CADMUS

Peak Perks Program Evaluation Report

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Acronyms and Abbreviations

Acronym/Abbreviation	Definition
AMI	Advance metering infrastructure
CBL	Customer baseline load
DR	Demand Response
EM&V	Evaluation, measurement, and verification
EUL	Effective useful life
FTE	Full-time equivalent
GHG	Greenhouse gas
IESO	Independent Electricity System Operator
IO	Input-output
kW	Kilowatt
kWh	Kilowatt-hour
LUEC	levelized-unit energy cost
MW	Megawatt
OLS	Ordinary least squares
PAC	Program administrator cost
SCT	Societal cost test
SME	Subject-matter expert
StatCan	Statistics Canada
TRC	Total resource cost

Executive Summary

The Independent Electricity System Operator (IESO) contracted with Cadmus to evaluate the annual load impact, program design, and cost-effectiveness of the 2023 and 2024 Residential Peak Perks Program (Peak Perks). This executive summary provides an overview of the program, evaluation objectives, and a summary of the impact and cost-effectiveness results, as well as the key findings and recommendations.

Program Description

Peak Perks enables Ontario residents to save energy with their smart thermostats by participating in time-limited thermostat adjustments during periods of peak electricity usage. Eligibility requirements for residents include the following:

- Must be a residential electricity customer in Ontario[1]
- Must have central air conditioning controlled by an eligible Wi-Fi-enabled smart thermostat[2, 3, 4]
- Must not be participating in any other residential demand response program

Additional promoted program benefits include helping participants manage their electricity consumption; helping the community and province by reducing grid stress on high-demand days; and supporting the province by contributing to a reliable, affordable, and sustainable grid.[5] Participants also receive an initial $75 incentive for enrollment. Participants who enrolled their thermostats in the program by September 30, 2023, received a $20 incentive for continued engagement through 2024. Additionally, participants who enrolled in 2024 received a $20 incentive for continued engagement through 2025.

The IESO selected a demand response (DR) service provider as the program implementer in 2023 and started adjusting participants' thermostats in the summer of 2023 during summer demand response events to reduce electricity demand for space cooling.

Evaluation Objectives

The following research objectives guided the evaluation (Figure 1).

1 As of January 2025, small businesses are also able to enroll.

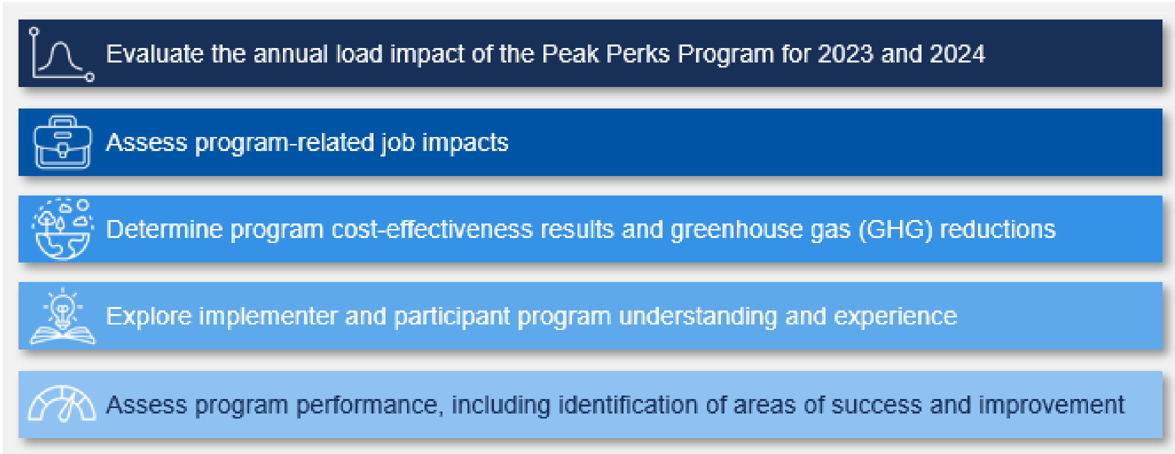
2 Eligible Wi-Fi-enabled thermostats included Nest, ecobee, Sensi, or Honeywell.

3 Electricity customers who resided in Cornwall, Ontario, were connected to the Hydro Quebec electricity grid and therefore are not eligible to participate in Peak Perks.

4 Central heat pumps were also eligible for the program.

5 Save on Energy. "Peak Perks." https://saveonenergy.ca/en/For-Your-Home/Peak-Perks. See Peak Perks Program web page for more information.

Figure 1. Evaluation Research Objectives



Summary of Impact and Cost-Effectiveness Results

Annual Load Impact Summary

This section summarizes the impact findings from Cadmus' load impact analysis and a comparison of reported and evaluated impacts.

Ex Post Impacts

Table 1 shows the estimated impact per load impact study participant for each 2023 and 2024 event, as well as the overall average by year. The all-event per device impact average does not represent the mean of the outputs from the individual day models but rather its own model, including all event days.

Table 1. Per Participant Load Impact Summary by Event

Event	Temperature (°C)	Average Treatment Load per Participant (kW)		Impact per Participant (kW)	Impact Estimate 90% Confidence Interval	Percent Impact
		without DR	with DR			
Thurs July 27, 2023, 4-7 p.m.	27.5	1.778	1.419	-0.359	(-0.413, -0.305)	20.2%
Fri July 28, 2023, 4-7 p.m.	28.4	1.760	1.476	-0.284	(-0.34, -0.228)	16.1%
Fri Aug 25, 2023, 4-7 p.m.	22.9	1.120	0.874	-0.246	(-0.287, -0.205)	22.0%
Tue Sept 5, 2023, 4-7 p.m.	29.8	2.113	1.380	-0.733	(-0.791, -0.674)	34.7%
Wed Sept 6, 2023, 4-7 p.m.	27.4	1.980	1.292	-0.688	(-0.746, -0.63)	34.7%
Thurs Sept 7, 2023, 5-8 p.m.	22.7	1.649	1.140	-0.509	(-0.558, -0.460)	30.9%
Wed, June 19, 2024, 3-6 p.m.	31.6	2.004	1.312	-0.692	(-0.748, -0.636)	34.5%
Thurs June 20, 2024, 4-7 p.m.	27.8	1.848	1.246	-0.602	(-0.652, -0.551)	32.6%
Mon Jul 8, 2024, 4-7 p.m.	27.9	1.927	1.277	-0.65	(-0.706, -0.594)	33.7%
Mon Jul 15, 2024, 3-6 p.m.	22.9	1.803	1.366	-0.437	(-0.483, -0.392)	24.2%
Tue Jul 30, 2024, 4-7 p.m.	26.4	1.785	1.192	-0.593	(-0.645, -0.542)	33.2%
Thu Aug 1, 2024, 4-7 p.m.	29.2	2.042	1.318	-0.724	(-0.779, -0.668)	35.5%
Thu Aug 15, 2024, 4-7 p.m.	26.7	1.605	1.121	-0.484	(-0.534, -0.434)	30.1%
Tue Aug 27, 2024, 4-7 p.m.	29.3	1.887	1.279	-0.608	(-0.667, -0.549)	32.2%

Event	Temperature (°C)	Average Treatment Load per Participant (kW)		Impact per Participant (kW)	Impact Estimate 90% Confidence Interval	Percent Impact
		without DR	with DR			
Mon Sep 16, 2024, 4-7 p.m.	25.2	1.554	1.126	-0.428	(-0.476, -0.379)	27.5%
Average: 2023 Events	**26.45**	**1.766**	**1.263**	**-0.503**	**(-0.533, -0.474)**	**28.5%**
Average: 2024 Events	**27.44**	**1.839**	**1.249**	**-0.590**	**(-0.614, -0.567)**	**32.1%**

Table 2 shows the estimated total impacts (averaged across the three hours) for each event for the entire program and the average by year. On average, the program demand impacts were 82 MW in 2024 and up to 101 MW in the August 1, 2024, event. As with the previous table, the all-event per device impact average does not represent the mean of the outputs from the individual day models but rather its own model, including all event days.

Table 2. Total Program Demand Reduction (MW) Summary

Event	Participants	Total Impact (MW)	90% Confidence Interval	Temp (C)
Thurs July 27, 2023, 4-7 p.m.	15,553	-5.584	(-6.423,-4.745)	27.5
Fri July 28, 2023, 4-7 p.m.	15,535	-4.409	(-5.275,-3.543)	28.4
Fri Aug 25, 2023, 4-7 p.m.	40,839	-10.059	(-11.74,-8.378)	22.9
Tue Sept 5, 2023, 4-7 p.m.	49,163	-36.030	(-38.912,-33.148)	29.8
Wed Sept 6, 2023, 4-7 p.m.	49,689	-34.204	(-37.089,-31.318)	27.4
Thurs Sept 7, 2023, 5-8 p.m.	53,545	-27.269	(-29.903, -24.631)	22.7
Wed, June 19, 2024, 3-6 p.m.	132,983	-92.023	(-99.46,-84.586)	31.6
Thurs June 20, 2024, 4-7 p.m.	133,596	-80.404	(-87.132,-73.677)	27.8
Mon Jul 8, 2024, 4-7 p.m.	136,011	-88.394	(-96.038,-80.75)	27.9
Mon Jul 15, 2024, 3-6 p.m.	136,933	-59.894	(-66.09,-53.698)	22.9
Tue Jul 30, 2024, 4-7 p.m.	139,794	-82.949	(-90.124,-75.773)	26.4
Thu Aug 1, 2024, 4-7 p.m.	140,037	-101.322	(-109.121,-93.523)	29.2
Thu Aug 15, 2024, 4-7 p.m.	141,822	-68.654	(-75.723,-61.584)	26.7
Tue Aug 27, 2024, 4-7 p.m.	142,750	-86.759	(-95.168,-78.351)	29.3
Mon Sep 16, 2024, 4-7 p.m.	145,606	-62.268	(-69.284,-55.253)	25.2
Average: 2023 Events	**37,387**	**-18.814**	**(-19.915,-17.713)**	**26.5**
Average: 2024 Events	**138,837**	**-81.981**	**(-85.241,-78.722)**	**27.4**

Ex Ante Impacts

Cadmus also estimated impacts as a function of outdoor weather in order to forecast impacts for each IESO load zone based on hypothetical weather conditions. Per-participant (kW) and total (MW) forecast results for the hottest day in each month in normal and extreme load scenarios are available under *Ex Ante Forecasts* in the *Detailed Findings* section later in this report.

External Validity Analysis

To assess the external validity of the impacts Cadmus estimated from Load Impact Study population's AMI data, Cadmus collected Summer 2024 AC runtime data for the entire Peak Perks population and compared average hourly AC runtime on non-event weekdays between the Load Impact Study and general Peak Perks populations. Cadmus found that the Load Impact Study participants' AC runtimes were approximately two minutes less than the general Peak Perks population in all hours of the day, which suggests that the impacts from Peak Perks participants outside the Load Impact Study are approximately 16% larger than those Cadmus estimated among the Load Impact Study participants.

Comparison of Reported and Evaluated Impacts

Cadmus compared the reported and evaluated impacts. In 2024, evaluated per-participant impacts were 60%, on average, of reported impacts. Refer to the *Comparison of Reported and Evaluated Impacts* in the *Detailed Findings* section for insights into the factors contributing to the discrepancies between reported and evaluated impacts.

Cost-Effectiveness Summary

Table 3 shows the Program Administrator Cost (PAC) and levelized-unit energy cost (LUEC) results for PY 2023 and PY 2024. Peak Perks also achieved 0.62 TRC and Societal Cost Test (SCT) ratios in PY 2024. The IESO expects cost effectiveness to increase in future years, as the pool of participants matures and the impacts of up-front costs are lessened.

Table 3. Peak Perks Cost-Effectiveness Test Results

Cost-Effectiveness Test	PY2023	PY2024
PAC		
PAC Costs ($)	$10,915,973	$19,149,322
PAC Benefits ($)	1,400,275	7,042,966
PAC Net Benefits ($)	-$9,515,698	-$12,106,356
PAC Net Benefit (Ratio)	0.13	0.37
LUEC		
$/kW	$269.99	$179.87

Key Findings and Recommendations

This section presents Cadmus' PY 2023 and PY 2024 key findings and recommendations.

Key Finding 1: Peak Perks produced substantial, statistically significant demand savings during all summer 2024 events, reaching a maximum reduction of 101 MW. The program events' precooling increased demand in the half hour preceding each event, and the events resulted in increased demand (or snapback) after the events ended.

Program load impact study participants reduced their demand by 0.590 kW per thermostat in 2024. Overall, the program reduced demand by an average of 82 MW across all participants, with a maximum reduction of 101 MW. Since its launch in 2023, the program has produced significant demand savings. Both the per-thermostat savings and the total number of participants were lower in 2023 than in 2024.

The IESO employed a precooling strategy to cool participants' homes before a scheduled event. When the event starts, the thermostats are set to a higher temperature, but because the homes were cooled beforehand, the temperature rise in the home is slower and more moderate. In 2024, precooling increased demand by 0.546 kW per thermostat across the hour immediately before each event. There was an increase in post-event demand (or snapback) of 0.173 kW per participant in the first hour following each event, with smaller statistically significant changes in demand in the second or third hour after events.

Key Finding 2: Preliminary analysis did not suggest statistically significant differences in impacts between thermostat brands, home ages, or IESO regions. Although differences among building types were observed in one model, further research is required.

Cadmus found no statistically significant differences in impacts between participants across IESO regions, housing age, or thermostat type. All housing age groups and IESO regions produced similar per-thermostat impacts. While Nest and Sensi thermostats produced somewhat higher impact estimates (0.711 and 0.753 kW, respectively) than ecobee or Honeywell thermostats (0.574 and 0.553 kW, respectively), these differences were not statistically significant. Also, the sample sizes of Sensi and Honeywell thermostats were much lower than those of ecobee or Nest.

Statistically significant differences were observed between housing types. However, these results came from the fixed effects regression model (Model A) rather than the post-only regression model (Model B). Cadmus found that the overall results from Model B were better aligned with the raw impacts observed in the AMI data than were the results from Model A, so further research is needed to determine if these results are accurate and are robust to changes in model specification.

Recommendation: Conduct further research (using Model B) to determine if there are differences in savings among building types.

Key Finding 3: Hotter outdoor temperatures produced higher event opt-outs, which diminished evaluated savings on hotter days.

If a participant adjusts their thermostat during an event, the higher thermostat setpoint is overridden, and the air conditioner returns to usual operation. This is called an event opt-out. In 2024, event opt-outs ranged from 18% to 26% among the load impact study treatment group and from 14% to 33% among the entire Peak Perks participant population. Event opt-outs diminish the average per-participant impacts. Cadmus found that participants were more likely to opt out during hotter weather events than they were during cooler events.

Key Finding 4: The DR service provider's reported impacts, which are based on thermostat runtime data, and evaluated impacts, which are based on advanced metering infrastructure (AMI) data, differed substantially for all 2023 and 2024 events. On average across 2024 events, evaluated impacts were 60% of reported impacts.

The observed disparity could result from the difference in data sources between reported and evaluated impacts. The DR service provider's impact estimates are based on AC runtime data and an assumed demand of 3.5 kW for each air conditioner. Cadmus' evaluated impacts are based on whole-home AMI data and include Peak Perks participants whose thermostats are off or disconnected from Wi-Fi during events. Whole-home AMI data captures total impacts at the meter level, such as the 30% to 44% of survey respondents who reported turning on fans during events to stay cool, which the DR service provider's thermostat runtime data cannot capture. In order to yield unbiased impact estimates, Cadmus employed a randomized control trial to randomly assign participants between the control group and treatment group on event days and a difference-in-differences technique to compare outcomes without making any assumptions about how warmer weather on event days affects customer baselines. Cadmus verified the performance of its savings estimation models against the observed average treatment and control group AMI data on event days for all 2024 events to confirm that its evaluated savings estimates are unbiased.

Key Finding 5: Participants who opted-in to share their AMI data for the Load Impact Study had approximately 16% lower average AC runtimes during the typical event window (4:00 p.m. to 7:00 p.m.) than the overall participant group, suggesting that the actual impacts of Peak Perks events outside of the Impact Study may be larger than estimated.

The impact study participants may not be representative of the whole program population due to a variety of factors, including both physical differences in home size or AC size and efficiency and behavioral differences such as typical thermostat setpoints that could bias the extrapolation of results from study participants to the entire population. Because AMI data for the participants who were not part of the load impact study was not available for evaluation and Ontario laws prevent the IESO from using AMI data for research without consent, Cadmus could not directly assess the external validity issue. Instead, Cadmus assessed differences between the two groups in AC runtimes on summer 2024 non-event weekdays. Load Impact Study participants' AC runtimes were approximately two minutes less than the general population throughout the day. During the 4:00 p.m. to 7:00 p.m. event window, this amounts to a 16% difference. Assuming all other material and behavioral factors to be the same between the two groups, the longer average AC runtimes among the general program population imply higher average demand savings among this group than those estimated for the Load Impact Study, as greater average AC runtime increases potential demand curtailable during Peak Perks events.

Recommendation: For planning purposes, consider scaling the DR service provider's impact estimates by 60% to adjust for whole-home demand response impacts and participants' event opt-out behaviour. Also, consider further research that incorporates the DR service provider's runtime and opt-out data with the IESO's AMI data to determine the reasons for the divergence between the DR service provider's AC runtime-derived customer baseline model and Cadmus' whole-home AMI difference-in-differences model.

This research could also incorporate an AC runtime impact analysis comparing the Load Impact Study with the general population, enabling the IESO to assess whether its forecasts for Peak Perks' overall demand impacts should be scaled up or down to reflect the differences between the two groups.

Key Finding 6: Peak Perks did not pass the PAC ratio for cost-effectiveness, though the program came close to passing the TRC and SCT frameworks in PY 2024 and contributed to meaningful job creation in Ontario and across Canada in PY 2024.

Peak Perks achieved a PY 2023 PAC ratio of 0.09 and a PY 2024 PAC ratio of 0.42. The program also achieved a LUEC of $384.14 per kW and $50.66 per kWh in PY 2023 and a LUEC of $156.93 per k W and $59.49 per kWh in PY 2024. The program achieved 0.90 TRC and SCT ratios in PY2024.

The program supported 138 total jobs in Ontario and 155 total jobs across Canada when accounting for direct, indirect, and induced impacts in 2024. This equates to 26 total jobs per $1 million in Ontario and 27 total per $1 million across Canada, reflecting the program's contribution to employment outcomes relative to its investment or spend.

Key Finding 7: Although the IESO and implementer staff successfully engaged participants in the program by providing sufficient information, a variety of notification channels, and an effective incentive, there is room to refine data tracking and increase consistency.

The IESO program staff confirmed that the original program goal was to enroll 137,00 devices; however, staff explained that when they met the original participation goal, they were able to increase the goal to 190,000 devices. This level of engagement reflected an overall positive experience by participants. For example, respondents reported generally receiving the right amount of program communication from the IESO, with respondents with Nest thermostats averaging a score of 2.9 and ecobee a 2.7.[6] Additionally, more than 80% of respondents reported they were aware that their thermostat would be adjusted as part of the program with no significant differences by year or thermostat type. Respondents reported receiving event notifications through a variety of methods. While most respondents in 2023 preferred notification through their thermostat app (70%) or display (62%), results were more divided amongst respondents in 2024 between thermostat displays (44%), thermostat apps (37%), text (30%), and email (30%). The majority (75%) of respondents identified the prepaid Mastercard as the motivating driver for participating in the program, and 80% of respondents identified the incentive as the key benefit for participating. Finally, when asked how many events they would be willing to participate in, 49% of ecobee respondents and 38% of Nest respondents reported they would be open to 10 or more events annually.

While the IESO and the DR service provider staff agreed that program implementation was generally going well, they also agreed that one area for potential improvement was data tracking. For example, the DR service provider staff said that the thermostat manufacturers notified and tracked data differently, which contributed to inconsistent participant experience and inconsistent data available to the IESO. Another potential area for improvement is how IESO and the DR service provider define participants who opt out of an event; both acknowledged that they currently identify opt-out participants differently.

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[6] On a scale of 1 to 5 where 1 meant *not enough* information and 5 meant *too much* information.

Recommendation: Review implementer data collection and tracking requirements as well as those of the qualifying thermostat manufacturers to ensure consistency in data collection and data definitions (e.g., opted-out). Also, consider research to explore if participants would continue to engage with a smaller incentive such as by adding a varied incentive question in the next round of participant surveys.

Key Finding 8: Overall, participants' home comfort was not negatively impacted during events, with some not aware of when events took place.

Respondents reported taking a variety of actions to stay cool during events. For example, more Nest respondents reported closing the blinds (37%) or using fans to circulate air (30%), while more ecobee respondents reported using fans to circulate air (44%) and adjusting their thermostats (38%). Overall, a number of Nest (26%) and ecobee (9%) respondents reported that they took no action to remain comfortable in the event.[7] Furthermore, many respondents (53% ecobee, 69% Nest) reported little to no impact on the comfort of their home, with more than half of respondents (58% ecobee, 61% Nest) reporting their home comfort was above a 7 out of 10 during events, indicating their home was moderately to very comfortable during an event.[8]

Additionally, while most (80%) respondents reported they were aware that their thermostat would be adjusted as part of the program, respondents with ecobee thermostats (46%) reported lower levels of awareness than respondents with Nest thermostats (16%) that adjustment had occurred. There did appear to be a possible difference by thermostat type regarding those who opted out, with more ecobee respondents (18%) reporting they had opted out of events than Nest respondents (2%).

[7] These results were statistically significant.

[8] On a scale of 1 to 10, where 1 meant *not at all comfortable* and 10 meant *very comfortable*.

Introduction

The Independent Electricity System Operator (IESO) contracted with Cadmus to evaluate the annual load impact, program design, and cost-effectiveness of the 2023 and 2024 Residential Peak Perks Program (Peak Perks), implemented by a DR service provider. The evaluation research objectives (Table 4) guided the evaluation.

Program Description

Peak Perks enables Ontario residents to save energy with their smart thermostats by participating in time-limited thermostat adjustments during periods of peak electricity. To be eligible, a resident must be a residential electricity customer in Ontario with central air conditioning controlled by an eligible Wi-Fi-enabled smart thermostat and not be participating in any other residential demand response program.[9]

Program benefits include managing home electricity consumption and supporting the province by contributing to a reliable, affordable, and sustainable grid. Participants also received an incentive for enrolling their thermostats in the program and were provided an opportunity for additional incentives through continued engagement in the program.

Evaluation Research Objectives

To address the research objectives, Cadmus completed the evaluation tasks shown in Table 4.

Table 4. Evaluation Objectives and Tasks

Research Objectives	Review Program Materials	Interview Stakeholders[a]	Survey Participants	Assess Load Impacts	Model Job Impacts[b]	Analyse Cost-Effectiveness /GHG Reductions
Evaluate the annual load impacts				✓		
Assess program-related job impacts		✓			✓	
Determine program cost-effectiveness results and greenhouse gas (GHG) reductions				✓		✓
Explore implementer and participant program understanding and experience	✓	✓	✓			
Assess program performance, including identification of successes and areas for improvement	✓	✓	✓	✓	✓	✓

[a] Stakeholders include the IESO and DR service provider staff.

[b] Job impacts analyses for PY 2024 only.

9 Eligible Wi-Fi-enabled thermostats included Nest, ecobee, Sensi, or Honeywell.

Methodology

This section summarizes the impact and process evaluation methodology for PY 2023 and PY 2024 l, including cost-effectiveness and job impacts. See *Appendix D* for methodological details.

Impact

Cadmus evaluated the annual load impacts of the Peak Perks for PY 2023 and PY 2024, forecasted *ex ante* demand impacts under a range of temperature scenarios provided by the IESO, assessed the external validity of the load impact results from the study population, and compared the reported savings (provided by the DR service provider) to the evaluated load impacts.

Summer 2023 and Summer 2024 Impact Studies

Cadmus employed a difference-in-differences regression framework and used advanced metering infrastructure (AMI) billing data and customer study participant characteristic data to estimate the impacts of the program's residential smart thermostat demand response events. The team estimated demand reduction impacts for all reported program events individually, as well as by participant characteristics and region, for events in the summer 2023 and 2024 seasons.

In advance of the 2024 season, Cadmus designed a randomized controlled trial for the Peak Perks impact evaluation. The team randomly assigned approximately half of the Peak Perks load impact study participants to one group (Group A) and the other half to another (Group B). Group A received treatment (that is, their thermostats were set to a higher setpoint during demand response events) in June and August 2024, while Group B served as a control group (they were not notified of events, and their thermostat setpoints were not changed during demand response events) during the same months. In July and September, Cadmus reversed each group's treatment assignments, with Group B receiving treatment during events while Group A served as the control group. This experimental design produces unbiased impact estimates.

Since there was no experimental design during the program's 2023 launch, Cadmus employed an alternative, quasi-experimental approach. For 2023, the team used variation in the timing of program enrollment among load impact study participants. Rather than using a control group, Cadmus used participants who enrolled in Peak Perks after the last 2023 demand response event as a comparison group, under the assumption that this group of later participants would likely be similar to the earlier participants in terms of eligibility (both groups were eligible to participate in Peak Perks), energy consumption behaviours, and other unobservable factors (both groups were among the small fraction of all the Peak Perks participants who chose to participate in the load impact study.)

Ex Ante Demand Impact Forecasting

As part of the IESO's 2024 Annual Planning Outlook (APO), the IESO used historical weather data to generate a range of potential system demand outcomes that capture the volatility of weather. Of the simulated demand output, the APO uses two demand forecast scenarios, which represent different levels of demand probability. The "normal" scenario represents the typical system load (both energy and demand) each month of the forecast. This is defined as the system peak and energy demand that has a

1-in-2 chance of occurring for that month of the forecast. This scenario is chosen by selecting the demand simulation that has the median system peak and energy demand. The “extreme” scenario has a system peak demand with a roughly 1-in-20 chance of occurring for each month. The historical weather that underpins these two scenarios represents weather conditions over a wide geographic area. There can be significant variation across the province in the weather conditions that give rise to a system peak.

Cadmus used the fixed-effects regression modelling framework developed for the 2023 and 2024 impact studies to construct a forecast model of demand response event performance, with weather data as an input. The team then input each summer month’s hottest day from the normal(and extreme load scenarios, described above, to calculate hypothetical event performance for each month by the IESO load zone.

External Validity Assessment

The Peak Perks impact study participants may not be representative of the whole program population due to a variety of factors that could bias the extrapolation of results from study participants to the entire population. Because AMI data for program participants who were not part of the load impact study was not available for evaluation, Cadmus could not directly assess the external validity issue. However, in lieu of AMI data for the wider participant population, the team partially assessed external validity by comparing the average non-event day AC runtimes from the load impact study and general Peak Perks participants to determine if there were any statistically significant differences in AC usage patterns between the groups that would suggest any external validity issue.

Comparison of Reported and Evaluated Impacts

Cadmus compared its evaluated demand impacts with those reported by the DR service provider to determine the likely source of any differences between the two and to provide the IESO and the DR service provider with a recommendation on how to revise the DR service provider’s estimation methodology going forward to bring their reported impacts closer to evaluated impacts.

Cost-Effectiveness

Cadmus leveraged the IESO’s cost-effectiveness tool to calculate benefit-cost ratios and GHG reductions. We populated the tool with evaluated program data, including verified energy and demand savings, effective useful life (EUL) of measures (EUL of one), net-to-gross ratios (one by default for DR programs using billing analyses), program costs and incentives measure costs (none for total resource cost [TRC] test), participation levels, and end-use load profiles (smart thermostat load profile).

Cadmus used the verified savings and other key impact evaluation findings noted above to calculate cost-effectiveness. We reviewed the verified program inputs and cost-effectiveness outputs prepared with the IESO’s updated cost-effectiveness tool to ensure they are reasonable, comply with the IESO evaluation, measurement, and verification (EM&V) protocols, and accurately reflect the evaluation results.

The IESO Cost Effectiveness Tool provides program- and measure-level results. This report presents the following key cost-effectiveness outputs: PAC test benefits, costs and ratio, and levelized unit energy cost (LUEC) by dollars per kilowatt-hours and dollars per kilowatt. The formulas and definitions for these tests and metrics are found in *Appendix D.*

Job Impacts

Cadmus assessed the net job impacts of Peak Perks, measured in full-time equivalent (FTE) positions and total net jobs, using Statistics Canada's (StatCan's) Input-Output (IO) modelling framework. This approach tracked how program activities, or economic "shocks," affected employment through direct, indirect, and induced impacts. To perform this analysis, Cadmus identified all relevant cash flows associated with the program, categorized them as specific economic shocks, and collected the necessary data accordingly. Data sources included participant surveys, the IESO Cost-Effectiveness Tool, and additional information provided directly by the IESO. Further details on the methodology are provided in *Appendix D*.

Process

Through the process evaluation, Cadmus collected findings about the program design (including projected impacts), delivery, and experience, as well as overall successes and challenges.[10] Table 5 lists the data collection task, audience, and target and achieved completes for the process evaluation. Further detail on process activity methodology can be found in *Appendix D*.

Table 5. Primary Data Collection Details

Tasks	Audience	Target	Achieved
Document Review	N/A	N/A	✓
Stakeholder Interviews	IESO staff	1 (IESO)	1
Stakeholder Interviews	Implementer staff	1 (DR service provider)	1
Online Survey	Participants	140	156[a]

[a] Survey respondents were all participants with Nest or ecobee thermostats.

10 Cadmus notes any statistical significance in the findings. If a note is not provided, the results were not statistically significant.

Detailed Findings

This section presents the PY 2023 and PY 2024 Peak Perks impact estimates and process insights, including job impacts, as well as program-level cost-effectiveness results.

Impact Findings

Cadmus received program tracking data for 15 events occurring during the summer months of 2023 and 2024 from the DR service provider. The first event occurred on July 27, 2023, and the most recent event on September 16, 2024. All events lasted for three hours, and 12 out of the 15 events occurred between 4:00 p.m. and 7:00 p.m. In addition, the IESO provided Cadmus with customer tracking data (including anonymized customer identifier, thermostat manufacturer, housing type and ages, and IESO load zone), and hourly AMI data, spanning the summers of 2023 and 2024, for 2,330 of the Peak Perks participants who agreed to share their energy data for evaluation purposes. This group was a small subset of the entire program participant population.

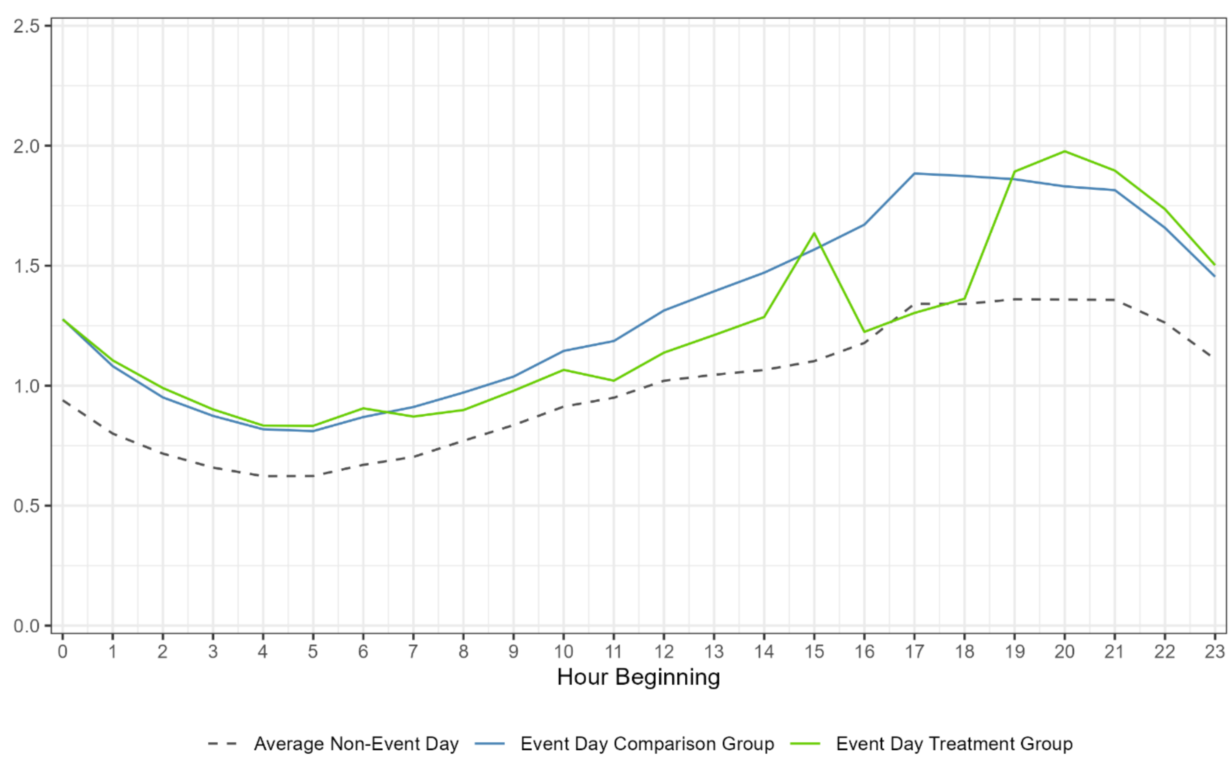
Cadmus used this data to conduct a series of regression-based hourly impact analyses based on the methods it proposed to the IESO. These methods included *ex post* retrospective analyses to generate program impact estimates for summer 2023 and summer 2024 and *ex ante* forecasts for varying severe weather conditions. Cadmus conducted *ex post* estimates, including estimates of impacts of demand response events for hours before, during, and after each demand response event, and impact estimates for population subgroups defined by thermostat brand, home type, home year built (age ranges), and the IESO regions. The team also carried out *ex ante* analyses, including event impact estimates for each participant and in aggregate by IESO region for normal and extreme weather conditions based on 2024 results.

Ex Post Impacts

Cadmus initially conducted preliminary data exploration to examine Peak Perks participants' energy usage patterns. In both summers, some participants were part of a treatment group, whose smart thermostats were included in events with half an hour of precooling (reduced thermostat setpoints) before most events and three hours of higher setpoints during events, and a comparison group, whose smart thermostats' temperature setpoints were unmodified during events. In 2024, Cadmus, in collaboration with the IESO, conducted a randomized controlled trial with a randomly selected treatment and control group. This group alternated each month (Group A was the treatment group in June and August, and Group B was the treatment group in July and September.) However, as the IESO did not implement a randomized controlled trial in 2023, Cadmus used later program participants (who enrolled in the program in fall 2023 after the last 2023 event) as a comparison group in lieu of a randomized control group for the 2023 analysis.

During the summer of 2023, Cadmus enrolled 975 participants in the treatment group, with the remaining 1,355 accounts serving as a comparison group. Figure 2 shows the average daily event day load shapes during summer 2023 for the Peak Perks participants in treatment and comparison groups, as well as the average daily load shape for all load impact study participants on non-event days. Across nearly all hours, event day load shapes for both treatment and comparison groups were higher than the average non-event day load shape because events were called on relatively warmer days. After 6:00 a.m. on event days, participants in the treatment group began to use less energy on average than the comparison group. The treatment group's consumption diverged more substantially from the comparison group starting at 11 a.m., which coincides with the starting hour of Ontario's summer on-peak time of use rate. While time-of-use rates are the default for Ontario residential electric customers in both the treatment and comparison groups, this divergence suggests that there was a systematic difference in energy consumption between the treatment and comparison groups in 2023. This difference during on-peak hours could be the result of greater adoption of thermostat manufacturers' time-of-use optimization programs, which 2023 treatment group customers may have opted in to at greater rates than the comparison group, especially if the thermostats prompted participants to enable these optimization programs during their Peak Perks enrollment. However, thermostat OEM optimization program enrollment was not available for the evaluation to investigate this possibility. The diminished energy usage among the treatment group relative to the comparison group continued until 3:00 p.m. in the afternoon when treatment group participants' smart thermostats began pre-cooling in the hour before the typical 4:00 p.m. to 7:00 p.m. event timing. During the event hours (hour beginning 4:00 p.m. to 6:00 p.m.), treatment group participant energy usage dropped substantially below the comparison group's usage as thermostat setpoints increased, reducing air conditioning load. However, there was an observable snapback effect after events, and average treatment group energy usage overtook comparison group usage for the remainder of the average event day.

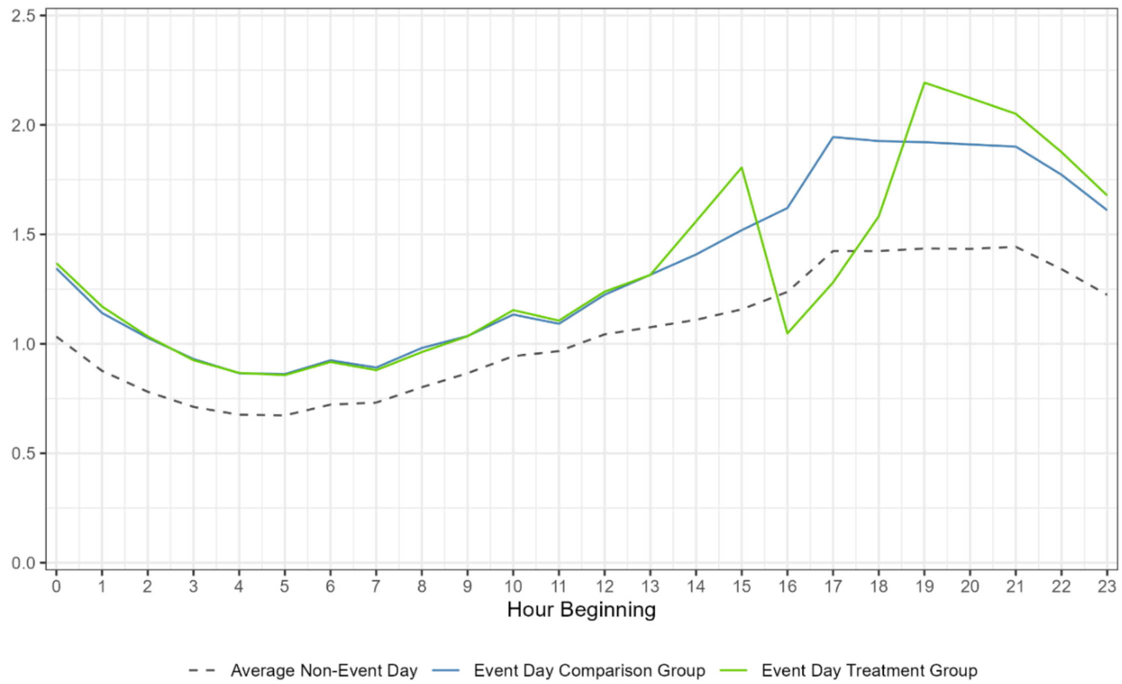
Figure 2. Participant Average Daily Load Shapes (kW), Summer 2023



During the summer of 2024, Cadmus split 2,330 load impact study participants into two groups: Group A and Group B, each with 1,165 members. During June and August, the team used Group A as the treatment group and Group B as the control group. During July and September, the team switched groups and Group A became the control group, and Group B became the treatment group. Figure 3 shows the average daily event day load shapes during the summer of 2024 for participants in the treatment and comparison groups, as well as the average participant's daily load shape on non-event days. As in 2023, participants in both treatment and comparison groups used more energy on event days during most hours than on non-event days because the IESO called events based on its load forecasts, which are higher on hot days. Unlike in the summer of 2023, in the summer of 2024, prior to 1:00 p.m., group energy usage patterns were, as expected, nearly identical due to the randomized control trial. In the two hours prior to an event (hours beginning 2:00 p.m. and 3:00 p.m.), the treatment group's energy use increased above the comparison group. This is likely due to smart thermostat pre-cooling in the half hour immediately prior to events. Two of the 2024 events started at 3 p.m. and the rest started at 4 p.m. In addition, the DR service provider reported that it did not deploy any precooling for two 2024 events: August 15, 2024, and September 16, 2024. However, Cadmus observed increases in treatment group demand (shown in *Appendix G*) in the hour preceding each of these events, suggesting that some or all Peak Perks load impact study treatment group participants' thermostats continued precooling as usual in advance of these events.

During the event hours (HB 4:00 p.m. to 6:00 p.m.), treatment group participant energy usage dropped substantially below the comparison group's usage as thermostats took higher setpoints, reducing air conditioning demand. Again, there was a snapback effect after events, and participants in the treatment group used more energy than comparison group participants for the remainder of the day. As shown in Figure 3, the unconditional mean demand impact (the difference between the treatment and control groups' demand before any regression analysis) appears to range from under 0.5 kW in the last event hour up to around 0.75 kW in the second event hour. As the IESO implemented the Peak Perks load impact study as a randomized controlled trial in 2024, the unconditional difference in means between the treatment and control groups is expected to be an unbiased estimate of demand impacts during events. Regression analysis is expected to deliver similar results regardless of model specification, along with estimates of statistical significance.

Figure 3. Participant Average Daily Load Shapes (kW), 2024



Appendix G provides the average loadshape for the treatment and control group for each 2024 event day, as well as the difference between them (the expected unconditional mean load impact before regression modelling.) Cadmus used these load shapes and the difference in means observed between the treatment and control groups during 2024 events to verify the accuracy of its two regression modelling approaches. While the two regression models produced similar results for load impact estimates during 2024 events (the confidence intervals of each model's estimate overlap), Cadmus' fixed effects model (Model A) produced biased estimates in the hours following events, which did not accurately reflect observed and expected snapback in demand following events. Cadmus' post-only regression model (Model B), however, produced impact estimates that were very well aligned with observed differences in mean consumption between the two groups before, during, and after events. For this reason, Cadmus recommends that the IESO use the results from Model B. Results from Model A are available in *Appendix E*

Table 6 shows the average performance of treatment group participants before, during, and after events. During both summer 2023 and summer 2024, treatment participants used more energy on average in the hour immediately preceding an event for precooling. In 2024, consumption increased by 0.546 kW per thermostat in the hour before the event due to precooling. Following events, consumption also increased by 0.173 kW per thermostat (in the first hour following the event) due to snapback in air conditioning demand.

Table 6. Average Event Performance

Year	Time	Event Impact (kW)	90% Confidence Interval
2023	Pre-Event Hour 3	-0.060	(-0.09, -0.031)
	Pre-Event Hour 2	-0.105	(-0.137, -0.073)
	Pre-Event Hour 1	0.285	(0.246, 0.325)
	During Event	-0.503	(-0.533, -0.474)
	Post-Event Hour 1	0.075	(0.04, 0.11)
	Post-Event Hour 2	0.058	(0.022, 0.094)
	Post-Event Hour 3	0.060	(0.028, 0.093)
2024	Pre-Event Hour 3	0.025	(0.007, 0.042)
	Pre-Event Hour 2	0.005	(-0.015, 0.024)
	Pre-Event Hour 1	0.546	(0.518, 0.574)
	During Event	-0.590	(-0.614, -0.567)
	Post-Event Hour 1	0.173	(0.149, 0.197)
	Post-Event Hour 2	0.159	(0.133, 0.185)
	Post-Event Hour 3	0.112	(0.088, 0.135)

Table 7 shows the average per-device, per-event demand response impact for each event day in 2023, as well as the average impact for events by their start time and the average impact across all events in the 2023 season. Five of the events ran from 4:00 p.m. to 7:00 p.m. EST, and one ran from 5:00 p.m. to 8:00 p.m. EST. The 4:00 p.m. to 7:00 p.m. events had an average reduction of 0.522 kW, and the single 5:00 p.m. to 8:00 p.m. event had an average reduction of 0.509 kW. Of these events, the event with the highest average impact was on September 5, 2023, with an average demand reduction of 0.733 kW, which also had the highest average temperature of all the events (29.8 °C.) The average per-device impact across all events in the 2023 season was 0.503 kW, for a 28.5% demand reduction.

Table 7. 2023 Average Per Device, Per Event Demand Response Impacts

Event	Average Temperature (°C)	Average Treatment Load Without DR (kW)		DR Impact (kW)	90% Confidence Interval	Percent Impact
		Without DR Impact	With DR Impact			
Thurs July 27, 2023, 4-7 p.m.	27.5	1.778	1.419	-0.359	(-0.413, -0.305)	20.2%
Fri July 28, 2023, 4-7 p.m.	28.4	1.760	1.476	-0.284	(-0.34, -0.228)	16.1%
Fri Aug 25, 2023, 4-7 p.m.	22.9	1.120	0.874	-0.246	(-0.287, -0.205)	22.0%
Tue Sept 5, 2023, 4-7 p.m.	29.8	2.113	1.380	-0.733	(-0.791, -0.674)	34.7%
Wed Sept 6, 2023, 4-7 p.m.	27.4	1.980	1.292	-0.688	(-0.746, -0.63)	34.7%
Thurs Sept 7, 2023, 5-8 p.m.	22.7	1.515	1.140	-0.375	(-0.416, -0.334)	24.8%
Average - 4-7 p.m. Events	**27.2**	**1.810**	**1.288**	**-0.522**	**(-0.554, -0.491)**	**28.8%**
Average - 5-8 p.m. Events	**22.7**	**1.515**	**1.140**	**-0.375**	**(-0.416, -0.334)**	**24.8%**
Average - All Events	**26.5**	**1.766**	**1.263**	**-0.503**	**(-0.533, -0.474)**	**28.5%**

Table 8 contains the average per-device, per-event demand response impact for each event day in 2024, as well as averages by event start-time and across all 2024 events. The June 19 and July 15 events ran from 3:00 to 6:00 p.m. EST, while all other events ran from 4:00 p.m. to 7:00 p.m. EST. The average per-device impact across all events in the 2024 season was 0.590 kW, representing a 32.1% demand reduction (up from 2023). The all-event per device impact average does not represent the mean of the outputs from the individual day models but rather its own model, including all event days.

Table 8. 2024 Average Per Device, Per Event Demand Response Impacts

Event	Average Temperature (°C)	Average Treatment Load Without DR (kW)		DR Impact (kW)	90% Confidence Interval	Percent Impact
		Without DR Impact	With DR Impact			
Wed, June 19, 2024, 3-6 p.m.	31.6	2.004	1.312	-0.692	(-0.748, -0.636)	34.5%
Thurs June 20, 2024, 4-7 p.m.	27.8	1.848	1.246	-0.602	(-0.652, -0.551)	32.6%
Mon Jul 8, 2024, 4-7 p.m.	27.9	1.927	1.277	-0.65	(-0.706, -0.594)	33.7%
Mon Jul 15, 2024, 3-6 p.m.	22.9	1.803	1.366	-0.437	(-0.483, -0.392)	24.2%
Tue Jul 30, 2024, 4-7 p.m.	26.4	1.785	1.192	-0.593	(-0.645, -0.542)	33.2%
Thu Aug 1, 2024, 4-7 p.m.	29.2	2.042	1.318	-0.724	(-0.779, -0.668)	35.5%
Thu Aug 15, 2024, 4-7 p.m.	26.7	1.605	1.121	-0.484	(-0.534, -0.434)	30.1%
Tue Aug 27, 2024, 4-7 p.m.	29.3	1.887	1.279	-0.608	(-0.667, -0.549)	32.2%
Mon Sep 16, 2024, 4-7 p.m.	25.2	1.554	1.126	-0.428	(-0.476, -0.379)	27.5%
Average - 3-6 p.m. Events	**31.6**	**1.935**	**1.312**	**-0.623**	**(-0.655, -0.591)**	**32.2%**
Average - 4-7 p.m. Events	**26.9**	**1.820**	**1.241**	**-0.579**	**(-0.603, -0.555)**	**31.8%**
Average - All Events	**27.4**	**1.839**	**1.249**	**-0.59**	**(-0.614, -0.567)**	**32.1%**

Table 9 contains the extrapolated event performance for the total Peak Perks load study participants for each event in the 2023 season. The September 5, 2023, event from 4:00 to 7:00 p.m. had the highest total impact with a 36.030 MW demand reduction. The 4:00 p.m. to 7:00 p.m. events had an average of 34,156 participants, with participation increasing from just over 15,500 participants on July 27 and July 28 to between 40,000 and 50,000 participants during the August and September events. The relative impact of these events reflects the large increase in participants later in the season. All events showed statistically significant reductions in energy demand at the 90% confidence level.

Table 9. 2023 Extrapolated Population Event Performance

Event	Participants	Total Impact (MW)	90% Confidence Interval	Temp (C)
Thurs July 27, 2023, 4-7 p.m.	15,553	-5.584	(-6.423, -4.745)	20.456
Fri July 28, 2023, 4-7 p.m.	15,535	-4.409	(-5.275, -3.543)	21.550
Fri Aug 25, 2023, 4-7 p.m.	40,839	-10.059	(-11.74, -8.378)	18.114
Tue Sept 5, 2023, 4-7 p.m.	49,163	-36.030	(-38.912, -33.148)	22.329
Wed Sept 6, 2023, 4-7 p.m.	49,689	-34.204	(-37.089, -31.318)	20.824
Thurs Sept 7, 2023, 5-8 p.m.	53,545	-20.077	(-22.26, -17.895)	18.351
Average - 4-7 p.m. Events	**34,156**	**-17.841**	**(-18.905, -16.777)**	**20.655**
Average - 5-8 p.m. Events	**53,545**	**-20.077**	**(-22.26, -17.895)**	**18.351**
Average - All Events	**37,387**	**-18.814**	**(-19.915, -17.713)**	**20.271**

Table 10 contains the extrapolated event performance for the total number of participants for each event in the 2024 season. The participation in 2024 was relatively consistent compared to 2023 but steadily increased throughout the season. The lowest total impact event was July 15, 2024, from 3:00 p.m. to 6:00 p.m., with a 59.894 MW demand reduction. The event with the largest total impact was August 1, 2024, from 4:00 p.m. to 7:00 p.m., with 101.322 MW demand reduction. All events during 2024 showed statistically significant demand reductions at the 90% confidence level.

Table 10. 2024 Extrapolated Population Event Performance

Event	Participants	Total Impact (MW)	90% Confidence Interval	Temp (C)
Wed, June 19, 2024, 3-6 p.m.	132,983	-92.023	(-99.46,-84.586)	32.106
Thurs June 20, 2024, 4-7 p.m.	133,596	-80.404	(-87.132,-73.677)	26.018
Mon Jul 8, 2024, 4-7 p.m.	136,011	-88.394	(-96.038,-80.75)	27.995
Mon Jul 15, 2024, 3-6 p.m.	136,933	-59.894	(-66.09,-53.698)	26.680
Tue Jul 30, 2024, 4-7 p.m.	139,794	-82.949	(-90.124,-75.773)	26.133
Thu Aug 1, 2024, 4-7 p.m.	140,037	-101.322	(-109.121,-93.523)	28.657
Thu Aug 15, 2024, 4-7 p.m.	141,822	-68.654	(-75.723,-61.584)	25.649
Tue Aug 27, 2024, 4-7 p.m.	142,750	-86.759	(-95.168,-78.351)	27.679
Mon Sep 16, 2024, 4-7 p.m.	145,606	-62.268	(-69.284,-55.253)	24.281
Average - 3-6 p.m. Events	**132,983**	**-82.873**	**(-87.147,-78.6)**	**32.106**
Average - 4-7 p.m. Events	**139,569**	**-80.789**	**(-84.161,-77.418)**	**26.637**
Average - All Events	**138,837**	**-81.981**	**(-85.241,-78.722)**	**27.244**

Ex Ante Forecasts

The IESO provided Cadmus with supplemental weather projections, including hourly dry and wet bulb temperatures across the IESO territory weather stations for 2024. These weather conditions are aligned with the demand forecast scenarios generated for the IESO's 2024 Annual Planning Outlook (APO). The APO uses historical weather data to generate a range of potential demand outcomes that capture the volatility of weather. Of the simulated demand output, the APO uses two demand forecast scenarios which represent different levels of demand probability. The "normal" scenario represents typical system load (both energy and demand) each month of the forecast. This is defined as the system peak and energy demand that has a 1-in-2 chance of occurring for that month of the forecast. This scenario is chosen by selecting the demand simulation that has the median system peak and energy demand. The "extreme" scenario has a system peak demand with a roughly 1-in-20 chance of occurring for each month. The historical weather that underpins these two scenarios represents weather conditions over a wide geographic area. There can be significant variation across the province in the weather conditions that give rise to a system peak.

Cadmus tested two separate regression methodologies to estimate demand impacts as a function of projected outdoor temperatures. First, Cadmus used a variation of the fixed-effects regression model (Model A) previously employed for the *ex post* impact evaluation. However, given the bias observed in that model's *ex post* impact estimates, particularly for precooling and post-event demand snapback, the team opted to test a second model for *ex ante* forecasts. For the second model, Cadmus estimated a simple linear model that predicted demand reduction as a function of outdoor temperature based upon the *ex post* results estimated from Model B for each of the nine summer 2024 events. The *ex post* Model B produced impact estimates that were well aligned with the raw differences in consumption between the treatment and control group during 2024 events. The results of its second *ex ante* model follow, and Cadmus recommends that the IESO use this model going forward for forecasting Peak Perks demand impacts under hypothetical temperature conditions. Appendix E contains the results from Cadmus' first *ex ante* model.

To estimate cooling degree hour-dependent event impacts using regression analysis, Cadmus first estimated a simple linear model using the *ex post* impacts estimated previously using Model B:

$$Demand\ Reduction_e = \beta * CDH_e + y$$

Where:

$Demand\ Reduction_e$ = the estimated demand reduction for event *e* (as shown in Table 7) as a function of CDH, as defined below, during the event

CDH_e = the load impact study weighted average cooling degree hours during summer 2024 event *e*, based on weather station weights provided and a base temperature of 18 °C (as shown in Table 7)

y = the regression's estimated intercept term

β = the regression's estimated coefficient for the change in expected demand reduction as a function of outdoor temperature during the event

The team then used the resulting estimates for β and y to forecast per-thermostat demand reduction as a function of the projected outdoor temperatures the IESO provided. The team also estimated variations of this model for *each* hour of each event (for example, one model for the hours preceding each event to predict precooling demand impacts).

Table 11 shows the resulting models and each regression's R^2 value. Note that many of the R^2 values are relatively low, suggesting that outdoor temperature alone does not explain the variation in the 2024 estimated event impacts. This is likely due to the relatively small number of observations (nine events) used to estimate each model and the observed increases in event opt-out rates with hotter event days (discussed later in the Comparison of Reported and Evaluated Impacts section). Cadmus expects that subsequent Peak Perks summer events and evaluations will improve this model, particularly for hotter event days (for example, there was just one summer 2024 event where the outdoor temperature was above 30 °C.) The IESO may use these models for forecasting by multiplying cooling degree hours, calculated from a Centigrade outdoor temperature with a base temperature of 18 °C, by the β term and then adding the y intercept term. For example, to predict the within-event average impact (across the three hours of the event) for a 30°C event, multiply 30°C by 0.0357 and add -.3927. The resulting value is 0.6783 kW demand reduction per thermostat. Change the sign of the result if the use case for the forecast requires a negative value for demand reduction (for example, -0.6783 kW per thermostat.)

Table 11. *Ex Ante* Model Coefficients

Model	Estimated β coefficient	Estimated y intercept	Regression R^2
Within-Event Average Impact (Across Three Hours)	**0.0357**	**-0.3927**	**0.5636**
Precooling Hours	-0.02144	0.033426	0.300123
Event Hour 1	0.045873	-0.67192	0.53124
Event Hour 2	0.021086	0.064973	0.139422
Event Hour 3	0.040119	-0.57104	0.7871
Post-Event Hour 1	0.014461	-0.67524	0.254376
Post-Event Hour 2	0.000413	-0.2244	0.000234
Post-Event Hour 3	-0.01765	0.316627	0.596608
Post-Event Hour 4	-0.00857	0.118337	0.240172
Post-Event Hour 5	-0.00411	0.033695	0.228037

Next, Cadmus used the following formula to calculate the total impacts (in MW) for each IESO load zone:

$$EventImpact_{rm} = Pop_r * \frac{1}{3}\sum_{h=1}^{3}(CDH_{hmr} * -Impact_h)$$

Where:

$EventImpact_{rm}$ = the average hourly impact of an event called in month m and IESO load zone r

Pop_r = load zone r's enrollment

CDH_{hmr} = the maximum cooling degree hours in month m and load zone r during the hour corresponding to hour h of an event, based on weather station weights provided and a base temperature of 18 °C

$-Impact_h$ = the impact estimate for hour h of the event, multiplied by -1 to change the sign so that the resulting $EventImpact_{rm}$ value produces negative values for demand reductions and positive values for demand increases

Table 12 and Table 13 contain estimates for event impacts in the scenario of the hottest day in normal and extreme system demand years provided by the IESO, based on 2024 event impacts by cooling degree hours.[11] In the tables, demand reductions are negative values, and demand increases are positive values.

Cadmus calculated estimates separately based on the hourly weather scenario temperatures for each month of summer, between May and September, for each IESO load zone. In the scenario of normal weather conditions, average event impact estimates ranged from 0.50 kW per participant in September in the East, Essa, and Northwest regions to 0.96 kW per participant in the Northwest region during June. Note that the result for the Northwest region in June (38.0 °C) is unexpected, as that temperature is much higher than the maximum in June for any other region. However, Cadmus confirmed that this temperature observation appears in the original normal weather dataset provided by the IESO. The result is associated with the Thunder Bay weather station. In the scenario of extreme load conditions, average event impact estimates ranged from 0.56 kW per participant in May in the Northwest region to 0.81 kW per participant in the Ottawa region in July and the Southwest region in August.

Table 14 and Table 15 present average hourly estimates for events given cooling degree hours from normal and extreme load scenarios during pre- and post-event hours, with post-event hours extended to the end of the average four-to-seven event day. Across months and scenarios, Cadmus estimated impacts of about 0.4-0.6 kW increased energy usage due to precooling for the treatment group in the hour before events. During demand response events, savings are consistently highest in the second event hour and lowest in the third event hour. In both normal and extreme scenarios, the highest event savings occur in July due to hot weather conditions across the densest regions in the IESO's service territory.

11 Some cooling degree hour values are unlikely (38 °C in June during normal conditions for the Northwest region, which mapped to the Thunder Bay weather station); this is because the maximum cooling degree hours were used for each event hour per region and month.

Table 12. 2024 Average Event Impact Forecast, Normal Load Conditions

Region	May			Jun			Jul			Aug			Sep		
	Device Impact (kW)	Total Impact (MW)	Temp C	Device Impact (kW)	Total Impact (MW)	Temp C	Device Impact (kW)	Total Impact (MW)	Temp C	Device Impact (kW)	Total Impact (MW)	Temp C	Device Impact (kW)	Total Impact (MW)	Temp C
Bruce	-0.61	-0.15	28.17	-0.80	-0.20	33.43	-0.72	-0.18	31.27	-0.73	-0.18	31.50	-0.53	-0.13	25.77
East	-0.56	-3.92	26.71	-0.78	-5.42	32.71	-0.65	-4.53	29.17	-0.66	-4.60	29.44	-0.50	-3.50	25.03
Essa	-0.56	-6.37	26.71	-0.78	-8.80	32.71	-0.65	-7.36	29.17	-0.66	-7.48	29.44	-0.50	-5.69	25.03
Niagara	-0.61	-4.11	28.00	-0.81	-5.49	33.72	-0.70	-4.72	30.53	-0.71	-4.81	30.90	-0.53	-3.57	25.80
Northeast	-0.49	-1.57	24.83	-0.76	-2.41	32.23	-0.54	-1.71	26.02	-0.68	-2.16	29.98	-0.56	-1.77	26.57
Northwest	-0.65	-0.85	29.30	-0.96	-1.26	38.00	-0.58	-0.75	27.13	-0.59	-0.77	27.63	-0.49	-0.64	24.80
Ottawa	-0.58	-9.54	27.33	-0.74	-12.07	31.67	-0.67	-11.04	29.90	-0.71	-11.63	30.90	-0.58	-9.52	27.30
Southwest	-0.62	-30.21	28.33	-0.82	-40.09	34.00	-0.72	-35.03	31.10	-0.70	-34.34	30.70	-0.54	-26.55	26.23
Toronto	-0.61	-60.00	28.17	-0.80	-78.41	33.43	-0.72	-70.84	31.27	-0.73	-71.65	31.50	-0.53	-51.61	25.77
West	-0.62	-9.07	28.33	-0.82	-12.04	34.00	-0.72	-10.52	31.10	-0.70	-10.31	30.70	-0.54	-7.97	26.23

Table 13. 2024 Average Event Impact Forecast, Extreme Load Conditions

Region	May			Jun			Jul			Aug			Sep		
	Device Impact (kW)	Total Impact (MW)	Temp C	Device Impact (kW)	Total Impact (MW)	Temp C	Device Impact (kW)	Total Impact (MW)	Temp C	Device Impact (kW)	Total Impact (MW)	Temp C	Device Impact (kW)	Total Impact (MW)	Temp C
Bruce	-0.68	-0.17	30.07	-0.80	-0.20	33.43	-0.78	-0.19	32.83	-0.75	-0.19	32.13	-0.75	-0.18	31.97
East	-0.63	-4.42	28.70	-0.76	-5.32	32.33	-0.72	-5.06	31.29	-0.69	-4.80	30.26	-0.70	-4.90	30.64
Essa	-0.63	-7.17	28.70	-0.76	-8.65	32.33	-0.72	-8.22	31.29	-0.69	-7.80	30.26	-0.70	-7.96	30.64
Niagara	-0.72	-4.85	31.08	-0.77	-5.18	32.45	-0.78	-5.31	32.97	-0.78	-5.27	32.82	-0.75	-5.06	31.93
Northeast	-0.70	-2.22	30.50	-0.70	-2.23	30.62	-0.66	-2.10	29.50	-0.68	-2.17	30.07	-0.68	-2.16	29.98
Northwest	-0.56	-0.73	26.77	-0.58	-0.76	27.33	-0.70	-0.91	30.57	-0.66	-0.86	29.57	-0.65	-0.85	29.20
Ottawa	-0.63	-10.26	28.57	-0.76	-12.48	32.37	-0.81	-13.22	33.63	-0.73	-12.00	31.53	-0.79	-12.89	33.07
Southwest	-0.76	-36.89	32.17	-0.73	-35.67	31.47	-0.80	-39.28	33.53	-0.81	-39.51	33.67	-0.75	-36.72	32.07
Toronto	-0.68	-66.64	30.07	-0.80	-78.41	33.43	-0.78	-76.32	32.83	-0.75	-73.87	32.13	-0.75	-73.29	31.97
West	-0.76	-11.08	32.17	-0.73	-10.71	31.47	-0.80	-11.80	33.53	-0.81	-11.87	33.67	-0.75	-11.03	32.07

Table 14. 2024 Extended Average Hourly Impact, Normal Load Conditions

Time	May			June			July			August			September		
	Device Impact (kW)	Total Impact (MW)	Temp C	Device Impact (kW)	Total Impact (MW)	Temp C	Device Impact (kW)	Total Impact (MW)	Temp C	Device Impact (kW)	Total Impact (MW)	Temp C	Device Impact (kW)	Total Impact (MW)	Temp C
Pre-Event Hour 1	0.34	48.82	17.20	0.47	68.75	23.58	0.50	72.64	24.83	0.50	73.45	25.08	0.44	63.64	21.94
Event Hour 1	-0.13	-18.66	17.44	-0.43	-63.17	24.10	-0.50	-72.96	25.57	-0.50	-72.19	25.46	-0.32	-46.43	21.60
Event Hour 2	-0.43	-62.05	17.13	-0.57	-82.29	23.72	-0.60	-86.78	25.18	-0.59	-86.38	25.05	-0.51	-74.09	21.05
Event Hour 3	-0.09	-13.37	16.52	-0.35	-51.45	23.04	-0.41	-59.60	24.44	-0.40	-58.86	24.31	-0.24	-34.75	20.18
Post-Event Hour 1	0.45	65.24	15.71	0.36	51.96	22.02	0.33	48.73	23.55	0.34	49.72	23.08	0.40	58.53	18.89
Post-Event Hour 2	0.22	31.80	14.58	0.22	31.43	20.61	0.22	31.34	22.15	0.22	31.35	22.01	0.22	31.59	18.04
Post-Event Hour 3	-0.07	-10.76	13.75	0.03	4.02	19.50	0.06	8.27	21.16	0.06	8.54	21.26	-0.01	-1.52	17.35
Post-Event Hour 4	-0.01	-1.07	12.95	0.04	6.02	18.64	0.06	8.26	20.44	0.06	8.44	20.58	0.03	3.76	16.83
Post-Event Hour 5	0.02	2.53	12.42	0.04	5.75	17.81	0.05	6.98	19.86	0.05	7.08	20.04	0.03	4.92	16.42

Table 15. 2024 Extended Average Hourly Impact, Extreme Load Conditions

Time	May			June			July			August			September		
	Device Impact (kW)	Total Impact (MW)	Temp C	Device Impact (kW)	Total Impact (MW)	Temp C	Device Impact (kW)	Total Impact (MW)	Temp C	Device Impact (kW)	Total Impact (MW)	Temp C	Device Impact (kW)	Total Impact (MW)	Temp C
Pre-Event Hour 1	0.42	60.75	21.02	0.44	63.37	21.86	0.56	81.30	27.60	0.51	73.98	25.26	0.48	70.05	24.00
Event Hour 1	-0.31	-45.39	21.44	-0.33	-48.50	21.91	-0.59	-86.24	27.56	-0.50	-72.97	25.57	-0.44	-64.01	24.23
Event Hour 2	-0.51	-73.54	20.87	-0.52	-75.85	21.62	-0.64	-92.89	27.17	-0.59	-86.50	25.09	-0.56	-82.03	23.64
Event Hour 3	-0.23	-34.01	20.06	-0.27	-39.78	21.04	-0.50	-72.35	26.62	-0.40	-58.54	24.25	-0.32	-47.18	22.31
Post-Event Hour 1	0.40	58.94	18.70	0.38	55.77	20.21	0.31	44.45	25.58	0.34	49.77	23.06	0.37	54.57	20.78
Post-Event Hour 2	0.22	31.64	17.18	0.22	31.54	18.79	0.21	31.20	24.50	0.22	31.36	21.79	0.22	31.49	19.66
Post-Event Hour 3	-0.03	-4.63	16.14	0.00	-0.21	17.86	0.10	14.63	23.63	0.05	7.94	21.03	0.02	2.57	18.94
Post-Event Hour 4	0.01	2.10	15.49	0.03	4.09	17.10	0.08	11.47	23.01	0.06	8.11	20.32	0.04	5.51	18.23
Post-Event Hour 5	0.03	3.93	14.76	0.03	4.94	16.45	0.06	8.53	22.45	0.05	6.80	19.57	0.04	5.66	17.66

External Validity Assessment

Cadmus received summer 2024 thermostat air conditioning runtime data from the DR service provider for the entire Peak Perks program population. The Cadmus team used this data to compare the Load Impact Study group (participants who agreed to share their AMI data for the Peak Perks evaluation) to the overall Peak Perks participant population. Cadmus applied the following regression model to the runtime data:

$$CoolingTime_{ih} = \sum_{h=0}^{23} \boldsymbol{\alpha_h} hour_h + \boldsymbol{\beta_h} hour_h \; x \; InStudy,$$

Where:

$CoolingTime_{ih}$ = Customer i's average air conditioning runtime (in minutes) during hour h during all summer 2024 non-event, non-holiday weekdays.

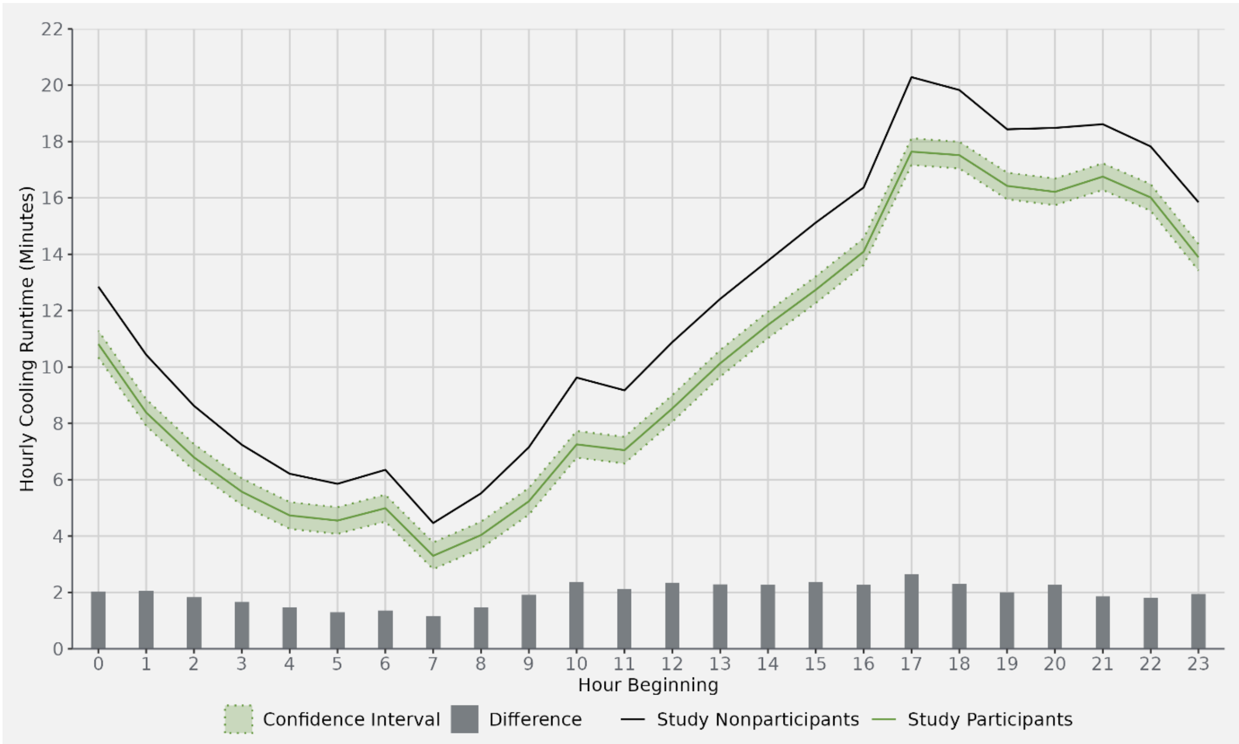
$hour_h$ = an indicator variable for each hour beginning at $h = 0, \ldots 23$

$InStudy_i$ = an indicator variable for whether customer i was a Load Impact Study participant

The Cadmus team used this model to derive the results shown in Figure 4. The figure shows the average air conditioning runtimes for Load Impact Study participants and nonparticipants (Peak Perks participants who did not share their AMI data for the evaluation), as well as the difference between the two groups and the 90% confidence interval for the difference. Across the average day during summer 2024, Load Impact Study participants' air conditioners ran approximately two minutes less per hour than those of the general Peak Perks participants. These differences were statistically significant in every hour of the day. During the most common event window (4:00 p.m. to 7:00 p.m.), the average difference in runtime (1.97 minutes) amounts to a 16.20% difference in runtime between Load Impact Study participants and the general Peak Perks population. This difference could result from material differences such as air conditioner capacity and efficiency, home air tightness and insulation levels, home size, and location (climate zone) between the two groups. It could also result from behavioral differences, such as different thermostat settings.

As discussed previously, the external validity of the Load Impact Study's impact results cannot be comprehensively assessed without a comparison of total home electricity consumption (from AMI data) between the Load Impact Study and the general Peak Perks population, but AMI data are not available from Peak Perks participants who did not agree to share their AMI data for the Load Impact Study. Nonetheless, the AC runtime analysis provides strong evidence that the Load Impact Study population's energy consumption likely differs from the general Peak Perks participant population. Assuming all other material and behavioral factors to be the same between the two groups, the longer average AC runtimes among the general Peak Perks population imply higher average demand savings among this group than those estimated for the Load Impact Study, as greater average AC runtime increases potential demand curtailable during Peak Perks events. Under these assumptions, Peak Perks' program-level impacts may be 10% higher than those estimated for the Load Impact Study.

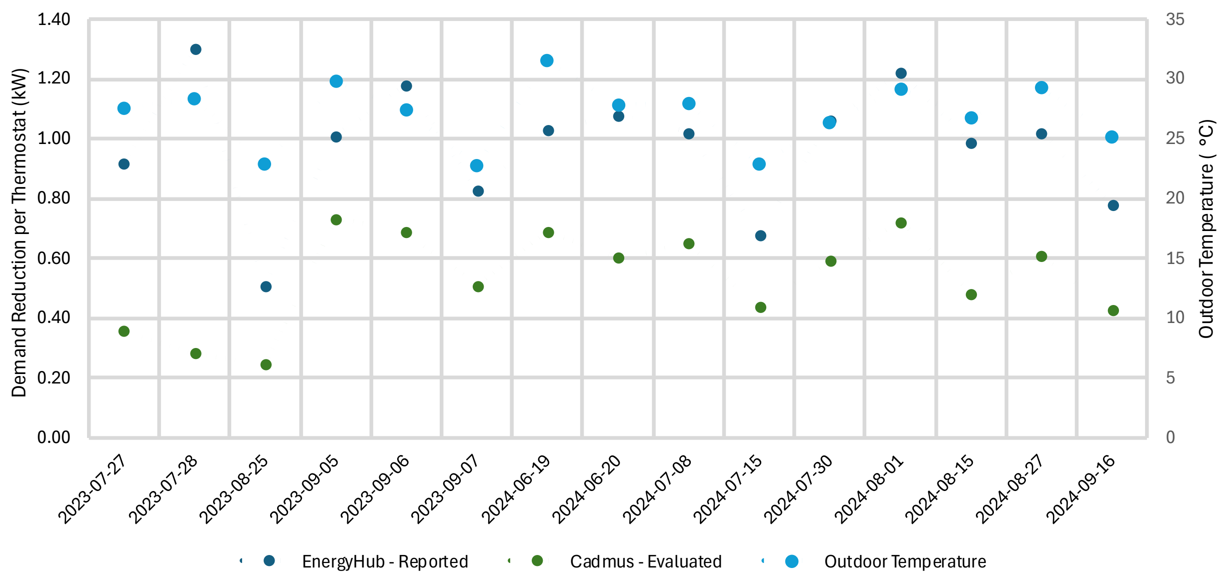
Figure 4. Average Hourly Non-Event Weekday AC Runtimes, Summer 2024



Comparison of Reported and Evaluated Impacts

Figure 5 shows a comparison of the DR service provider's reported per-thermostat impacts and Cadmus' evaluated impacts for each 2023 and 2024 event (based on results from Cadmus' Model B.) Evaluated impacts were always lower than reported impacts. However, the difference in evaluated and reported impact estimates was smaller in 2024 compared to 2023 due to low evaluated impacts for the first three 2023 events. On average, impact estimates in 2024 were 0.406 kW lower than reported estimates. Reported impacts correlated only weakly with outdoor temperature (R^2 = 0.1587), while evaluated impacts showed a stronger correlation (R^2 = 0.5636.) However, temperature alone did not explain the improved performance of 2024 events compared to those in 2023.

Figure 5. Reported Impacts Versus Evaluated Impacts and Outdoor Temperature



The DR service provider's method for calculating reported demand reductions differed from Cadmus' evaluation method in three major ways:

1. **Data Used for Estimation.** Cadmus' analysis used whole-home consumption from AMI meter data. The DR service provider used air conditioner runtime data only. Runtime data included only the amount of time the air conditioner was running during the interval, as well as the thermostat's mode (off/heating/cooling), Wi-Fi connectivity status, and setpoints.
2. **Baseline Estimation Method.** Cadmus used a regression-based difference-in-differences methodology that estimated impacts averaged across the load impact study group and compared the treatment and control groups during events, controlling for non-event day average hourly loads and for weather. In discussion with Cadmus, the DR service provider reported that it used a within-subject customer baseline load (CBL) method. The DR service provider reported that the CBL method is similar to those used by the regional transmission organization PJM for the settlement of demand response performance payments in its capacity market. However, the IESO reported that the DR service provider changed its estimation approach in 2024, adopting a regression method. Generally, similar CBL methods use a customer's average daily (or hourly) load from a specific number of the highest load days from a specific number of the most recent weekdays leading up to a demand response event, often with a day-of-event or weather adjustment, to calculate a customer-specific baseline load for the event period. Event savings are calculated as the difference between this adjusted baseline and the customer's actual observed load during the event. Unlike Cadmus' methodology, CBL methods do not usually include regression modelling, a control group, or a difference-in-differences methodology. The DR service provider used runtime data from thermostats to develop a baseline AC runtime and then calculated a runtime impact for each customer.

3. **AC Size and Efficiency Assumptions.** Cadmus did not make any assumptions about participants' AC sizes or efficiency levels. This is not necessary as we estimate impacts from actual, whole-home AMI data rather than from air conditioner runtime data collected by smart thermostats. To convert its runtime impact estimate to a kW estimate, the DR service provider assumed an average kW for an AC running at 100% duty cycle (i.e., the demand of the AC while it is running) and then applied this to its runtime reduction estimate from its CBL. The DR service provider reported that it assumed 3.5 kW per air conditioner. To calculate this 3.5 kW assumption, the DR service provider reported that it used the AHRI Directory to collect specification data for all Trane brand ACs currently for sale without weighting.[12] The DR service provider reported that 3.5 kW approximately matches the theoretical demand of a 4-ton (48,000 Btu) central air conditioner.

These differences in impact estimation methodology explain why Cadmus and the DR service provider estimated different impacts. Cadmus' estimation of impacts from whole-home AMI data is expected to produce lower impact estimates than the DR service provider's estimation of the air conditioner's load alone from runtime data, as runtime data will not capture other end-uses in the home that could be affected by Peak Perks events. For example, as described later in the

Process Evaluation section, 30% to 44% of participants reported using fans to stay comfortable during events—potentially, additional load that would not be captured by air conditioner runtime data.

While the DR service provider's air conditioner demand assumption (3.5 kW) may explain the difference in magnitude of the discrepancies in results, the differences in estimation methodology do not explain why some events show larger differences than other events. While Cadmus' randomized control trial and difference-in-differences impact estimation methodology is the industry gold standard for impact evaluation and is expected to yield unbiased impact estimates, CBL methods like the one the DR service provider employs are also proven and are utilized across North American capacity markets for demand response event payment settlement.[13]

To determine why the magnitude of the difference between the results was large and variable, Cadmus calculated the ratio of evaluated to report impacts for each event. The team then compared this against outdoor temperature during each event and the DR service provider's reported event opt-out rate. An event opt-out occurs when a participant adjusts the thermostat settings during an event, which cancels the higher setpoint treatment effect and returns the air conditioner to normal operation. The DR service provider records these instances at the participant level through thermostat telemetry data.

As shown in Figure 6, the event opt-out rate was highly correlated with weather in 2024, though it was less strongly correlated in 2023. Event opt-out rates were generally higher in 2023 than in 2024 for any outdoor temperature condition, however. This result makes sense, as participants are likely to be more

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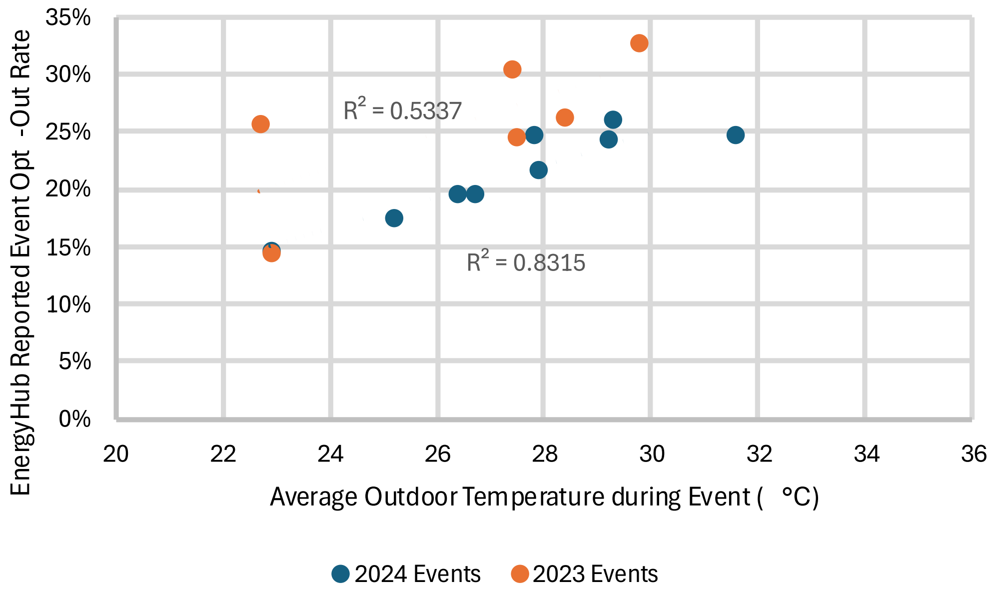
12 http://www.ahridirectory.org/

13 For example, see the IESO's comparison of hourly demand response baseline methodologies here: https://www.ieso.ca/-/media/Files/IESO/Document-Library/engage/rae/ra-20210923-hdr-baseline-review.pdf

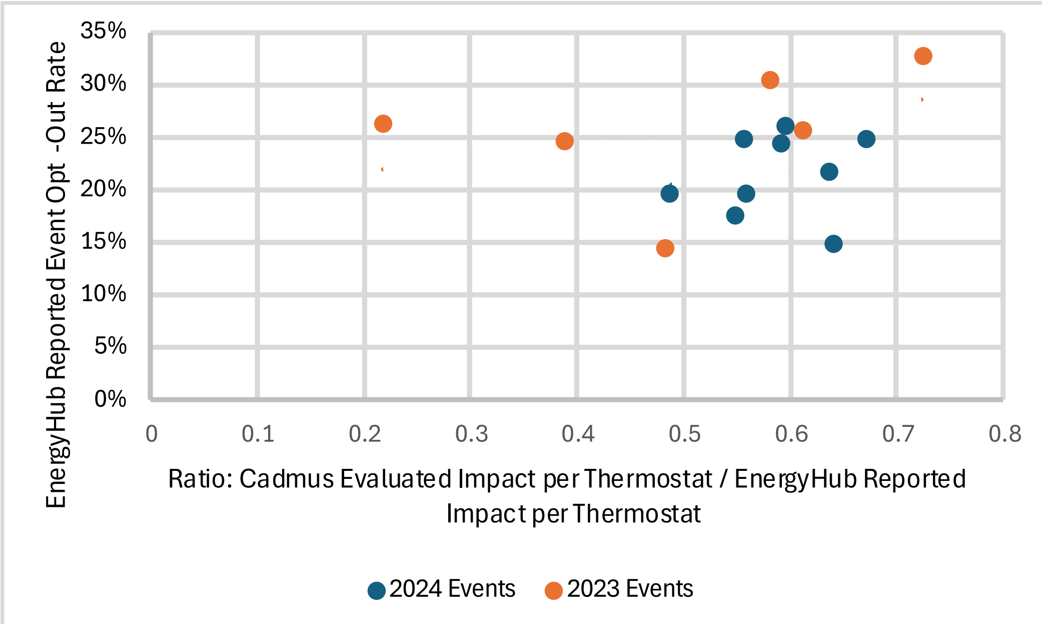
uncomfortable with higher than usual temperatures in their homes (due to Peak Perks events) on hotter days than they would be on cooler days.

Figure 6. Reported Event Opt-Out Rate Versus Average Outdoor Temperature During Events



As shown in Figure 7, Cadmus also compared the ratio of evaluated to reported impacts against event opt-out rates. A ratio of 1 means that evaluated savings equal reported savings; a ratio less than 1 means reported savings are larger than evaluated savings. As shown in Figure 7, differences in reported and evaluated savings were not strongly correlated with opt-out rates. The DR service provider confirmed that its reported savings represent all Peak Perks participants, not just those that remain in (do not opt out of) events, in alignment with Cadmus' evaluated savings methodology.

Figure 7. Ratio of Evaluated to Reported Impacts Versus Event Opt-Out Rate



While beyond the scope of this evaluation, further research into the details of the DR service provider's baseline methodology and a runtime data analysis to assess this approach's accuracy is required to further elucidate the sources of divergence between reported and evaluated impacts. Based on 2024 results, the IESO can expect evaluated impacts of approximately 60% of reported impacts on average for Peak Perks.

Job Impacts

This section outlines the industry job impact findings, by total job impact and by industry, related to Peak Perks PY 2024.

Total Job Impact

Cadmus determined the total job impacts by combining shocks from personal expenditures,[14] participant purchases of equipment, industry inputs (the IESO's administrative costs and payments to service providers), and avoided electricity generation costs.[15] The first three types of economic shocks are positive, whereas avoided cost is negative, reducing activity in the electric power industry (Table 16).

Table 16. Economic Shocks Due to the Program

Shock Type	Description	Impact
Personal Expenditures	Incentives (pre-paid MasterCard) paid to participants increased household spending	+
Commodity Output	Purchases made by participants for smart thermostats due to the program	+
Intermediary Input	IESO's administrative costs and payments to service providers	+
Industry Output	Reduced activity in the electric power industry due to avoided generation costs	-

Cadmus estimated the number of job changes in PY 2024 using StatCan's IO model. The IO model traces the ripple effects of investment or spending through different sectors of the economy and captures three layers of impact:

- **Direct – Jobs**: changes directly by the program's spending (e.g., staff hired, contracts awarded)
- **Indirect – Jobs:** changes along the supply chain (e.g., suppliers, materials, transportation)
- **Induced – Jobs**: changes when employees in direct and indirect roles

Table 17 summarizes the number of job changes, where a positive number indicates jobs created and a negative number indicates jobs decreased for Ontario and Canada as a whole. The table shows each job impact level in terms of the following:

- **FTE jobs**: Employee jobs converted to FTE jobs based on the overall average full-time hours worked in either the business or government.
- **Total jobs:** Includes full-time, part-time, temporary jobs, and self-employed jobs.
- **Jobs per $1 Million investment or Spent:** A job multiplier or metric that normalizes results for every million dollars invested or spent.

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14 Incentives (pre-paid MasterCard) paid to participants increased household spending, which the team modelled as personal expenditures shocks.

15 Energy bill savings shocks are not included in this analysis because, while the program has resulted in kWh savings in addition to kW savings, the per-household reduction in energy consumption is relatively small. Moreover, the program did not communicate expected energy bill savings to participants. As a result, households were unlikely to anticipate bill reductions or adjust their spending behaviour in response.

Table 17. Total Job Impact

Job Impact	Ontario			Total Across Canada		
	FTE Jobs	Total Jobs	Total jobs per $1M Investment	FTE Jobs	Total Jobs	Total jobs per $1M Investment or Spent
Direct impact	36	56	-	40	60	-
Total impact: Direct and Indirect	81	119	22	90	131	23
Total impact: Direct, Indirect, and Induced	95	138	26	108	155	27

The direct impact of the program on jobs in Ontario in PY 2024 was 36 FTE jobs and 56 total jobs; across Canada, it was 40 FTE jobs and 60 total jobs. When the team included indirect impacts, Ontario's employment rose to 81 FTE jobs and 119 total jobs in PY 2024, whereas Canada's employment increased to 90 FTE jobs and 131 total jobs. When the team added induced program impacts, Ontario's employment increased to 95 FTE jobs and 138 total jobs, and Canada's employment increased to 108 FTE jobs and 155 total jobs.

Beyond the absolute number of jobs, another important indicator of job growth is how many positions were sustained for each $1 million of investment or spent, which is helpful when comparing different program years and programs. In Ontario, the total impact (direct, indirect, and induced) corresponds to 26 total jobs per $1 million spent. Across Canada, the total impact (direct, indirect, and induced) corresponds to 27 jobs per $1 million spent. These results demonstrate the program's contribution to employment in 2024.

Job Impacts by Industry

This section examines how the program's combined shocks affect employment across different industries. As summarized in Table 18, evaluation results indicate that most industries experienced positive job gains. Overall, the positive PY 2024 impacts associated with personal expenditures, participant equipment purchases, and related activities outweighed the negative impact, resulting in a net employment gain across both Ontario and Canada. Several service-oriented industries stood out for their larger job gains, including professional, scientific and technical, retail trade, and accommodation and food services. These industries benefited from increased demand, either through direct program-related activities or through the subsequent ripple effects of higher consumer spending. The only industry that had a negative job impact was utilities;[16] this decrease reflects the avoided electricity generation component of the program, which reduced direct activity in the electric power industry.

Table 18. Total Job Impact by Industry

Job Impact	Ontario		Total Across Canada	
	FTE Jobs	Total Jobs	FTE Jobs	Total Jobs
Crop and animal production	0.4	0.9	0.9	1.9

16 The analysis did not differentiate different types of utilities.

Job Impact	Ontario		Total Across Canada	
	FTE Jobs	Total Jobs	FTE Jobs	Total Jobs
Forestry and logging	0.0	0.0	0.0	0.0
Fishing, hunting, and trapping	0.0	0.0	0.0	0.1
Support activities for agriculture and forestry	0.1	0.1	0.1	0.1
Mining, quarrying, and oil and gas extraction	0.0	0.0	0.0	0.0
Utilities	-17.3	-17.7	-17.2	-17.6
Repair construction	3.5	4.1	3.7	4.3
Other activities of the construction industry	0.1	0.3	0.1	0.3
Manufacturing	4.3	4.6	6.3	6.7
Wholesale trade	6.4	6.8	7.8	8.2
Retail trade	24.7	36.8	25.9	38.5
Transportation and warehousing	3.9	5.1	5.0	6.3
Information and cultural industries	2.4	2.6	2.8	3.1
Finance, insurance, real estate, rental and leasing and holding companies	4.0	4.6	4.8	5.6
Professional, scientific and technical services	34.7	49.3	37.1	52.7
Administrative and support, waste management and remediation services	3.6	5.0	4.3	5.9
Educational services	0.5	1.2	0.5	1.2
Health care and social assistance	4.4	6.9	4.6	7.2
Arts, entertainment, and recreation	1.2	2.2	1.4	2.6
Accommodation and food services	7.1	11.4	8.3	13.3
Other services (except public administration)	3.5	4.9	4.0	5.6
Non-profit institutions serving households	1.5	1.8	1.6	2.0
Government education services	2.3	2.7	2.5	2.9
Government health services	0.8	0.9	0.9	1.0
Other federal government services	0.2	0.2	0.2	0.2
Other provincial and territorial government services	1.3	1.3	1.3	1.4
Other municipal government services	1.4	1.6	1.5	1.7
Total	**95**	**138**	**108**	**155**

Process Evaluation

To explore the program implementer's and participants' understanding and experience and to assess program performance to identify areas of success and possible improvement, Cadmus conducted several activities:

- Reviewed program documents
- Conducted in-depth interviews with the IESO program staff and program implementer staff
- Administered an experience survey with PY 2023 and PY 2024 participants

As detailed below, these process evaluation activities explored various aspects of the program: design and delivery, program awareness, participation motivation, and experience.

Design and Delivery

The IESO program staff confirmed that the program was designed to encourage participants to reduce peak demand during the summer period. To achieve this, program staff reduced participants' air conditioning to a pre-set temperature during peak hours. In return, participants received a $75 prepaid Mastercard to enroll in the program and an additional $20 for staying enrolled for the next activation period.

Program and implementer staff also confirmed the eligibility requirements for participation:

- Must be an Ontario resident who lives within qualifying postal codes (excluding Cornwall)
- Must own a qualifying smart thermostat (ecobee, Honeywell, Nest, and Sensi)
- Must not be participating in another demand response program

The program staff reported contracting with the DR service provider to implement the program starting in the summer of 2023. To implement the program, the DR service provider staff said they contracted with eligible smart thermostat manufacturers to engage interested residents. Staff also confirmed that the DR service provider verified that enrolled participants lived in a qualifying postal code area and that they work with manufacturers to track event data, distribute the prepaid Mastercards, and notify participants of events.[17] Participants receive notifications either through their thermostat display or via the smart thermostat app.

Program and implementer staff said that participants are notified two hours prior to an event and have the opportunity to opt out at any time. Program staff explained that they use daily reports to identify peak hours by monitoring the megawatt threshold, which helps them determine when to call an event.

Program Performance

The IESO program staff indicated that they were generally pleased with the program's performance to date. Program staff confirmed that the original goal was to enroll 137,00 devices and reduce consumption by 123 MW. However, staff reported that since the program met the original participation goal in May 2024, they increased it to 190,000 devices by year end. Additionally, staff reported that less than 5% of participants unenrolled once they engaged with the program.

While the IESO and DR service provider staff agreed that program implementation was generally going well, they also acknowledged that data tracking could be improved. For example, DR service provider staff explained that the thermostat manufacturers notified and tracked participant data differently, which contributed to inconsistent participant experiences and inconsistency across data available to the IESO. In addition, DR service provider staff reported that the thermostat manufacturers also varied in

[17] Events may last up to four hours.

the frequency of marketing outreach, with Nest, Honeywell, and Sensi distributing quarterly email campaigns, whereas ecobee only sent one pre-season email.

IESO and DR service provider staff also acknowledge that the way they define participants who opt out of events could be improved; they currently identify opt-out participants differently. The IESO identifies a participant as one who participated in the majority of an event, whereas the DR service provider identifies a participant as someone who does not adjust their thermostat from the beginning of an event to 15 minutes right before the event.

Program Awareness

The *Program Awareness* section includes findings on marketing and outreach, thermostat adjustment awareness, event notifications, and communication preferences.

Marketing and Outreach

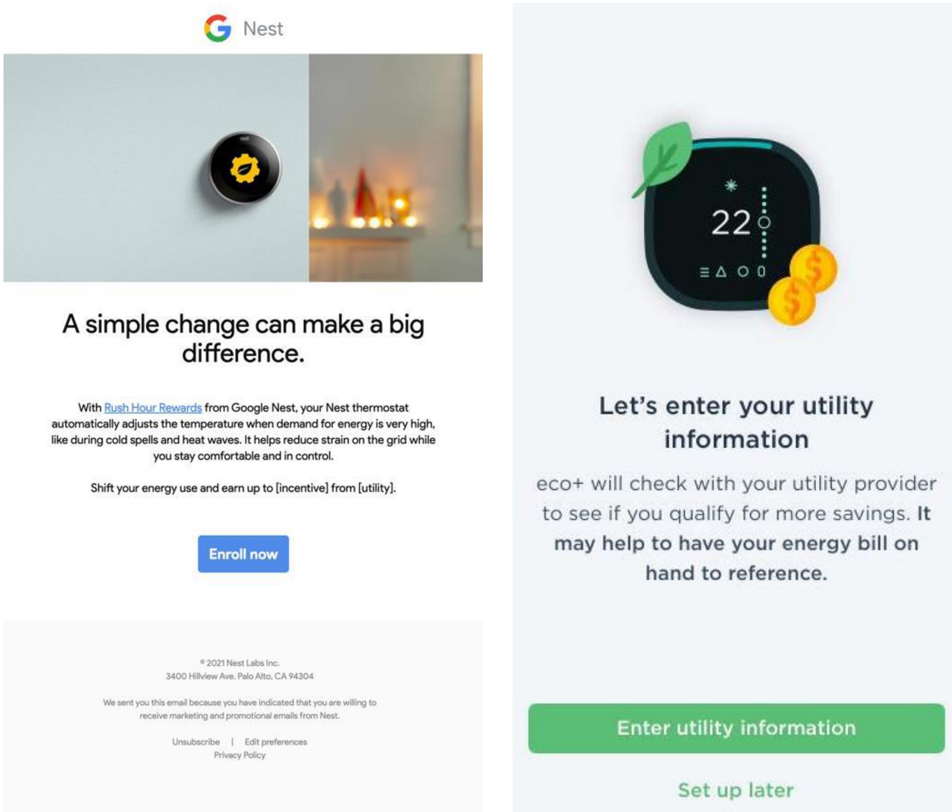
Program and implementer staff reported that thermostat manufacturers employed a variety of marketing efforts, as shown in Table 19, and agreed that the majority of outreach efforts consisted of emails and notifications via the application. DR service provider staff said the most successful marketing and outreach activities had been via the application offers, reporting that 80% of the participants enrolled through their smart thermostat application, and many customers use the app once a day.

Table 19. Marketing and Notification Channels by Thermostat Manufacturer

Smart Thermostat	Marketing Channels	Notification Channels
ecobee	Email, mobile application	Email, mobile application, device notification
Honeywell	Email, mobile application	Email, mobile application, device notification
Nest	Email, mobile application	Mobile application, device notification
Sensi	Email, mobile application	Email, mobile application

DR service provider staff said in the cases where the smart thermostat manufacturers conducted their own marketing, the DR service provider worked with the IESO staff to ensure that the final messaging was presented clearly and thoughtfully. The IESO staff confirmed that they made efforts to ensure that the overall message of the program was generally consistent across all outreach efforts. Figure 8 provides examples of marketing material the smart thermostat manufacturers used.

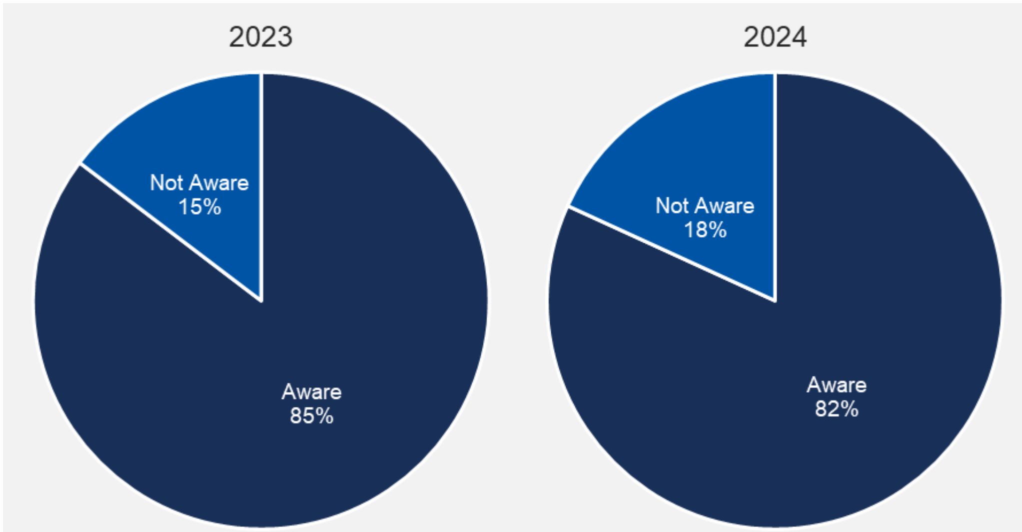
Figure 8. Marketing Material by Smart Thermostat Providers



Thermostat Awareness

As shown in Figure 9, survey respondents (participants) reported they were aware that their thermostat would be adjusted as part of the program with no significant differences by year.[18]

Figure 9. Awareness of Thermostat Adjustment by Year



Source: Peak Perks Program Customer Survey Question C1. "When you enrolled in the Peak Perks program, were you aware that your thermostat settings would be remotely adjusted by no more than two degrees during times of high electricity demand between June and September?" (2023 n=75; 2024 n=66)

Event Notifications

Although most respondents reported they were aware that their thermostat would be adjusted in the program *(Thermostat Awareness*), they reported a range of awareness regarding whether their thermostat was actually adjusted or whether they had received a notification. As shown in Figure 10 respondents with ecobee thermostats (46%) reported lower levels of awareness than respondents with Nest thermostats (16%). Of those who recalled being notified, respondents could select multiple options in the survey for how they received notifications. Most Nest respondents reported receiving a notification through the app (55%), thermostat display (43%), or email (20%). Fewer ecobee respondents (37%) reported receiving a notification on their thermostat display, and 20% recalled receiving an email or app notification.[19]

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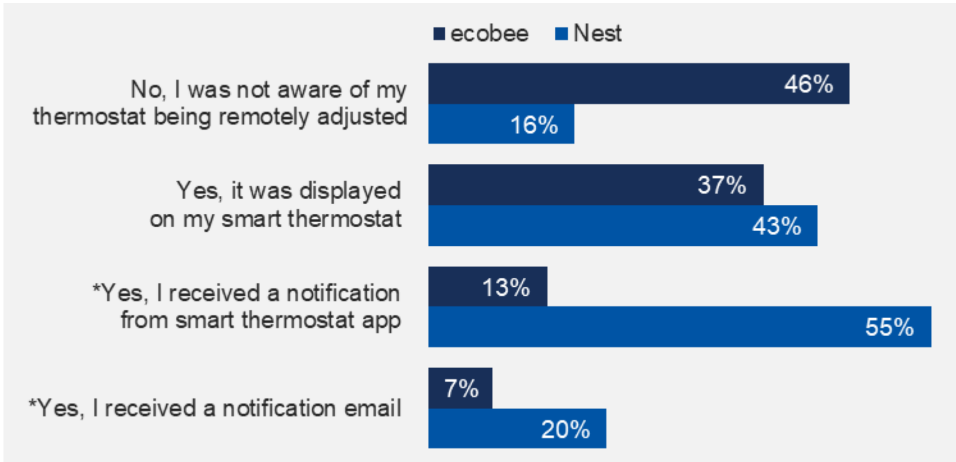
18 There were no significant differences between respondents by thermostat type.

19 The difference between ecobee and Nest respondents recalling notifications on email and on the smart thermostat was statistically significant.

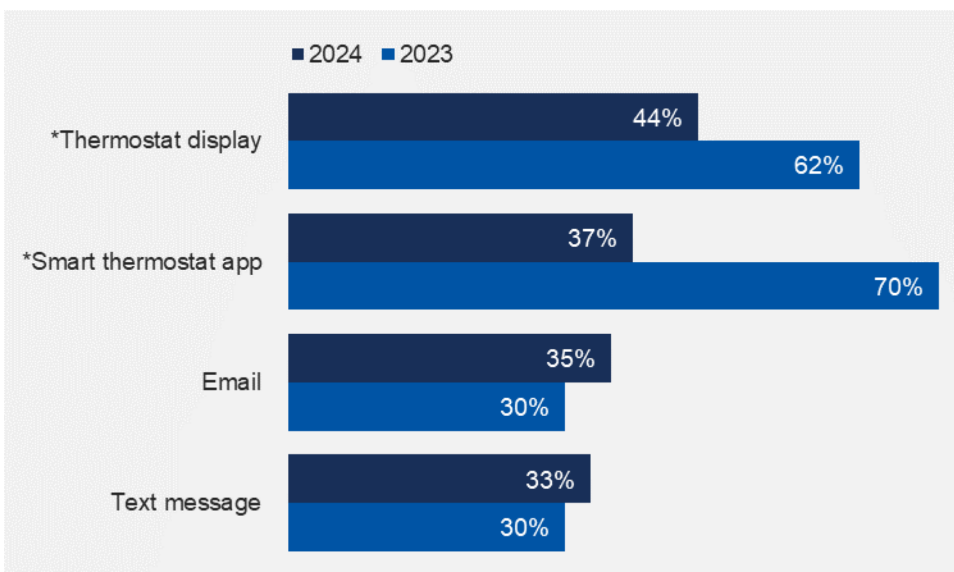
Figure 10. Awareness of Notifications by Thermostat Type



*Denotes z-test statistical significance at the 95% confidence level.
Source: Peak Perks Program Customer Survey Question D8. "Do you recall any of the times when you were notified that your thermostat would be adjusted through the program for an event? Select all that apply." (ecobee n=84, Nest n=56).

As shown in Figure 11, while a majority of respondents in PY 2023 reported preferring notification through their thermostat app (70%) or display (62%), results were more divided in PY 2024: thermostat displays (44%), thermostat apps (37%), email (35%), and text (33%).[20]

Figure 11. Preferred Notification Methods by Year

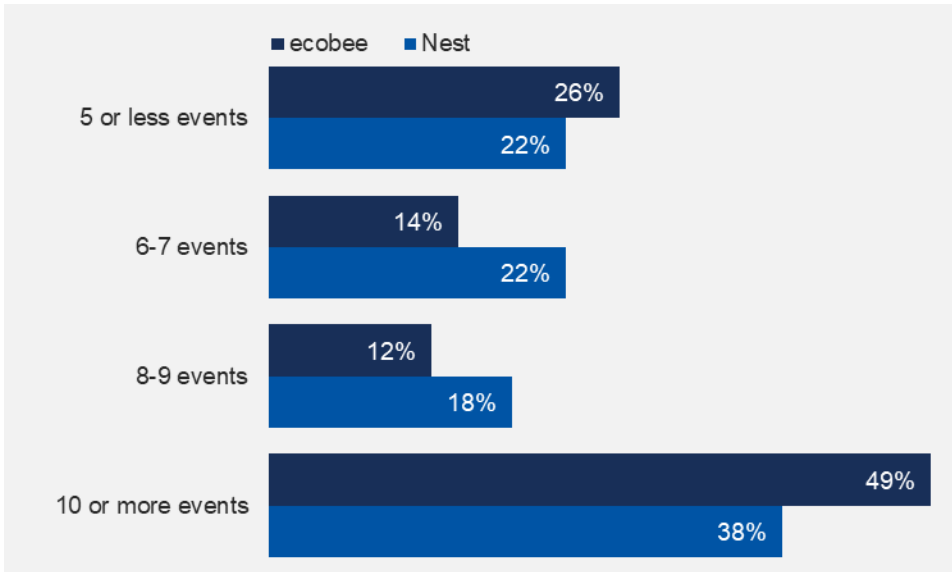


*Denotes z-test statistical significance at the 95% confidence level.
Source: Peak Perks Program Customer Survey Question D9. "What notification methods do you prefer? Select all that apply." (PY 2024 n=43, PY 2023 n=47)

[20] The difference between PY 2023 and PY 2024 participants preferences of thermostat displays and smart thermostat app notification was statistically significant.

When asked how many events they would be willing to participate in, 49% of ecobee respondents and 38% of Nest respondents reported they would be open to 10 or more events annually (Figure 12).

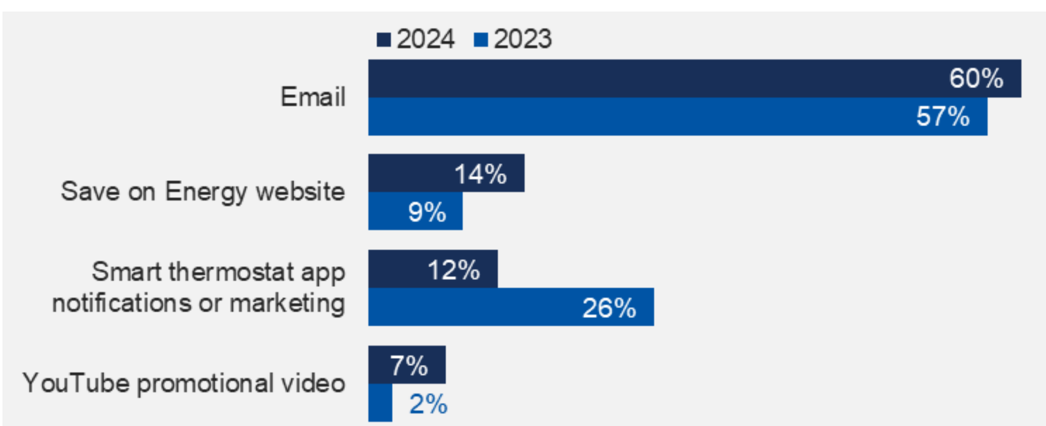
Figure 12. Preferred Number of Events by Thermostat



Source: Peak Perks Program Customer Survey Question D13. "Up to how many Peak Perks activations would you be willing to participate in?" (n=89)

When asked about preferences for communication on additional IESO program offerings, a vast majority of respondents (60%) said they preferred email (Figure 13). Very few respondents selected a preference for social media ads, social media posts, and bill inserts as communication methods (not displayed, each 5% or under).

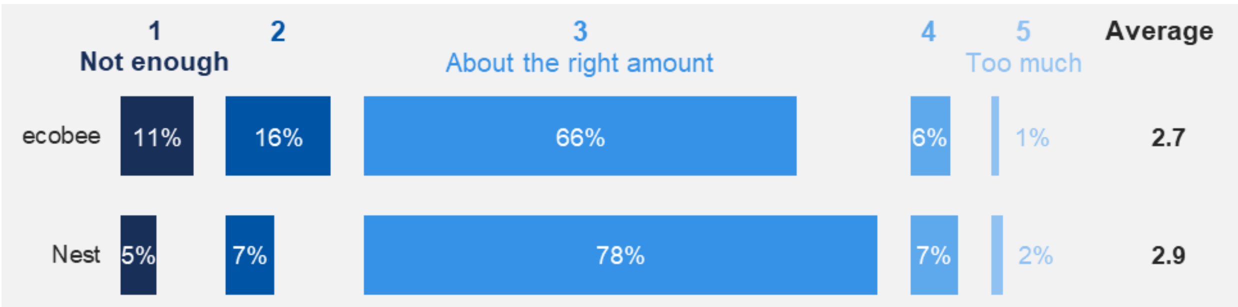
Figure 13. Preferred IESO Communications by Year



Source: Peak Perks Program Customer Survey Question D14. "How would you like to further hear about Peak Perks or any other IESO offerings?" (2023 n=46, 2024 n=42)

The survey also asked respondents to rate program communication, where 1 meant *not enough communication*, 3 meant the *right amount*, and 5 meant *too much*. As shown in Figure 14, respondents generally felt they had received the *right amount* of program communication from the IESO. However, respondents with Nest thermostats had a slightly higher average score of 2.9 than ecobee at 2.7. More ecobee respondents reported they did not receive enough information (27% recorded a two or one on the five-point scale) than Nest respondents (12%).

Figure 14. Ratings for Amount of Communication by Thermostat Type

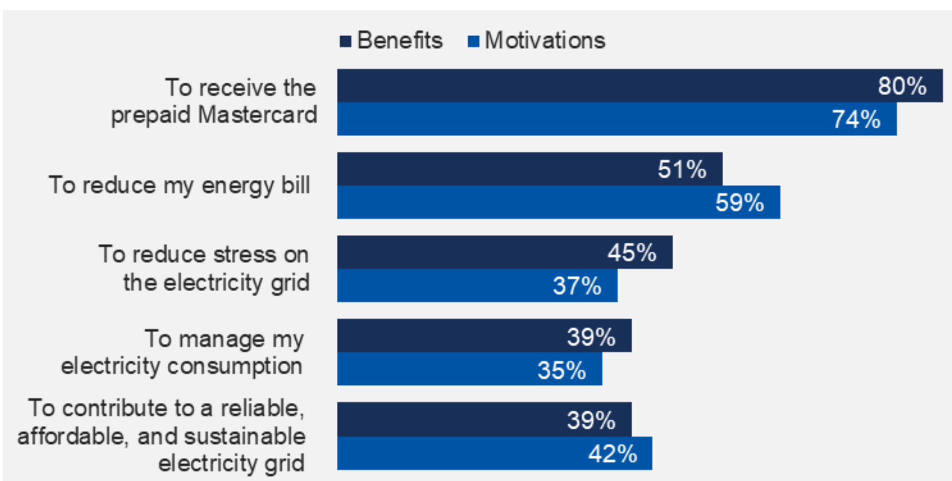


Source: Peak Perks Program Customer Survey Question D6. "On a scale from 1 to 5, where one is *not enough information* and 5 is *too much information*, how would you rate the amount of communication you received from the IESO about the Peak Perks Program?" (ecobee n=82, Nest n=55)

Participant Motivation

The survey asked respondents what initially motivated their participation and what benefits motivated them to stay enrolled in the program. As shown in Figure 15, a majority of respondents selected the prepaid MasterCard and savings on energy costs as their top motivation (80%) and benefit (74%) for program participation.

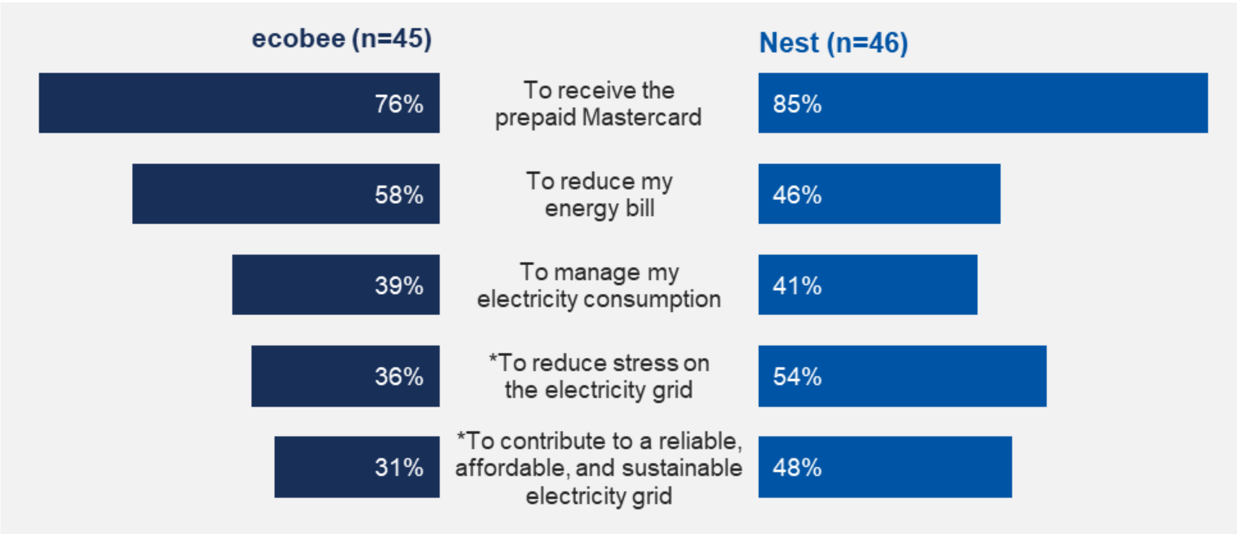
Figure 15. Motivation to Participate and Benefits of Staying Enrolled



Source: Peak Perks Program Customer Survey Questions C2 and D13b. "What motivated you to participate in the Save on Energy Peak Perks Program?" (Multiple response; n=148) and "What benefits keep you motivated to stay enrolled in the Peak Perks Program?" (Multiple response; n=92)

Figure 16 breaks down the perceived participation benefits by thermostat type. Nest respondents were slightly more likely to report benefits than ecobee respondents in all but one category (reducing energy bills).[21]

Figure 16. Benefits by Thermostat Type



*Denotes z-test statistical significance at the 95% confidence level.

Source: Peak Perks Program Customer Survey Question D13b. “What benefits keep you motivated to stay enrolled in the Peak Perks Program?”

Participant Experience

In addition to program awareness and participation motivation, Cadmus explored key aspects of participant experience, such as actions participants may have taken in response to events and home comfort during events.

Event Actions

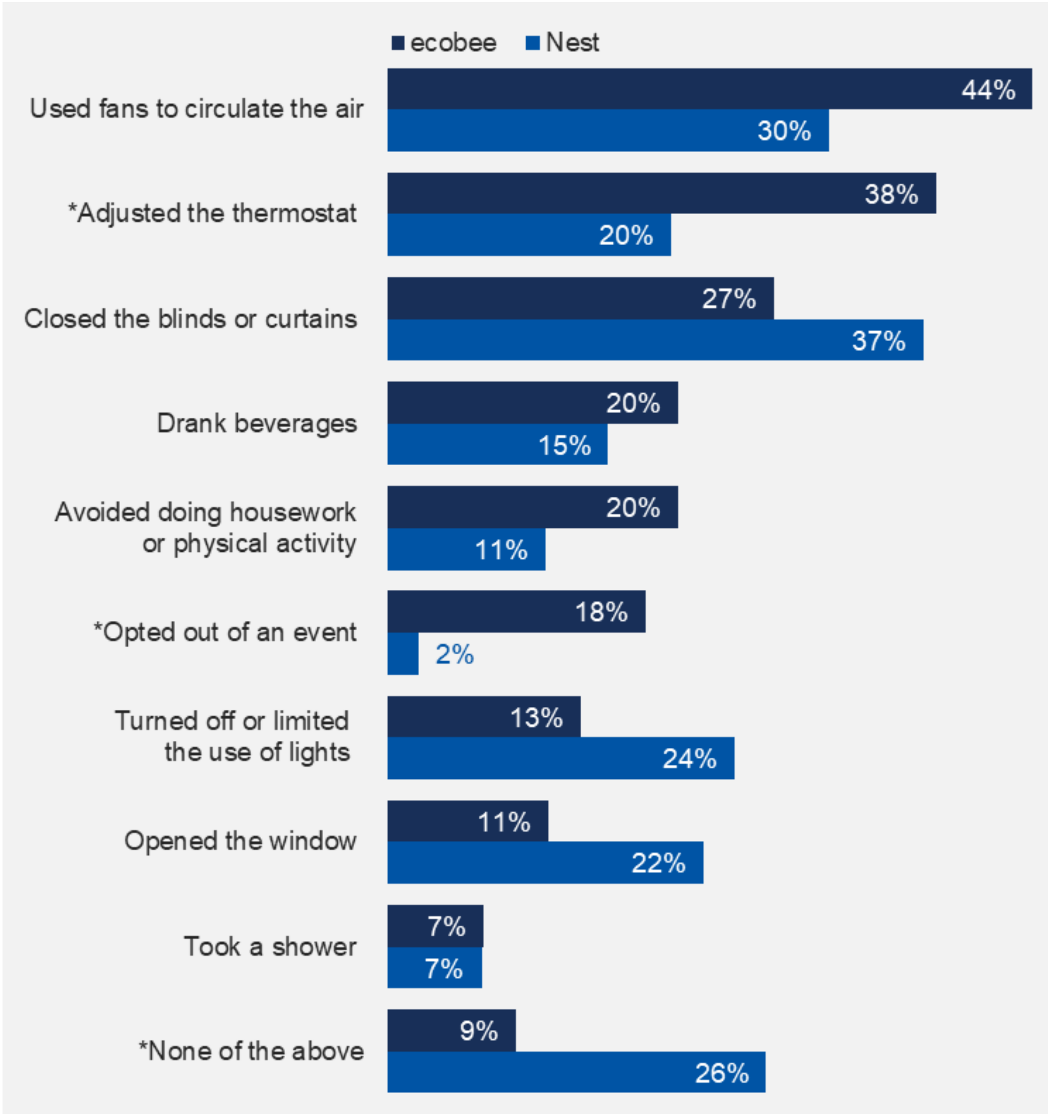
As shown in Figure 17, respondents reported taking a variety of actions to stay cool during events. For example, more Nest respondents reported closing the blinds (37%) or using fans to circulate air (30%), while more ecobee respondents reported using fans to circulate air (44%) and adjusting their thermostats (38%). Furthermore, more Nest respondents (26%) than ecobee (9%) reported taking no actions to remain comfortable in the event.[22] Finally, more ecobee respondents (18%) opted out of events than Nest respondents (2%).[23]

[21] This difference was statistically significant.

[22] The difference between Nest and ecobee respondents was statistically significant.

[23] The difference between Nest and ecobee respondents was statistically significant.

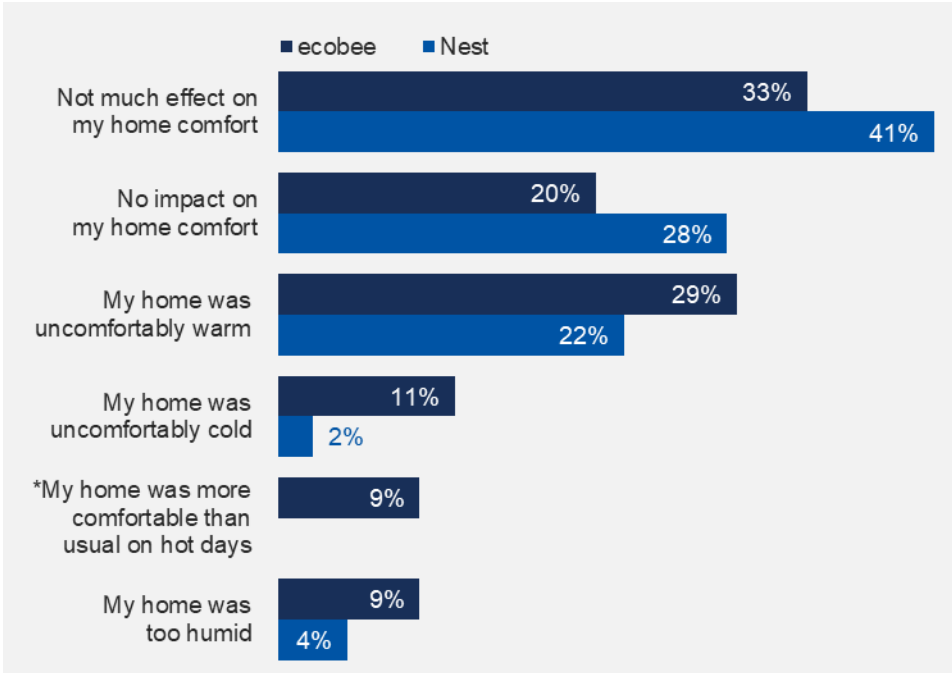
Figure 17. Actions Taken to Stay Comfortable During an Event by Thermostat Type



*Denotes z-test statistical significance at the 95% confidence level.
Source: Peak Perks Program Customer Survey Question D12. "What actions, if any, did you take during a Peak Perks activation to stay comfortable?" (Multiple responses allowed; ecobee n=45, Nest n=46)

As shown in Figure 18, most respondents (53% ecobee, 69% Nest) reported little to no impact on the comfort of their homes.

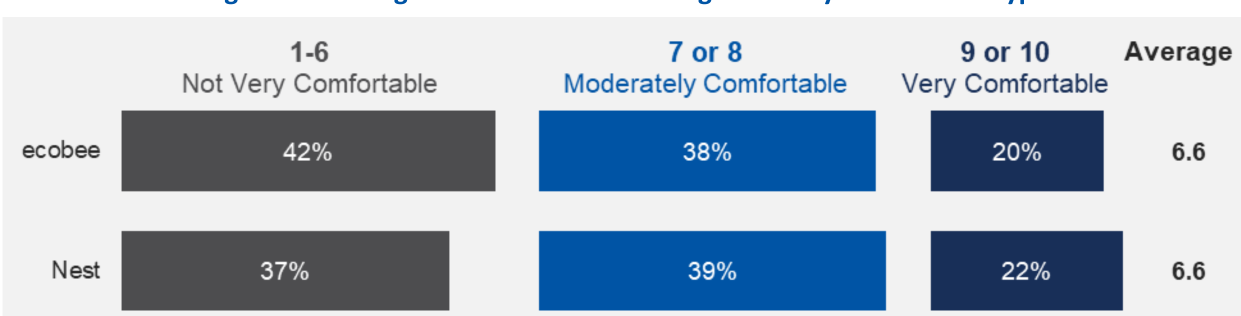
Figure 18. Event Effect on Home Comfort by Thermostat Type



*Denotes z-test statistical significance at the 95% confidence level.
Source: Peak Perks Program Customer Survey Question D10. "In general, how was your home comfort affected during events (periods when your smart thermostat was remotely adjusted)?" (Multiple responses allowed; ecobee n=45, Nest n=46)

The survey asked respondents on a scale of 1 (*not very comfortable*) to 10 (*very comfortable*) how they would rate their home comfort during an event. Similar to the findings on the event effect on home comfort (Figure 19), most respondents (58% ecobee, 61% Nest) reported their home was above a 7.

Figure 19. Rating of Home Comfort during Events by Thermostat Type



Source: Peak Perks Program Customer Survey Question D11. "On a scale of 1 to 10, where 1 is *not at all comfortable* and 10 is *very comfortable*, how comfortable was the interior temperature of your home during a Peak Perks activation?" (ecobee n=45, Nest n=46)

Appendix A. PY2024 EM&V Key Findings and Recommendations with IESO Response

NO.	KEY FINDINGS	EM&V RECOMMENDATIONS	IMPACTS	IESO RESPONSES
1	There were no statistically significant differences in impacts between thermostat brands, home ages, or IESO regions. Although significant differences among some building types were observed in one model, further research is required to determine if this observation is repeatable.	Conduct further research to determine if there are differences in savings by building type.	Low	Future evaluation cycles can investigate differences in savings by residential building type.
2	The DR service provider's reported impacts, which are based on thermostat runtime data, and evaluated impacts, which are based on advanced metering infrastructure (AMI) data, differed substantially for all 2023 and 2024 events. On average across 2024 events, evaluated impacts were 60% of reported impacts. Participants who opted-in to share their AMI data for the Load Impact Study had approximately 16% lower average AC runtimes during the typical event window (4:00 p.m. to 7:00 p.m.) than the overall participant group, suggesting that the actual impacts of Peak Perks events outside of the Impact Study may be larger than estimated.	For planning purposes, consider scaling the DR service provider's impact estimates by 60% to adjust for whole-home demand response impacts and participants' event opt-out behaviour. Also, consider further research that incorporates the DR service provider's runtime and opt-out data with the IESO's AMI data to determine the reasons for the divergence between the DR service provider's AC runtime-derived customer baseline model and Cadmus' whole-home AMI difference-in-differences model. This research could also incorporate an AC runtime impact analysis comparing the Load Impact Study with the general population, enabling the IESO to assess whether its forecasts for Peak Perks' overall demand impacts should be scaled up or down to reflect the differences between the two groups.	High	Upon further analysis and investigation, the connected load and air conditioner size assumption was determined to be a contributing factor in the variance between the reported and evaluated impacts. The assumption was subsequently adjusted in light of the evaluation findings.

NO.	KEY FINDINGS	EM&V RECOMMENDATIONS	IMPACTS	IESO RESPONSES
3	Although the IESO and implementer staff successfully engaged participants in the program by providing sufficient information, a variety of notification channels, and an effective incentive, there is room to refine data tracking and increase consistency.	Review implementer data collection and tracking requirements as well as those of the qualifying thermostat manufacturers to ensure consistency in data collection and data definitions (e.g., opted-out).	Medium	The IESO has explored data collection requirements for implementers and thermostat manufacturers, and recommended alignment in definitions.
4	The incentive was found to be a key driver for participation, as the majority (75%) of respondents identified the prepaid Mastercard as the motivating driver for participating in the program, and 80% of respondents identified the incentive as the key benefit for participating. The level of incentive necessary to motivate participation was not explored.	Consider research to explore if participants would continue to engage with a smaller incentive such as by adding a varied incentive question in the next round of participant surveys.	Medium	The appropriate level of incentive will be explored through future studies (e.g. process evaluations and/or customer satisfaction surveys).

Appendix B. Survey Instrument

Please double-click on the PDF icon below to view the final survey instrument.

2024 IESO DR
Participant Survey_15(

Appendix C. Respondent Demographics

Table C-1 through Table C-7 summarize the survey respondent demographics.

Table C-1. Additional Equipment

Measures Installed	Respondents
No other cooling equipment changes	75%
Ceiling fan(s)	13%
Central heat pump	12%

Source: Peak Perks Program Customer Survey Question E1: “What, if any, other cooling equipment changes did you make in your home alongside the installation of the smart thermostat?” n=137.

Table C-2. Primary Home Cooling

Square Feet	Respondents
Central Air Conditioner	75%
Central Heat Pump	18%
Other	7%

Source: Peak Perks Program Customer Survey Question E2: “What is the primary way you cool your home?” n=140.

Table C-3. Home Size

Square Feet	Respondents
<1,000 sq. ft.	9.3%
1,000 – 1,999 sq. ft.	51.4%
2,000 – 2,999 sq. ft.	24.3%
3,000 – 4,999 sq. ft.	12.1%
Don’t know	2.9%

Source: Peak Perks Program Customer Survey Question E4: “Approximately how many square feet is your home?” n=140.

Table C-4. Household Size

Persons in the home	Respondents
1	9.8%
2	33.1%
3	18.8%
4	24.1%
5	4.5%
6	6.0%
7	3.0%
10	0.8%

Source: Peak Perks Program Customer Survey Question E5: “How many people live in the household full time?” n=133.

Table C-5. Household Income

Income	Respondents
Under $15,000	1.5%
$15,000 to $19,999	1.5%
$20,000 to $29,999	0.8%
$30,000 to $39,999	3.8%
$40,000 to $49,999	3.8%
$50,000 to $59,999	4.5%
$60,000 to $69,999	3.8%
$70,000 to $79,999	5.3%
$80,000 to $89,999	2.3%
$90,000 to $99,999	7.5%
$100,000 to $109,999	10.5%
$110,000-$119,999	2.3%
$120,000 or greater	36.8%
Prefer not to answer	15.8%

Source: Peak Perks Program Customer Survey Question E6: “Please indicate which of the following categories applies to your total annual household income before taxes.” n=133.

Table C-6. Household Internet

Internet Access	Respondents
Yes	98.5%
No	0%
Don’t know	1.5%

Source: Peak Perks Program Customer Survey Question E7: “Is there internet at the participating home?” n=137.

Table C-7. Household Language

Language	Respondents
English	75.2%
Chinese	15.3%
Tamil	1.4%
Other	5.8%

Source: Peak Perks Program Customer Survey Question E8: “What is the primary language spoken in the home?.” n=137.

Appendix D. Methodology Details

Appendix C presents the detailed methodology for impact evaluation, including cost-effectiveness and job impacts, as well as for the process evaluation.

Impact Evaluation

Summer 2023 and 2024 Impact Studies

2023 Study Design

Cadmus evaluated the summer 2023 Peaks Perk Program by comparing participants who enrolled before or during summer 2023 and participated in one or more summer 2023 demand response events (participants) with participants who enrolled after the final summer 2023 event (event nonparticipants). The IESO provided information about each study participant's thermostat brand, home year built, location, and home type. Cadmus matched participants to event nonparticipants on the basis of these characteristics and participants' energy consumption and demand. The resulting comparison group of event nonparticipants group is similar in composition to the participant group, enabling the team to obtain impact estimates unbiased by differences in non-event day energy consumption between the two groups.

Cadmus used difference-in-differences regressions to compare the electricity demand of participants and the comparison group in the hours before, during, and after demand response events, adjusting for any differences in electricity demand during the same hours on similar non-event days. This approach is robust to differences in electricity demand between participants and the comparison group that persist across event and non-event days. This estimation approach is described in detail later in this document.

2024 Study Design

For the summer 2024 impact evaluation, Cadmus used data from participants who had agreed to share their data for program evaluation (the load research study participants) by the end of the 2023 season. The major difference between the summer 2024 and the summer 2023 evaluation involves the study design. For 2024, Cadmus and the IESO implemented a randomized controlled study. For each event, Cadmus randomly assigned each study participant to a treatment group or control group. The treatment group experienced the demand response event treatment (adjusted thermostat settings), while the control group did not (providing the baseline for measuring demand response impacts).

Cadmus conducted several iterations of random assignment of study participants to A and B testing groups, then provided IESO with two sets of participant random assignments to the two groups. In randomly selecting these groups, Cadmus conducted tests to ensure there was an acceptable balance between the two groups across observable characteristics such as housing type, housing age, thermostat type, and IESO load zone. The IESO selected one of these random assignments and worked with the DR service provider to assign participants to A and B groups. The IESO used the groups to reverse treatment and control groups every month; during June and August, Group A served as the treatment group, and Group B acted as the control group. In July and September, Group B served as the treatment group, and Group A was the control group. This alternation was intended to offset the potential bias from any unobservable relevant study participant characteristics. As with the summer 2023 evaluation, Cadmus estimated demand response impacts for each event as a difference-in-differences regression.

Study Population and Analysis Sample

In the summer of 2023, 975 residential local distribution company customers who participated in at least one Peak Perks demand response event opted into the load impact study. The IESO demand-side management team collected the counts of study participants who enrolled after the summer and did not participate in any events (event nonparticipants). Cadmus drew the comparison group from this subpopulation of participants.

Table D-1 shows the distribution of summer 2023 study participants across different subgroups defined by thermostat type, home year built, home type, IESO load zone, and IESO climate zone. For 2024, Cadmus explored the impacts of these customer characteristics using indicator variables within a difference-in-differences model, as described later in this appendix.

Table D-1. Summer 2023 Analysis Sample

Category	Total (Treatment)	Total (Comparison Group)	Total
Nest	442	437	879
ecobee eco+	505	717	1,222
Honeywell TCC	8	68	76
Honeywell Home	15	60	75
Sensi	4	75	79
1975 or older	320	441	761
1976-1989	1,76	230	406
1990-1996	83	115	198
1997-2005	148	221	369
2006-2011	99	154	253
2012 or newer	148	196	344
Cottage	0	5	5
Detached House	655	910	1,565
Duplex, triplex, or fourplex	5	17	22
Semi-detached home	100	143	243
Townhouse or rowhouse	166	242	408
Other building types	48	40	88
Bruce	2	1	3
East	20	44	64
Essa	37	65	102
Niagara	21	43	64
Northeast	15	27	42
Northwest	4	10	14

Category	Total (Treatment)	Total (Comparison Group)	Total
Ottawa	115	184	299
Southwest	263	334	597
Toronto	397	505	902
West	93	135	228
Climate Zone 5 - South	173	111	284
Climate Zone 6 - East	283	177	460
Climate Zone 6 - West	233	193	426
Climate Zone 7 - North	49	21	70
Climate Zone 4 - GTA	617	472	1,089

In the summer of 2024, the DR service provider implemented the two-group random assignment method described above for participants enrolled by the end of the summer 2023 season. Table D-2 shows the distribution of summer 2024 study participants across different customer characteristics.

Table D-2. Summer 2024 Analysis Sample

Category	Total (Group A)	Total (Group B)	Total
Nest	442	437	879
ecobee eco+	505	717	1,222
Honeywell TCC	8	68	76
Honeywell Home	15	60	75
Sensi	4	75	79
1975 or older	320	441	761
1976-1989	176	230	406
1990-1996	83	115	198
1997-2005	148	221	369
2006-2011	99	154	253
2012 or newer	148	196	344
Apartment	5	2	7
Detached House	655	910	1,565
Duplex, triplex, or fourplex	5	17	22
Semi-detached home	100	143	243
Townhouse or rowhouse	166	242	408
Other building types	48	40	88
Bruce	2	1	3
East	20	44	64
Essa	37	65	102
Niagara	21	43	64
Northeast	15	27	42

Category	Total (Group A)	Total (Group B)	Total
Northwest	4	10	14
Ottawa	115	184	299
Southwest	263	334	597
Toronto	397	505	902
West	93	135	228
Climate Zone 5 - South	173	111	284
Climate Zone 6 - East	283	177	460
Climate Zone 6 - West	233	193	426
Climate Zone 7 - North	49	21	70
Climate Zone 4 - GTA	617	472	1,089

Data Collection

The IESO provided the following data to Cadmus for customers who opted into the study for the summer 2023 impact evaluation:

- One-hour interval AMI meter consumption data for participants and event nonparticipants for all hours from June 1, 2023, through September 30, 2023.
- Dates and times of demand response events from the DR service provider team, including participant event notifications, pre-conditioning, event start time, and event end time.
- Hourly weather data from the weather station nearest to each study participant.

AMI Meter Data

Cadmus conducted several data-cleaning steps for summer 2023 participants and event nonparticipants:

1. Subset meter data to weekdays from June 1 to September 30
2. Removed meter data occurring during Canadian federal holidays
3. Removed data after September 19, 2023, due to incomplete weather data past this point

Impact Estimation

For all events, Cadmus estimated the demand response impacts with a difference-in-differences panel regression of customer electricity demand. The team used the specification in **Equation 1** to measure the impact estimates for each event hour and capture variation in both electricity consumption and the sensitivity of consumption to outside temperature across hours of the day.

During the initial model and subsequent models, the coefficients of the interaction variables between *Part* and $PreEventHour$, $DuringEvent$, and $PostEventHour$ (α_k , $\theta_,$ and ϕ_m respectively) are the key parameters of interest; they indicate the impact of the demand response event on participant electricity demand before, during, and after the event, respectively.

Cadmus estimated the model using Ordinary Least Squares (OLS) and AMI meter data for the treatment group and the control group (or comparison group of event nonparticipants in 2023) on the event day and the baseline days for the event, which were non- holiday and non-event days.

Equation 1. Average Impact Across All Events

$$kWhit = \sum_{j=1}^{24} \beta_j \, Hour_{jt} + \sum_{j=1}^{24} \delta_j \, Hour_{jt} x \; CDH_{it} +$$
$$\sum_{j=1}^{24} \gamma_j \, Hour_{jt} \; x \; Part_{iq} + \sum_{j=1}^{24} \mu_j \, Hour_{jt} x \; CDH_{it} \; x \; Part_i +$$
$$\sum_{k=1}^{K} \rho_k \, PreEventHour_k + \sum_{k=1}^{K} \alpha_k \, PreEventHour_k \; x \; Part_i +$$
$$\eta_t DuringEvent_t + \theta DuringEvent_t \; x \; Part_i +$$
$$\sum_{m=1}^{M} \lambda_m \, PostEventHour_m + \sum_{m=1}^{M} \phi_m \, PostEventHour_m \; x \; Part_i + \varepsilon_{it}$$

Where:

$\boldsymbol{i}$	=	the participant and t denotes the hour of the analysis sample during the summer (e.g., 1 p.m. on July 16, 2023).
$\boldsymbol{Hour_{jt}}$	=	an indicator for hour of the day $j, j = 1, 2, \dots, 24$, where $Hour_{jt} = 1$ if hour t is hour j and $Hour_{jt} = 0$ otherwise.
$\boldsymbol{CDH_{it}}$	=	the cooling degree hours for participant i in hour t. The team selected a base temperature for all households based on standard IESO load forecasting (18 °C).
$\boldsymbol{Part_{iq}}$	=	whether participant i was an event participant (in 2023) or in the treatment group (in 2024) in the month q.
$\boldsymbol{PreEventHour_k}$	=	if an hour was within the pre-event period for hours $k = 1$, 2, or 3, where $PreEventHour_k = 1$ for the hour directly before the event, 2 for the hour before that, and 3 for the hour before that. $PreEventHour_k = 0$ all other times.
$\boldsymbol{DuringEvent_t}$	=	an indicator for if the hour t was during an event. $DuringEvent_t = 1$ if that hour was during an event, and 0 otherwise.
$\boldsymbol{PostEventHour_m}$	=	if an hour was within the post-event period for hours $m = 1$, 2, or 3, where $PostEventHour_m = 1$ for the hour directly after the event, 2 for the hour after that, and 3 for the hour after that. $PostEventHour_m = 0$ all other times.

Coefficients of $\overline{\theta_l}$ measure the average per-participant demand response impact (kW) of each event hour l. A negative coefficient means a reduction in demand. Likewise, coefficients of $\overline{\alpha_k}$ measure the average per-participant demand response impact (kW) of each pre-event hour k and coefficients of $\overline{\phi_m}$ measure the per-participant demand response impact (kW) of each post-event hour m.

Cadmus used the following specification to estimate average impacts for each event.

Equation 2. Average Impact by Each Event

$$kWhit \ = \ \sum_{j=1}^{24} \beta_j \ Hour_{jt} + \sum_{j=1}^{24} \delta_j \ Hour_{jt} x \ CDH_{it} +$$
$$\sum_{j=1}^{24} \gamma_j \ Hour_{jt} \ x \ Part_{iq} + \sum_{j=1}^{24} \mu_j \ Hour_{jt} x \ CDH_{it} \ x \ Part_i +$$
$$\sum_{k=1}^{K} \rho_k \ PreEventHour_k \ + \sum_{k=1}^{K} \alpha_k \ PreEventHour_k \ x \ Part_i +$$
$$\eta_t DuringEvent_t + \sum_{p=1}^{P} \theta_p DuringEvent_t \ x \ Part_i \ x \ EventDate_p \ +$$
$$\sum_{m=1}^{M} \lambda_m \ PostEventHour_m \ + \sum_{m=1}^{M} \phi_m \ PostEventHour_m \ x \ Part_i + \varepsilon_{it}$$

For Equation 2, $EventDate_p$ indicates the date of each event, from the first event day in the season to the last event day, where $EventDate_p = \ 1$ if the current event day is the pth event day, and 0 otherwise. For example, for an event on June 1, 2024, $EventDate_p$ would equal 1 for all hours on June 1. $\overline{\theta_p}$ estimates the average event impact per participant on energy demanded for event p.

All other variables are defined in the same way as **Equation 1**.

Cadmus employed the following model to estimate separate events by event timing group.

Equation 3. Average Impact by Event Start Time

$$kWhit \ = \ \sum_{j=1}^{24} \beta_j \ Hour_{jt} + \sum_{j=1}^{24} \delta_j \ Hour_{jt} x \ CDH_{it} +$$
$$\sum_{j=1}^{24} \gamma_j \ Hour_{jt} \ x \ Part_{iq} + \sum_{j=1}^{24} \mu_j \ Hour_{jt} x \ CDH_{it} \ x \ Part_i +$$
$$\sum_{k=1}^{K} \rho_k \ PreEventHour_k + \sum_{k=1}^{K} \alpha_k \ PreEventHour_k \ x \ Part_i \ x \ EventType_q + \eta_t DuringEvent_t +$$
$$\sum_{q=1}^{Q} \theta_l \ DuringEvent_t \ x \ Part_i \ x \ EventType_q +$$
$$\sum_{m=1}^{M} \lambda_m \ PostEventHour_m \ + \sum_{m=1}^{M} \phi_m \ PostEventHour_m \ x \ Part_i \ x \ EventType_q + \varepsilon_{it}$$

For Equation 3, $EventType_q$ indicates the start and end time of the event. For each event day, $EventType_q$ is equal to 1 if an event occurring on the day t had the start and end times indicated by event type q, and otherwise equal to 0.

All other variables are defined in the same way as **Equation 1**.

Cadmus employed a variation on Equation 1 to estimate characteristic models. This model allows the estimated effect of event impacts to vary by characteristic but is otherwise identical to Equation 1. The model is shown in Equation 4.

Equation 4. Participant Characteristic Model

$$kWhit \ = \ \sum_{j=1}^{24} \beta_j \ Hour_{jt} \ + \ \sum_{j=1}^{24} \delta_j \ Hour_{jt} x \ CDH_{it} +$$
$$\sum_{j=1}^{24} \gamma_j \ Hour_{jt} \ x \ Part_{iq} + \sum_{j=1}^{24} \mu_j \ Hour_{jt} x \ CDH_{it} \ x \ Part_i +$$
$$\sum_{k=1}^{K} \rho_k \ PreEventHour_k \ + \sum_{k=1}^{K} \alpha_k \ PreEventHour_k \ x \ Part_i \ +$$
$$\eta_t DuringEvent_t \ + \sum_{r=1}^{R} \theta_l \ DuringEvent_t \ x \ Part_i \ x \ Characteristic_{ri} +$$
$$\sum_{m=1}^{M} \lambda_m \ PostEventHour_m \ + \sum_{m=1}^{M} \phi_m \ PostEventHour_m \ x \ Part_i \ + \varepsilon_{it}$$

For Equation 4, $Characteristic_{ri}$ indicates the value for the characteristic variable for each characteristic of interest. The model was run individually for each characteristic, so for the IESO region, r = the region for participant i. For Home Age, r = the home age for participant i.

Task 3. External Validity Assessment

Note: Cadmus will complete this section after completing the external validity assessment.

Task 4. *Ex Ante* Demand Impact Forecasting – Model A

Cadmus combined forecasts of future demand impacts per participant for typical and extreme weather conditions with weather-conditional estimates for 2024 event performance to generate forecasts of program demand impacts before, during, and after demand response events for extreme and normal weather years. In consultation with internal IESO stakeholders, Cadmus determined forecasts would be optimally provided at the level of the IESO's load zones.

The *ex post* forecasts involved re-estimating the demand impacts from Task 2 as a function of weather conditions. The team estimated a new regression model for the study population that allowed the impacts to depend on CDH by including interaction variables between CDH, event hour indicators, and the indicator for assignment to treatment for the event. The model specification was as follows:

$$\begin{aligned} kWh_{it} = {} & \sum_{j=1}^{24} \beta_j \, Hour_{jt} + \sum_{j=1}^{24} \delta_j \, Hour_{jt} x \; CDH_{it} + \\ & \sum_{j=1}^{24} \gamma_j \, Hour_{jt} \; x \; S24Part_i + \sum_{j=1}^{24} \mu_j \, Hour_{jt} x \; CDH_{it} \; x \; S24Part_i + \\ & \sum_{p=1}^{P} \rho_p \, PreEventHour_{pt} + \sum_{p=1}^{P} \omega_p \, PreEventHour_{pt} \; x \; S24Part_i x \; CDH_{it} + \\ & \sum_{q=1}^{Q} \eta_q \, EventHour_{qt} + \sum_{q=1}^{Q} \psi_q \, EventHour_{qt} \; x \; S24Part_i x \; CDH_{it} + \\ & \sum_{r=1}^{R} \lambda_r \, PostEventHour_{rt} + \sum_{r=1}^{R} \chi_r \, PostEventHour_{rt} \; x \; S24Part_i x \; CDH_{it} + \varepsilon_{it} \end{aligned}$$

Where:

$\boldsymbol{S24Part_i}$	=	an indicator for whether customer i was in the summer 2024 treatment group during event day t (=1) or control group (=0.)
$\boldsymbol{Preeventhour_p}$	=	an indicator for the pth pre-event hour, $p = 1, 2, \dots, P$. This variable equals one if hour t is the pth pre-event hour and zero otherwise.
$\boldsymbol{Eventhour_q}$	=	an indicator for the Qth event hour, $q = 1, 2, \dots, Q$. This variable equals one if hour t is the qth pre-event hour and zero otherwise.
$\boldsymbol{Posteventhour_r}$	=	an indicator for the rth post-event hour, $r = 1, 2, \dots, R$. This variable equals one if hour t is the rth post-event hour and zero otherwise.

Cadmus estimated the model with data pooled across all event days and basis days used to estimate *ex post* impacts.

Next, for each region in the IESO's service area, Cadmus predicted the demand impacts per participant for the extreme and normal load years using the regression results from the previous step. For each region, Cadmus generated forecasts for each pre-event, event, and post-event hour by multiplying the coefficients on the temperature interaction terms (ω, ψ, and χ) by the CDH value provided for each forecast (extreme and normal load years) for the hottest day in the month and summing these with the participant-event fixed effect coefficients (α, θ, and ϕ.) This delivers the per-participant expected demand reductions under the forecast temperature conditions. To calculate a population-wide forecast, the team then multiplied these per-participant forecasts by the total number of Peak Perks participants reported by the IESO within the corresponding region.

Cadmus ran the model described above, resulting in the estimated coefficients listed in Table D-3.

Table D-3. Extended Forecast Coefficient Results

Interval Relative to Event Time	Average Impact per CDH (kW)	90% Confidence Interval
Pre-Event Hour 3	0.002	(-0.001, 0.004)
Pre-Event Hour 2	0.004	(0.001, 0.006)
Pre-Event Hour 1	0.041	(0.038, 0.044)
Event Hour 1	-0.056	(-0.059, -0.053)
Event Hour 2	-0.064	(-0.067, -0.061)
Event Hour 3	-0.052	(-0.055, -0.048)
Post-Event Hour 1	0.016	(0.012, 0.02)
Post-Event Hour 2	0.016	(0.01, 0.021)
Post-Event Hour 3	0.018	(0.012, 0.024)
Post-Event Hour 4	0.011	(0.004, 0.018)
Post-Event Hour 5	0.011	(-0.005, 0.028)

Cadmus additionally ran a simplified version of the above specification to derive results by region by month during events:

$$kWh_{it} = \sum_{j=1}^{24} \beta_j\, Hour_{jt} + \sum_{j=1}^{24} \delta_j\, Hour_{jt} x\ CDH_{it} +$$
$$\sum_{j=1}^{24} \gamma_j\, Hour_{jt}\ x\ S24Part_i + \sum_{j=1}^{24} \mu_j\, Hour_{jt} x\ CDH_{it}\ x\ S24Part_i +$$
$$\sum_{p=1}^{P} \rho_p\, PreEventHour_{pt} + \sum_{p=1}^{P} \omega_p\, PreEventHour_{pt}\ x\ S24Part_i +$$
$$\sum_{q=1}^{Q} \eta_q\, EventHour_{qt} + \sum_{q=1}^{Q} \psi_q\, EventHour_{qt}\ x\ S24Part_i x\ CDH_{it} +$$
$$\sum_{r=1}^{R} \lambda_r\, PostEventHour_{rt} + \sum_{r=1}^{R} \chi_r\, PostEventHour_{rt}\ x\ S24Part_i + \varepsilon_{it}$$

This resulted in the coefficients shown in Table D-4.

Table D-4. Simplified Forecast Coefficient Results

Interval Relative to Event Time	Average Impact per CDH (kW)	90% Confidence Interval
Event Hour 1	-0.056	(-0.059, -0.053)
Event Hour 2	-0.064	(-0.067, -0.061)
Event Hour 3	-0.052	(-0.055, -0.048)

Cost-Effectiveness Analysis

Cadmus completed the cost-effectiveness analysis per the IESO *Cost-Effectiveness Guide for Energy Efficiency* combined with the recommended approach for demand response evaluation and used the IESO Cost-Effectiveness Tool to obtain results.[24] In the IESO Cost-Effectiveness Tool, the team used maximum event peak *ex post* kilowatt and full seasonal kilowatt-hour savings from the PY 2023 and PY 2024 event seasons, and the IESO provided administrative costs and incentives. The IESO Cost Effectiveness Tool provides program- and measure-level results, though those are the same for this program. This report presents the following key cost-effectiveness outputs: PAC test benefits, costs and ratio, and LUEC by dollars per kilowatt-hours and dollars per kilowatt. This section also defines the TRC, PAC, and LUEC test components, following the guidelines established in the IESO *Cost Effectiveness Guide for Energy Efficiency*.

Table D-5. TRC, PAC, and LUEC Test Components

Components	TRC	PAC	LUEC
Avoided Electricity supply-side resource costs (ASC)	Benefit	Benefit	
Other Supply-Side Resource Benefits (ORB)	Benefit		
Net Participant Costs (NPC)	Cost		
Incentive Costs (IC)		Cost	Cost
Program Costs (PRC)	Cost	Cost	Cost
Non-Energy Benefits/Externalities (NEB)	Benefit		
Tax credits (TC)	Benefit		
Energy and Peak Demand Savings (NPV of annualized savings)			Benefit

24 IESO. January 20, 2021. *Cost-Effectiveness Guide for Energy Efficiency*. https://www.ieso.ca/-/media/Files/IESO/Document-Library/EMV/CDM_CE-TestGuide.ashx

Total Resource Costs

The TRC formula is as follows:

$$TRC\frac{B}{C} = \frac{[ASC + ORB + \ TC + NEB] * NTG}{[(NPC * NTG) + PRC]}$$

NTG is net-to-gross.

TRC costs are defined as the following:

- Total expenses incurred by a program administrator to design and deliver CDM
- The incremental expenses incurred by participants to implement the conservation action

TRC benefits are defined as the following:

- The electricity system-related costs that are no longer required because of the savings achieved by CDM, including these:
  - Generation costs
  - T&D costs
  - Fuel costs
  - Operation and maintenance costs
- Other avoided supply-side resource costs (e.g., natural gas).
- Non-resource or non-energy benefits, such as avoided greenhouse gas emissions, reduced water consumption or improved water quality, and avoided health costs.

Program Administrator Costs

The PAC formula is as follows:

$$PAC\frac{B}{C} = \frac{[ASC] * NTG}{[PRC + (IC * NTG)]}$$

PAC costs are defined as the following:

- Total expenses incurred by a program administrator to design and deliver CDM
- The cost of providing incentives to participants to entice participation in the program

PAC benefits are defined as the following:

- The electricity system-related costs that are no longer required because of the savings achieved by CDM, including these:
  - Generation costs
  - T&D costs
  - Fuel costs
  - Operation and maintenance costs

Levelized Unit Electricity Costs

The LUEC metric formula is as follows:

$$LUEC\frac{C}{B} = \frac{[(IC * NTG) + PRC]}{[NPVI]}$$

LUEC costs are defined as the following:

- Total expenses incurred by a program administrator to design and deliver CDM.
- The cost of providing incentives to participants to entice participation in the program.

LUEC benefits are defined as the following:

- Energy savings (kWh) over the lifetime of the CDM resource
- Peak demand reduction (kW) over the lifetime of the CDM resource

Job Impacts

This section outlines the approach used to evaluate the net job impacts of Peak Perks. Cadmus collected and categorized program-related cash flows, transforming them into economic shocks for analysis using Statistics Canada's Input-Output (IO) modelling framework. The following subsections detail the model input data and the IO modelling process.

Model Input Data

Cadmus identified all relevant cash flows associated with the program, categorizing them into economic shocks to capture their impact on various industries. The team sourced input data from participant surveys, the IESO Cost-Effectiveness Tool, and additional information provided by the IESO. The cash flows and corresponding shocks are summarized as follows:

- **Personal Expenditure**
  - Incentives paid to participants for enrolling in the program were modelled as personal expenditure shocks, increasing household spending within the economy.
  - Participants' purchases of smart thermostats, encouraged by the program, generated new demand in the electrical equipment manufacturing sector.
  - In connection with smart thermostat purchases, fees paid by participants for installation services and warranty protection were also modelled as personal expenditure shocks, boosting demand in the repair construction and insurance carrier industries.

- **Industry Inputs:**
  - IESO's internal fixed administrative costs, including internal wages paid by IESO, created input shocks within the government services industry.
  - Variable and fixed fees paid by IESO to service providers generated input shocks in the management, scientific, and technical consulting services industry.

- **Industry Outputs**
    - Avoided electricity generation costs due to reduced demand for generation, transmission, and distribution were modelled as output shocks in the electric power industry.

These categorized cash flows formed the foundation for analyzing how program activities propagated through the economy to generate job impacts.

StatCan Input-Output Modelling

The Canadian IO Model, maintained by Statistics Canada (StatCan), is a robust tool used to analyse the economic ripple effects of exogenous shocks, such as program investments or policy changes, on production, employment, and value-added metrics. For the evaluation of the program, StatCan ran the simulation using the 2021 dataset, the most recent and comparable to the 2024 economy. Cadmus selected this dataset to ensure the analysis reflected the current economic structure and sectoral interactions.

The IO model uses Supply and Use Tables (SUTs) to depict the flow of goods and services through the economy, covering 240 industries and 500 product categories. These tables include data on production, imports, intermediate consumption (used in production processes), and final demand (e.g., household consumption, government spending, and capital investments). At the interprovincial level, the model also captures trade flows between provinces and territories, as well as international imports and exports, providing a detailed picture of regional economic dynamics.

StatCan's IO model is a static, Leontief-type open model, meaning it captures the relationships between industries and final demand at a specific point in time. While highly detailed, the model assumes fixed production technologies and linear relationships between inputs and outputs, which do not account for dynamic changes over time, such as shifts in industry efficiency, pricing, or consumer behaviour. This static nature makes the model well suited for estimating short-term impacts of exogenous shocks, such as program investments, but less adaptable to forecasting longer-term or structural changes in the economy. For the Peak Perks Program, this static approach effectively measured the immediate economic impacts of expenditures, avoided costs, and demand changes associated with the program.

When using IO modelling, it is generally acknowledged that the open model, which includes direct and indirect effects, tends to underestimate total economic impact because household activity is absent. Conversely, the closed model, which incorporates direct, indirect, and induced effects, can overestimate impacts due to rigid assumptions about labour income and consumer spending. Consequently, the open and closed models provide lower and upper bounds for the program's job impacts, respectively.

Cadmus collaborated closely with StatCan to prepare the necessary input data for the model. Exogenous shocks were categorized by industry and commodity demand, reflecting expenditures and avoided costs associated with the Peak Perks Program. StatCan economists then used the IO model to simulate the program's direct, indirect, and induced impacts. Direct effects captured economic activity in industries directly affected by the program, such as consulting services and equipment manufacturing. Indirect effects accounted for supply chain impacts, while induced effects measured household consumption changes from increased wages and income.

The results, delivered by StatCan in detailed Excel tables, quantified the Peak Perks Program's contribution to Ontario and Canada's economy. Outputs included impacts on the gross domestic product, full-time equivalent jobs by industry, and interprovincial trade flows. This collaboration ensured a high degree of precision and relevance in assessing the program's job impacts. The out-of-province impact primarily resulted from indirect and induced effects. For example, smart thermostats purchased within the province may contain components manufactured in other regions of Canada. Similarly, the distribution of prepaid Mastercards increased personal expenditures, some of which may have been spent outside the province.

Process Evaluation

The process evaluation included a document review, in-depth stakeholder interviews, and a participant survey. Each methodology is detailed below.

Document Review

Cadmus reviewed the Peak Perks online materials, business plans, customer mapping, customer satisfaction survey results, and other documentation to inform the development of the stakeholder interviews and participant surveys, as well as a foundational understanding of the program.

In-Depth Stakeholder Interviews

Cadmus interviewed the IESO program and implementation staff to understand how the program was designed and delivered, which elements worked well, and how the program could be improved. The interviews covered a wide range of topics, such as program goals, design and administration, communication and data tracking processes, marketing strategies, implementer and participant interactions, and challenges and successes. Cadmus further asked about the specifics of the program's enrollment process, how events are decided, and how event notifications are administered. Two interviews were conducted, one with the IESO program staff and another with the DR service provider staff.

Participant Surveys

To assess participation experiences, awareness of notifications, and notification preferences and to identify changes in customer behaviour, purchase considerations, and participation barriers, Cadmus conducted online surveys with PY2023 and PY2024 participants. The team also collected data that supported the job impact evaluation, such as identifying whether participants purchased smart thermostats to be able to participate in the program. Based on population size, the team used a census approach by the year with the target to achieve 70 completes per year for a total of 140. The team exceeded this target with 156 completes. See *Appendix A* for a copy of this survey instrument and *Appendix C* for a breakdown of respondents by demographics.

Appendix E. *Ex Ante* Forecasts – Model A

Cadmus used the following specification to estimate forecasted impacts (Table E-1) for the average hour of an event run in each month of summer, based on the summer 2024 season data.

The IESO provided Cadmus with supplemental weather projections, including hourly dry and wet bulb temperatures across the IESO territory weather stations for 2024, in order to forecast per-participant and system-wide event impacts in severe weather conditions. Cadmus estimated cooling degree hour-dependent event impacts using regression analysis. The team used the following formula to calculate these impacts:

$$EventImpact_{rm} = Pop_r * \frac{1}{3}\sum_{h=1}^{3}(CDH_{hmr} * \ Impact_h)$$

Where:

$EventImpact_{rm}$ = the average hourly impact of an event called in month m and IESO load zone r

Pop_r = load zone r's enrollment

CDH_{hmr} = the maximum cooling degree hours in month m and load zone r during the hour corresponding to hour h of an event, based on weather station weights provided and a base temperature of 18 °C

$Impact_h$ = the impact estimate for hour h of the event

Table E-1 and Table E-2 contain estimates for event impacts in the scenario of the hottest day in the normal and extreme year system demand conditions provided by the IESO, based on 2024 event impacts by cooling degree hours.[25]

The team calculated regression estimates for each hour of an event and multiplied these estimates with cooling degree hours (from a base temperature of 18 °C) calculated from the IESO's normal and extreme load conditions to derive impact estimates. *Task 4. Ex Ante Demand Impact Forecasting* contains details as well as the specific coefficients estimated. Note that Cadmus used a variation of its Model A regression specification for these results, rather than Model B (which provided better accuracy in estimating impacts during events, as previously discussed), with the goal of modelling event impact as a function of outdoor temperature. However, due to the inaccuracy of Model A in estimating post-event snapback, as well as the effects of higher event opt-out rates associated with hotter event days (discussed later in the *Comparison of Reported and Evaluated Impacts* section) diminishing the expected increase in impacts on hotter days, Cadmus recommends that the IESO conduct further research to improve *Ex Ante* modelling.

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25 Some cooling degree hour values are unlikely (38 °C in June during normal conditions for the Northwest region, which mapped to the Thunder Bay weather station); this is because the maximum cooling degree hours were used for each event hour per region and month.

Finally, the team took the average of the products of coefficient estimates and cooling degree hours to calculate the average impact over the three hours of the event. Cadmus calculated estimates separately based on the hourly weather scenario temperatures for each month of summer, between May and September, for each IESO load zone. In the scenario of normal load conditions, average event impact estimates ranged from 0.40 kW per participant in September in the East, Essa, and Northwest regions to 1.15 kW per participant in the Northwest region during June. Note that the result for the Northwest region in June (38.0 °C) is unexpected, as that temperature is much higher than the maximum in June for any other region. However, Cadmus confirmed that this temperature observation appears in the original normal load conditions dataset provided by the IESO. The result is associated with the Thunder Bay weather station. In the scenario of extreme load conditions, average event impact estimates ranged from 0.50 kW per participant in May in the Northwest region to 0.90 kW per participant in the Ottawa region in July and the Southwest region in August.

Table E-3E-3 and E-4 present average hourly estimates for events given cooling degree hours from normal and extreme scenarios during pre- and post-event hours, with post-event hours extended to the end of the average four-to-seven event day. Across months and scenarios, Cadmus consistently observed impacts of about 0.1 kW increased energy usage for the treatment group two to three hours before events, increasing up to between 0.7 to 1.12 kW additional average energy usage due to precooling in the hour before a demand response event. During demand response events, savings are consistently highest in the second event hour and lowest in the third event hour. In both normal and extreme scenarios, the highest event savings occur in July due to hot weather conditions across the densest regions in the IESO's service territory.

Table E-1. 2024 Average Event Impact Forecast, Normal Load Conditions

Region	May			Jun			Jul			Aug			Sep		
	Device Impact (kW)	Total Impact (MW)	Temp C	Device Impact (kW)	Total Impact (MW)	Temp C	Device Impact (kW)	Total Impact (MW)	Temp C	Device Impact (kW)	Total Impact (MW)	Temp C	Device Impact (kW)	Total Impact (MW)	Temp C
Bruce	0.58	0.14	28.17	0.89	0.22	33.43	0.76	0.19	31.27	0.77	0.19	31.50	0.45	0.11	25.77
East	0.50	3.49	26.71	0.84	5.90	32.71	0.64	4.47	29.17	0.66	4.60	29.44	0.40	2.82	25.03
Essa	0.50	5.67	26.71	0.84	9.59	32.71	0.64	7.26	29.17	0.66	7.47	29.44	0.40	4.58	25.03
Niagara	0.57	3.87	28.00	0.90	6.10	33.72	0.72	4.86	30.53	0.74	5.00	30.90	0.45	3.03	25.80
Northeast	0.40	1.27	24.83	0.82	2.60	32.23	0.46	1.46	26.02	0.69	2.19	29.98	0.49	1.57	26.57
Northwest	0.65	0.85	29.30	1.15	1.49	38.00	0.52	0.68	27.13	0.55	0.72	27.63	0.40	0.52	24.80
Ottawa	0.54	8.79	27.33	0.78	12.82	31.67	0.68	11.20	29.90	0.74	12.16	30.90	0.54	8.78	27.30
Southwest	0.59	28.99	28.33	0.92	44.77	34.00	0.75	36.69	31.10	0.73	35.52	30.70	0.47	23.09	26.23
Toronto	0.58	57.10	28.17	0.89	86.68	33.43	0.76	74.34	31.27	0.77	75.79	31.50	0.45	43.73	25.77
West	0.59	8.71	28.33	0.92	13.45	34.00	0.75	11.02	31.10	0.73	10.67	30.70	0.47	6.93	26.23

Table E-2. 2024 Average Event Impact Forecast, Extreme Load Conditions

Region	May			Jun			Jul			Aug			Sep		
	Device Impact (kW)	Total Impact (MW)	Temp C	Device Impact (kW)	Total Impact (MW)	Temp C	Device Impact (kW)	Total Impact (MW)	Temp C	Device Impact (kW)	Total Impact (MW)	Temp C	Device Impact (kW)	Total Impact (MW)	Temp C
Bruce	0.69	0.17	30.07	0.88	0.22	33.43	0.85	0.21	32.83	0.81	0.20	32.13	0.80	0.20	31.97
East	0.61	4.29	28.70	0.82	5.74	32.33	0.76	5.32	31.29	0.70	4.91	30.26	0.73	5.08	30.64
Essa	0.61	6.97	28.70	0.82	9.33	32.33	0.76	8.65	31.29	0.70	7.98	30.26	0.73	8.25	30.64
Niagara	0.75	5.08	31.08	0.83	5.60	32.45	0.86	5.80	32.97	0.85	5.75	32.82	0.80	5.42	31.93
Northeast	0.72	2.28	30.50	0.72	2.30	30.62	0.66	2.10	29.50	0.69	2.21	30.07	0.69	2.19	29.98
Northwest	0.50	0.65	26.77	0.53	0.70	27.33	0.72	0.94	30.57	0.66	0.86	29.57	0.64	0.84	29.20
Ottawa	0.61	9.92	28.57	0.82	13.48	32.37	0.90	14.66	33.63	0.78	12.71	31.53	0.87	14.18	33.07
Southwest	0.81	39.66	32.17	0.77	37.70	31.47	0.89	43.48	33.53	0.90	43.85	33.67	0.81	39.46	32.07
Toronto	0.69	67.94	30.07	0.88	86.62	33.43	0.85	83.16	32.83	0.81	79.49	32.13	0.80	78.52	31.97
West	0.81	11.91	32.17	0.77	11.32	31.47	0.89	13.06	33.53	0.90	13.17	33.67	0.81	11.85	32.07

Table E-3. 2024 Extended Average Hourly Impact, Normal Load Conditions

Time	May			June			July			August			September		
	Device Impact (kW)	Total Impact (MW)	Temp C	Device Impact (kW)	Total Impact (MW)	Temp C	Device Impact (kW)	Total Impact (MW)	Temp C	Device Impact (kW)	Total Impact (MW)	Temp C	Device Impact (kW)	Total Impact (MW)	Temp C
Pre-Event Hour 3	0.03	3.85	17.60	0.04	5.29	24.23	0.04	5.56	25.44	0.04	5.56	25.46	0.03	4.79	21.65
Pre-Event Hour 2	0.07	10.04	17.61	0.09	13.71	24.05	0.10	14.38	25.24	0.10	14.45	25.36	0.09	12.49	21.93
Pre-Event Hour 1	0.70	101.72	17.20	0.96	139.49	23.58	1.01	146.85	24.83	1.02	148.38	25.08	0.88	128.08	21.94
Event Hour 1	-0.97	-141.65	17.44	-1.34	-195.77	24.10	-1.43	-207.67	25.57	-1.42	-206.74	25.46	-1.20	-175.41	21.60
Event Hour 2	-1.09	-159.39	17.13	-1.52	-220.73	23.72	-1.61	-234.36	25.18	-1.60	-233.14	25.05	-1.35	-195.89	21.05
Event Hour 3	-0.86	-124.59	16.52	-1.19	-173.75	23.04	-1.27	-184.27	24.44	-1.26	-183.32	24.31	-1.05	-152.18	20.18
Post-Event Hour 1	0.25	36.90	15.71	0.36	51.73	22.02	0.38	55.33	23.55	0.37	54.23	23.08	0.30	44.39	18.89
Post-Event Hour 2	0.23	33.10	14.58	0.32	46.77	20.61	0.35	50.28	22.15	0.34	49.95	22.01	0.28	40.93	18.04
Post-Event Hour 3	0.25	36.58	13.75	0.36	51.88	19.50	0.39	56.28	21.16	0.39	56.56	21.26	0.32	46.14	17.35
Post-Event Hour 4	0.15	21.52	12.95	0.21	30.97	18.64	0.23	33.95	20.44	0.23	34.19	20.58	0.19	27.96	16.83
Post-Event Hour 5	0.14	20.56	12.42	0.20	29.46	17.81	0.23	32.86	19.86	0.23	33.15	20.04	0.19	27.17	16.42

Table E-4. 2024 Extended Average Hourly Impact, Extreme Load Conditions

Time	May			June			July			August			September		
	Device Impact (kW)	Total Impact (MW)	Temp C	Device Impact (kW)	Total Impact (MW)	Temp C	Device Impact (kW)	Total Impact (MW)	Temp C	Device Impact (kW)	Total Impact (MW)	Temp C	Device Impact (kW)	Total Impact (MW)	Temp C
Pre-Event Hour 3	0.03	4.72	21.59	0.03	4.82	22.07	0.04	6.07	27.78	0.04	5.65	25.85	0.04	5.37	24.59
Pre-Event Hour 2	0.08	12.21	21.43	0.09	12.52	21.97	0.11	15.89	27.88	0.10	14.66	25.72	0.10	13.95	24.49
Pre-Event Hour 1	0.85	124.32	21.02	0.89	129.30	21.86	1.12	163.26	27.60	1.03	149.39	25.26	0.97	141.94	24.00
Event Hour 1	-1.20	-174.15	21.44	-1.22	-177.93	21.91	-1.54	-223.82	27.56	-1.43	-207.68	25.57	-1.35	-196.79	24.23
Event Hour 2	-1.33	-194.21	20.87	-1.38	-201.22	21.62	-1.74	-252.85	27.17	-1.60	-233.50	25.09	-1.51	-219.94	23.64
Event Hour 3	-1.04	-151.23	20.06	-1.09	-158.68	21.04	-1.38	-200.72	26.62	-1.26	-182.90	24.25	-1.16	-168.23	22.31
Post-Event Hour 1	0.30	43.94	18.70	0.33	47.47	20.21	0.41	60.11	25.58	0.37	54.17	23.06	0.34	48.81	20.78
Post-Event Hour 2	0.27	39.00	17.18	0.29	42.65	18.79	0.38	55.60	24.50	0.34	49.46	21.79	0.31	44.62	19.66
Post-Event Hour 3	0.29	42.92	16.14	0.33	47.50	17.86	0.43	62.87	23.63	0.38	55.94	21.03	0.35	50.38	18.94
Post-Event Hour 4	0.18	25.74	15.49	0.20	28.40	17.10	0.26	38.22	23.01	0.23	33.75	20.32	0.21	30.28	18.23
Post-Event Hour 5	0.17	24.42	14.76	0.19	27.22	16.45	0.26	37.14	22.45	0.22	32.38	19.57	0.20	29.22	17.66

Appendix F. Post-Only Impact Estimates (Model B)

Impact Estimates by Hour and Event

Cadmus used the following specification to estimate average impacts (Table F-1) for each event day hour during the summer 2023 and summer 2024 seasons:

Equation 6. Average Impact by Each Event

$$kWhit = \sum_{j=1}^{24} \beta_j \, Hour_{jt} + \sum_{j=1}^{24} \delta_j \, Hour_{jt} x \, CDH_{it} + \sum_{j=1}^{24} \delta_j \, Hour_{jt} x \, Baseline_{it} + \sum_{j=1}^{24} \theta_j \, Hour_{jt} \, x \, Part_{iq} + \varepsilon_{it}$$

Cadmus ran this alternate specification only on AMI data for event days and ran the specification separately for each event day. In Equation 6, $Baseline_{it}$ indicates participant i's average energy usage during hour t in non-event days during the month of the given event. $\overline{\theta_j}$ estimates the average difference between the treatment and control group participants' energy usage during a given event day and hour t. All other variables are defined in the same way as **Equation 1**.

Table F-1. Impact Estimates for Each Hour of Each Event Day

Event Datetime	Event Day Impact Estimate	90% Confidence Interval	Average Treatment Group Load (kW) - Without DR	Average Treatment Group Load (kW) - With DR	Percent Reduction
07/27/2023, 0:00	-0.036	(-0.095, 0.023)	1.215	1.179	3.06%
07/27/2023, 1:00	-0.003	(-0.056, 0.05)	1.033	1.030	0.28%
07/27/2023, 2:00	0.001	(-0.051, 0.053)	0.927	0.927	-0.08%
07/27/2023, 3:00	0.014	(-0.034, 0.061)	0.865	0.879	-1.55%
07/27/2023, 4:00	0.021	(-0.027, 0.069)	0.805	0.827	-2.59%
07/27/2023, 5:00	0.027	(-0.016, 0.069)	0.809	0.836	-3.18%
07/27/2023, 6:00	-0.019	(-0.059, 0.02)	0.883	0.864	2.25%
07/27/2023, 7:00	-0.017	(-0.058, 0.023)	0.843	0.825	2.11%
07/27/2023, 8:00	-0.012	(-0.054, 0.029)	0.864	0.851	1.44%
07/27/2023, 9:00	0.063	(0.015, 0.11)	0.904	0.967	-6.48%
07/27/2023, 10:00	-0.030	(-0.08, 0.02)	1.037	1.007	2.99%
07/27/2023, 11:00	-0.066	(-0.119, -0.013)	1.033	0.967	6.83%
07/27/2023, 12:00	-0.055	(-0.107, -0.002)	1.107	1.052	5.20%
07/27/2023, 13:00	-0.042	(-0.098, 0.013)	1.165	1.122	3.76%
07/27/2023, 14:00	-0.072	(-0.128, -0.017)	1.272	1.199	6.03%
07/27/2023, 15:00	0.179	(0.116, 0.243)	1.381	1.560	-11.48%
07/27/2023, 16:00	-0.359	(-0.419, -0.3)	1.545	1.186	30.30%
07/27/2023, 17:00	-0.384	(-0.453, -0.315)	1.894	1.510	25.42%
07/27/2023, 18:00	-0.334	(-0.402, -0.266)	1.894	1.561	21.39%
07/27/2023, 19:00	0.078	(0.005, 0.15)	1.917	1.995	-3.89%
07/27/2023, 20:00	0.082	(0.007, 0.157)	1.839	1.921	-4.26%

Event Datetime	Event Day Impact Estimate	90% Confidence Interval	Average Treatment Group Load (kW) - Without DR	Average Treatment Group Load (kW) - With DR	Percent Reduction
07/27/2023, 21:00	0.085	(0.012, 0.158)	1.846	1.931	-4.40%
07/27/2023, 22:00	0.101	(0.029, 0.172)	1.751	1.851	-5.43%
07/27/2023, 23:00	0.042	(-0.028, 0.111)	1.574	1.615	-2.58%
07/28/2023, 0:00	-0.008	(-0.069, 0.054)	1.325	1.318	0.57%
07/28/2023, 1:00	0.005	(-0.056, 0.066)	1.122	1.127	-0.45%
07/28/2023, 2:00	0.035	(-0.018, 0.089)	0.962	0.997	-3.55%
07/28/2023, 3:00	0.036	(-0.018, 0.09)	0.877	0.913	-3.92%
07/28/2023, 4:00	0.040	(-0.011, 0.091)	0.798	0.838	-4.77%
07/28/2023, 5:00	0.021	(-0.025, 0.066)	0.808	0.829	-2.48%
07/28/2023, 6:00	0.011	(-0.031, 0.053)	0.858	0.869	-1.31%
07/28/2023, 7:00	-0.039	(-0.077, -0.001)	0.867	0.829	4.66%
07/28/2023, 8:00	-0.030	(-0.074, 0.013)	0.958	0.927	3.27%
07/28/2023, 9:00	0.017	(-0.037, 0.07)	1.040	1.056	-1.57%
07/28/2023, 10:00	0.001	(-0.05, 0.053)	1.080	1.081	-0.12%
07/28/2023, 11:00	-0.038	(-0.093, 0.017)	1.093	1.055	3.61%
07/28/2023, 12:00	-0.082	(-0.139, -0.025)	1.259	1.178	6.94%
07/28/2023, 13:00	-0.002	(-0.064, 0.059)	1.301	1.299	0.16%
07/28/2023, 14:00	-0.016	(-0.079, 0.048)	1.403	1.387	1.15%
07/28/2023, 15:00	0.140	(0.073, 0.208)	1.510	1.650	-8.50%
07/28/2023, 16:00	-0.259	(-0.325, -0.194)	1.600	1.341	19.34%
07/28/2023, 17:00	-0.301	(-0.373, -0.228)	1.856	1.556	19.32%
07/28/2023, 18:00	-0.292	(-0.361, -0.223)	1.824	1.532	19.03%
07/28/2023, 19:00	0.113	(0.034, 0.192)	1.831	1.944	-5.82%
07/28/2023, 20:00	0.079	(-0.001, 0.159)	1.819	1.898	-4.15%
07/28/2023, 21:00	-0.015	(-0.099, 0.069)	1.943	1.928	0.78%
07/28/2023, 22:00	0.016	(-0.063, 0.095)	1.827	1.843	-0.89%
07/28/2023, 23:00	0.002	(-0.072, 0.076)	1.636	1.638	-0.13%
08/25/2023, 0:00	-0.061	(-0.116, -0.006)	0.941	0.880	6.94%
08/25/2023, 1:00	-0.018	(-0.062, 0.026)	0.783	0.765	2.32%
08/25/2023, 2:00	0.007	(-0.033, 0.048)	0.722	0.729	-0.98%
08/25/2023, 3:00	-0.020	(-0.06, 0.02)	0.676	0.656	3.05%
08/25/2023, 4:00	-0.009	(-0.046, 0.028)	0.649	0.640	1.43%
08/25/2023, 5:00	-0.011	(-0.045, 0.023)	0.668	0.657	1.67%
08/25/2023, 6:00	-0.008	(-0.042, 0.026)	0.709	0.701	1.15%
08/25/2023, 7:00	-0.021	(-0.054, 0.011)	0.703	0.681	3.15%
08/25/2023, 8:00	-0.018	(-0.053, 0.018)	0.732	0.714	2.49%
08/25/2023, 9:00	-0.016	(-0.052, 0.021)	0.759	0.743	2.12%
08/25/2023, 10:00	-0.027	(-0.069, 0.015)	0.840	0.813	3.29%

Event Datetime	Event Day Impact Estimate	90% Confidence Interval	Average Treatment Group Load (kW) - Without DR	Average Treatment Group Load (kW) - With DR	Percent Reduction
08/25/2023, 11:00	-0.058	(-0.103, -0.013)	0.848	0.790	7.34%
08/25/2023, 12:00	-0.037	(-0.082, 0.007)	0.895	0.858	4.34%
08/25/2023, 13:00	-0.036	(-0.083, 0.012)	0.912	0.876	4.05%
08/25/2023, 14:00	-0.039	(-0.086, 0.008)	0.930	0.891	4.35%
08/25/2023, 15:00	0.418	(0.357, 0.48)	0.962	1.380	-30.29%
08/25/2023, 16:00	-0.210	(-0.255, -0.166)	0.990	0.779	26.99%
08/25/2023, 17:00	-0.284	(-0.338, -0.23)	1.184	0.900	31.55%
08/25/2023, 18:00	-0.245	(-0.302, -0.187)	1.189	0.945	25.90%
08/25/2023, 19:00	0.124	(0.056, 0.191)	1.241	1.365	-9.06%
08/25/2023, 20:00	0.069	(0.001, 0.136)	1.269	1.337	-5.12%
08/25/2023, 21:00	0.011	(-0.057, 0.079)	1.330	1.341	-0.82%
08/25/2023, 22:00	-0.028	(-0.09, 0.034)	1.252	1.224	2.32%
08/25/2023, 23:00	-0.020	(-0.078, 0.039)	1.083	1.063	1.85%
09/05/2023, 0:00	-0.013	(-0.08, 0.055)	1.405	1.392	0.91%
09/05/2023, 1:00	0.017	(-0.051, 0.085)	1.187	1.204	-1.41%
09/05/2023, 2:00	-0.015	(-0.074, 0.044)	1.049	1.033	1.47%
09/05/2023, 3:00	0.013	(-0.038, 0.064)	0.936	0.950	-1.41%
09/05/2023, 4:00	0.002	(-0.044, 0.047)	0.874	0.876	-0.20%
09/05/2023, 5:00	-0.007	(-0.053, 0.038)	0.870	0.863	0.84%
09/05/2023, 6:00	0.047	(0.002, 0.092)	0.927	0.974	-4.81%
09/05/2023, 7:00	0.014	(-0.028, 0.057)	0.934	0.948	-1.50%
09/05/2023, 8:00	-0.055	(-0.1, -0.009)	1.013	0.959	5.69%
09/05/2023, 9:00	-0.030	(-0.086, 0.025)	1.117	1.087	2.76%
09/05/2023, 10:00	-0.031	(-0.091, 0.03)	1.280	1.249	2.44%
09/05/2023, 11:00	-0.110	(-0.176, -0.045)	1.327	1.217	9.06%
09/05/2023, 12:00	-0.109	(-0.179, -0.04)	1.485	1.375	7.96%
09/05/2023, 13:00	-0.139	(-0.207, -0.071)	1.596	1.456	9.56%
09/05/2023, 14:00	-0.142	(-0.213, -0.071)	1.707	1.564	9.08%
09/05/2023, 15:00	0.319	(0.245, 0.393)	1.793	2.112	-15.10%
09/05/2023, 16:00	-0.836	(-0.901, -0.772)	1.922	1.086	77.02%
09/05/2023, 17:00	-0.762	(-0.836, -0.688)	2.200	1.438	52.99%
09/05/2023, 18:00	-0.600	(-0.673, -0.528)	2.218	1.618	37.10%
09/05/2023, 19:00	0.207	(0.125, 0.29)	2.271	2.479	-8.37%
09/05/2023, 20:00	0.190	(0.104, 0.277)	2.262	2.452	-7.76%
09/05/2023, 21:00	0.099	(0.015, 0.184)	2.213	2.312	-4.30%
09/05/2023, 22:00	0.076	(-0.007, 0.158)	2.034	2.110	-3.58%
09/05/2023, 23:00	0.046	(-0.03, 0.123)	1.739	1.785	-2.60%
09/06/2023, 0:00	0.062	(-0.006, 0.13)	1.445	1.507	-4.12%

Event Datetime	Event Day Impact Estimate	90% Confidence Interval	Average Treatment Group Load (kW) - Without DR	Average Treatment Group Load (kW) - With DR	Percent Reduction
09/06/2023, 1:00	0.051	(-0.013, 0.114)	1.261	1.312	-3.86%
09/06/2023, 2:00	0.073	(0.014, 0.131)	1.111	1.183	-6.13%
09/06/2023, 3:00	0.052	(-0.005, 0.109)	1.013	1.065	-4.87%
09/06/2023, 4:00	0.021	(-0.033, 0.076)	0.953	0.975	-2.20%
09/06/2023, 5:00	0.018	(-0.031, 0.068)	0.939	0.957	-1.91%
09/06/2023, 6:00	0.041	(-0.006, 0.088)	1.005	1.046	-3.91%
09/06/2023, 7:00	-0.001	(-0.046, 0.044)	1.001	1.001	0.05%
09/06/2023, 8:00	-0.059	(-0.11, -0.009)	1.089	1.029	5.77%
09/06/2023, 9:00	-0.044	(-0.096, 0.009)	1.131	1.087	4.00%
09/06/2023, 10:00	-0.022	(-0.081, 0.036)	1.268	1.245	1.79%
09/06/2023, 11:00	-0.148	(-0.209, -0.086)	1.306	1.159	12.73%
09/06/2023, 12:00	-0.180	(-0.247, -0.112)	1.492	1.312	13.70%
09/06/2023, 13:00	-0.178	(-0.248, -0.109)	1.576	1.397	12.77%
09/06/2023, 14:00	-0.124	(-0.193, -0.055)	1.629	1.505	8.25%
09/06/2023, 15:00	0.165	(0.091, 0.238)	1.720	1.885	-8.73%
09/06/2023, 16:00	-0.777	(-0.843, -0.711)	1.867	1.090	71.32%
09/06/2023, 17:00	-0.694	(-0.766, -0.622)	2.069	1.376	50.44%
09/06/2023, 18:00	-0.594	(-0.664, -0.524)	2.007	1.412	42.09%
09/06/2023, 19:00	0.257	(0.176, 0.338)	2.050	2.307	-11.13%
09/06/2023, 20:00	0.239	(0.158, 0.32)	2.034	2.273	-10.51%
09/06/2023, 21:00	0.200	(0.122, 0.279)	1.932	2.133	-9.39%
09/06/2023, 22:00	0.124	(0.053, 0.195)	1.746	1.870	-6.63%
09/06/2023, 23:00	0.071	(-0.001, 0.142)	1.537	1.608	-4.41%
09/07/2023, 0:00	0.049	(-0.019, 0.116)	1.328	1.376	-3.54%
09/07/2023, 1:00	0.069	(0.01, 0.129)	1.121	1.191	-5.81%
09/07/2023, 2:00	0.076	(0.021, 0.13)	0.993	1.069	-7.10%
09/07/2023, 3:00	0.014	(-0.034, 0.061)	0.929	0.942	-1.45%
09/07/2023, 4:00	-0.004	(-0.048, 0.039)	0.853	0.849	0.52%
09/07/2023, 5:00	-0.015	(-0.057, 0.027)	0.869	0.854	1.76%
09/07/2023, 6:00	0.045	(0.001, 0.088)	0.934	0.979	-4.55%
09/07/2023, 7:00	-0.008	(-0.051, 0.034)	0.952	0.944	0.90%
09/07/2023, 8:00	-0.048	(-0.091, -0.004)	0.959	0.911	5.21%
09/07/2023, 9:00	-0.050	(-0.097, -0.004)	0.984	0.934	5.40%
09/07/2023, 10:00	-0.043	(-0.091, 0.006)	1.041	0.999	4.26%
09/07/2023, 11:00	-0.103	(-0.154, -0.053)	1.040	0.937	11.00%
09/07/2023, 12:00	-0.112	(-0.167, -0.058)	1.163	1.051	10.69%
09/07/2023, 13:00	-0.109	(-0.167, -0.051)	1.223	1.114	9.78%
09/07/2023, 14:00	-0.079	(-0.138, -0.02)	1.251	1.172	6.76%

Event Datetime	Event Day Impact Estimate	90% Confidence Interval	Average Treatment Group Load (kW) - Without DR	Average Treatment Group Load (kW) - With DR	Percent Reduction
09/07/2023, 15:00	-0.108	(-0.168, -0.049)	1.334	1.226	8.84%
09/07/2023, 16:00	0.382	(0.312, 0.452)	1.484	1.866	-20.47%
09/07/2023, 17:00	-0.642	(-0.702, -0.583)	1.686	1.043	61.59%
09/07/2023, 18:00	-0.517	(-0.578, -0.457)	1.627	1.109	46.63%
09/07/2023, 19:00	-0.368	(-0.437, -0.3)	1.635	1.267	29.06%
09/07/2023, 20:00	0.252	(0.175, 0.33)	1.728	1.980	-12.75%
09/07/2023, 21:00	0.085	(0.012, 0.158)	1.649	1.734	-4.89%
09/07/2023, 22:00	0.044	(-0.026, 0.114)	1.473	1.517	-2.90%
09/07/2023, 23:00	0.034	(-0.032, 0.099)	1.273	1.307	-2.58%
06/19/2024, 0:00	0.008	(-0.07, 0.086)	1.569	1.577	-0.51%
06/19/2024, 1:00	0.057	(-0.014, 0.127)	1.301	1.358	-4.18%
06/19/2024, 2:00	0.052	(-0.012, 0.117)	1.189	1.241	-4.22%
06/19/2024, 3:00	0.015	(-0.044, 0.074)	1.093	1.108	-1.36%
06/19/2024, 4:00	0.056	(0.004, 0.107)	0.990	1.046	-5.32%
06/19/2024, 5:00	0.053	(0.003, 0.103)	1.005	1.059	-5.03%
06/19/2024, 6:00	0.032	(-0.014, 0.079)	1.067	1.100	-2.94%
06/19/2024, 7:00	-0.008	(-0.052, 0.035)	1.017	1.009	0.81%
06/19/2024, 8:00	-0.004	(-0.053, 0.046)	1.091	1.088	0.33%
06/19/2024, 9:00	0.027	(-0.024, 0.078)	1.092	1.119	-2.44%
06/19/2024, 10:00	0.038	(-0.017, 0.094)	1.183	1.221	-3.14%
06/19/2024, 11:00	0.025	(-0.03, 0.08)	1.149	1.174	-2.13%
06/19/2024, 12:00	0.059	(-0.004, 0.123)	1.329	1.388	-4.28%
06/19/2024, 13:00	0.010	(-0.053, 0.073)	1.473	1.484	-0.70%
06/19/2024, 14:00	0.651	(0.579, 0.723)	1.606	2.257	-28.85%
06/19/2024, 15:00	-0.714	(-0.78, -0.649)	1.754	1.039	68.72%
06/19/2024, 16:00	-0.658	(-0.726, -0.589)	1.956	1.298	50.68%
06/19/2024, 17:00	-0.704	(-0.777, -0.631)	2.302	1.598	44.05%
06/19/2024, 18:00	0.198	(0.124, 0.273)	2.319	2.517	-7.88%
06/19/2024, 19:00	0.208	(0.13, 0.286)	2.262	2.470	-8.42%
06/19/2024, 20:00	0.268	(0.184, 0.351)	2.190	2.458	-10.90%
06/19/2024, 21:00	0.148	(0.068, 0.229)	2.190	2.339	-6.34%
06/19/2024, 22:00	0.107	(0.027, 0.187)	2.075	2.182	-4.91%
06/19/2024, 23:00	0.064	(-0.01, 0.138)	1.921	1.985	-3.22%
06/20/2024, 0:00	0.039	(-0.033, 0.112)	1.654	1.693	-2.32%
06/20/2024, 1:00	0.096	(0.03, 0.162)	1.351	1.447	-6.65%
06/20/2024, 2:00	0.057	(-0.003, 0.118)	1.219	1.276	-4.48%
06/20/2024, 3:00	0.032	(-0.025, 0.089)	1.113	1.145	-2.81%
06/20/2024, 4:00	0.012	(-0.039, 0.064)	1.038	1.051	-1.18%

Event Datetime	Event Day Impact Estimate	90% Confidence Interval	Average Treatment Group Load (kW) - Without DR	Average Treatment Group Load (kW) - With DR	Percent Reduction
06/20/2024, 5:00	-0.005	(-0.054, 0.044)	1.041	1.035	0.50%
06/20/2024, 6:00	0.047	(0.003, 0.09)	1.050	1.097	-4.24%
06/20/2024, 7:00	0.043	(-0.002, 0.089)	1.013	1.057	-4.09%
06/20/2024, 8:00	0.020	(-0.027, 0.067)	1.102	1.122	-1.77%
06/20/2024, 9:00	0.023	(-0.029, 0.075)	1.156	1.179	-1.94%
06/20/2024, 10:00	0.029	(-0.024, 0.083)	1.267	1.296	-2.26%
06/20/2024, 11:00	0.014	(-0.04, 0.068)	1.189	1.203	-1.19%
06/20/2024, 12:00	0.025	(-0.035, 0.084)	1.343	1.368	-1.81%
06/20/2024, 13:00	0.047	(-0.016, 0.109)	1.417	1.464	-3.19%
06/20/2024, 14:00	0.053	(-0.007, 0.113)	1.499	1.552	-3.42%
06/20/2024, 15:00	0.587	(0.521, 0.653)	1.615	2.202	-26.67%
06/20/2024, 16:00	-0.617	(-0.675, -0.558)	1.680	1.063	58.01%
06/20/2024, 17:00	-0.715	(-0.78, -0.651)	1.977	1.261	56.71%
06/20/2024, 18:00	-0.474	(-0.539, -0.408)	1.886	1.412	33.53%
06/20/2024, 19:00	0.353	(0.282, 0.424)	1.839	2.192	-16.10%
06/20/2024, 20:00	0.283	(0.209, 0.357)	1.826	2.109	-13.42%
06/20/2024, 21:00	0.171	(0.097, 0.244)	1.877	2.048	-8.34%
06/20/2024, 22:00	0.112	(0.04, 0.184)	1.786	1.898	-5.90%
06/20/2024, 23:00	0.062	(-0.012, 0.135)	1.637	1.698	-3.62%
07/08/2024, 0:00	-0.022	(-0.09, 0.047)	1.275	1.254	1.73%
07/08/2024, 1:00	-0.013	(-0.078, 0.051)	1.073	1.060	1.23%
07/08/2024, 2:00	-0.015	(-0.071, 0.042)	0.934	0.919	1.60%
07/08/2024, 3:00	-0.046	(-0.099, 0.007)	0.867	0.821	5.59%
07/08/2024, 4:00	-0.030	(-0.081, 0.02)	0.788	0.758	3.98%
07/08/2024, 5:00	-0.056	(-0.106, -0.006)	0.812	0.756	7.40%
07/08/2024, 6:00	-0.030	(-0.069, 0.009)	0.870	0.840	3.59%
07/08/2024, 7:00	0.002	(-0.034, 0.038)	0.827	0.828	-0.23%
07/08/2024, 8:00	-0.020	(-0.063, 0.024)	0.964	0.944	2.07%
07/08/2024, 9:00	-0.020	(-0.067, 0.027)	1.060	1.041	1.89%
07/08/2024, 10:00	0.056	(0.007, 0.105)	1.109	1.165	-4.83%
07/08/2024, 11:00	0.074	(0.022, 0.126)	1.069	1.143	-6.45%
07/08/2024, 12:00	0.018	(-0.037, 0.073)	1.224	1.241	-1.44%
07/08/2024, 13:00	-0.020	(-0.075, 0.036)	1.318	1.298	1.51%
07/08/2024, 14:00	-0.040	(-0.095, 0.016)	1.421	1.381	2.87%
07/08/2024, 15:00	0.493	(0.427, 0.559)	1.551	2.044	-24.12%
07/08/2024, 16:00	-0.639	(-0.704, -0.575)	1.673	1.033	61.87%
07/08/2024, 17:00	-0.712	(-0.783, -0.641)	2.035	1.323	53.83%
07/08/2024, 18:00	-0.598	(-0.67, -0.527)	2.074	1.476	40.55%

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07/08/2024, 19:00	0.247	(0.175, 0.319)	2.091	2.338	-10.56%
07/08/2024, 20:00	0.219	(0.148, 0.29)	2.019	2.238	-9.78%
07/08/2024, 21:00	0.157	(0.085, 0.228)	2.022	2.179	-7.20%
07/08/2024, 22:00	0.061	(-0.01, 0.132)	1.886	1.947	-3.13%
07/08/2024, 23:00	0.088	(0.019, 0.157)	1.621	1.710	-5.17%
07/15/2024, 0:00	0.086	(0.017, 0.155)	1.270	1.356	-6.36%
07/15/2024, 1:00	0.043	(-0.018, 0.105)	1.121	1.165	-3.73%
07/15/2024, 2:00	0.006	(-0.052, 0.065)	1.030	1.036	-0.59%
07/15/2024, 3:00	-0.003	(-0.059, 0.053)	0.955	0.952	0.32%
07/15/2024, 4:00	0.003	(-0.049, 0.055)	0.891	0.895	-0.37%
07/15/2024, 5:00	-0.033	(-0.084, 0.018)	0.903	0.870	3.76%
07/15/2024, 6:00	-0.024	(-0.068, 0.021)	0.963	0.940	2.53%
07/15/2024, 7:00	-0.030	(-0.069, 0.009)	0.924	0.894	3.31%
07/15/2024, 8:00	-0.017	(-0.058, 0.024)	1.011	0.994	1.73%
07/15/2024, 9:00	-0.042	(-0.086, 0.002)	1.064	1.022	4.11%
07/15/2024, 10:00	-0.025	(-0.074, 0.024)	1.127	1.103	2.24%
07/15/2024, 11:00	0.012	(-0.038, 0.063)	1.024	1.036	-1.18%
07/15/2024, 12:00	0.020	(-0.032, 0.072)	1.074	1.094	-1.83%
07/15/2024, 13:00	0.022	(-0.032, 0.076)	1.100	1.122	-1.99%
07/15/2024, 14:00	0.661	(0.596, 0.727)	1.160	1.821	-36.31%
07/15/2024, 15:00	-0.380	(-0.431, -0.328)	1.239	0.859	44.23%
07/15/2024, 16:00	-0.382	(-0.438, -0.327)	1.357	0.975	39.20%
07/15/2024, 17:00	-0.551	(-0.615, -0.486)	1.729	1.178	46.75%
07/15/2024, 18:00	0.173	(0.107, 0.239)	1.770	1.943	-8.90%
07/15/2024, 19:00	0.084	(0.015, 0.153)	1.831	1.915	-4.38%
07/15/2024, 20:00	0.082	(0.008, 0.155)	1.795	1.877	-4.36%
07/15/2024, 21:00	0.110	(0.037, 0.184)	1.767	1.878	-5.88%
07/15/2024, 22:00	0.055	(-0.016, 0.127)	1.667	1.723	-3.21%
07/15/2024, 23:00	-0.022	(-0.097, 0.054)	1.510	1.488	1.46%
07/30/2024, 0:00	-0.003	(-0.069, 0.064)	1.352	1.350	0.19%
07/30/2024, 1:00	0.044	(-0.024, 0.111)	1.164	1.208	-3.62%
07/30/2024, 2:00	0.004	(-0.053, 0.061)	1.048	1.052	-0.38%
07/30/2024, 3:00	0.018	(-0.033, 0.069)	0.936	0.953	-1.88%
07/30/2024, 4:00	-0.008	(-0.051, 0.036)	0.902	0.894	0.85%
07/30/2024, 5:00	-0.019	(-0.058, 0.019)	0.895	0.876	2.19%
07/30/2024, 6:00	-0.039	(-0.077, -0.001)	0.961	0.921	4.26%
07/30/2024, 7:00	-0.001	(-0.04, 0.038)	0.923	0.923	0.09%
07/30/2024, 8:00	-0.040	(-0.083, 0.002)	1.015	0.974	4.15%

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07/30/2024, 9:00	-0.004	(-0.051, 0.043)	1.068	1.064	0.37%
07/30/2024, 10:00	-0.027	(-0.08, 0.027)	1.199	1.172	2.29%
07/30/2024, 11:00	-0.021	(-0.076, 0.035)	1.164	1.143	1.82%
07/30/2024, 12:00	0.012	(-0.047, 0.071)	1.263	1.275	-0.93%
07/30/2024, 13:00	0.008	(-0.055, 0.072)	1.343	1.351	-0.62%
07/30/2024, 14:00	0.075	(0.013, 0.138)	1.401	1.476	-5.11%
07/30/2024, 15:00	0.606	(0.536, 0.675)	1.512	2.117	-28.61%
07/30/2024, 16:00	-0.548	(-0.611, -0.485)	1.574	1.026	53.45%
07/30/2024, 17:00	-0.686	(-0.752, -0.62)	1.897	1.211	56.68%
07/30/2024, 18:00	-0.545	(-0.609, -0.482)	1.885	1.340	40.71%
07/30/2024, 19:00	0.260	(0.19, 0.329)	1.983	2.243	-11.58%
07/30/2024, 20:00	0.151	(0.082, 0.221)	1.974	2.126	-7.12%
07/30/2024, 21:00	0.133	(0.062, 0.205)	1.931	2.064	-6.46%
07/30/2024, 22:00	0.068	(0.003, 0.134)	1.830	1.899	-3.60%
07/30/2024, 23:00	0.107	(0.033, 0.182)	1.632	1.739	-6.18%
08/01/2024, 0:00	0.000	(-0.068, 0.069)	1.561	1.561	-0.02%
08/01/2024, 1:00	0.059	(-0.006, 0.124)	1.302	1.361	-4.34%
08/01/2024, 2:00	0.035	(-0.025, 0.096)	1.175	1.211	-2.92%
08/01/2024, 3:00	-0.004	(-0.058, 0.05)	1.054	1.050	0.41%
08/01/2024, 4:00	0.006	(-0.042, 0.054)	0.977	0.983	-0.61%
08/01/2024, 5:00	-0.013	(-0.059, 0.032)	0.970	0.957	1.39%
08/01/2024, 6:00	0.012	(-0.031, 0.054)	0.987	0.998	-1.17%
08/01/2024, 7:00	-0.026	(-0.063, 0.012)	0.935	0.909	2.85%
08/01/2024, 8:00	-0.055	(-0.1, -0.009)	1.098	1.043	5.25%
08/01/2024, 9:00	-0.006	(-0.056, 0.044)	1.171	1.165	0.50%
08/01/2024, 10:00	0.049	(-0.005, 0.103)	1.256	1.305	-3.74%
08/01/2024, 11:00	-0.033	(-0.09, 0.024)	1.231	1.198	2.74%
08/01/2024, 12:00	-0.032	(-0.093, 0.029)	1.396	1.364	2.33%
08/01/2024, 13:00	-0.026	(-0.089, 0.036)	1.544	1.518	1.73%
08/01/2024, 14:00	0.009	(-0.054, 0.072)	1.623	1.632	-0.56%
08/01/2024, 15:00	0.550	(0.48, 0.62)	1.760	2.310	-23.81%
08/01/2024, 16:00	-0.785	(-0.851, -0.719)	1.881	1.096	71.61%
08/01/2024, 17:00	-0.811	(-0.88, -0.742)	2.151	1.340	60.54%
08/01/2024, 18:00	-0.575	(-0.645, -0.504)	2.093	1.518	37.84%
08/01/2024, 19:00	0.311	(0.234, 0.389)	2.061	2.373	-13.13%
08/01/2024, 20:00	0.243	(0.166, 0.32)	2.060	2.303	-10.55%
08/01/2024, 21:00	0.180	(0.104, 0.256)	2.073	2.253	-7.99%
08/01/2024, 22:00	0.160	(0.088, 0.232)	1.942	2.102	-7.60%

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08/01/2024, 23:00	0.072	(-0.003, 0.146)	1.831	1.903	-3.76%
08/15/2024, 0:00	0.056	(-0.004, 0.116)	1.167	1.224	-4.60%
08/15/2024, 1:00	0.000	(-0.056, 0.057)	0.997	0.998	-0.03%
08/15/2024, 2:00	-0.002	(-0.055, 0.052)	0.859	0.858	0.20%
08/15/2024, 3:00	-0.015	(-0.06, 0.029)	0.762	0.747	2.07%
08/15/2024, 4:00	-0.005	(-0.045, 0.036)	0.720	0.715	0.64%
08/15/2024, 5:00	0.000	(-0.041, 0.04)	0.719	0.719	0.02%
08/15/2024, 6:00	-0.049	(-0.08, -0.018)	0.778	0.729	6.70%
08/15/2024, 7:00	-0.018	(-0.048, 0.012)	0.735	0.717	2.49%
08/15/2024, 8:00	-0.011	(-0.047, 0.024)	0.818	0.806	1.42%
08/15/2024, 9:00	0.000	(-0.038, 0.038)	0.876	0.876	0.04%
08/15/2024, 10:00	0.033	(-0.011, 0.076)	0.995	1.028	-3.18%
08/15/2024, 11:00	0.008	(-0.038, 0.053)	0.976	0.983	-0.78%
08/15/2024, 12:00	0.011	(-0.038, 0.06)	1.090	1.100	-0.97%
08/15/2024, 13:00	-0.011	(-0.063, 0.042)	1.176	1.166	0.91%
08/15/2024, 14:00	0.011	(-0.046, 0.067)	1.268	1.279	-0.83%
08/15/2024, 15:00	0.482	(0.413, 0.551)	1.382	1.864	-25.86%
08/15/2024, 16:00	-0.467	(-0.522, -0.412)	1.424	0.957	48.80%
08/15/2024, 17:00	-0.575	(-0.638, -0.512)	1.710	1.135	50.69%
08/15/2024, 18:00	-0.410	(-0.475, -0.346)	1.683	1.273	32.24%
08/15/2024, 19:00	0.342	(0.273, 0.412)	1.651	1.993	-17.17%
08/15/2024, 20:00	0.224	(0.153, 0.294)	1.693	1.917	-11.67%
08/15/2024, 21:00	0.155	(0.081, 0.229)	1.718	1.873	-8.27%
08/15/2024, 22:00	0.130	(0.06, 0.199)	1.572	1.702	-7.61%
08/15/2024, 23:00	0.059	(-0.012, 0.131)	1.467	1.526	-3.88%
08/27/2024, 0:00	0.020	(-0.044, 0.084)	1.293	1.313	-1.52%
08/27/2024, 1:00	0.011	(-0.047, 0.07)	1.090	1.101	-1.01%
08/27/2024, 2:00	0.009	(-0.044, 0.061)	0.962	0.970	-0.89%
08/27/2024, 3:00	0.017	(-0.03, 0.063)	0.855	0.871	-1.91%
08/27/2024, 4:00	0.027	(-0.014, 0.067)	0.788	0.815	-3.29%
08/27/2024, 5:00	0.026	(-0.009, 0.062)	0.761	0.787	-3.35%
08/27/2024, 6:00	0.052	(0.014, 0.09)	0.808	0.860	-6.03%
08/27/2024, 7:00	0.001	(-0.034, 0.037)	0.814	0.816	-0.15%
08/27/2024, 8:00	-0.005	(-0.048, 0.038)	0.916	0.911	0.53%
08/27/2024, 9:00	0.021	(-0.026, 0.068)	1.000	1.021	-2.06%
08/27/2024, 10:00	0.042	(-0.012, 0.095)	1.125	1.167	-3.56%
08/27/2024, 11:00	0.074	(0.024, 0.124)	1.068	1.142	-6.49%
08/27/2024, 12:00	0.045	(-0.013, 0.103)	1.240	1.285	-3.49%

Event Datetime	Event Day Impact Estimate	90% Confidence Interval	Average Treatment Group Load (kW) - Without DR	Average Treatment Group Load (kW) - With DR	Percent Reduction
08/27/2024, 13:00	0.020	(-0.041, 0.08)	1.348	1.368	-1.45%
08/27/2024, 14:00	-0.001	(-0.065, 0.064)	1.473	1.472	0.05%
08/27/2024, 15:00	0.541	(0.471, 0.612)	1.603	2.144	-25.26%
08/27/2024, 16:00	-0.661	(-0.725, -0.596)	1.687	1.027	64.36%
08/27/2024, 17:00	-0.693	(-0.767, -0.619)	2.012	1.319	52.54%
08/27/2024, 18:00	-0.470	(-0.544, -0.396)	1.961	1.491	31.51%
08/27/2024, 19:00	0.324	(0.247, 0.401)	1.957	2.281	-14.20%
08/27/2024, 20:00	0.260	(0.181, 0.339)	1.924	2.184	-11.90%
08/27/2024, 21:00	0.201	(0.119, 0.282)	1.926	2.127	-9.43%
08/27/2024, 22:00	0.167	(0.089, 0.245)	1.804	1.971	-8.47%
08/27/2024, 23:00	0.075	(-0.003, 0.152)	1.685	1.760	-4.26%
09/16/2024, 0:00	-0.052	(-0.124, 0.019)	1.035	0.983	5.32%
09/16/2024, 1:00	-0.066	(-0.128, -0.005)	0.890	0.824	8.04%
09/16/2024, 2:00	-0.095	(-0.151, -0.039)	0.827	0.732	13.00%
09/16/2024, 3:00	-0.056	(-0.101, -0.011)	0.726	0.670	8.29%
09/16/2024, 4:00	-0.051	(-0.094, -0.008)	0.692	0.641	7.99%
09/16/2024, 5:00	-0.022	(-0.062, 0.017)	0.668	0.646	3.45%
09/16/2024, 6:00	-0.025	(-0.063, 0.013)	0.788	0.763	3.27%
09/16/2024, 7:00	-0.028	(-0.059, 0.003)	0.786	0.758	3.68%
09/16/2024, 8:00	-0.037	(-0.07, -0.005)	0.808	0.770	4.87%
09/16/2024, 9:00	-0.036	(-0.074, 0.002)	0.850	0.814	4.45%
09/16/2024, 10:00	-0.030	(-0.078, 0.018)	0.949	0.919	3.26%
09/16/2024, 11:00	-0.003	(-0.048, 0.043)	0.925	0.923	0.31%
09/16/2024, 12:00	-0.027	(-0.079, 0.024)	1.049	1.022	2.67%
09/16/2024, 13:00	-0.043	(-0.095, 0.009)	1.097	1.054	4.06%
09/16/2024, 14:00	-0.012	(-0.07, 0.047)	1.166	1.154	1.03%
09/16/2024, 15:00	0.385	(0.316, 0.453)	1.273	1.658	-23.19%
09/16/2024, 16:00	-0.390	(-0.446, -0.333)	1.340	0.951	40.98%
09/16/2024, 17:00	-0.522	(-0.585, -0.459)	1.681	1.158	45.07%
09/16/2024, 18:00	-0.371	(-0.434, -0.309)	1.641	1.270	29.24%
09/16/2024, 19:00	0.322	(0.251, 0.393)	1.597	1.919	-16.80%
09/16/2024, 20:00	0.246	(0.173, 0.32)	1.637	1.883	-13.08%
09/16/2024, 21:00	0.132	(0.062, 0.202)	1.541	1.673	-7.89%
09/16/2024, 22:00	0.079	(0.014, 0.144)	1.348	1.427	-5.53%
09/16/2024, 23:00	0.079	(0.008, 0.15)	1.181	1.260	-6.25%

Average Impact Estimates

Cadmus applied an alternate set of post-only model specifications to equations 1-3, as this method aligned more closely to observed trends in AMI load shapes on event days immediately following event timing.

The team used the following post-only specification to estimate average impacts across all events:

Equation 1. Average Impact Across All Events

$$\begin{aligned} kWhit \ = \ & \sum_{j=1}^{24} \beta_j \ Hour_{jt} + \sum_{j=1}^{24} \delta_j \ Hour_{jt} x \ CDH_{it} + \sum_{j=1}^{24} \delta_j \ Hour_{jt} x \ Baseline_{it} + \\ & \theta DuringEvent_t \ x \ Part_i + \\ & \sum_{m=1}^{M} \lambda_m \ PreEventHour_m x \ Part_i \ + \\ & \sum_{m=1}^{M} \phi_m \ PostEventHour_m \ x \ Part_i + \varepsilon_{it} \end{aligned}$$

Cadmus used the following post-only specification to estimate average impacts for each event, only using the AMI data for the event day and respective baseline period:

Equation 2. Average Impact by Each Event

$$\begin{aligned} kWhit \ = \ & \sum_{j=1}^{24} \beta_j \ Hour_{jt} + \sum_{j=1}^{24} \delta_j \ Hour_{jt} x \ CDH_{it} + \sum_{j=1}^{24} \delta_j \ Hour_{jt} x \ Baseline_{it} + \\ & \theta DuringEvent_t \ x \ Part_i + \\ & \sum_{m=1}^{M} \lambda_m \ PreEventHour_m x \ Part_i \ + \\ & \sum_{m=1}^{M} \phi_m \ PostEventHour_m \ x \ Part_i + \varepsilon_{it} \end{aligned}$$

Cadmus employed the following post-only model to estimate separate events by event timing group:

Equation 3. Average Impact by Event Start Time

$$\begin{aligned} kWhit \ = \ & \sum_{j=1}^{24} \beta_j \ Hour_{jt} + \sum_{j=1}^{24} \delta_j \ Hour_{jt} x \ CDH_{it} + \sum_{j=1}^{24} \delta_j \ Hour_{jt} x \ Baseline_{it} + \\ & \sum_{k=1}^{K} \theta_k DuringEvent_t \ x \ Part_i \ x \ EventType_k + \\ & \sum_{k=1}^{K} \sum_{m=1}^{M} \lambda_{mk} \ PreEventHour_m x \ Part_i x \ EventType_k + \\ & \sum_{k=1}^{K} \sum_{m=1}^{M} \lambda_{mk} \ PostEventHour_m x \ Part_i x \ EventType_k + \varepsilon_{it} \end{aligned}$$

For the above models, all variables are defined in the same way as in **Equation 1** and **Equation 6**.

Appendix G. Average Daily Load Shapes for Each 2024 Event Day

Figure G-1 through Figure G-9 show the average daily load shapes (calculated from the IESO's AMI data) for the treatment and control groups for each 2024 event day.

Figure G-1. Average AMI Load Shapes, June 19, 2024

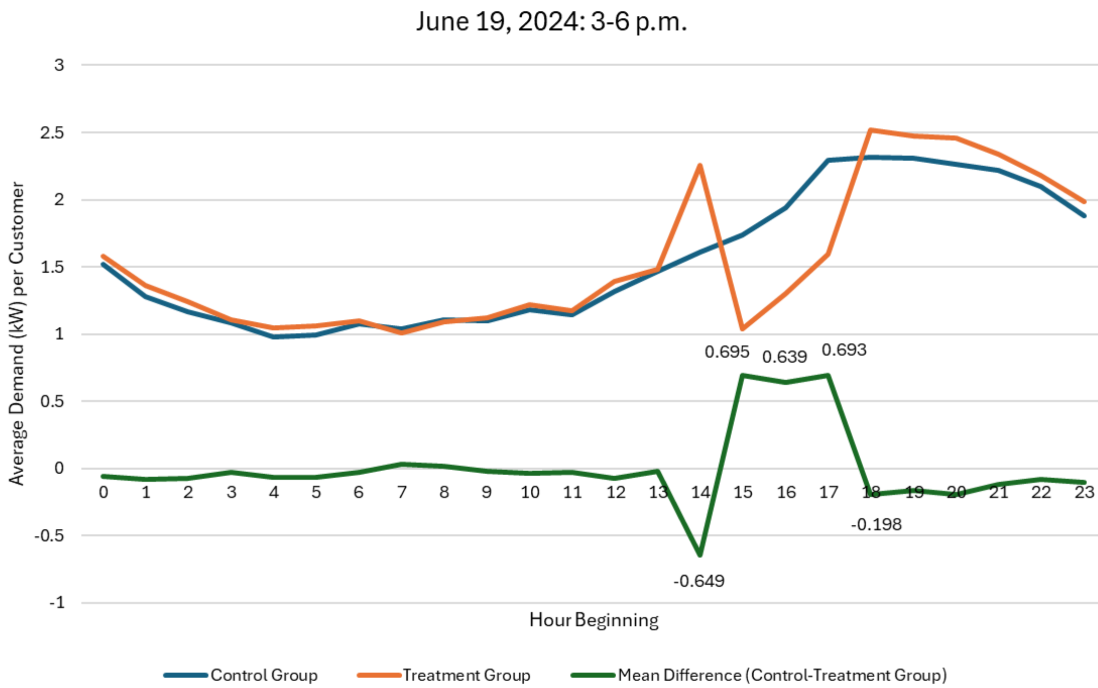


Figure G-2. Average AMI Load Shapes, June 20, 2024

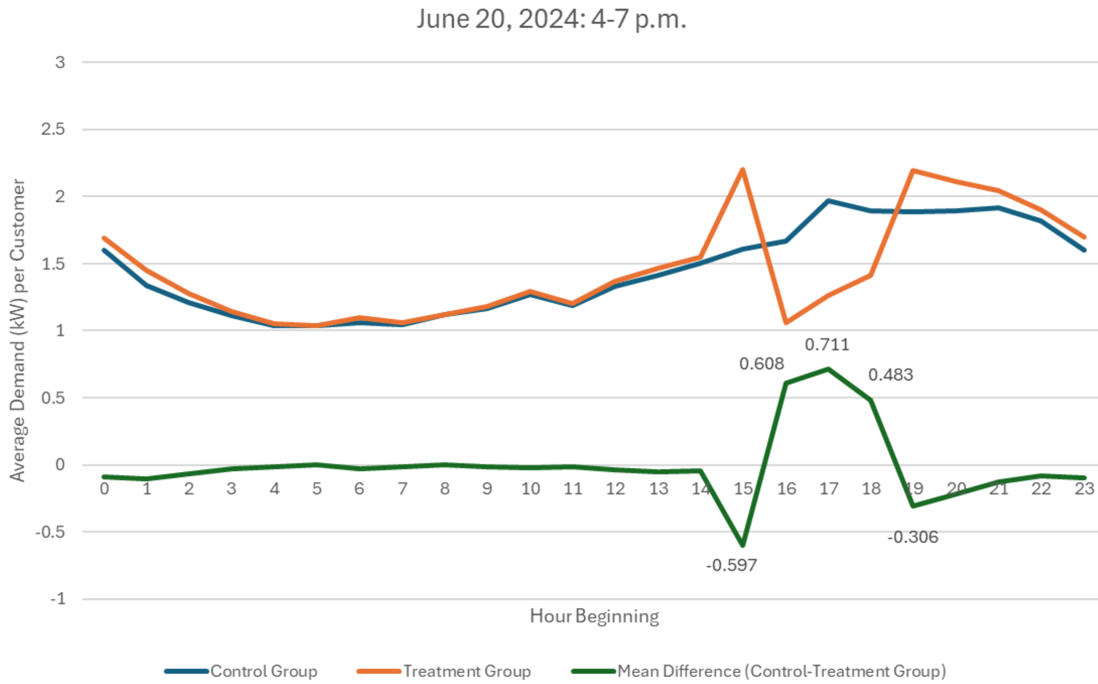


Figure G-3. Average AMI Load Shapes, July 8, 2024

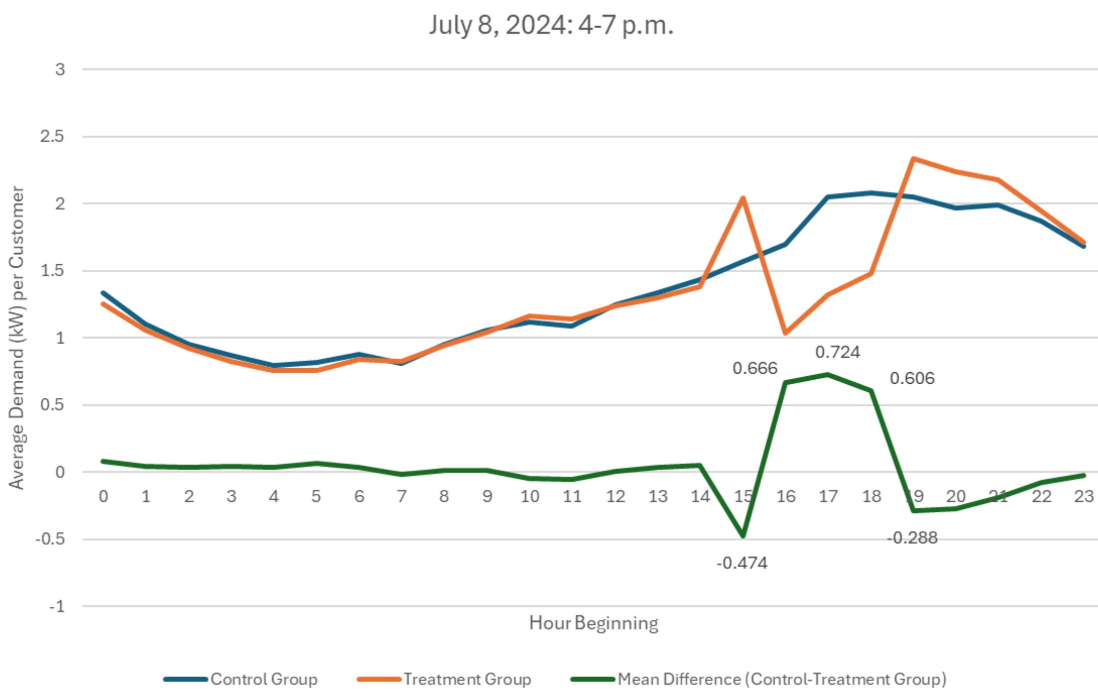


Figure G-4. Average AMI Load Shapes, July 15, 2024

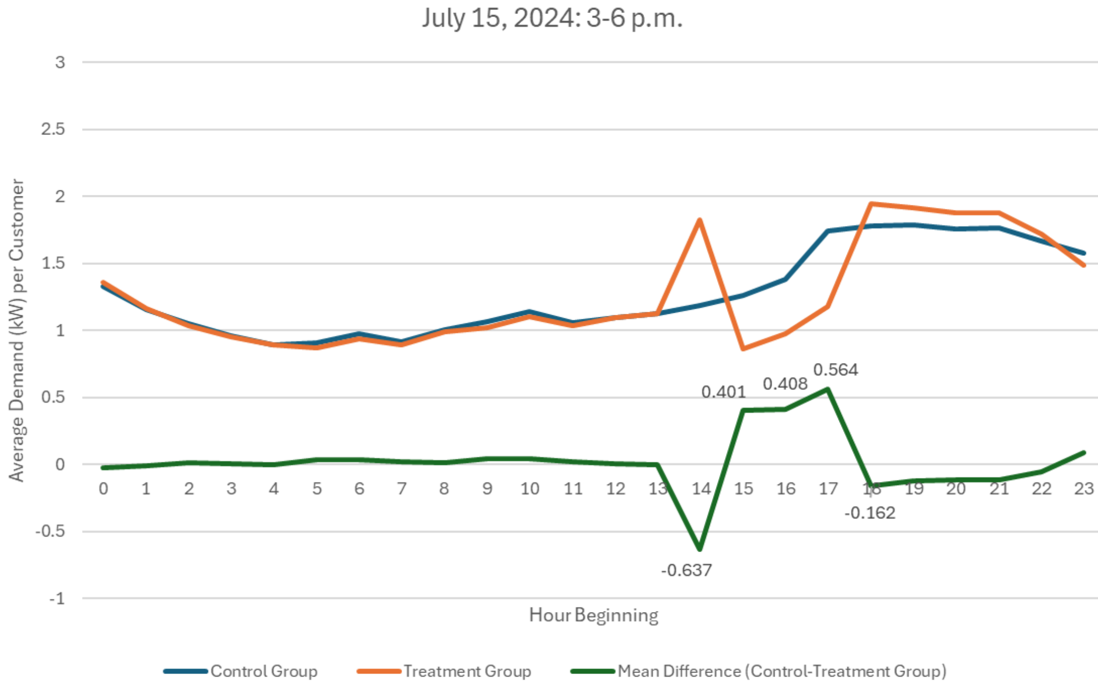


Figure G-5. Average AMI Load Shapes, July 30, 2024

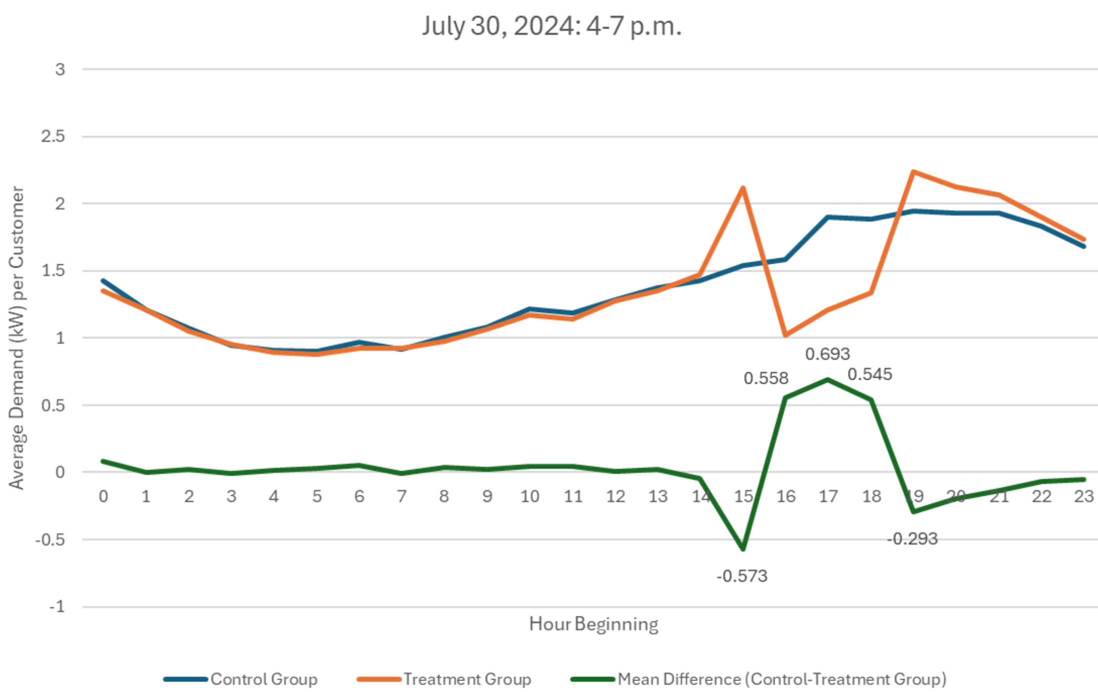


Figure G-6. Average AMI Load Shapes, August 1, 2024

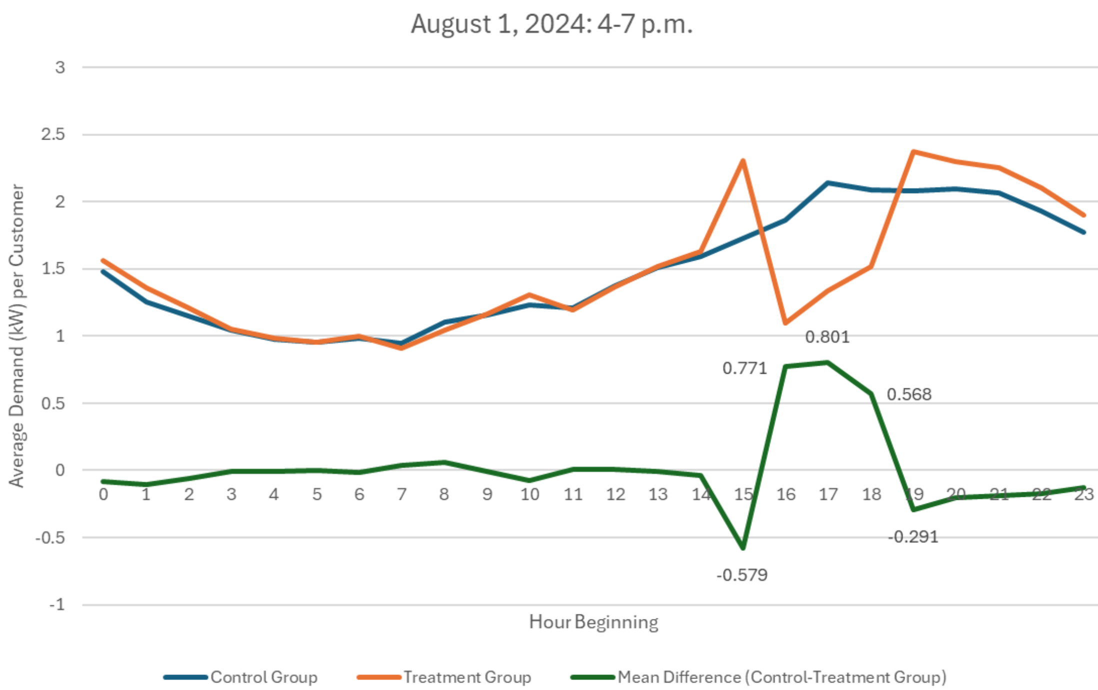


Figure G-7. Average AMI Load Shapes, August 15, 2024

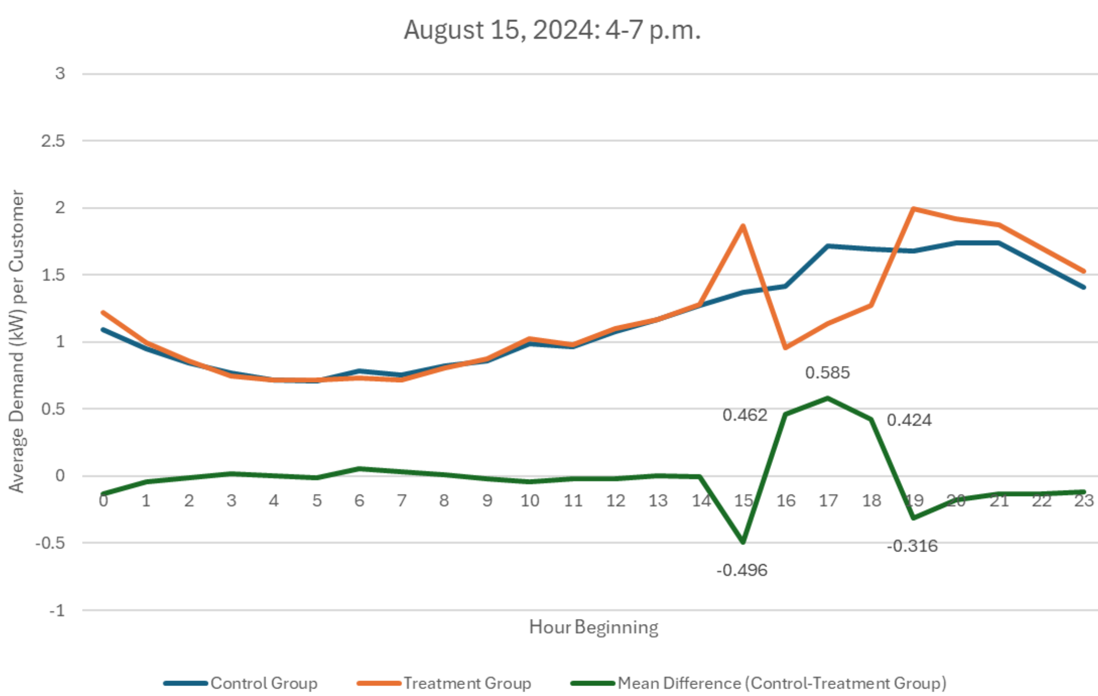


Figure G-8. Average AMI Load Shapes, August 27, 2024

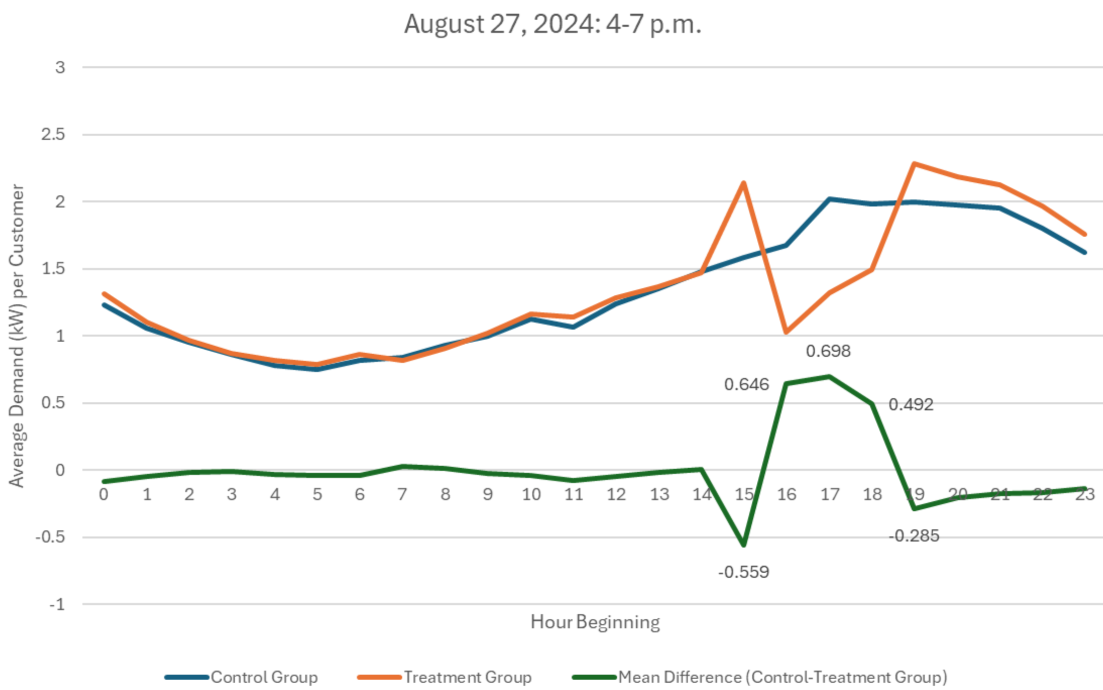
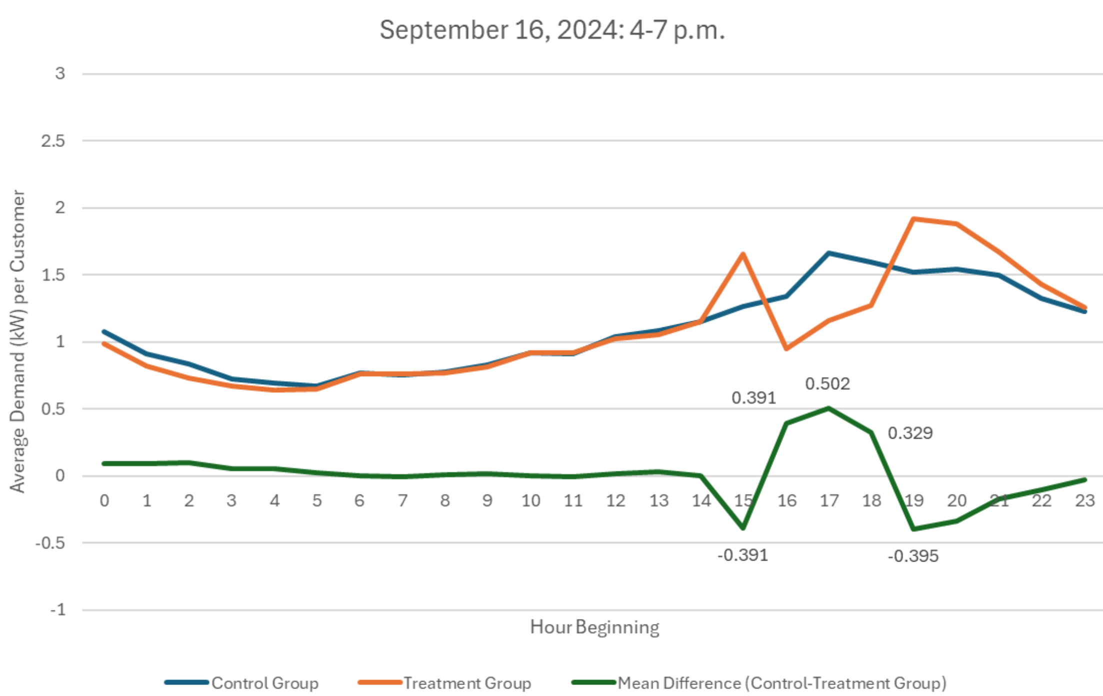


Figure G-9. Average AMI Load Shapes, September 16, 2024



Appendix H. Model A Estimated Event Impacts

Table H-1. Average Event Performance

Year	Time	Event Impact (kW)	90% Confidence Interval
2023	Pre-Event Hour 3	-0.009	(-0.057, 0.038)
	Pre-Event Hour 2	-0.033	(-0.103, 0.037)
	Pre-Event Hour 1	0.269	(0.194, 0.344)
	During Event	-0.494	(-0.567, -0.421)
	Post-Event Hour 1	-0.106	(-0.164, -0.048)
	Post-Event Hour 2	-0.072	(-0.141, -0.003)
	Post-Event Hour 3	-0.021	(-0.071, 0.029)
2024	Pre-Event Hour 3	0.041	(-0.022, 0.104)
	Pre-Event Hour 2	0.044	(-0.054, 0.142)
	Pre-Event Hour 1	0.714	(0.612, 0.816)
	During Event	-0.629	(-0.734, -0.523)
	Post-Event Hour 1	-0.074	(-0.131, -0.016)
	Post-Event Hour 2	-0.038	(-0.116, 0.039)
	Post-Event Hour 3	-0.024	(-0.086, 0.037)

Table H-2. 2023 Average Per Device, Per Event Demand Response Impacts

Event	Average Temperature (°C)	Average Treatment Load Without DR (kW)		DR Impact (kW)	90% Confidence Interval	Percent Impact
		Without DR Impact	With DR Impact			
Thu, Jul 27, 2023, 4-7 p.m.	27.5	1.585	1.419	-0.166	(-0.282, -0.051)	10.5%
Fri, Jul 28, 2023, 4-7 p.m.	28.4	1.600	1.476	-0.124	(-0.251, 0.004)	7.7%
Fri, Aug 25, 2023, 4-7 p.m.	22.9	1.517	0.874	-0.643	(-0.725, -0.561)	42.4%
Tue, Sep 5, 2023, 4-7 p.m.	29.8	1.619	1.380	-0.239	(-0.386, -0.092)	14.8%
Wed, Sep 6, 2023, 4-7 p.m.	27.4	1.579	1.292	-0.287	(-0.402, -0.173)	18.2%
Thu, Sep 7, 2023, 5-8 p.m.	22.7	1.655	1.140	-0.515	(-0.588, -0.442)	31.1%
Average: 4-7 p.m. Events	**27.2**	**1.676**	**1.288**	**-0.388**	**(-0.454, -0.321)**	**23.2%**
Average: 5-8 p.m. Events	**22.7**	**1.655**	**1.140**	**-0.515**	**(-0.588, -0.442)**	**31.1%**
Average: All Events	**26.5**	**1.757**	**1.263**	**-0.494**	**(-0.567, -0.421)**	**28.1%**

Table H-3. 2024 Average Per Device, Per Event Demand Response Impacts

Event	Average Temperature (°C)	Average Treatment Load Without DR (kW)		DR Impact (kW)	90% Confidence Interval	Percent Impact
		Without DR Impact	With DR Impact			
Wed, Jun 19, 2024, 3-6 p.m.	31.6	1.736	1.312	-0.424	(-0.526, -0.322)	24.4%
Thu, Jun 20, 2024, 4-7 p.m.	27.8	1.736	1.312	-0.705	(-0.814, -0.595)	24.4%
Mon, Jul 8, 2024, 4-7 p.m.	27.9	1.951	1.246	-0.707	(-0.831, -0.582)	36.1%
Mon, Jul 15, 2024, 3-6 p.m.	22.9	1.984	1.277	-0.609	(-0.734, -0.484)	35.6%

Event	Average Temperature (°C)	Average Treatment Load Without DR (kW)		DR Impact (kW)	90% Confidence Interval	Percent Impact
		Without DR Impact	With DR Impact			
Tue, Jul 30, 2024, 4-7 p.m.	26.4	1.975	1.366	-0.779	(-0.903, -0.655)	30.8%
Thu, Aug 1, 2024, 4-7 p.m.	29.2	1.971	1.192	-0.667	(-0.769, -0.564)	39.5%
Thu, Aug 15, 2024, 4-7 p.m.	26.7	1.985	1.318	-0.844	(-0.952, -0.737)	33.6%
Tue, Aug 27, 2024, 4-7 p.m.	29.3	1.965	1.121	-0.691	(-0.794, -0.588)	42.9%
Mon, Sep 16, 2024, 4-7 p.m.	25.2	1.970	1.279	-0.829	(-0.956, -0.702)	35.1%
Average: 3-6 p.m. Events	**31.6**	**1.736**	**1.312**	**-0.424**	**(-0.526, -0.322)**	**24.4%**
Average: 4-7 p.m. Events	**26.9**	**1.854**	**1.312**	**-0.601**	**(-0.647, -0.556)**	**29.2%**
Average: All Events	**27.4**	**1.842**	**1.241**	**-0.629**	**(-0.734, -0.523)**	**32.6%**

Table H-4. 2023 Extrapolated Population Event Performance

Event	Participants	Total Impact (MW)	90% Confidence Interval	Temp (C)
Thu, Jul 27, 2023, 4-7 p.m.	15,553	-2.589	(-4.378, -0.799)	20.456
Fri, Jul 28, 2023, 4-7 p.m.	15,535	-1.924	(-3.903, 0.054)	21.550
Fri, Aug 25, 2023, 4-7 p.m.	40,839	-26.252	(-29.591, -22.913)	18.114
Tue, Sep 5, 2023, 4-7 p.m.	49,163	-11.739	(-18.956, -4.521)	22.329
Wed, Sep 6, 2023, 4-7 p.m.	49,689	-14.278	(-19.958, -8.597)	20.824
Thu, Sep 7, 2023, 5-8 p.m.	53,545	-27.573	(-31.503, -23.644)	18.351
Average: 4-7 p.m. Events	**34,156**	**-13.240**	**(-15.512, -10.969)**	**20.655**
Average: 5-8 p.m. Events	**53,545**	**-27.573**	**(-31.503, -23.644)**	**18.351**
Average: All Events	**37,387**	**-18.480**	**(-21.216, -15.745)**	**20.271**

Table H-5. 2024 Extrapolated Population Event Performance

Event	Participants	Total Impact (MW)	90% Confidence Interval	Temp (C)
Wed, Jun 19, 2024, 3-6 p.m.	132,983	-56.417	(-69.984, -42.849)	32.106
Thu, Jun 20, 2024, 4-7 p.m.	133,596	-94.136	(-108.813, -79.459)	26.018
Mon, Jul 8, 2024, 4-7 p.m.	136,011	-96.117	(-113.041, -79.194)	27.995
Mon, Jul 15, 2024, 3-6 p.m.	136,933	-83.410	(-100.566, -66.253)	26.680
Tue, Jul 30, 2024, 4-7 p.m.	139,794	-108.905	(-126.212, -91.598)	26.133
Thu, Aug 1, 2024, 4-7 p.m.	140,037	-93.364	(-107.751, -78.976)	28.657
Thu, Aug 15, 2024, 4-7 p.m.	141,822	-119.761	(-135.036, -104.486)	25.649
Tue, Aug 27, 2024, 4-7 p.m.	142,750	-98.618	(-113.318, -83.918)	27.679
Mon, Sep 16, 2024, 4-7 p.m.	145,606	-120.774	(-139.269, -102.278)	24.281
Average: 3-6 p.m. Events	**132,983**	**-56.417**	**(-69.984, -42.849)**	**32.106**
Average: 4-7 p.m. Events	**139,569**	**-83.940**	**(-90.329, -77.547)**	**26.637**
Average: All Events	**138,837**	**-87.303**	**(-101.962, -72.651)**	**27.244**