.49 | 0.39 | 0.39 | 40.35 | Yes |
| **Avg Weekend Event** | **6 to 8 pm** | **75.0** | **32,216** | **34,415** | **32,041** | **12.02** | **0.37** | **0.38** | **46.77** | **Yes** |
| 10/7/2023 | 5 to 9 pm | 69.5 | 32,161 | 34,344 | 31,941 | 5.90 | 0.18 | 0.18 | 23.62 | Yes |
| 10/8/2023 | 5 to 9 pm | 68.1 | 32,143 | 34,323 | 31,921 | 4.62 | 0.14 | 0.14 | 19.18 | Yes |

The impacts for the free thermostats are detailed in Table 3-7 for weekday and weekend events. The average aggregate load reduction for weekday events from 6 to 8 pm was 0.79 MW across all 2,368 enrolled sites and the average reduction per site was 0.33 kW. Though 2,759 devices were enrolled at enrolled sites, only 2,661 devices on average were connected during the PY 2023 event season. Because only connected devices can be dispatched, all reductions are delivered by these connected devices. The average reduction on weekday events 6 to 8pm per connected device was 0.30 kW. Impacts tended to be larger for events where the average event temperature was higher.

Aggregate reductions for significant events range from 0.16 MW (October 9) to 1.00 MW (August 28). The August 28 event, shown in Table 3-7 exhibited the highest average reductions with a maximum reduction of 0.43 kW per site and 0.38 kW per connected thermostat. In the tables, the orange bars

show a visual comparison of the reductions that are numerically labeled on the left of the bars. As in Table 3-6, weekend event days rows are highlighted in light grey, and average weekend events are highlighted in dark grey.

### Table 3-7: ACSDA Residential Program Event Reductions (FREE)

| Event Date | Event Window | Avg Event Temp (F) | Sites Enrolled | Enrolled Devices | Connect-ed Devices | Reduction | | | t-stat | Significant (90% CI) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Aggregate (MW) | Average Site (kw) | Average Connected Tstat (kw) | | |
| 7/14/2023 | 7 to 9 pm | 70.0 | 2,373 | 2,765 | 2,667 | 0.52 | 0.22 | 0.20 | 8.03 | Yes |
| 7/20/2023 | 7 to 9 pm | 70.6 | 2,356 | 2,747 | 2,649 | 0.62 | 0.26 | 0.23 | 11.23 | Yes |
| 7/21/2023 | 7 to 9 pm | 67.3 | 2,372 | 2,763 | 2,665 | 0.46 | 0.19 | 0.17 | 7.97 | Yes |
| 7/25/2023 | 7 to 9 pm | 71.4 | 2,371 | 2,763 | 2,665 | 0.74 | 0.31 | 0.28 | 11.35 | Yes |
| 7/26/2023 | 7 to 9 pm | 71.3 | 2,367 | 2,757 | 2,659 | 0.83 | 0.35 | 0.31 | 12.33 | Yes |
| **Average Weekday Event** | **7 to 9 pm** | **70.1** | **2,368** | **2,759** | **2,661** | **0.63** | **0.27** | **0.24** | **17.79** | **Yes** |
| 8/14/2023 | 6 to 8 pm | 68.2 | 2,358 | 2,746 | 2,648 | 0.60 | 0.25 | 0.23 | 10.01 | Yes |
| 8/28/2023 | 6 to 8 pm | 74.4 | 2,340 | 2,726 | 2,628 | 1.00 | 0.43 | 0.38 | 14.34 | Yes |
| 8/30/2023 | 6 to 8 pm | 72.5 | 2,355 | 2,743 | 2,645 | 0.76 | 0.32 | 0.29 | 10.81 | Yes |
| **Average Weekday Event** | **6 to 8 pm** | **71.7** | **2,351** | **2,738** | **2,640** | **0.79** | **0.33** | **0.30** | **18.12** | **Yes** |
| 8/15/2023 | 5 to 9 pm | 71.3 | 2,354 | 2,742 | 2,645 | 0.56 | 0.24 | 0.21 | 10.27 | Yes |
| 8/16/2023 | 5 to 9 pm | 72.6 | 2,348 | 2,731 | 2,633 | 0.64 | 0.27 | 0.24 | 11.75 | Yes |
| 10/9/2023 | 5 to 9 pm | 64.4 | 2,332 | 2,716 | 2,618 | 0.16 | 0.07 | 0.06 | 3.63 | Yes |
| 7/15/2023 | 7 to 9 pm | 67.2 | 2,373 | 2,765 | 2,667 | 0.53 | 0.22 | 0.20 | 8.79 | Yes |
| 7/16/2023 | 7 to 9 pm | 69.3 | 2,366 | 2,758 | 2,660 | 0.51 | 0.22 | 0.19 | 8.35 | Yes |
| 7/22/2023 | 7 to 9 pm | 67.0 | 2,371 | 2,763 | 2,665 | 0.34 | 0.14 | 0.13 | 5.93 | Yes |
| 9/9/2023 | 6 to 8 pm | 75.5 | 2,336 | 2,718 | 2,620 | 0.40 | 0.17 | 0.15 | 5.52 | Yes |
| 9/10/2023 | 6 to 8 pm | 74.1 | 2,341 | 2,726 | 2,628 | 0.35 | 0.15 | 0.13 | 4.81 | Yes |
| **Average Weekend Event** | **6 to 8 pm** | **74.8** | **2,339** | **2,722** | **2,624** | **0.36** | **0.16** | **0.14** | **6.10** | **Yes** |
| 10/7/2023 | 5 to 9 pm | 68.7 | 2,336 | 2,721 | 2,623 | 0.27 | 0.11 | 0.10 | 4.65 | Yes |
| 10/8/2023 | 5 to 9 pm | 67.5 | 2,336 | 2,721 | 2,623 | 0.25 | 0.11 | 0.10 | 5.00 | Yes |

The impacts for the BYOT thermostats are detailed in Table 3-8 for weekday and weekend events. The average aggregate load reduction for weekday events from 6 to 8 pm was 13.27 MW across all 29,929 enrolled sites and the average reduction per site was 0.44 kW. Almost all 31,744 enrolled devices were still connected throughout the PY 2023 event season, with 29,582 connected devices on average for weekday 6 to 8pm events. Because only connected devices can be dispatched, all reductions are delivered by these connected devices. The average reduction per connected device was 0.45 kW. Aggregate impacts are about five times as large for the BYOT devices. There are nearly ten times as

many connected devices in the BYOT program and impacts per connected thermostat are around 50% larger for the BYOT program with 0.45 kW compared to the 0.30 kW savings per free connected device.

BYOT aggregate reductions for significant events range from 4.33 MW (October 9) to 15.77 MW (August 28). These dates, respectively, also exhibited the lowest and highest average site reductions and average connected thermostat reductions of the BYOT thermostats.

### Table 3-8: ACSDA Residential Program Event Reductions (BYOT)

| Event Date | Event Window | Avg Event Temp (F) | Sites Enrolled | Enrolled Devices | Connect-ed Devices | Reduction | | | t-stat | Significant (90% CI) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Aggregate (MW) | Average Site (kw) | Average Connected Tstat (kw) | | |
| 7/14/2023 | 7 to 9 pm | 70.2 | 27,728 | 29,456 | 27,992 | 9.68 | 0.35 | 0.35 | 37.89 | Yes |
| 7/20/2023 | 7 to 9 pm | 70.7 | 27,759 | 29,489 | 27,878 | 10.07 | 0.36 | 0.36 | 42.47 | Yes |
| 7/21/2023 | 7 to 9 pm | 67.7 | 27,736 | 29,463 | 27,838 | 8.63 | 0.31 | 0.31 | 36.64 | Yes |
| 7/25/2023 | 7 to 9 pm | 71.3 | 27,797 | 29,528 | 27,844 | 11.49 | 0.41 | 0.41 | 45.66 | Yes |
| 7/26/2023 | 7 to 9 pm | 71.7 | 27,782 | 29,513 | 27,820 | 12.38 | 0.45 | 0.44 | 46.14 | Yes |
| **Avg Weekday Event** | **7 to 9 pm** | **70.3** | **27,760** | **29,490** | **27,875** | **10.44** | **0.38** | **0.37** | **74.96** | **Yes** |
| 8/14/2023 | 6 to 8 pm | 68.5 | 29,967 | 31,785 | 29,756 | 9.16 | 0.31 | 0.31 | 35.50 | Yes |
| 8/28/2023 | 6 to 8 pm | 74.8 | 29,845 | 31,652 | 29,442 | 15.77 | 0.53 | 0.54 | 55.34 | Yes |
| 8/30/2023 | 6 to 8 pm | 72.8 | 29,974 | 31,796 | 29,548 | 14.80 | 0.49 | 0.50 | 51.59 | Yes |
| **Avg Weekday Event** | **6 to 8 pm** | **72.0** | **29,929** | **31,744** | **29,582** | **13.27** | **0.44** | **0.45** | **73.85** | **Yes** |
| 8/15/2023 | 5 to 9 pm | 71.3 | 29,925 | 31,741 | 29,695 | 7.90 | 0.26 | 0.27 | 35.55 | Yes |
| 8/16/2023 | 5 to 9 pm | 72.5 | 29,921 | 31,733 | 29,680 | 9.19 | 0.31 | 0.31 | 39.70 | Yes |
| 10/9/2023 | 5 to 9 pm | 65.1 | 29,806 | 31,605 | 29,295 | 4.33 | 0.15 | 0.15 | 21.85 | Yes |
| 7/15/2023 | 7 to 9 pm | 67.3 | 27,796 | 29,527 | 28,056 | 6.82 | 0.25 | 0.24 | 27.35 | Yes |
| 7/16/2023 | 7 to 9 pm | 69.3 | 27,721 | 29,452 | 27,983 | 8.00 | 0.29 | 0.29 | 32.57 | Yes |
| 7/22/2023 | 7 to 9 pm | 67.6 | 27,790 | 29,523 | 27,876 | 6.68 | 0.24 | 0.24 | 27.76 | Yes |
| 9/9/2023 | 6 to 8 pm | 75.7 | 29,872 | 31,687 | 29,412 | 11.30 | 0.38 | 0.38 | 36.91 | Yes |
| 9/10/2023 | 6 to 8 pm | 74.4 | 29,882 | 31,699 | 29,422 | 12.22 | 0.41 | 0.42 | 40.55 | Yes |
| **Avg Weekend Event** | **6 to 8 pm** | **75.1** | **29,877** | **31,693** | **29,417** | **11.73** | **0.39** | **0.40** | **46.84** | **Yes** |
| 10/7/2023 | 5 to 9 pm | 69.6 | 29,825 | 31,623 | 29,318 | 5.66 | 0.19 | 0.19 | 23.22 | Yes |
| 10/8/2023 | 5 to 9 pm | 68.1 | 29,807 | 31,602 | 29,298 | 4.38 | 0.15 | 0.15 | 18.52 | Yes |

Reductions were also analyzed by TOU status for residential customers in the ACSDA program. To tease out any differential impacts by TOU status, customers were classified as not being on TOU rates throughout the entire PY 2023 demand response season or being on TOU rates at any point during the season. There is no separate classification for customers who transitioned onto TOU rates during the

PY 2023 demand response season because only a few customers did[8]. Table 3-9 details the reference loads and load reductions overall and by TOU category for the average 6 pm to 8 pm weekday event window. In addition to aggregate reductions, average reductions per connected thermostat are also shown. Note that the reference load for aggregate impacts includes the whole building load across all enrolled sites as recorded at the meter; the reference load for the average connected thermostat is the cooling load per connected thermostat, estimated by isolating the weather sensitive portion of whole building load. In aggregate, 26.1% of whole building load was curtailed during the average event, while 47% of cooling load was curtailed per connected device.

In aggregate, 41% of connected devices were in the coastal zone and these devices delivered 0.41 MW of the 0.79 MW—23%—of reductions for the ACSDA Residential Free program. However, as expected, the load reduction (kW) per device is higher among participants in the inland climate zone.

Approximately 12% of the sites and devices are Non-TOU, and the rest are TOU (88%). About 5% of sites transitioned during PY 2023 and these are included in the TOU group. Average connected thermostat percent reductions are 45% of cooling load for all customers. TOU sites exhibit larger reductions than the Non-TOU sites do in aggregate. Differences are not meaningful on average but can be observed by comparing sub-segments. For non-NEM customers, inland and coastal TOU customers showed percent reductions of 46% of cooling load compared to 54% for coastal. For participants not on TOU rates, non-NEM average percent impacts were 48% reduction of cooling load.

NEM sites appear to deliver larger percent reductions per connected device than non-NEM when comparing within the same rate and climate zone categories. Load (kW) reductions per connected device are substantially larger for NEM sites. Reference loads (estimated cooling loads) are also higher for NEM sites than for Non-NEM sites.

[8] It is notable that the second phase of SDG&E's default TOU rollout has not been randomized, rather it has been deployed strategically targeting customers expected to benefit most from the new rates. As such the TOU segments for this study are not comparable populations and differ in their underlying usage patterns as well as in their rate status.

### Table 3-9: ACSDA Residential Program Average Event Reductions by Segment (FREE)

| TOU Status | Climate Zone | NEM | Event Window | Avg Event Temp (F) | Sites Enrolled | Enrolled Devices | Connect-ed Devices | Aggregate (MW) | | | Average connected tstat (kW) | | | t-stat |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Ref load (whole bldg) | Reduc-tion | % Reduc-tion | Ref load (cooling) | Reduc-tion | % Reduc-tion | |
| Non-TOU | Coastal | No | 6 to 8 pm | 71.5 | 229 | 260 | 251 | 0.28 | 0.05 | 18.3% | 0.43 | 0.21 | 48% | 4.56 |
| | Inland | No | 6 to 8 pm | 72.4 | 408 | 448 | 435 | 0.72 | 0.18 | 25.1% | 0.87 | 0.42 | 48% | 10.46 |
| TOU | Coastal | No | 6 to 8 pm | 71.4 | 502 | 607 | 584 | 0.63 | 0.11 | 17.2% | 0.34 | 0.18 | 54% | 5.64 |
| | | Yes | 6 to 8 pm | 71.2 | 223 | 271 | 260 | 0.34 | 0.07 | 21.0% | 0.57 | 0.27 | 48% | 5.27 |
| | Inland | No | 6 to 8 pm | 71.8 | 582 | 659 | 638 | 0.88 | 0.17 | 19.1% | 0.58 | 0.26 | 46% | 8.52 |
| | | Yes | 6 to 8 pm | 71.6 | 407 | 493 | 472 | 0.80 | 0.21 | 25.9% | 0.71 | 0.44 | 62% | 9.20 |
| | | | **6 to 8 pm** | **71.7** | **2,351** | **2,738** | **2,640** | **3.65** | **0.79** | **21.6%** | **0.63** | **0.30** | **47%** | **18.12** |

Table 3-10 shows the same results for the two BYOT categories-Nest and other thermostats. Overall, aggregate reductions were 13.27 MW which is 25.6% of whole building load. As with the Free thermostats, inland thermostats deliver greater load reductions (kW) per thermostat and many sites have transitioned to TOU rates. Also, similarly to the Free devices, NEM sites appear to deliver larger reductions per connected device, on a kW and percent basis, than non-NEM when comparing within the same across rate and climate zone categories.

### Table 3-10: ACSDA Residential Program Average Event Reductions by Segment (BYOT)

| TOU Status | Climate Zone | NEM | Event Window | Avg Event Temp (F) | Sites Enrolled | Enrolled Devices | Connect-ed Devices | Aggregate (MW) | | | Average connected tstat (kW) | | | t-stat |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Ref load (whole bldg) | Reduc-tion | % Reduc-tion | Ref load (cooling) | Reduc-tion | % Reduc-tion | |
| Non-TOU | Coastal | No | 6 to 8 pm | 71.9 | 1,297 | 1,336 | 1,260 | 1.83 | 0.42 | 22.8% | 0.51 | 0.33 | 65% | 14.72 |
| | | Yes | 6 to 8 pm | 71.7 | 238 | 238 | 238 | 0.56 | 0.16 | 28.3% | 1.16 | 0.67 | 58% | 7.79 |
| | Inland | No | 6 to 8 pm | 72.5 | 1,295 | 1,319 | 1,260 | 2.38 | 0.62 | 26.2% | 1.02 | 0.49 | 49% | 19.48 |
| | | Yes | 6 to 8 pm | 72.2 | 472 | 519 | 478 | 1.35 | 0.38 | 27.9% | 1.42 | 0.79 | 55% | 11.93 |
| TOU | Coastal | No | 6 to 8 pm | 71.9 | 8,746 | 9,085 | 8,558 | 11.90 | 2.74 | 23.0% | 0.52 | 0.32 | 62% | 33.39 |
| | | Yes | 6 to 8 pm | 71.7 | 5,752 | 6,336 | 5,855 | 11.06 | 2.93 | 26.5% | 0.81 | 0.50 | 61% | 32.77 |
| | Inland | No | 6 to 8 pm | 72.2 | 5,653 | 5,794 | 5,448 | 8.81 | 2.16 | 24.5% | 0.74 | 0.40 | 54% | 32.71 |
| | | Yes | 6 to 8 pm | 72.3 | 6,476 | 7,117 | 6,486 | 14.29 | 3.96 | 27.7% | 1.10 | 0.61 | 56% | 39.27 |
| | | | **6 to 8 pm** | **72.0** | **29,929** | **31,744** | **29,582** | **51.91** | **13.27** | **25.6%** | **0.83** | **0.45** | **54%** | **73.85** |

The average event day load shape is summarized in greater detail in Figure 3-3 for Free thermostats and in Figure 3-4 for BYOT thermostats. Note that the figures, extracted from the Ex Post Load Impact Table, are for the ACSDA residential participant population for the average event day. The average event day reflects weekday events where event hours matched the 6 to 8 pm window. The left panel shows the aggregate hourly loads (actual and counterfactual) for these sites. The right panel shows impacts per customer. The tables accompanying each figure show aggregate impacts for the 6 pm to 8 pm weekday event window.

The load shapes in Figure 3-3 exhibit a clear impact during the event window, followed by a one-hour snapback in hour ending 21. There is a 21.6% reduction across all Free residential customers on the average weekday 6-8 pm 2023 event.

Figure 3-4 also has clearly visible event impacts and provides the load shapes for the BYOT thermostats. There is a similar snapback effect in hour ending 21 as is seen in Figure 3-3 for the free thermostats. In contrast, there is also a clear load increase just prior to the event start, typically indicative of pre-cooling. Overall savings are 25.6% load reductions for the average customer and on aggregate for the BYOT category.

## Figure 3-3: ACSDA Residential Summary for Average Event (FREE)

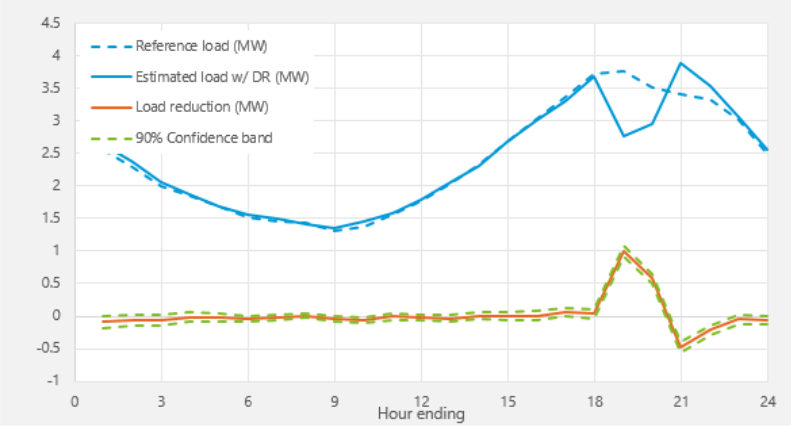
### Aggregate (MW)

Table 1: Menu options

| | |
|---|---|
| **Program** | ACSDARES (Free) |
| **Type of result** | Aggregate |
| **Type of site** | All |
| **Category** | All |
| **Subcategory** | All study segments |
| **Event date** | Avg Weekday 6-8pm |

Table 2: Event day information

| | |
|---|---|
| Event start | 6:00 PM |
| Event end | 8:00 PM |
| Total sites | 2,351 |
| Total enrolled thermostats | 2,738 |
| Total connected thermostats | 2,640 |
| Percent of thermostats connected | 96% |
| Avg load reduction 6PM-8PM | 0.79 |
| % Load reduction 6PM-8PM | 21.6% |



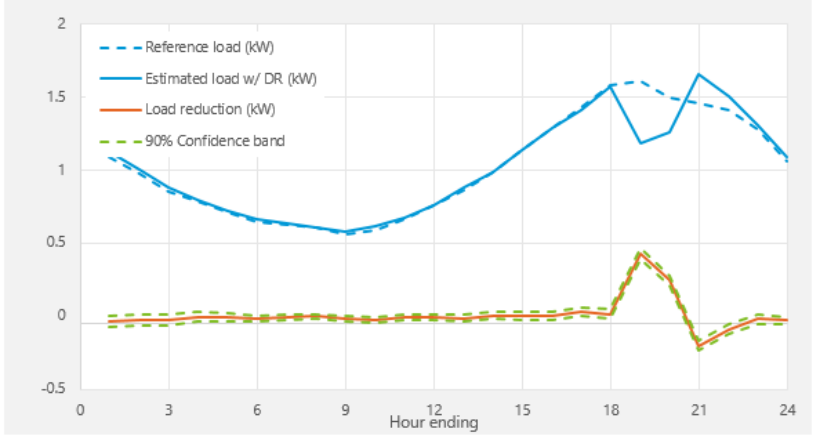

### Average Customer (kW)

Table 1: Menu options

| | |
|---|---|
| **Program** | ACSDARES (Free) |
| **Type of result** | Average Customer |
| **Type of site** | All |
| **Category** | All |
| **Subcategory** | All study segments |
| **Event date** | Avg Weekday 6-8pm |

Table 2: Event day information

| | |
|---|---|
| Event start | 6:00 PM |
| Event end | 8:00 PM |
| Total sites | 2,351 |
| Total enrolled thermostats | 2,738 |
| Total connected thermostats | 2,640 |
| Percent of thermostats connected | 96% |
| Avg load reduction 6PM-8PM | 0.33 |
| % Load reduction 6PM-8PM | 21.6% |



## Figure 3-4: ACSDA Residential Summary for Average Event (BYOT)

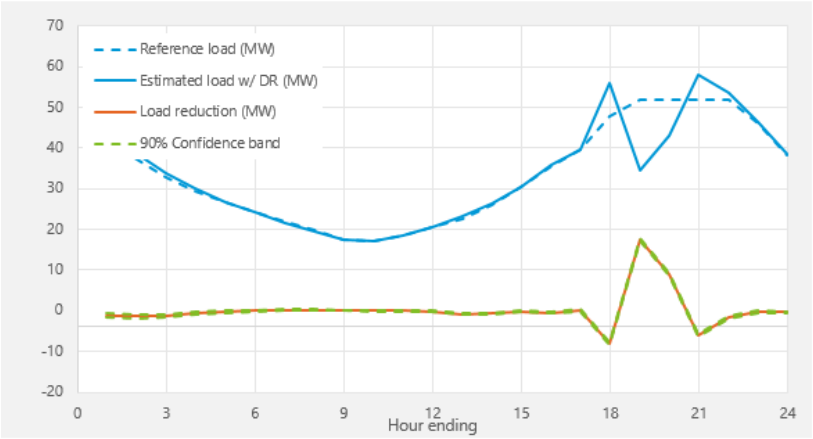
### Aggregate (MW)

Table 1: Menu options

| | |
|---|---|
| **Program** | ACSDARES (BYOT) |
| **Type of result** | Aggregate |
| **Type of site** | All |
| **Category** | All |
| **Subcategory** | All study segments |
| **Event date** | Avg Weekday 6-8pm |

Table 2: Event day information

| | |
|---|---|
| Event start | 6:00 PM |
| Event end | 8:00 PM |
| Total sites | 29,929 |
| Total enrolled thermostats | 31,744 |
| Total connected thermostats | 29,582 |
| Percent of thermostats connected | 93% |
| Avg load reduction 6PM-8PM | 13.27 |
| % Load reduction 6PM-8PM | 25.6% |



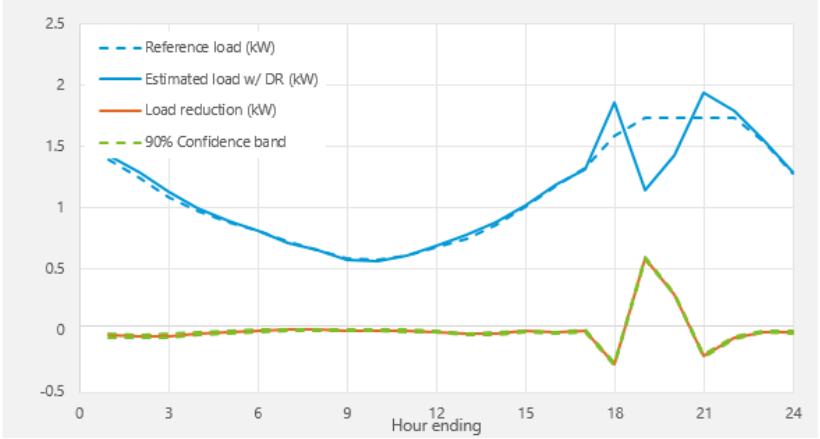

### Average Customer (kW)

Table 1: Menu options

| | |
|---|---|
| **Program** | ACSDARES (BYOT) |
| **Type of result** | Average Customer |
| **Type of site** | All |
| **Category** | All |
| **Subcategory** | All study segments |
| **Event date** | Avg Weekday 6-8pm |

Table 2: Event day information

| | |
|---|---|
| Event start | 6:00 PM |
| Event end | 8:00 PM |
| Total sites | 29,929 |
| Total enrolled thermostats | 31,744 |
| Total connected thermostats | 29,582 |
| Percent of thermostats connected | 93% |
| Avg load reduction 6PM-8PM | 0.44 |
| % Load reduction 6PM-8PM | 25.6% |



## 3.4 EX ANTE LOAD IMPACTS

On December 14, 2023, Decision (D.) 23-12-005 OP28 ordered SDG&E to terminate the current Smart Energy Program (SEP) formerly named as AC Saver program at the end of 2023 and decline to fund the SEP for future years. As such ex ante load impacts are no included in this report.

# 4 CONCLUSIONS AND RECOMMENDATIONS

The residential ACSDA program delivered statistically significant demand reduction and energy savings, but there is room for improvement. The recommendations below may not be currently funded, and costs need to be considered alongside other research and program priorities.

## 4.1 TECHNOLOGY DEPLOYMENT RECOMMENDATIONS

- **If possible, avoid bidding sites that lack connected thermostats into the CAISO markets.** Sites with loads that cannot be controlled or dispatched do not deliver any detectable demand reduction. They simply dilute the demand reductions and make them harder to detect. SDG&E should continue efforts to remove thermostats disconnected for prolonged periods[9] from the dispatch portal.

- **Review dispatch strategy to optimize load reductions.** While there are a few methods of demand response dispatch, the 4-degree setback is an algorithm with diminishing returns. PY 2020 was the first year with several events lasting 3 to 5 hours, demonstrating that impacts may be high in the first hour or two of an event drop notably in the third and fourth hour of an event. Dispatch strategies can be designed to maintain more consistent impacts across multiple event hours and potentially produce higher average impacts across event hours by producing greater impacts in later event hours, e.g. in hour 3 or 4. For example, setbacks can be stepped such that the setback is 2-degrees in hour 1, 3-degrees in hour 2, and 4- degrees in hour 3. Setback strategies can also be used to minimize customer discomfort while maximizing average impact. As an example, a stepped dispatch may be less noticeable and less uncomfortable for residential occupants, which is all the more important as residential weekday occupancy has increased since COVID-19. Another area for consideration is a more gradual pre-cooling strategy. BYOT thermostats exhibit a clear, substantial pre-cooling notch in the hour before events. Stepped pre-cooling, similar to stepped event hour setbacks, can be used to dampen the pre-cooling notch while improving participant comfort.

[9] Currently devices disconnected for more than one year are periodically removed and unenrolled