SDG&E eco+ Evaluation

Evaluation Report

DR21SDG0001 Report

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Disclaimer

Abbreviations and Acronyms

AC	Air conditioning
CARE	California Alternative Rates for Energy
DiD	Difference-in-differences
DR	Demand Response
FERA	Family Electric Rate Assistance Program
HVAC	Heating, ventilation, and air conditioning
ITT	Intent-to-treat
kW	Kilowatt
kWh	Kilowatt-hour
NEM	Net energy metered
RED	Randomized encouragement design
SDG&E	San Diego Gas & Electric
TOU	Time-of-use

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1 Executive Summary

This report documents the evaluation of the energy and on-peak demand savings attributable to the eco+ software feature that was rolled out to ecobee thermostats in the San Diego Gas & Electric Co. (SDG&E) service territory. The implementation of the feature was conducted on a randomized encouragement design (RED) basis to facilitate a sound impact evaluation net of selection effects. The feature was offered to eligible residential customers in August 2019. The primary objective of this report is to document the findings of an ex post (after the fact) study that estimates energy and on-peak demand savings attributable to the eco+ software feature between September 2019 and August 2020.

1.1 Program Background and Design

The study was structured as a randomized encouragement design (RED) experiment. With a RED, different randomly selected samples of customers are offered an experimental treatment (in this case, to install the eco+ software feature) and another random group of customers is not offered anything (e.g., the control group). Some who are offered the treatment take it and some do not. Because each sample is a statistical clone of the other due to the random selection, comparing the behavior of the encouraged group with that of the control group allows for an unbiased assessment of the impact of the treatment. This analysis requires a two-step process in order to isolate the impact of the encouragement (e.g., the offer of a treatment) from the treatment itself, as explained more fully in Section 3.

Daily energy and on-peak demand impacts were estimated for two different climate regions[1] in SDG&E's service territory (Cool and Moderate). Impacts were not estimated in the Hot climate region due to low sample sizes and acceptance rates. Daily energy and on-peak demand impacts were also estimated for net metered (NEM) and non-net metered (non-NEM) customers.

1.2 Key Findings

1.2.1 On-Peak Load Impacts

The following tables summarize winter and summer on-peak load impacts for non-NEM and NEM customers.

Table 1-1: Winter On-Peak Load Impacts

Segment	Control Customers	Encouraged Customers	Accepted Customers	Reference kW	Treat kW	Impact kW	% Impact	Lower 90% (kW)	Upper 90% (kW)
Non-NEM	732	710	319	0.78	0.73	0.06	7.3%	0.05	0.06
NEM	225	228	109	0.66	0.66	0.00	0.6%	-0.02	0.03

[1] Cool, Moderate, and Hot climate regions are based on the definition from TOU pilots.

Table 1-2: Summer On-Peak Load Impacts

Segment	Control Customers	Encouraged Customers	Accepted Customers	Reference kW	Treat kW	Impact kW	% Impact	Lower 90% (kW)	Upper 90% (kW)
Non-NEM	727	702	318	1.06	1.01	0.05	4.4%	0.04	0.06
NEM	224	231	110	0.74	0.58	0.16	21.8%	0.13	0.19

Key findings pertaining to the on-peak load impacts analysis include:

- Winter on-peak load impacts for non-NEM customers were 0.06 kW and statistically significant at the 90% confidence interval
- Winter on-peak load impacts for NEM customers were not statistically significant
- Summer on-peak load impacts for non-NEM customers were 0.05 kW and statistically significant at the 90% confidence level
- Summer on-peak load impacts for NEM customers were 0.16 kW and statistically significant at the 90% confidence level

1.2.2 Daily Consumption Impacts

The following tables summarize winter and summer daily consumption impacts for non-NEM and NEM customers.

Table 1-3: Winter Daily Consumption Impacts

Segment	Control Customers	Encouraged Customers	Accepted Customers	Reference kWh	Treat kWh	Impact kWh	% Impact	Lower 90% (kWh)	Upper 90% (kWh)
Non-NEM	732	710	319	15.25	14.56	0.69	4.5%	0.60	0.78
NEM	225	228	109	3.67	3.51	0.16	4.4%	-0.12	0.44

Table 1-4: Summer Daily Consumption Impacts

Segment	Control Customers	Encouraged Customers	Accepted Customers	Reference kWh	Treat kWh	Impact kWh	% Impact	Lower 90% (kW)	Upper 90% (kW)
Non-NEM	727	702	318	19.05	18.69	0.36	1.9%	0.25	0.47
NEM	224	231	110	5.11	4.27	0.85	16.5%	0.50	1.19

Key findings pertaining to the daily consumption impacts analysis include:

- Winter daily consumption impacts for non-NEM customers were 0.69 kWh and statistically significant at the 90% confidence interval
- Winter daily consumption impacts for NEM customers were not statistically significant
- Summer daily consumption impacts for non-NEM customers were 0.36 kWh and statistically significant at the 90% confidence level
- Summer daily consumption impacts for NEM customers were 0.85 kWh and statistically significant at the 90% confidence level

1.3 Conclusions and Recommendations

The eco+ software features that were offered to customers proved to be an effective tool for reducing on-peak load for participating customers. The software was also effective in producing overall energy consumption savings at the daily level. While some of the findings for the NEM customers were not statistically significant, this was likely due to the small sample size. There is no reason to believe that the software should be less effective for NEM versus non-NEM customers given both customer types have thermostats and space conditioning needs that can be modified via the thermostat software.

If energy and demand savings evaluations similar to this study are needed in the future, it would be beneficial to coordinate with the evaluator prior to the pilot or program launch to validate the treatment assignments, including a pre-treatment load check, in order to ensure the validity of the experimental design.

SDG&E has already expanded the offering of the eco+ software features tested in this pilot to the known ecobee customer base, including those who were in the control group. Resource Innovations recommends continuing to offer this software feature as new ecobee customers are identified. Resource Innovations also recommends that SDG&E encourage other thermostat manufacturers to develop similar offerings if they aren't already available to customers.

2 Introduction

Eco+ is a free software upgrade compatible with ecobee 3 lite, ecobee 3, ecobee 4 and ecobee Smart Thermostat with Voice thermostats. The eco+ software features five energy and demand saving functions that are not otherwise enabled on ecobee thermostats:

- **Feels Like** – The Feels Like function detects fluctuations in the home's indoor humidity to ensure that it feels like the temperature homeowners set on their thermostat. This function is designed for both energy efficiency and home comfort even during periods of high or low humidity.
- **Schedule Assistant** – The Schedule Assistant function monitors the thermostat's schedule. When the schedule doesn't match with the home's historic HVAC usage routine, Schedule Assistant recommends a new schedule to the user.
- **Smart Home and Away** – The Smart Home and Away feature adjusts the temperature setpoint when it detects that the home is unoccupied and quickly restores the temperature settings when it detects that the home is occupied again.
- **Time of Use** – The Time of Use function precools and preheats the home during off-peak times of day. For customers that are on time of use electricity rates, this function can lower electricity bills by shifting cooling and heating to times of day when electricity is less expensive.
- **Community Energy Savings** – The CES function makes small thermostat setpoint adjustments to reduce energy consumption from cooling or heating during demand response events.

Prior to the rollout of eco+ in San Diego, SDG&E and ecobee worked together to identify the group of SDG&E customers that would receive an offer from ecobee to receive the eco+ software update. SDG&E first identified approximately 4,000 customers that have either already received an energy efficiency rebate for an ecobee thermostat or who participate in an SDG&E DR program using an eligible ecobee thermostat. These 4,000 customers were additionally screened to exclude any customers that have requested SDG&E to refrain from sending them any marketing or survey communications.

Of those 4,000 customers, 2,600 of them also have registered the same contact information (e-mail address) with ecobee and thus were eligible to receive the ecobee offer of the eco+ software. Half of the 2,600 eligible SDG&E customers were randomly selected to receive the offer for the software. The eco+ offer was made through both email and the ecobee thermostat app in August 2019. Of the 1,300 customers that received the offer, 950 enrolled. This implementation approach is known as a randomized encouragement design (RED) and is often used in research settings where assignment to treatment and control conditions cannot be controlled due to the voluntary nature of an intervention. Table 2-1 summarizes the RED framework of this study as described above.

Table 2-1: Summary of eco+ RED Framework

Research Group	Number of Customers	Description
SDG&E customers eligible to receive the eco+ offer	2,600	Customers who have already elected to receive communications concerning their thermostats from both SDG&E and ecobee
Control group	1,300	Randomly selected to receive no communications from SDG&E or ecobee about eco+
Encouraged group	1,300	Randomly selected to receive an invitation via email and the ecobee app to enroll in eco+
Enrolled group	950	Customers from the Encouraged group that elected to enroll in eco+

SDG&E began its default time-of-use (TOU) rate roll out in March of 2019 and approximately 46% of customers included in the eco+ study were on a TOU rate when the pilot was launched in August of 2019. By the end of the analysis period in August 2020, about 64% of customers in the study were on a TOU rate. Customers not enrolled on a TOU rate can still utilize the eco+ plus feature; however, in this case the eco+ feature will provide only overall energy savings. For customers enrolled on a TOU rate the eco+ feature is designed to both provide overall energy savings and to take into account TOU periods.

2.1 Evaluation Objectives

The primary purpose of the evaluation was to estimate the incremental impact of the eco+ software upgrade on overall customer energy use and on energy use by time of use period.

2.2 Report Organization

The remainder of this report is organized as follows:

- Section 3 describes the methodology used to estimate on-peak load and daily consumption impacts;
- Section 4 presents the methodology to validate the RED framework and final customer sample; and
- Section 5 presents the ex post on-peak load and daily consumption impacts

3 Methodology

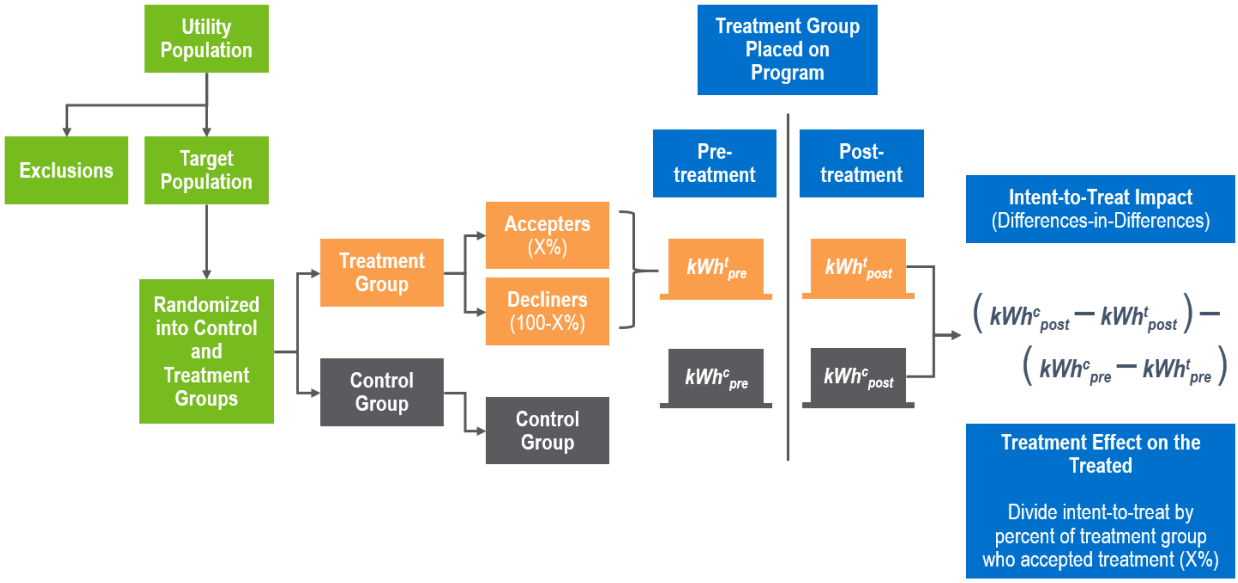
The primary objectives of this evaluation were to estimate ex post load impacts for the eco+ software feature that was installed in ecobee thermostats (by ecobee) in August 2019. Impacts were estimated for overall energy consumption and average demand by time-of-use period. This section summarizes the methodological approaches used to estimate the metrics of interest for each customer segment.

3.1 Ex Post Load Impacts

The rollout of the software was implemented as a randomized encouragement design (RED) experiment. With a RED structure involving a single intervention (i.e., the eco+ software), the study population is randomly divided into two groups. One group is offered the intervention (also referred to as the "treatment") and the other is not. The group offered the intervention is referred to as the encouraged group and the group not offered the treatment is referred to as the control group. Some people in the encouraged group will accept the treatment and others will not. Impacts are estimated in a RED setting for those who accept the treatment offer using a two-step process. In the first step, loads by time period for the encouraged group are subtracted from loads for the control group.

As stated above, the encouraged group includes both those who accept the encouragement (that is, those who accepted ecobee's offer to enable their eco+ feature on their thermostats) and those who do not. The estimated load impact based on these two groups of customers is referred to as the intention-to-treat (ITT) effect. In the second analysis step, the ITT estimate is divided by the percent of the encouraged group who take up the treatment offer. This value represents the impact for those who took the treatment (referred to as the impact of the treatment on the treated). A conceptual overview of the RED design and DiD analysis for estimating load impacts is shown in Figure 3-1.

Figure 3-1: Design and Analysis Schematic for a RED Experiment



For this evaluation, the first stage ITT impact was estimated using what is called a difference-in-differences (DiD) analysis. This method estimates impacts by subtracting treatment customers' loads (or in this first stage, the encouraged customers' loads) from control customers' loads in each hour or time period after the treatments are in place and subtracts from this value the difference in loads between treatment and control customers for the same time period in the pretreatment period. Subtracting any difference between treatment and control customers prior to the treatment going into effect adjusts for any difference between the two groups that might occur due to random chance.

The DiD calculation can be done arithmetically using simple averages or can be done using regression analysis. Customer fixed effects regression analysis allows each customer's mean usage to be modeled separately, which reduces the standard error of the impact estimates without changing their magnitude. Additionally, regression software allows for the calculation of standard errors, confidence intervals, and significance tests for load impact estimates that correctly account for the correlation in customer loads over time.[2] Implementing a DiD through simple arithmetic would yield the same point estimate but it would not generate confidence intervals.

A typical regression specification for estimating impacts is shown in Equation 1.

Equation 1: Ex Post Load Impact Model Specification

$$kW_{i,t} = \alpha_i + \delta \text{treat}_i + \gamma \text{post}_t + \beta(\text{treatpost})_{i,t} + v_i + \varepsilon_{i,t}$$

In the above equation, the variable $kW_{i,t}$ equals electricity usage during the time period of interest. For this evaluation, the time periods include on-peak (4-9 PM) and daily usage (all

[2] More accurately, they account for the correlation in regression errors within customers over time.

hours). The index *i* refers to customers and the index *t* refers to the time period of interest. The estimating database would contain electricity usage data during both the pretreatment and post-treatment periods for both treatment (encouraged) and control group customers. The variable *treat* is equal to 1 for treatment customers and 0 for control customers, while the variable *post* is equal to 1 for days after the eco+ software rollout has been implemented and a value of 0 for days during the pretreatment period. The *treatpost* term is the interaction of treat and post and its coefficient β is a difference-in-differences estimator of the treatment effect that makes use of the pretreatment data. The primary parameter of interest is β, which provides the estimated demand impact during the relevant period. The parameter a_i is equal to mean usage for each customer for the relevant time period (e.g., hourly, peak period, etc.). The v_i term is the customer fixed effects variable that controls for unobserved factors that are time-invariant and unique to each customer.

Customer attrition is an important factor to address in the load impact analysis. Customer attrition stems from four factors; customers who move (referred to as churn); customers who become ineligible after enrolling in the pilot; customers who opted out before the pilot began; and customers who asked ecobee to remove the software after enrollment. Customer churn and changes in eligibility should be the same for both treatment and control customers. As such, dropping customers from both treatment and control groups due to churn and changes in eligibility does not introduce selection effects.

The majority of load impact estimates reported in Section 5 are based on a comparison of loads between each treatment group and the control group. Estimates for customer segments and climate regions are developed by first partitioning the treatment and control groups into samples for each climate region and/or customer segment of interest and then applying the analysis method outlined above to the partitioned data.

4 RED Validation

Before reporting results, the Resource Innovations team validated the RED framework by analyzing customer segments and comparing pre-treatment load of the control and treatment groups.

4.1 Customer Segments

SDG&E provided demographics and interval data for 2,561 customers who were either encouraged to download the eco+ software for their thermostat or were assigned to control group. The Resource Innovations team found that about a third of customers in the population were reported to have a NEM system in their home. Due to the large influence that a NEM system has on a customer's electricity load, customers needed to have a NEM system in both the pre and post treatment period to avoid the NEM system biasing the results. Customers who were identified as never owning a NEM system during the analysis period were identified as "non-NEM" and customers who were recorded as having a NEM system for the duration of the analysis period were identified as "NEM" customers. Any customer who had NEM in one period and not the other was removed from the analysis.

Table 4-1 displays the totals of NEM and non-NEM customers by their treatment group in September 2019[3] and records how many of the encouraged customers accepted the eco+ treatment that was offered to them. In total, 588 customers were removed from the analysis for being non-NEM in the pre-treatment period and having a NEM system in the post-treatment period (or vice-versa), being classified as an outlier, or not having complete pre-treatment data. The customers that were removed were balanced across the control and encouraged group, and customer counts were still balanced after this cleaning step. Of the 979 remaining customers encouraged to install the eco+ software, 467 customers accepted treatment, providing an ITT ratio of about 48%.

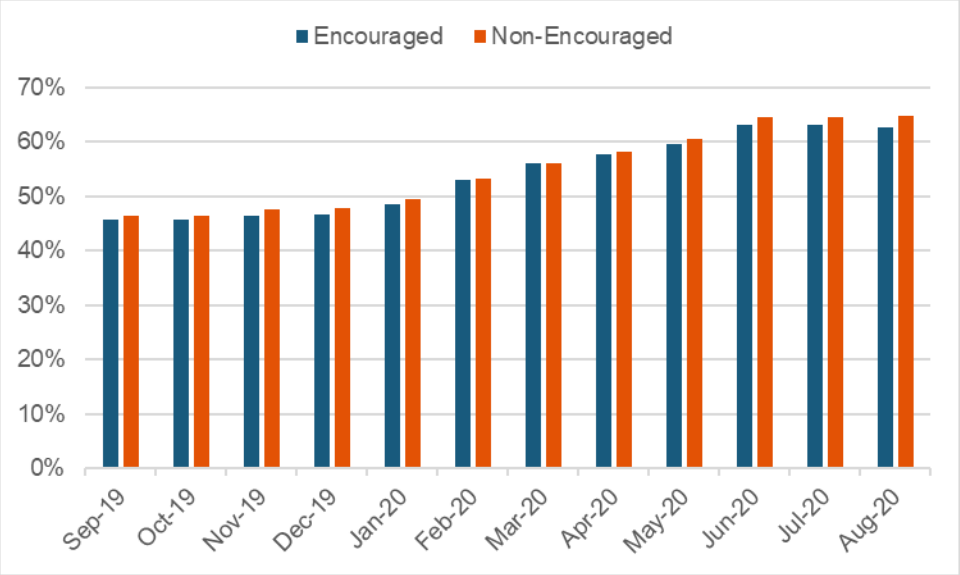
Table 4-1: Customer Counts by Analysis Group

Segment	Total	Control	Encouraged	Accepted
Original Total	2,561	1,297	1,264	593
Removed	588	303	285	126
Remaining Non-NEM Customers	1,506	764	742	353
Remaining NEM Customers	467	230	237	114
Total Customers in Analysis	**1,973**	**994**	**979**	**467**

[3] The first month of the post-treatment period.

The Resource Innovations team also evaluated the balance of participation in SDG&E TOU rates across the control and encouraged groups. The portion of encouraged and non-encouraged customers on a TOU rate over the analysis period is displayed in Figure 4-1. Customer counts were balanced across these two groups and grew at a similar rate over the evaluation period, which led to the conclusion that further cleaning was not needed to remove potential bias based on TOU rate enrollment.

Figure 4-1: Fraction of Customers on a TOU Rate, Encouraged vs. Non-Encouraged



4.2 Pre-Treatment Load Validation

The Resource Innovations team compared the hourly pre-treatment load between control and encouraged customers as part of the data validation process. Significant differences in electricity usage were observed between the control and encouraged group during the pre-treatment period from August 2018 – July 2019. While the differences varied by month, the average summer difference in on-peak (4-9 PM) load was 0.02 kW (1.9%) and 0.01 kW (0.9%) for non-NEM and NEM customers, respectively. Differences in pre-treatment load during the winter on-peak period were greater than the summer at 0.03 kW (3.6%) for non-NEM customers and 0.02 kW (4.0%) for NEM customers. These findings are detailed in Table 4-2. Small differences in pre-treatment load between the encouraged and control groups are expected; and are the reason a DiD calculation is used rather than calculating a simple difference between the encouraged and the control group in the treatment period. The pre-treatment differences were larger than what is typically observed in this type of evaluation. However, the differences weren't so large that the DiD approach couldn't be applied. Resource Innovations recommends that the treatment and control group assignment randomization validation process include a check for equivalent pre-treatment load in any future experiments of a similar nature.

Table 4-2: Comparison of Pre-Treatment On-Peak (4-9 PM) Load

Period	Segment	Encouraged (kW)	Control (kW)	Difference (kW)	Percent Difference
Summer On-Peak Period	Non-NEM	1.06	1.08	0.02	1.9%
	NEM	0.76	0.75	0.01	0.9%
Winter On-Peak Period	Non-NEM	0.70	0.73	0.03	3.6%
	NEM	0.53	0.55	0.02	4.0%

Another aspect unique to evaluations covering the 2020 period is the impact of the COVID-19 pandemic on electricity usage. Although the difference was mostly even across the control and encouraged groups, electricity usage was almost 30% higher in April and May 2020 compared to their pre-treatment months in 2019. It is expected that such a drastic change in electric usage could influence some of the results for the winter period which included the peak COVID-19 lockdown months.

5 Ex Post Load Impacts

This report section summarizes the daily consumption and on-peak load impacts associated with the eco+ software feature. Load impacts were estimated for the following customer segments and climate regions:

- For all customers that installed the eco+ software feature for the population as a whole and for all customers in each climate region[4] (moderate, cool);
- Non-net metered and net metered customers

5.1 Analysis Customer Counts

Counts by customer segment included in the final analysis are summarized in Table 5-1. The counts presented reflect the customers who were active in September 2019, the month the analysis period started. All of these customers were included in the "All customers" results presented below. There were only 165 CARE/FERA customers in the final study population. There were also only 23 customers in the "Hot" climate region, with only four of them being NEM. Due to the small size of the CARE/FERA and "Hot" climate region groups, they are only included in the "All Customers" results and are not reported separately. Note that customer counts reported in the impact tables in this section are based on average customer counts across the corresponding season.

Table 5-1: Analysis Customer Counts by NEM, CARE/FERA, and Climate Region

Customer Type	Non-NEM Customers	NEM Customers	Total
All Customers	1,506	467	1,973
CARE/FERA Status			
Non-CARE/FERA	1,359	449	1,808
CARE/FERA	147	18	165
Climate Region			
Cool	825	209	1,034
Moderate	661	255	916
Hot	20	3	23

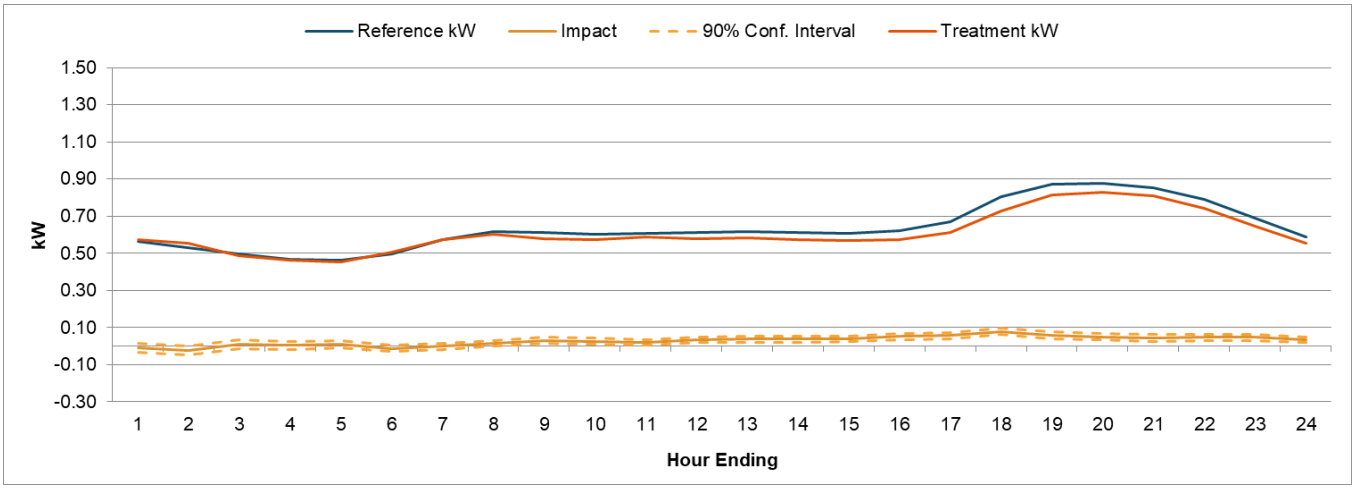
[4] The "Hot" climate region was not analyzed separately due to low customer counts.

5.2 Winter Non-NEM Customer Impacts

The SDG&E winter period is an average of load impacts from November 1st, 2019 to May 31st, 2020. This period does include some of the peak months of the COVID-19 pandemic, resulting in a large increase in customer electricity use between the pre-treatment period in April and May 2019 compared to the post-treatment period in April and May 2020. Results are presented for both the on-peak period from 4 PM to 9 PM (reported in kW) and the daily consumption level encompassing all 24 hours (reported in kWh).

Figure 5-1 displays the 24-hour winter load shape for non-NEM reference customers and the estimated load shape for treatment customers. There were significant reductions in load impacts in both the peak period from 4 PM to 9 PM and earlier in the day, which may have been influenced by significant differences in the pre-treatment period between the two treatment groups and the presence of the COVID-19 pandemic in the post-treatment period.

Figure 5-1: Non-NEM Winter Average Weekday Load Curve



5.2.1 On-Peak Load Impacts

Winter load impacts are presented for all customers and then split between the “Cool” and “Moderate climate regions. Customers in the “Hot” climate region were not reported separately in this analysis due to very low customer counts shown in Table 5-1.

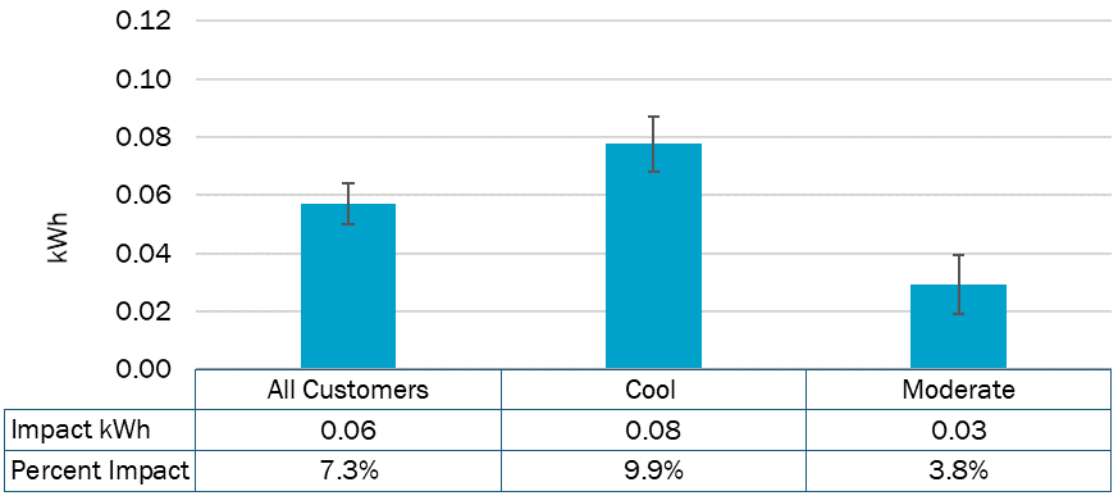
On-peak load impact results split by customer segment are presented in Table 5-2. The average load impact for all customers was 7.3% (0.6 kW), driven by large on-peak impacts of 9.9% (0.07 kW) in the Cool climate region. The impacts were higher than the Moderate climate region which had peak period load impacts of 3.8% (0.03 kW), attributable to the increased winter space conditioning loads in the Cool climate region compared to the Moderate climate region. The difference in peak period load impacts between the climate regions was statistically significant at the 90% confidence level.

Table 5-2: Non-NEM Winter Weekday On-Peak (4-9 PM) Load Impacts

Climate Region	Control Customers	Encouraged Customers	Accepted Customers	Reference kW	Treat kW	Impact kW	% Impact	Lower 90% (kW)	Upper 90% (kW)
All Customers	732	710	319	0.78	0.73	0.06	7.3%	0.05	0.06
Cool	400	391	153	0.78	0.71	0.08	9.9%	0.07	0.09
Moderate	323	309	164	0.77	0.74	0.03	3.8%	0.02	0.04

Figure 5-2 shows the winter weekday on-peak load impacts for all non-NEM customers and those in the Cool and Moderate climate regions.

Figure 5-2: Non-NEM Winter Weekday On-Peak (4-9 PM) Load Impacts by Climate Region



5.2.2 Daily Consumption Impacts

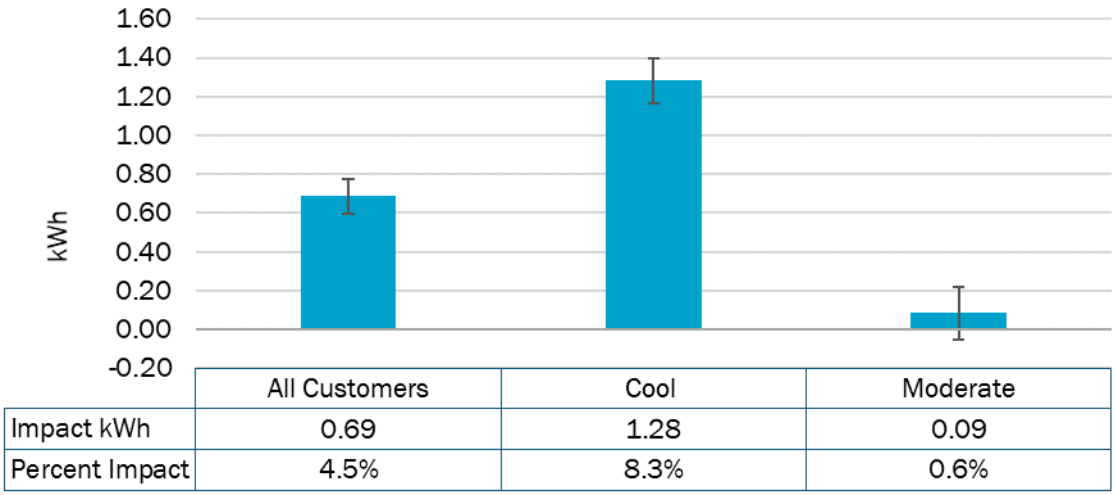
Daily consumption impacts reported in kWh are presented in Table 5-3. During winter weekdays, all non-NEM customers had consumption impacts of 4.5% (0.69 kWh). These impacts were statistically significant at the 90% confidence level and were largely driven by customers in the Cool climate region who had significant daily consumption impacts of 8.3% (1.28 kWh). Daily consumption impacts in the Moderate climate region were not statistically significant for non-NEM customers. Similar to on-peak winter impacts, greater winter space conditioning loads in the Cool climate region results in higher impacts than the Moderate climate region.

Table 5-3: Non-NEM Winter Weekday Daily Consumption Impacts

Climate Region	Control Customers	Encouraged Customers	Accepted Customers	Reference kWh	Treat kWh	Impact kWh	% Impact	Lower 90% (kWh)	Upper 90 (kWh)
All Customers	732	710	319	15.25	14.56	0.69	4.5%	0.60	0.78
Cool	400	391	153	15.40	14.11	1.28	8.3%	1.17	1.40
Moderate	323	309	164	14.88	14.79	0.09	0.6%	-0.05	0.22

Figure 5-3 shows the winter weekday daily consumption impacts for all non-NEM customers and those in the Cool and Moderate climate regions.

Figure 5-3: Non-NEM Winter Weekday Daily Consumption Impacts by Climate Region



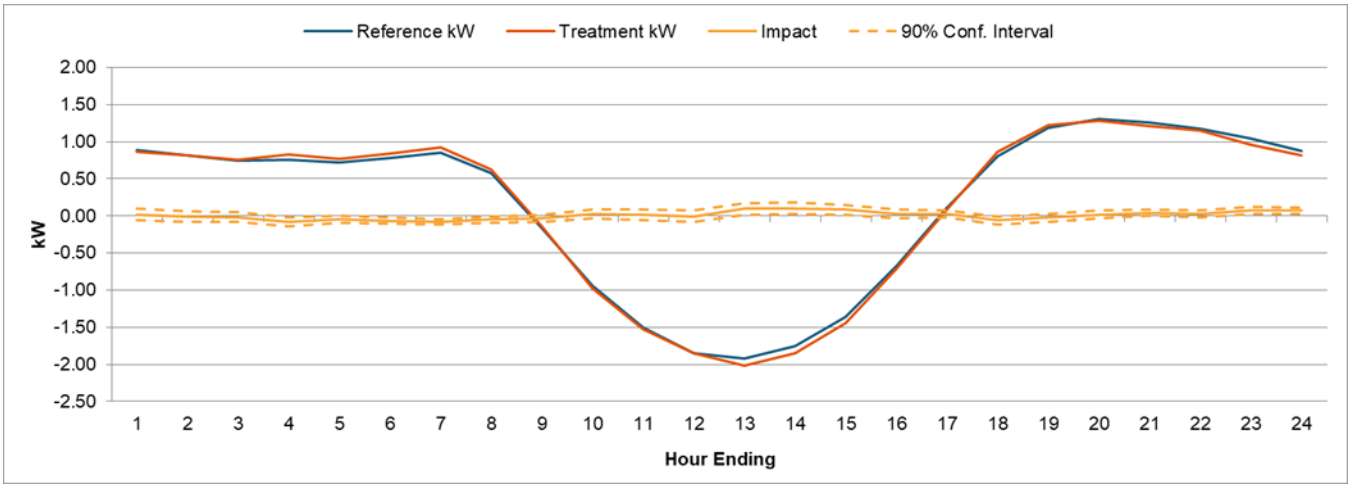
	All Customers	Cool	Moderate
Impact kWh	0.69	1.28	0.09
Percent Impact	4.5%	8.3%	0.6%

5.3 Winter NEM Customer Impacts

NEM customers were evaluated over the same winter period as non-NEM customers. While about a third of the population was reported to have some sort of NEM system, low customer counts lead to high variability in the load impact results for NEM customers.

Figure 5-4 compares the 24-hour winter weekday load curve between treatment and reference NEM customers analyzed for the eco+ evaluation. Compared to the non-NEM customers, there were lower impacts during the early afternoon hours before the groups followed a similar trajectory during the rest of the day.

Figure 5-4: NEM Winter Average Weekday Load Curve



5.3.1 On-Peak Load Impacts

Table 5-4 presents the on-peak winter weekday load impacts for NEM customers. It is important to note the customers counts for NEM customers, across the board they are less than a third the size of the non-NEM customer counts.

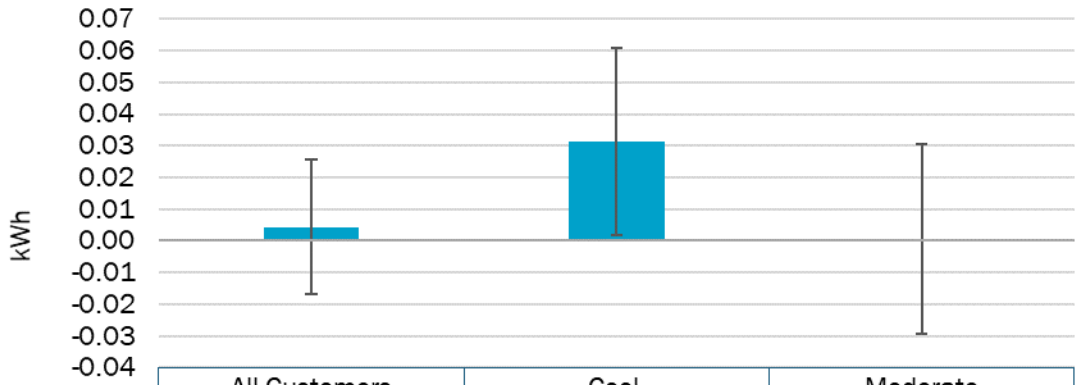
For all non-NEM customers, winter peak period impacts were 0.6%, or 0.004 kW. This impact was not significant at the 90% confidence level. Impacts in the Moderate climate region were 0.1% (0.001 kW), which was also not significant at the 90% confidence level. Like non-NEM customers, the largest impacts came from the Cool climate region, which had impacts of 4.7% (0.03 kW) that were significant at the 90% confidence level.

Table 5-4: NEM Winter Weekday On-Peak (4-9 PM) Load Impacts

Climate Region	Control Customers	Encouraged Customers	Accepted Customers	Reference kW	Treat kW	Impact kW	% Impact	Lower 90% (kW)	Upper 90% (kW)
All Customers	225	228	109	0.66	0.66	0.00	0.6%	-0.02	0.03
Cool	104	101	45	0.67	0.63	0.03	4.7%	0.00	0.06
Moderate	119	126	64	0.67	0.67	0.00	0.1%	-0.03	0.03

Figure 5-5 shows the winter weekday on-peak load impacts for all NEM customers and those in the Cool and Moderate climate regions.

Figure 5-5: NEM Winter Weekday On-Peak (4-9 PM) Load Impacts by Climate Region



	All Customers	Cool	Moderate
Impact kWh	0.00	0.03	0.00
Percent Impact	0.6%	4.7%	0.1%

5.3.2 Daily Consumption Impacts

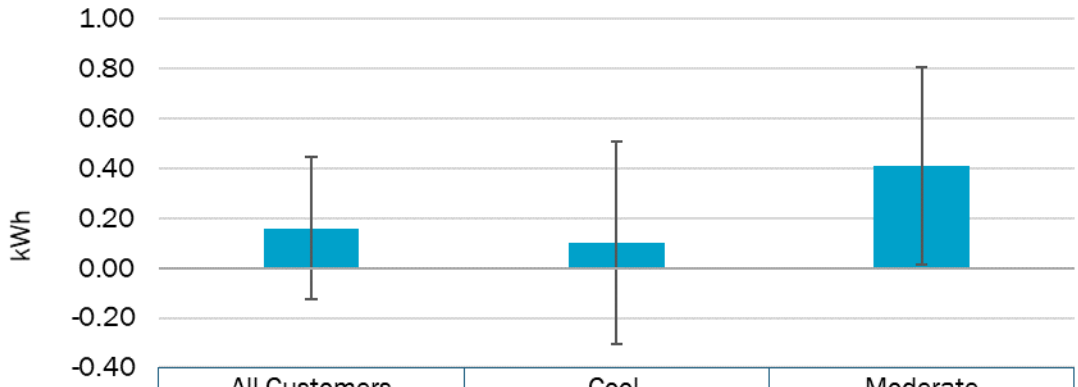
Daily consumption impacts for NEM customers are displayed in Table 5-5. Among all customers there was a daily consumption impact of 4.4% (0.16 kWh). This difference was not statistically significant at the 90% confidence level. There were higher impacts in the Moderate climate region, which had daily consumption impacts of 10.7% (0.41 kWh) that were statistically significant at the 90% confidence level. While these results are statistically significant, it should be mentioned that the NEM population customer counts are very low and could be skewed by different NEM systems and significant differences between the control and encouraged groups in the pre-treatment period.

Table 5-5: NEM Winter Weekday Daily Consumption Impacts

Climate Region	Control Customers	Encouraged Customers	Accepted Customers	Reference kWh	Treat kWh	Impact kWh	% Impact	Lower 90% (kWh)	Upper 90% (kWh)
All Customers	225	228	109	3.67	3.51	0.16	4.4%	-0.12	0.44
Cool	104	101	45	3.52	3.42	0.10	2.9%	-0.31	0.51
Moderate	119	126	64	3.84	3.43	0.41	10.7%	0.02	0.81

Figure 5-6 shows the winter weekday daily consumption impacts for all NEM customers and those in the Cool and Moderate climate regions.

Figure 5-6: NEM Winter Weekday Daily Consumption Impacts by Climate Region



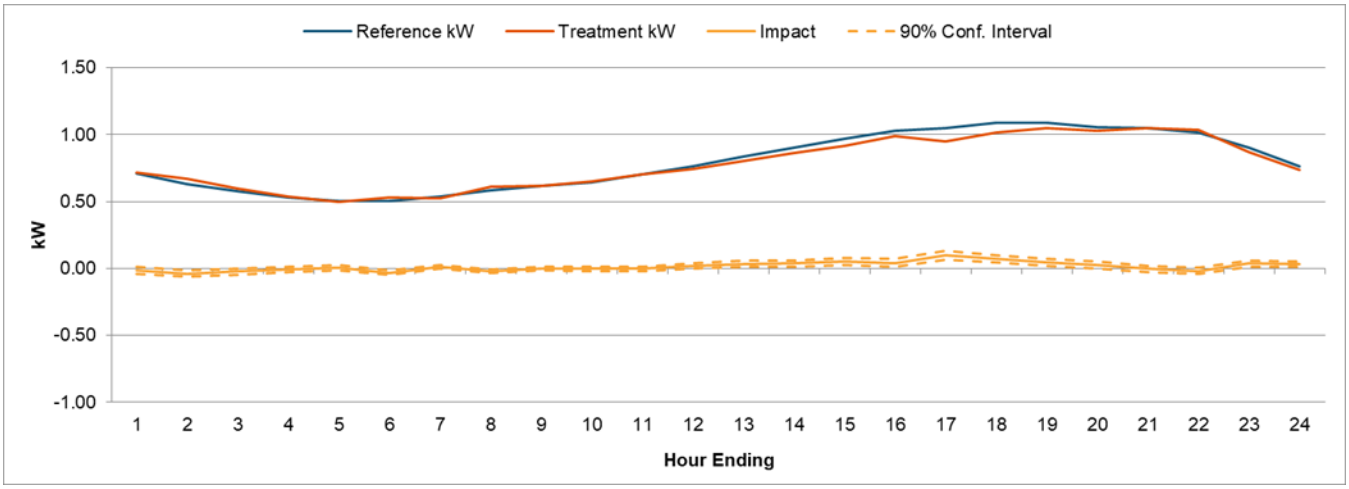
	All Customers	Cool	Moderate
Impact kWh	0.16	0.10	0.41
Percent Impact	4.4%	2.9%	10.7%

5.4 Summer Non-NEM Customer Impacts

The SDG&E summer period is an average of load impacts from September 1st, 2019 to October 31st, 2019, and June 1st, 2020 to August 31st, 2020. Although it is a best practice for months to be consecutive, the control group was provided treatment with the eco+ software in September 2020, therefore the program could not be analyzed past August 2020. While this period does include some of the months impacted by the COVID-19 pandemic, it was less pronounced than the winter months. The summer months also had a much better pre-treatment period than the winter months, with fewer months having significant differences in usage between the control and encouraged groups.

Figure 5-7 displays the 24-hour summer load shape for non-NEM reference customers and the estimated load shape for non-NEM treatment customers. There were significant reductions in load impacts in both the peak period from 4 PM to 9 PM that align with the TOU on-peak period.

Figure 5-7: Non-NEM Summer Average Weekday Load Curve



5.4.1 On-Peak Load Impacts

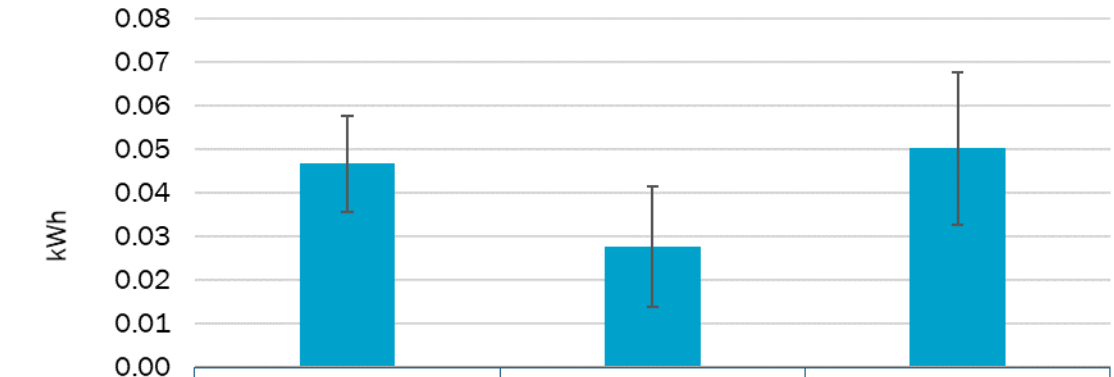
On-peak load impacts for non-NEM customers are displayed in Table 5-6. Averaged across all customers, peak period impacts were 4.4% (0.05 kW) during the afternoon peak period. This load impact was statistically significant at the 90% confidence level. The Cool climate region had impacts that were slightly lower at 2.8% (0.03 kW) and had lower reference usage than the average customer in the summer. The impacts in the Moderate climate region were 4.4% (0.05 kW) which were higher than the Cool climate region, indicating that these customers have higher temperatures and more opportunity for curtailment in their AC usage. Load impacts were statistically significant at the 90% confidence level for both the Cool and Moderate climate regions, although they were not statistically significantly different from each other.

Table 5-6: Non-NEM Summer Weekday On-Peak (4-9 PM) Load Impacts

Climate Region	Control Customers	Encouraged Customers	Accepted Customers	Reference kW	Treat kW	Impact kW	% Impact	Lower 90% (kW)	Upper 90% (kW)
All Customers	727	702	318	1.06	1.01	0.05	4.4%	0.04	0.06
Cool	397	386	157	0.99	0.96	0.03	2.8%	0.01	0.04
Moderate	322	306	160	1.14	1.09	0.05	4.4%	0.03	0.07

Figure 5-8 shows the summer weekday on-peak load impacts for all non-NEM customers (excluding the Hot climate) and those in the Cool and Moderate climate regions.

Figure 5-8: Non-NEM Summer Weekday On-Peak (4-9 PM) Load Impacts by Climate Region



	All Customers	Cool	Moderate
Impact kWh	0.05	0.03	0.05
Percent Impact	4.4%	2.8%	4.4%

5.4.2 Daily Consumption Impacts

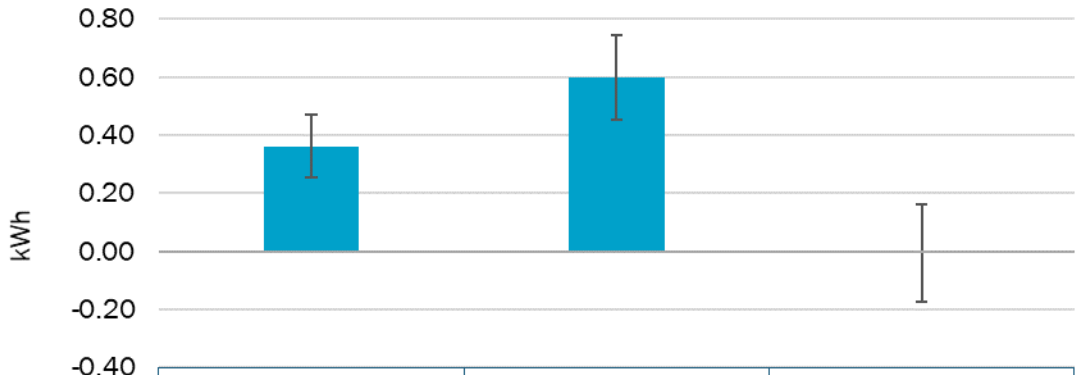
Table 5-7 displays the daily consumption results for non-NEM customers during summer weekdays. For all customers, the daily consumption impact was 1.9% (0.36 kWh) which were statistically significant at the 90% confidence level. The daily consumption impacts were driven by the Cool climate region, who had statistically significant consumption impacts of 3.2% (0.60 kWh). There were not statistically significant changes in daily electricity usage in the Moderate climate region.

Table 5-7: Non-NEM Summer Weekday Daily Consumption Impacts

Climate Region	Control Customers	Encouraged Customers	Accepted Customers	Reference kWh	Treat kWh	Impact kWh	% Impact	Lower 90% (kWh)	Upper 90% (kWh)
All Customers	727	702	318	19.05	18.69	0.36	1.9%	0.25	0.47
Cool	397	386	157	18.58	17.98	0.60	3.2%	0.45	0.74
Moderate	322	306	160	19.45	19.46	-0.01	0.0%	-0.18	0.16

Figure 5-9 shows the summer weekday daily consumption impacts for all non-NEM customers and those in the Cool and Moderate climate regions.

Figure 5-9: Non-NEM Summer Weekday Daily Consumption Impacts by Climate Region



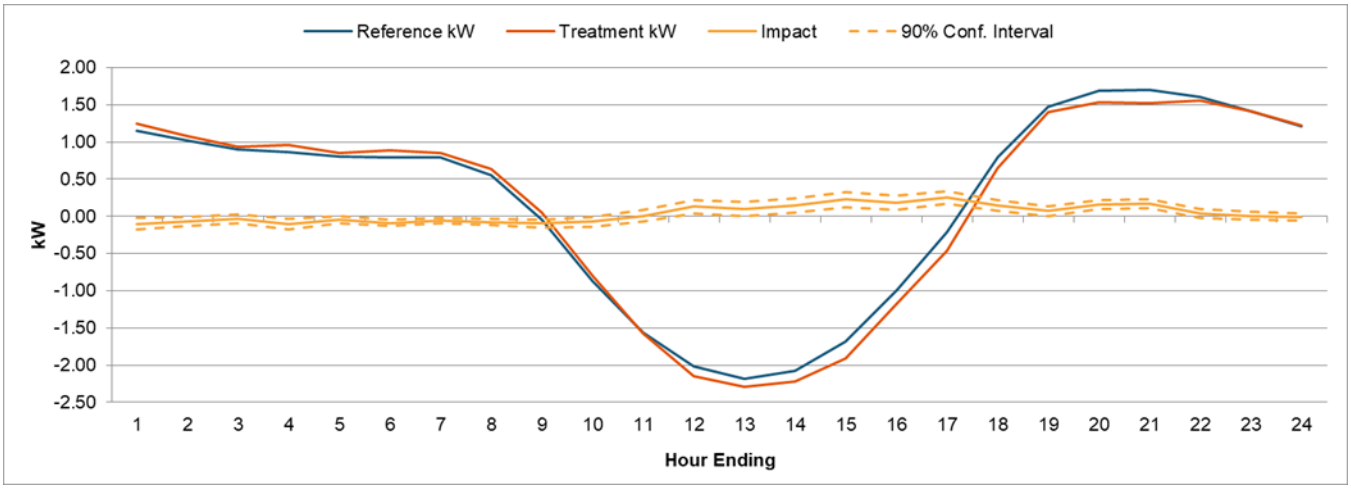
	All Customers	Cool	Moderate
Impact kWh	0.36	0.60	-0.01
Percent Impact	1.9%	3.2%	0.0%

5.5 Summer NEM Customer Impacts

NEM customers were evaluated over the same summer period as non-NEM customers. About a third of the customers evaluated were reported to own some sort of NEM system. As mentioned before in the winter NEM results, there is expected variability in customer NEM systems that may influence the results, as well as significant differences in usage during the pre-treatment period. There were also much fewer NEM customers included in the analysis, which could lead to more variability if customers in different groups have different NEM systems.

Figure 5-10 compares the 24-hour summer weekday load curve between treatment and reference NEM customers analyzed for the eco+ evaluation. Treatment customers had lower electricity usage starting midday and continuing into the late evening. There was a clear separate in load between the treatment and control groups in the hours between 7 PM–10 PM, when treatment customers usage flattened out a lower level than the reference customers.

Figure 5-10: NEM Summer Average Weekday Load Curve



5.5.1 On-Peak Load Impacts

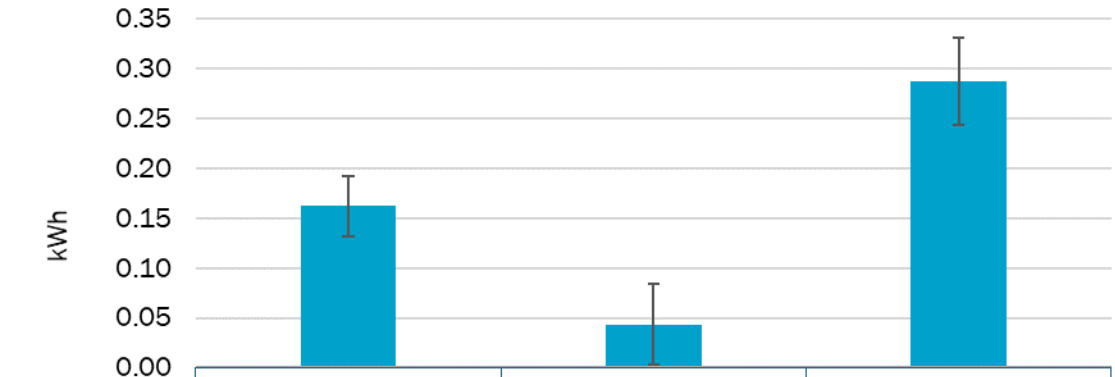
Summer weekday on-peak load impacts for NEM customers are displayed in Table 5-8. On-peak impacts for all NEM customers were 21.8% (0.16 kW) and were statistically significant at the 90% confidence level. While the percentage impact is high for NEM customers, it's important to consider that load for NEM customers is low at the start of the on-peak period, which can increase the percentage impacts. Like the non-NEM customers, reference loads and the potential for load reduction were higher in the Moderate climate region than the Cool, with on-peak load impacts of 0.29 kW. Despite the Cool climate region having lower impacts of 0.04 kW, both climate regions analyzed had statistically significant impacts at the 90% confidence level.

Table 5-8: NEM Summer Weekday On-Peak (4-9 PM) Load Impacts

Climate Region	Control Customers	Encouraged Customers	Accepted Customers	Reference kW	Treat kW	Impact kW	% Impact	Lower 90% (kW)	Upper 90% (kW)
All Customers	224	231	110	0.74	0.58	0.16	21.8%	0.13	0.19
Cool	104	102	45	0.59	0.55	0.04	7.3%	0.00	0.08
Moderate	119	128	65	0.89	0.60	0.29	32.4%	0.24	0.33

Figure 5-11 shows the summer weekday daily consumption impacts for all non-NEM customers and those in the Cool and Moderate climate regions.

Figure 5-11: NEM Summer Weekday On-Peak (4-9 PM) Load Impacts by Climate Region



	All Customers	Cool	Moderate
Impact kWh	0.16	0.04	0.29
Percent Impact	21.8%	7.3%	32.4%

5.5.2 Daily Consumption Impacts

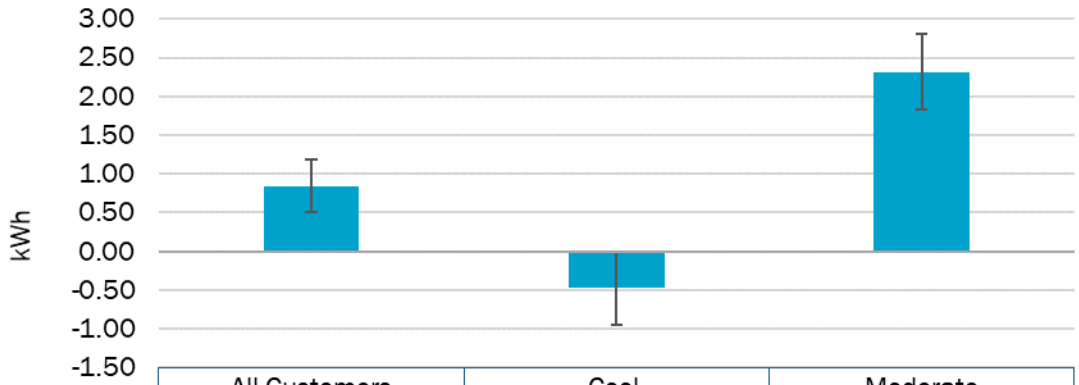
Summer weekday daily consumption impacts for NEM customers are presented in Table 5-9. Among all NEM customers the daily consumption impacts were 16.5% (0.85 kWh). These impacts were statistically significant at the 90% confidence level and when broken up by climate region there were much higher impacts in the Moderate climate region. Customers in the Moderate climate region had daily consumption impacts of 2.32 kWh, which are very large, but it must be reiterated that the customer counts in the NEM segment are very low, and some influential customers may influence the results across the groups. Customers in the Cool climate region were found to have an increase in daily consumption impacts of -0.47 kWh, which was statistically significant at the 90% confidence level.

Table 5-9: NEM Summer Weekday Daily Consumption Impacts

Climate Region	Control Customers	Encouraged Customers	Accepted Customers	Reference kWh	Treat kWh	Impact kWh	% Impact	Lower 90% (kWh)	Upper 90% (kWh)
All Customers	224	231	110	5.11	4.27	0.85	16.5%	0.50	1.19
Cool	104	102	45	4.67	5.15	-0.47	-10.1%	-0.94	0.00
Moderate	119	128	65	5.74	3.42	2.32	40.3%	1.83	2.80

Figure 5-12 shows the summer weekday daily consumption impacts for all NEM customers and those in the Cool and Moderate climate regions.

Figure 5-12: NEM Summer Weekday Daily Consumption Impacts by Climate Region



	All Customers	Cool	Moderate
Impact kWh	0.85	-0.47	2.32
Percent Impact	16.5%	-10.1%	40.3%

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