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October 11, 2021

Public Utility Commission of Oregon
201 High Street, S.E., Suite 100
P.O. Box 1088
Salem, OR 97308-1088

**Re: PGE UM 1708 Residential Pricing and Behavioral Demand Response Pilot
(Flex 2.0) 2020/2021 Evaluation**

Enclosed is the Year Two evaluation of Portland General Electric Company's (PGE's) Residential Pricing and Behavioral Demand Response (Flex 2.0) Pilot. PGE contracted with a third-party evaluator (Cadmus) to evaluate and measure the effectiveness of the Flex 2.0 Pilot, identify areas for continuous improvements, and assess energy impacts on the system. Cadmus' evaluation addresses results from the summer 2020 and winter 2020/2021 seasons. Provided as Attachment A.

Peak Time Rebates (PTR) is a cornerstone of PGE's residential flexible load portfolio and delivers on our commitment to decarbonization while maintaining reliability and affordability. There is no up-front equipment investment making it the ideal platform by which to introduce our Residential Customers to the concept and value of demand response, educate them about the role they can play in supporting a reliable, greener grid for the community, and reward them financially for their efforts in doing so. PTR serves as the gateway to a deeper engagement with PGE's energy-shifting products and services. It is also PGE's first behavior-based demand response resource and is proving to be a reliable, consistent resource that will support PGE's goal of achieving 211 MW of Flexible Load by 2025.

PTR micro-segments¹ and learnings from seasonal evaluation reports and surveys are informing PGE's communication, education, and retention efforts and support our customer-focused data strategy. In Summer 2020, for example, Cadmus found impact of the high propensity customer segment was 10-15 times as large as the lowest impact customer group, and the high-impact customers were most satisfied with the program. While PTR will remain open to all Customers, PGE is tailoring its marketing approach to focus on Customers with the highest propensity to save energy and encouraging Customers who may be more successful and satisfied with Direct Load Control offerings to migrate to those programs. On that note, some 3,100 PTR Customers have moved to the Smart Thermostat program where they have an opportunity to earn higher rebates and PGE can expect higher demand response value.

¹ The PTR micro-segments are customer groupings based on propensity to shift energy during events as well as other customer attributes.

Second year evaluation results have also informed significant updates to the program designed to improve the overall Customer experience and satisfaction. For example, PGE has:

- Adjusted the baseline model and weather adjustment to increase rebate accuracy for events days with extreme heat conditions. (Summer 2021 saw record-breaking temperatures as high as 114°.)
- Introduced same-day text notifications on PTR Event days as 25% of Customers reported forgetting about the events without a day-of reminder.
- Expanded savings tips and tools giving customers more data-driven and specific ways to help them reduce energy use and save during PTR events.

Please direct any questions regarding this filing to Chris Pleasant at (503) 503-464-2555. Please direct all formal correspondence and requests to the following e-mail address pge.opuc.filings@pqn.com.

Sincerely,

\s\ Robert Macfarlane

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Enclosure

cc: UM 1938 Service List
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Flex 2.0 Demand Response Pilot Program

EVALUATION REPORT

September 2021

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Acronyms, Terms, and Definitions

AMI	Advanced metering infrastructure
CIS	Customer Information System, referring to PGE data containing customer-level attributes
Control group	Control group refers to nonparticipants matched to participants through propensity score matching (see <i>Appendix A</i> for details). The electricity demand of the control group provided a baseline for measuring the PTR event demand impacts.
DLC	Direct load control
°F	Degrees Fahrenheit
HVAC	Heating, ventilation, and air conditioning
IRP	Integrated Resource Plan
kW	Kilowatt
kWh	Kilowatt-hour
Microsegment	Five PGE customer segments characterize demand response potential: Big Impactors, Fast Growers, Middle Movers, Borderliners, and Low Engagers (in order of highest to lowest potential)
MW	Megawatt
OLS	Ordinary least squares
Peak time event	A period of high energy demand when PGE asks PTR participants to shift or reduce their energy usage
PGE	Portland General Electric
PTR	Peak time rebates
SGTB	Smart Grid Test Bed, in reference to PGE’s SGTB project
Test Bed	Test Bed refers collectively to three local distribution substation service areas (Hillsboro, Milwaukie, and North Portland) participating in the Test Bed project. The majority of residential customers residing in the Test Bed were automatically enrolled in the PTR program. Throughout this document, reporting will differentiate between participants within the Test Bed (Test Bed PTR) areas and outside of the Test Bed (Flex PTR) areas.
Treatment group	Treatment group refers to participants in the Flex 2.0 PTR program, including participants that opted into the program and participants that were automatically enrolled in the PTR program as part of the Test Bed project.
TOU	Time of use

Executive Summary

The 2016 Integrated Resource Plan (IRP) called for Portland General Electric (PGE) to reduce its dependence on coal-based generation and to increase its use of renewable energy resources while maintaining system reliability.¹ The plan identified residential dynamic pricing as presenting a large and cost-effective opportunity for PGE to achieve these goals.²

Dynamic electricity pricing can help PGE integrate renewable energy resources and manage peak demand by giving customers incentives to reduce their consumption when PGE system demand and costs of electricity supply are highest. The ability to manage demand through dynamic prices that can respond to short-run system conditions will become increasingly important with the expected expiration of power contracts and further integration of renewable energy resources in the mid-2020s.³

In 2016, PGE launched the Flex 1.0 Pricing and Behavioral Demand Response Pilot Program, which tested residential time of use (TOU) rates, peak time rebates, and behavioral demand response over two years. Based on the learnings from the Flex 1.0 pilot, PGE designed and began offering an opt-in peak time rebates (PTR) program to residential customers in April 2019 through the Flex 2.0 pilot.

Flex 2.0 PTR is a behavioral, event-based, demand response resource that pays customers to reduce their electricity consumption during summer and winter peak demand events. PGE notifies participants in advance of PTR events and pays them a rebate of \$1 per kWh of savings. PGE calculates participants' savings by comparing their metered consumption to an estimate of their baseline consumption during events. PGE called five PTR events in summer 2020 and two events in winter 2020/2021.⁴

As of March 2021, PGE had approximately 92,500 customers enrolled in Flex 2.0 PTR. Using this evaluation's estimates of per-participant demand savings for summer and winter, PGE possesses approximately 10.9 MW of winter demand response capacity and 13.1 MW of summer demand response capacity from Flex 2.0 PTR.⁵

¹ Portland General Electric. November 15, 2016. *2016 Integrated Resource Plan*.

<https://www.portlandgeneral.com/our-company/energy-strategy/resource-planning/integrated-resource-planning/2016-irp>

² The 2016 IRP called for PGE to add 77 MW of demand response capacity in winter and 69 MW of demand response capacity in summer by 2020.

³ Portland General Electric. July 19, 2019. *2019 Integrated Resource Plan*.

<https://www.portlandgeneral.com/our-company/energy-strategy/resource-planning/integrated-resource-planning>

⁴ PTR events were called for three hours each (5 p.m. through 8 p.m.) on these weekday, non-holiday dates in 2020 (June 23, July 21, July 30, August 17, and September 3) and in 2021 (January 25 and January 27).

⁵ For this calculation, Cadmus used the average demand savings per participant across all event hours for each season (0.142 kW in 2020 summer and 0.118 kW in 2020/2021 winter) and multiplied these by the enrollment count (92,455) as of March 11, 2021, for each season.

This report focuses on the evaluation of Flex 2.0 PTR in its second year and covers summer 2020 and winter 2020/2021. The evaluation includes PTR participants who opted into the program and participants in PGE's Smart Grid Test Bed (SGTB) project who were automatically enrolled in PTR (starting in June 2019, if they had not previously self-enrolled).⁶ This report refers to the opt-in PTR program outside the Test Bed as *Flex PTR* and the PTR component of the SGTB project as *Test Bed PTR*.

Impact estimates for the SGTB project in this report pertain to all enrolled PTR customers in the Test Bed, whether they self-enrolled or were automatically enrolled by PGE. There is a separate SGTB project evaluation that focuses on other Test Bed-specific research objectives.

Through meter data analysis, interviews with program staff, and customer surveys, the evaluation assessed the load impacts, program implementation, and customer experience. The evaluation covered these key objectives:

- Track customer enrollment, retention, and satisfaction levels with the PTR offering
- Measure demand impacts of demand response events by season and microsegment
- Assess the accuracy of the customer rebate calculations for savings during PTR events
- Identify Flex 2.0 implementation successes and challenges and opportunities for improvement
- Assess any differences in demand impacts and program experience between Flex PTR and Test Bed PTR participants

Program Performance Overview

These overarching takeaways from this Flex PTR Program evaluation provide greater context for the conclusions and recommendations to follow.

During the second year of the Flex PTR Program, PGE incorporated more best practices for PTR programs. PGE significantly improved the accuracy of the customer baseline calculations and delivered same-day events notifications to customers. These changes have enhanced the customer experience and are likely to have improved the program's savings performance.

PGE enhanced the demand response capacity and capabilities of the Flex PTR Program. PGE increased customer enrollments since the first program year, maintained or increased the savings per enrollee, and improved resource flexibility by eliminating constraints on days, times, and durations it could call PTR events.

Opportunities exist for PGE to further increase the demand response capacity and capabilities of Flex PTR. PGE could enroll summer-only Smart Thermostat Demand Response Program enrollees in winter PTR, automatically re-enroll PTR participants who move residences when they open their new accounts, and continue to selectively market PTR to customers with high expected savings.⁷

⁶ Since the Flex 2.0 pilot administers PTR consistently for both opt-in and opt-out participant groups (i.e., sends event notifications, calculates, and distributes rebates), PTR impacts for Test Bed customers are included in this report.

⁷ Beginning in January 2021, PGE resumed re-enrolling customers who move within the service territory using customer service representatives.

Performance Metrics

The peak demand savings estimates for summer 2020 and winter 2020/2021 and customer satisfaction results for summer 2020 are shown in Table 1.⁸ All values are mean estimates per enrolled or surveyed customer. Flex PTR saved about 8% of demand in summer and 7% in winter. Test Bed PTR saved less, about 4% in summer and 3% in winter. Flex PTR achieved higher customer satisfaction than did Test Bed PTR.

Table 1. PTR Event Demand Savings and Program Satisfaction Results

PTR Group	Demand Savings								Summer 2020 Program Satisfaction	
	Summer 2020 (N=5 events)				Winter 2020/2021 (N=2 events)				Satisfied (6-10)	Delighted (9-10)
	Mean kW	%	Max kW	%	Mean kW	%	Max kW	%		
Flex PTR	0.159	8.2%	0.169	8.6%	0.134	7.1%	0.134	7.2%	78%	39%
Test Bed PTR	0.076	3.9%	0.113	6.1%	0.048	2.8%	0.056	3.3%	68%	33%

Note: Mean savings is the average kW demand reduction per participant across all event hours. Max kW is the maximum of the event average demand savings per participant during each event season. The percentage savings are the kW savings divided by estimated baseline demand.

All impact values are statistically significant at the 10% level. Satisfaction values reflect the percentage of survey respondents who rated their program satisfaction on a 0 to 10 rating scale. The evaluation did not conduct a winter customer survey.

To provide information about Flex 2.0 PTR’s performance that may be useful to PGE grid operators, Table 2 displays additional performance metrics from the summer 2020 and winter 2020/2021 impact evaluations. The table reports the mean, minimum, and maximum demand savings across Flex events by event hour as well as mean load impacts before and after the events.

⁸ Due to a limited winter season (two events) and power outages from the 2021 winter storm, customer surveys were not conducted during the winter 2020/2021 season.

Table 2. Peak Demand Savings Metrics for Summer 2020 and Winter 2020/2021

Key Metrics		Savings Per Enrollee	
		Summer 2020	Winter 2020/2021
Average kW Savings	Event Hour 1	0.127 kW (6.6%)	0.099 kW (5.5%)
	Event Hour 2	0.152 kW (7.7%)	0.130 kW (6.9%)
	Event Hour 3	0.147 kW (7.5%)	0.125 kW (6.8%)
Min kW Savings	Event Hour 1	0.113 kW (5.9%)	0.096 kW (5.4%)
	Event Hour 2	0.128 kW (6.9%)	0.127 kW (6.7%)
	Event Hour 3	0.126 kW (6.8%)	0.122 kW (6.7%)
Max kW Savings	Event Hour 1	0.151 kW (8.2%)	0.101 kW (5.6%)
	Event Hour 2	0.172 kW (8.2%)	0.133 kW (7.1%)
	Event Hour 3	0.161 kW (8.7%)	0.129 kW (6.9%)
Change in Average Savings (difference from previous hour savings)	Event Hour 1 to 2	0.025 kW (19.6%)	0.031 kW (31.4%)
	Event Hour 2 to 3	-0.005 kW (-3.1%)	-0.004 kW (-3.5%)
Average Savings during Hour before Event Begins		0.024 kW (1.3%)	0.007 kW (0.5%)
Average Savings during Hour after Event Ends		0.042 kW (2.2%)	0.011 kW (0.7%)
Event Day Average Energy Savings		0.465 kWh (1.5%)	0.434 kWh (1.3%)

Note: Mean savings is the average kW demand reduction per enrollee for the event hour across all events. Max kW is the maximum of the average demand reduction per enrollee for the event hour across all events, and min kW is the minimum defined analogously. The percentage savings are the kW savings divided by estimated baseline demand. All impact values are statistically significant at the 10% level.

Conclusions and Recommendations

The following are conclusions, supporting findings, and recommendations from the Flex 2.0 PTR evaluation for summer 2020 and winter 2020/2021.

Load Impacts

In summer, the PTR program resulted in large kW and percentage reductions in demand during Flex events.

In summer, the PTR program achieved large average demand savings per participant of 0.159 kW (8.2% of baseline consumption) for Flex PTR enrollees and 0.076 kW (3.9%) for Test Bed PTR enrollees. Overall, the PTR program saved 0.142 kW per participant (7.4%). These estimates were statistically significant at the 10% level. Overall, the PTR program averaged total savings of 12.6 MW across all summer event hours.

Both winter PTR events reduced demand. However, as PGE dispatched only two winter events, it is not possible to draw strong conclusions regarding the capabilities of PTR as a demand management resource in winter.

PGE dispatched only two events during the winter 2020/2021 season. The PTR program achieved average demand savings per enrollee of 0.134 kW (7.1% of baseline consumption) for Flex PTR enrollees

and 0.048 kW (2.8%) for Test Bed PTR enrollees. Overall, the PTR program saved 0.118 kW per participant (6.4%). These estimates were statistically significant at the 10% level. The PTR program saved an average of 10.8 MW across the winter event hours. PGE could learn more about the PTR program's performance in winter by calling more winter events.

In summer, PTR savings spilled over to the hours immediately preceding and following summer events. In winter, savings only spilled over to the hour immediately after the event.

As in summer 2019, PTR produced demand savings before and after summer 2020 events. The savings were less than half of the event period savings. In winter, however, there were no statistically significant savings in the hour before the event. Though savings behaviors differ between seasons, Flex PTR and Test Bed enrollees generally follow the same behaviors with respect to savings achieved during the pre-event and post-event snapback periods.

Summer and winter PTR delivered relatively constant savings across event hours and between events.

In both seasons, kW savings were typically highest in the middle hour of the events (6 p.m. to 7 p.m.), but these savings were only marginally higher than the first or last hours of the events. In contrast to smart thermostat demand response, there was no degradation of savings across event hours. Also, PTR savings were fairly consistent across events, ranging between 7% to 9% for Flex PTR and 2% to 6% for Test Bed PTR. Reliable, constant savings during each event hour are an important benefit of PTR for demand response planning.

In summer, demand savings from PTR differed significantly between demand response microsegments.

PGE assigned most residential customers to one of five PTR-specific customer segments (microsegments) that represent the potential to provide PGE with demand savings: Big Impactors, Fast Growers, Middle Movers, Borderliners, and Low Engagers (in order of highest to lowest potential). For both Flex PTR and Test Bed PTR, the Big Impactors, Fast Growers, and Middle Movers microsegments achieved much higher savings than the other microsegments. In general, the savings per enrollee of these groups averaged between two and four times the savings for Borderliners and Low Engagers.

The Low Engager microsegment constituted the majority of PTR enrollees but had small average demand savings per participant, which reduced the average for the program.

In summer, Low Engagers saved about 0.04 kW (4.2%) per Flex PTR enrollee and 0.01 kW (1.1%) per Test Bed PTR enrollee. Because Low Engagers represented 37% of the summer 2020 program population, they significantly reduced the average demand savings per enrollee for the whole program. When Low Engagers and those with missing microsegment assignments were omitted from the savings analysis, the average demand savings per enrollee increased to 0.20 kW (8.7%) per Flex PTR enrollee and 0.10 kW (4.2%) per Test Bed PTR enrollee.

Low Engagers also produced the lowest winter average demand savings per Flex PTR enrollee (0.08 kW, 6.4%) among the microsegments. Unlike other microsegments, however, Low Engagers' winter savings were higher than their summer savings, suggesting that their patterns of seasonal engagement with PTR

differ from other groups. Evaluation of more winter events would provide deeper insight regarding the performance of this microsegment.

Demand savings from Flex PTR differed significantly between demand response microsegments.

PTR enrollees in the Big Impactors, Fast Growers, and Middle Movers microsegments achieved much higher savings than other microsegments, and the differences were greatest in summer and for Flex PTR customers. For example, among Flex PTR customers, in summer, Big Impactor savings were 10-15 times as large as Low Engager savings and 4-5 as large as Borderliner savings. In the Test Bed, there were also differences between the microsegments, but they were not always statistically significant because of the smaller analysis sample sizes. Though the differences were not always statistically significant, Big Impactors consistently achieved higher savings across both events and in both Flex and Test Bed PTR in summer and winter. The differences between microsegments suggest that PGE could increase the average savings per enrolled PTR customers by selectively marketing the program to or automatically enrolling the highest expected savers.

The average kW savings per PTR enrollee increased relative to 2019 in both summer and winter seasons.

PTR enrollees' average savings across all summer events rose from 0.103 kW in 2019 to 0.142 kW in 2020 and from 0.083 kW to 0.118 kW in winter. The specific causes of these savings increases are unknown, but greater program awareness, changes to customer pre-event notifications, calling events from 5 p.m. to 8 p.m. instead of 4 p.m. to 7 p.m., changes in the composition of the participant population, and/or improvements in accuracy of customer rebate calculations that strengthen the link between action and reward could all be factors. The percentage savings increased slightly or were unchanged between years.

Correlation of PTR savings with outside temperature in summer 2020 was positive but not very strong.

Though savings achieved during summer 2019 events suggested correlation with outdoor temperature, this was not the case during the summer 2020 events. The maximum demand savings per enrollee of 0.113 kW for Test Bed PTR enrollees and 0.169 kW for Flex PTR enrollees were achieved during event 2, when the outdoor temperature was 84°F. Event 3 had the highest outdoor temperature at 92°F and achieved the same level of savings for Flex PTR enrollees as in event 2, but it achieved only 0.08 kW of savings for Test Bed PTR enrollees. Evaluation of another summer may clarify the relationship, but over the course of two summer seasons there does not appear to be a clear-cut relationship between temperature and average savings per enrollee. The absence of a strong correlation is consistent with survey-based findings that most participants do not adjust their thermostat setting during Flex events.

Load Impact Recommendations

PGE should call more events in winter to learn more about the performance of PTR in winter. PGE should be prepared to call events on cold days throughout the winter.

To increase the demand response capabilities of PTR and improve the customer experience, PGE should consider the following steps for the program:

- **Expanding auto-enrollment to broader PGE customer populations.** The Phase 1 SGTB evaluation showed that auto-enrolled customers in Test Bed PTR realized energy savings during summer PTR events and that auto-enrolling these customers led to very large and persistent increases in PTR enrollment.⁹ To increase the MW impacts of Flex PTR, PGE should consider auto-enrolling customers outside of the Test Bed. To ensure that per-customer impacts from auto-enrolled customers are maintained (or improved) relative to the existing opt-in Flex PTR population, PGE could consider auto-enrolling customers from the highest-saving microsegments (Big Impactors, Fast Growers, and Middle Movers) first while continuing to allow Borderliners and Low Engagers to opt in.

Auto-enrollment to PTR could also benefit PGE's other demand response and distributed energy resources (DER) offerings, as the SGTB evaluation showed higher migration to the thermostat demand response programs among PTR enrollees than among the general population.

- **Hybrid options for PTR.** PGE can increase Flex PTR demand response value, customer enrollment, and total customer incentive opportunities by allowing smart thermostat demand response program participants with central air conditioning and non-electric heating to enroll in PTR during the winter. Enrolling smart thermostat customers in winter Flex PTR would require new customer messaging, operational upgrades needed to track enrollment and participation across these two product paths, and strategies to ensure consistency in participation experience between PTR and Smart Thermostats.

Implementation

By improving the average accuracy of customer baseline calculations, PGE reduced overpayment for PTR savings and program delivery costs.

After testing the accuracy of different baseline calculation approaches, PGE updated its approach for calculating individual customer baselines and rebates. This appears to have resulted in a reduction in the overpayment of rebates for savings. In summer 2020, PGE paid customers an average of \$2.50 in rebates for every kWh of evaluated savings. This was a 32% reduction in the overpayment for savings from summer 2019. Likewise, in winter 2021, PGE paid an average of about \$3.00 in rebates per kWh of savings, a reduction of 43% in overpayment for savings from the previous year. The overpayment arises from inaccuracies in the baseline calculations and the asymmetric payment structure for the PTR program (PGE pays rebates for savings but does not charge customers for increasing their consumption above baseline).

PGE did not meet its 2020 enrollment goal due to limited marketing activities and a high number of account closures.

PGE did not meet its 2020 Flex 2.0 PTR enrollment goal of 110,000 customers, ending the year with

⁹ Portland General Electric. January 28, 2021. *Interim Evaluation Report of the Smart Grid Test Bed Project*.

92,455 customers. In the early 2020, PGE was quickly approaching its enrollment goal, so it limited recruitment marketing activities and instead focused on targeted email marketing with the two smallest-sized yet highest-impact microsegments, Big Impactors and Fast Growers. Marketing campaigns to recruit new customers for the program were planned for September 2020 but stalled due to the Oregon wildfires.

At the same time, unenrollments were higher in 2020 (22%) than 2019 (13%), stemming from a high rate of account closures in 2020. Account closures made up 87% of unenrollments in 2020 compared to 77% in 2019. Higher account closures in 2020 were likely due to customers moving, canceling leases, or changing their housing situation during the COVID-19 pandemic.

PGE plans to increase enrollments during summer 2021 with several promotions with the Portland Thorns FC, which has one of the largest online audience and social media presences in the region, and has reinstated transferring customer program enrollment when they move and re-start their service.

PGE achieved its 2020 participant retention goal for PTR.

PGE set a goal to retain 97% of enrolled customers in 2020 (i.e., 3% or lower opt-out rate). When retention was calculated to exclude PTR participants who migrated to the Smart Thermostat Demand Response pilot program or closed their accounts, the retention rate was 98%. Despite achieving high cumulative enrollments and retaining almost all enrollees who do not migrate or close their accounts, the program lost about 20% of PTR enrollees between March 2020 and March 2021 because of account closures. To maintain the program's enrollment levels, PGE must enroll enough new customers to make up for these losses, which requires significant program resources. PGE may be able to reduce this churn by automatically re-enrolling customers who move residences within its service territory and open new accounts.

PGE improved the event communications to its customers.

In Cadmus' evaluation of summer 2019, surveyed customers reported forgetting about the peak time events and wanting same-day event reminders. In response to these findings, PGE delivered same-day email reminders to all PTR customers in summer 2020. Then for winter 2020/2021, PGE partnered with a text message vendor and delivered same-day text message reminders to customers. PGE also changed the timing of the email and text message delivery to 3 p.m. instead of the morning starting in winter 2020/2021 to bring the reminders closer to the event start time. Thirteen percent of summer 2020 survey respondents reported forgetting about the event compared to 25% of summer 2019 survey respondents, a large and statistically significant decrease. This suggests that the same-day reminders likely helped customers remember events.

In response to continuing program delivery challenges, PGE implemented several changes to improve demand response capabilities and the customer experience.

The event prepurchase stipulations with the implementation contractor did not allow PGE to call back-to-back events, events with different start times and durations, morning events or weekend events. Event prepurchases were also made in blocks, rather than by individual events. These limitations reduced PGE's ability to call more events throughout the summer and winter seasons. To overcome

these limitations, PGE decided to take responsibility for dispatching events and implement event communications starting in summer 2021.

In the previous evaluation, Cadmus reported that PGE was having customer enrollment synchronization issues with its implementation contractors. PGE reported that this issue continued through summer 2020 and winter 2020/2021 seasons, though with fewer customers affected (around 3,500 customers did not receive pre- or post-event communications). PGE expects that the synchronization issue will be reduced to nominal numbers starting in summer 2021 when it begins implementing event communications in house.

Implementation Recommendations

- Enhance re-enrollment procedures to increase enrollments and demonstrate excellent customer service for PGE customers who close their accounts because they are relocating within PGE's service territory. PGE should auto-enroll, follow up, and confirm the program enrollment status and event communication preferences of these customers under the new account. Note, as of January 2021, PGE resumed re-enrollment efforts associated with customers who move within the service territory using customer service representatives.

Customer Experience

Customers absorbed PGE messaging about actions to reduce electricity demand.

During summer 2020, PGE emailed customers tips on ways to shift or reduce energy use during events. The tip that PGE promoted the most was to *minimize appliance use during peak time events*. The survey asked respondents what actions they had taken were learned from PGE. Four of the top five actions that customers learned from PGE aligned with the tip that was promoted the most. The top five actions that respondents took and learned from PGE were:

- Turning off or unplugging electronics during the event (50%) [promoted]
- Doing dishes before or after the event (50%) [promoted]
- Turning off or limiting the use of lights during the event (48%) [did not promote]
- Charging electronic devices before or after the event (47%) [promoted]
- Doing laundry before or after the event (46%) [promoted]

Customers took actions to reduce electricity demand during Flex events, with the majority of customers with electric space cooling taking the highest potential savings actions.

Seventy-eight percent of respondents took action to shift or reduce their energy use during a summer 2020 event. Actions that reduce the use of electric space cooling are among the highest-savings actions that a customer can take during an event. Of the respondents with electric space cooling in their home, 59% turned off the air conditioning unit during the event, 50% cooled the house before the event by lowering the thermostat, and 36% turned the thermostat up two to three degrees during the event.

Gift card sweepstakes show potential to motivate customers to save, but awareness must first be established.

To motivate customers to participate in events and increase their demand savings, PGE offered an Amazon gift card sweepstakes during summer 2020. Fewer than half of respondents (42%) were aware of the sweepstakes. Of respondents who were aware, 38% said the sweepstakes were an important motivating factor in their event participation. This implies that 15% of respondents were motivated by the sweepstakes. More customers could be motivated to participate in events if they were made aware of the sweepstakes.

Customers continued to exhibit relatively low satisfaction with the rebate amount and to perceive a disconnect between the rebate amount and their efforts to save.

Customer satisfaction with the rebate did not differ between 2020 respondents (63% satisfied, 25% delighted) and 2019 respondents (63% satisfied, 22% delighted). Interestingly, more 2020 respondents said their earned rebate amount was higher than expected (19%) compared to 2019 respondents (7%), and fewer 2020 respondents said their earned rebate amount was lower than expected (29%) compared to 2019 respondents (42%). Despite these improvements in customers' rebate expectations, many respondents still reported perceiving a disconnect between the rebate and their actions. About 38% percent of 2020 respondents agreed with the statement *the rebate doesn't seem to be linked to the actions I take*, which did not differ statistically differ from 2019 respondents (40%).

PGE did not meet its customer satisfaction goals for PTR.

Although a majority of summer 2020 respondents were satisfied with the program, PGE did not meet its customer satisfaction goals of 80% satisfied and 60% delighted. Overall, 77% of respondents were satisfied and 38% were delighted. The program achieved similar customer satisfaction results as summer 2019 (76% satisfied, 34% delighted). PGE nearly met its 80% satisfied satisfaction goal among the Flex PTR respondents. When broken out by PTR group, 78% of Flex PTR respondents were satisfied and 39% were delighted, and 68% of Test Bed PTR respondents were satisfied and 33% were delighted.

Customer Experience Recommendations

- Provide customers with a personalized action plan of tips. Action plans could be customized by the heating/cooling system type and place the highest savings actions at the top. This may increase customer savings, rebate earnings, and satisfaction.
- Consider other incentive payment structures such as variable peak rebates that will give customers greater incentives to save and opportunities to earn more.¹⁰ For example, PGE could explore a tiered or varying rebate structure, with higher rebates on critical days when demand response capacity is more valuable to PGE and customers have higher costs to participate.

¹⁰ A variable peak rebate would operate analogously to a variable peak price pricing (VPP) program, which varies the retail price of electricity during demand response events according to forecasted system and market conditions. Oklahoma Gas and Electric's SmartHours is an example of a residential VPP program.

Introduction

In April 2019, PGE launched the Flex 2.0 pilot program, which started with an opt-in peak time rebates (PTR) offering and will follow with an opt-in time of use (TOU) rate offering (currently scheduled for 2021) as a stand-alone option or paired with PTR. This report presents results from the second year of the Flex 2.0 pilot program—summer 2020 and winter 2020-2021.

Flex 2.0 Peak Time Rebates (PTR) is an event-based, behavioral demand response pilot program. To reduce residential peak demand during summer and winter months, PGE educates and incentivizes customers in PTR to participate in peak time events. PGE pays participants a rebate of \$1 per kWh for reducing their demand below their baseline consumption during peak time events. PGE calculates PTR participants' savings by comparing their metered consumption to their estimated baseline consumption. PGE called five events in summer 2020 and two events in winter 2020/2021.

At the same time as the Flex 2.0 pilot, PGE launched the Smart Grid Test Bed (SGTB)—a neighborhood smart grid project aimed at accelerating the development of demand response resources.¹¹ The SGTB project field tests and evaluates various demand response offerings, new technologies, and customer value propositions about demand response in three local neighborhoods (referred to as Hillsboro, Milwaukie, and North Portland), whose boundaries are defined by distinct distribution substation service areas. PGE auto-enrolled residential customers in these three neighborhoods in July 2019 in opt-out PTR. These SGTB customers also received different promotional and educational materials than did PGE residential customers who opted into the Flex 2.0 pilot.

This report focuses on the evaluation of the Flex 2.0 PTR program in summer 2020 and winter 2020/2021, the third and fourth event seasons since the program's launch in April 2019. The evaluation covers participants who opted into the Flex 2.0 PTR program and participants in the SGTB project, almost all of whom were automatically enrolled by PGE.¹²

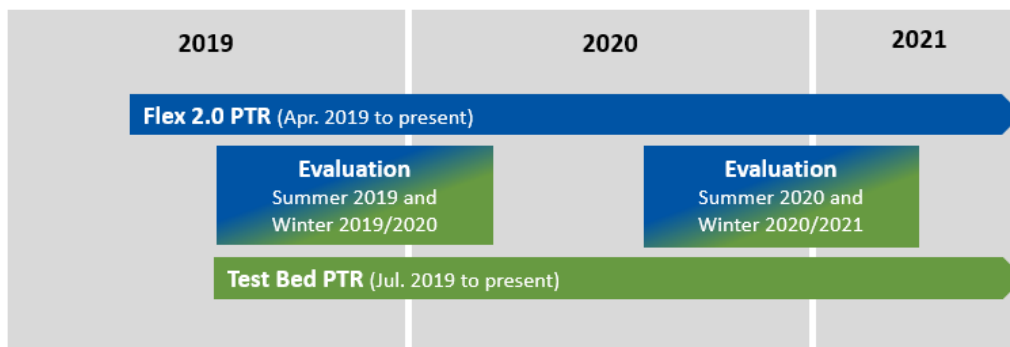
This report refers to the opt-in PTR program outside the SGTB as *Flex PTR* and the PTR component of the SGTB project as *Test Bed PTR*. Impact estimates for the SGTB project in this report pertain to all customers in the Test Bed PTR as a single group, whether they enrolled themselves or were automatically enrolled by PGE. A separate SGTB project evaluation focuses on other Test Bed-specific research objectives.

¹¹ Portland General Electric. October 2018. *PGE Testbed Proposal*.
<https://edocs.puc.state.or.us/efdocs/UAC/adv859uac113045.pdf>

¹² PTR auto-enrollment occurred for the vast majority of PGE customers in the Test Bed in July 2019; additional auto-enrollment will still occur periodically for new customer accounts.

Figure 1 shows a timeline for Flex 2.0 PTR and the SGTB project and their evaluations to date.¹³

Figure 1. Timeline of Flex Pilot Programs and Evaluations to Date



¹³ The Flex 2.0 pilot was built upon lessons from the PGE Flex 1.0 pilot, which ran from March 2016 to June 2018. This pilot enrolled approximately 14,000 residential customers in one of 12 different pricing and behavior-based program treatments. See the Flex 1.0 Evaluation Report for more details:

Portland General Electric. July 10, 2018. *UM 1708 Cadmus Evaluation of PGE's Residential Pricing Pilot*.
<https://edocs.puc.state.or.us/efdocs/HAH/um1708hah16432.pdf>

Evaluation Objectives and Approach

PGE contracted with Cadmus to evaluate the Flex 2.0 pilot program. This report presents Flex 2.0 evaluation findings and recommendations regarding PTR from summer 2020 and winter 2020/2021. The evaluation includes impacts from Test Bed PTR participants who were auto-enrolled in Flex 2.0 PTR.

This report addresses the following objectives for the Flex 2.0 PTR evaluation:

Objective	1	Track customer enrollment, retention, and satisfaction levels with the PTR offering
	2	Measure demand impacts of demand response events by season and microsegment
	3	Assess the accuracy of the customer rebate calculations for savings during PTR events
	4	Identify Flex 2.0 implementation successes and challenges and opportunities for improvement
	5	Assess any differences in demand impacts and program experience between Flex PTR and Test Bed PTR participants

Evaluation Design

The evaluation of the Flex 2.0 PTR employed a quasi-experimental research design. To estimate the load impacts, event-hour demand of PTR participants (the treatment group) was compared to the event-hour demand of similar nonparticipants (the control group) identified from a propensity score matching procedure. Cadmus estimated PTR savings through panel regression analysis of customer-level advanced metering infrastructure (AMI) interval consumption data. The *PTR Load Impact Estimation* section in *Appendix A* provides details about the approaches for the propensity score matching and the savings estimation.

Evaluation Activities

Table 3 lists the evaluation activities Cadmus conducted and how each activity addressed the evaluation objectives. *Appendix A* describes each evaluation activity in more detail. Due to the limited number of winter events (two) and power outages from the 2021 winter storm, customer surveys were not conducted during the winter 2020/2021 season.

Table 3. Flex 2.0 Evaluation Activities

Activity	Description	Corresponding Objective(s)	Outcome
Research Design	Quasi-experimental design using matched comparison group to estimate baseline consumption	2	Accurate and precise estimates of program impacts
Data Collection and Preparation	Collect and prepare analysis of individual customer advanced metering infrastructure (AMI) meter interval consumption data	2	Final analysis sample for estimation of load impacts
Load Impact Analysis	Regression analysis of individual customer AMI meter interval consumption data	2, 5	Estimates of demand savings by event, hour, PTR group (Flex, Test Bed), and by customer microsegment
PTR Overpayment Analysis	Comparison of evaluated savings to PGE’s load impact estimates used for rebate calculation	3	Estimate of the level of PTR overpayment for the summer 2020 and winter 2020-2021 seasons
Participation Analytics	Reporting of enrollment, retention, and demographic distribution of participants	1, 4	Summary statistics of program participant
Staff Interviews	Interviews with PGE and implementation staff to understand program processes, successes, and challenges	4	Thorough understanding and documentation of the program design and implementation
Customer Surveys	Summer event surveys with participants	1, 3, 4, 5	Findings on pre-event notifications, event participation, motivations, and satisfaction

Pilot Program Description and Implementation

In April 2019, PGE launched Flex 2.0 PTR to reduce residential peak demand during summer and winter months. Customers participating in PTR earned \$1 for every kWh saved during designated times of high energy demand called peak time events. Participants comprised customers who self-enrolled in PTR, were auto-enrolled as part of the SGTB project, or had been enrolled in Flex 1.0 PTR and were automatically re-enrolled in Flex 2.0 PTR. PGE partnered with E Source and Oracle to serve as the program's implementation contractors and selected Cadmus as the evaluator.¹⁴

For this evaluation period, PGE set the following goals for Flex 2.0 PTR:

- Enroll 110,000 customers by the end of 2020
- Retain 97% of enrolled customers in 2020 (i.e., 3% or lower opt-out rate)¹⁵
- Reduce demand by 18 MW in summer 2020 and 12 MW in winter 2020/2021
- Achieve high levels of customer satisfaction with the program (80% satisfied, 60% delighted)

Program Eligibility Requirements

To be eligible for Flex 2.0 PTR, customers had to meet the following criteria:

- Be on PGE's Schedule 7 Basic Service rate or Schedule 7 TOU rate
- Not be a participant in PGE's Smart Thermostat Demand Response pilot program or Solar Payment Option
- Must reside in the enrolled property (landlords were not eligible to enroll any service agreements associated with properties in which they did not reside)
- Provide PGE with a valid email address or working mobile number
- Have a functioning interval consumption meter that records and communicates energy consumption to PGE

Flex 2.0 PTR has an enrollment cap of 160,000 Schedule 7 Basic Service rate customers. This cap does not include the customers who were auto-enrolled in Test Bed PTR, for which enrollment is not capped but limited by the number of customers residing in the SGTB.

Recruitment Marketing

PGE oversees the marketing and content creation for Flex 2.0 PTR. Recruitment marketing activities differed according to whether customers voluntarily enrolled in PTR (i.e., opt-in PTR, in which the

¹⁴ In early 2020, E Source acquired TROVE Predictive Data Science. TROVE served as an implementation contractor for PGE's Flex 2.0 PTR during summer 2019 and winter 2019/2020.

¹⁵ Customers enrolled in PTR who stopped their PGE service or switched over to the Smart Thermostat Demand Response pilot program do not count toward the PTR retention/opt-out goal.

majority are Flex PTR participants outside of the Test Bed) or were auto-enrolled as part of the SGTB project (i.e., opt-out, in which the majority are Test Bed PTR participants).

Flex PTR (Opt-In)

In the early part of 2020, PGE was quickly approaching its 2020 end-of-year enrollment goal of 110,000 customers, so it conducted limited recruitment marketing activities from spring 2020 through the winter 2020/2021 period. PGE employed the five marketing activities described in Table 4. In particular, PGE focused on targeted email marketing with a small subset of customers expected to have high savings for opt-in PTR.

Table 4. Summary of Flex PTR (Opt-In) Recruitment Marketing Activities

Activity	Description of Activity
Targeted Emails	PGE sent multiple PTR recruitment emails to Big Impactors and Fast Growers (i.e., the two microsegments with the highest demand savings potential among the five microsegments).
PTR Webpage	PGE promoted PTR on its website and updated program information content.
Paid Media Ads	PGE promoted PTR in local newspapers, Pandora Radio, and social media.
YouTube Video	PGE created a video to explain peak times, describe what shifting energy is, and promote PTR. This video was posted on the PTR program webpage and on social media.
Live Stream Concert	To celebrate customers who participated in PTR summer 2020 and promote PTR, PGE held a live stream concert in October 2020.

Test Bed PTR (Opt-Out)

No recruitment marketing was necessary for Test Bed PTR because customers are auto-enrolled. PGE auto-enrolled most of its residential Test Bed customers in PTR in June 2019 when the SGTB project launched. Every few months since then, PGE auto-enrolled any new Test Bed customer accounts in PTR. PGE informs these new customers of their auto-enrollment in PTR via email and direct mail.

Enrollment Process

The enrollment process for Flex 2.0 PTR differed by how the customer was recruited. PGE customers outside of the Test Bed could enroll in PTR online through the PGE website or by calling PGE’s customer call center. Customers within the Test Bed were auto-enrolled by PGE. Upon enrollment, customers selected their preferences for event communication (text, email, or both).

Enrolled customers could opt out at any time by either unsubscribing from all event communications or contacting the PGE call center.

Customer Engagement and Education Marketing

PGE prioritized keeping its current enrolled customers engaged with PTR and increasing their demand impacts from the previous summer and winter seasons. As shown in Table 5, PGE employed many new

customer engagement and education marketing materials and activities for summer 2020 and winter 2020/2021.¹⁶

¹⁶ During recent event seasons, PGE also tested enhanced messaging going beyond rebates, using customer testimonials about participation, touching on topics of community involvement, and emphasizing clean energy solutions.

Table 5. Summary of PTR Customer Engagement and Education Marketing Materials and Activities

Material/Activity	Description of Material/Activity	New in Summer 2020 and Winter 2020/2021
Welcome-to-the-Season Email	At the start of the summer and winter season, PGE emailed customers to announce the start of the event season. This email contained links to resources on how to prepare for and participate in events.	
Energy Saving and Shifting Tips	PGE sent tip-focused emails to educate customers on how to reduce and shift energy during events. Every pre-event notification sent to customers included a link to tips and resources. Tips were not customized.	
Energy Savings Guide infographic	To help customers understand which actions and areas of the home save the most money during an event, PGE created an infographic and emailed it to customers. This infographic was also embedded in pre-event notification emails and was also available on the PTR webpage.	✓
PTR Checklist	During the start of the summer and winter seasons, PGE emailed customers a checklist, customized according to the season, on how to prepare for events and what to do. This checklist was also embedded in pre-event notification emails and available on the PTR webpage.	✓
Event Forecast Email	In early February 2021, PGE emailed customers an event forecast that alerted them of possible events during the current and following weeks. PGE planned to send more event forecast emails during the winter season but was unable to because a winter storm caused widespread power outages.	✓
Day-ahead Event Notification	PGE scheduled and dispatched events through the Oracle technology platform, which sent event notifications to customers on the day before the scheduled event. Event notifications, sent via email and/or text, came with tips on how to shift or reduce energy usage during the event.	
Same-day Event Notification	Starting in summer 2020, PGE directly emailed all customers event notifications on the morning of the event. Event notifications, sent via email and/or text, came with tips on how to shift or reduce energy usage during the event. In winter 2020/2021, PGE partnered with a text message vendor to send same-day text message reminders.	✓
Gift Card Sweepstakes	To motivate customers to participate in events and increase their participation (i.e., demand impacts), PGE offered an end-of-season sweepstakes that customers who earned a rebate during at least one event could enter. Prizes included Amazon, Fred Meyer, and local business gift cards.	✓
Web Program Information	PGE revised content for its PTR program with clearer explanations and links to resources.	
Family Activity Sheets	To give families with kids something to do during events, PGE offered downloadable activity sheets from the PTR webpage. These included PTR- and energy-themed coloring sheets and word puzzles.	✓
YouTube Video	PGE created a video to explain peak times and shifting energy. This video was posted on the PTR program webpage and on social media.	✓
Live Stream Concert	To celebrate customers who participated in PTR summer 2020, PGE held a live stream concert on August 13, 2020 on Facebook. PGE planned another concert to celebrate winter 2020/2021 participation, but it was canceled due to the winter storm.	✓
End-of-the-Season Email	After the end of the summer season, PGE sent an email to thank customers for their participation and announce winners of the gift card sweepstakes. The end-of-season email for winter was canceled due to the winter storm.	

Event Management

This evaluation covers two Flex 2.0 PTR peak time event seasons—summer (June through September 2020) and winter (November 2020 through February 2021). PGE called five events in summer 2020 and two events in winter 2020/2021, as shown in Table 6. Each event lasted three hours. Events were called only on non-holiday weekdays Monday through Thursday. Because of the prepurchase stipulations with its implementation contractor, PGE could call events only at a fixed time and duration (i.e., three-hour events from 5 p.m. to 8 p.m.), was unable to dispatch morning events, back-to-back events, or on weekends, and was limited to five events within a single block purchase.

Table 6. Flex 2.0 Summer 2020 and Winter 2020/2021 Peak Time Events

Season	Event	Day of week	Date	Avg. Outdoor Temp. (°F) ¹	Start Time	Duration (hours)
Summer 2020	1	Tuesday	6/23/2020	88°	5 p.m.	3 hours
	2	Tuesday	7/21/2020	84°	5 p.m.	3 hours
	3	Thursday	7/30/2020	92°	5 p.m.	3 hours
	4	Monday	8/17/2020	90°	5 p.m.	3 hours
	5	Thursday	9/03/2020	89°	5 p.m.	3 hours
Winter 2020/2021	1	Monday	1/25/2021	38°	5 p.m.	3 hours
	2	Wednesday	1/27/2021	41°	5 p.m.	3 hours

¹ Outdoor temperature is the average temperature during event hours.

Event Communications

PGE scheduled and dispatched events through the Oracle technology platform, which sent event notifications to customers on the day before the scheduled event. Event notifications, sent via email and/or text, came with tips on how to shift or reduce energy usage during the event. Starting in summer 2020, PGE directly emailed all customers event notification reminders on the morning of the event. In winter 2020/2021, PGE partnered with a text message vendor to send same-day text message reminders.

By 8 p.m. the day after the event, most customers had received an email and/or text with their event results. Most customers received their post-event results within three days. Customers learned if they saved energy during the event and, for those who did save, how much they earned in bill credits. These credits appeared in the customer’s next billing statement. Customers could also view their past event results on the PTR performance history page of their individual online PGE account.

Event Impact and Rebate Calculations

PTR customers earned \$1 for every kWh of savings relative to their baseline energy consumption. PGE calculated savings and paid rebates after each event.

PGE contracted with E Source to calculate the baseline energy consumption for each customer, the customer’s energy savings, and rebates resulting from the peak time events. E Source coordinated with PGE’s data management system to obtain AMI consumption data for calculating load impacts and with Oracle’s data management system to supply the data that fed into customers’ event results.

Beginning in summer 2020, each PTR customer’s baseline energy consumption was calculated using a 10-in-10 day day-matching method that included a weather-based adjustment to the baseline to account for each customer’s cooling and heating sensitivity. This method was different from the methods used in summer 2019 (each customer’s baseline was calculated using one of four methods, and updated across the summer to provide better accuracy as new data became available) and winter 2019-2020 (customer baselines were calculated using a 5-in-10 day day-matching method with no weather adjustment). These changes were made to simultaneously improve baseline calculation accuracy, repeatability, and comprehension by participants.

Microsegments

Before summer 2019, E Source also segmented PGE customers into one of five microsegments. As described in Table 7, these microsegments reflect customers’ predicted potential demand response capacity and likely engagement with demand response programs. These microsegments, ranked here in order of potential demand response from highest (Big Impactors) to lowest (Low Engagers), were developed specifically for the Flex 2.0 pilot to identify the customers who are the best fit for the program and to guide program marketing and evaluation.

Table 7. Microsegment Descriptions

Microsegment	Description
Big Impactors (3%)	Larger single-family dwellings, with high income ranges and subsequent billing metrics, busy and likely to have digital subscription activity
Fast Growers (10%)	Tend to track tightly with Big Impactors, except behaviors show the most engaged with technology
Middle Movers (24%)	Track with Fast Growers, proportionally lower housing size and income, notably close with respect to technology
Borderliners (34%)	May lean toward Low Engagers or toward Middle Movers, could be viewed as potential Middle Movers, tend to rent
Low Engagers (27%)	Most likely to interact with newspapers, flyers, and traditional media, least technologically inclined, tend to live in smaller housing (by square footage), lower household income, and comparatively older demographic

Source: E Source

Note: Microsegment proportions of 92,428 participants still enrolled as of March 21, 2021. The remaining 3% of participants did not have a microsegment indicated. Percentages do not sum to 100% due to rounding. Microsegment percentages shown here differ from those used in the impact evaluation for two reasons. First, E Source regularly updates microsegment assignments for each customer, so customer microsegment classifications are not static over time. Second, the population enrolled as of March 21, 2021, differs from the population enrolled during summer 2020 and winter 2020-2021 events due to changes in program enrollment.

Evaluation Findings

This section presents the major evaluation findings on Flex 2.0 PTR in the order of program flow, from enrollment and delivery through savings achieved and customer experience, about these topics:

- Enrollment and retention
- Event communications and management
- Load impacts
- Customer experience

Additional impact findings are presented in *Appendix C*.

Enrollment and Retention

Table 8 presents the counts of PTR enrollments and unenrollments, including starting and ending enrollments, opt-outs, account closures, and new enrollments for the evaluation period covered in this report. As of March 11, 2021, 92,455 customers were enrolled in PTR. This enrollment constituted a net increase of 25,682 customers from a year earlier (March 1, 2020).

At the end of 2020, PGE had 87,234 enrolled customers, which fell short of PGE's 2020 enrollment goal of 110,000 customers. The shortfall was due to PGE's decision in the early part of 2020 to decelerate its recruitment activities as it quickly approached its enrollment goal. PGE limited its recruitment and marketing by focusing on the two smallest yet highest impact microsegments, Big Impactors and Fast Growers. Marketing campaigns to recruit new customers for the program were planned for September 2020, but stalled due to the Oregon wildfires.

PTR enrollment was also affected by higher unenrollments in 2020 (22%) than 2019 (13%), stemming primarily from a high rate of account closures (rather than customers leaving the program). Between March 2020 and March 2021, over 25,000 customers were unenrolled from the program. Account closures made up 22,138 or 87% of this total, with migration to the smart thermostat program and other opt-outs making up the remainder. The large volume of account closures was costly to address because PGE had to market the program to and enroll thousands of new customers just to maintain enrollments. The higher-than-normal number of account closures in 2020 may have been due to customers moving, canceling leases, or changing their housing situation as a result of the COVID-19 pandemic. PGE plans to increase enrollments during summer 2021 with several promotions with the Portland Thorns FC, which has one of the largest online audiences and social media presences in the region, and has reinstated transferring program enrollment during move and start service through customer service representatives.

Table 8. Flex 2.0 PTR Enrollment and Unenrollment Rates

Category	Group	Participant Counts		
		Test Bed PTR	Flex PTR	Totals
Beginning Enrollment	Beginning Enrollment (as of March 1, 2020)	15,645	74,887	90,532
New Enrollment	New Enrollees through March 11, 2021	4,163	23,442	27,605
Unenrollments	Opt Outs (total)	585	2,959	3,544
	Opt Out - migrated	186	1,270	1,456
	Opt Out - non-migrated	399	1,689	2,088
	Account Closures	2,845	19,293	22,138
	Total Unenrollments (March 1, 2020, to March 11, 2021)	3,430	22,252	25,682
Ending Enrollment	Enrollment (December 31, 2020)	14,785	72,449	87,234
	Enrollment (March 11, 2021)	16,378	76,077	92,455
	Retention Rate	96.6%	96.3%	96.3%
	Retention Rate (adjusted for smart thermostat migration)	97.6%	97.8%	97.8%
Total Enrollment	Customers Enrolled (including unenrollments) – March 1, 2020 through March 11, 2021	19,808	98,329	118,137

Source: PGE program tracking data. The PTR retention rate was calculated as (ending enrollment)/(total enrollment – number of account closures). “Migrated” refers to migration of customers from PTR to PGE’s smart thermostat demand response program.

Though attrition from account closures was high, the retention rate for customers who did not close their accounts remained high and consistent from 2019. From March 1, 2020 (end of winter 2019/2020 season), through March 11, 2021 (most recent data), the PTR retention rate was 96.6% for Test Bed PTR participants and 96.3% for Flex PTR participants.¹⁷ The PTR retention rate is defined as the percentage of customers enrolled at the beginning of the period whose service accounts remained active and who remained enrolled in PTR at the end of the period.

When retention was recalculated after excluding PTR participants who migrated to the Smart Thermostat Demand Response pilot program, retention rates increased to 97.6% for Test Bed PTR participants and 97.8% for Flex PTR participants.¹⁸ PGE is therefore meeting its 97% participant retention goal both overall and individually for Flex PTR and Test Bed PTR.

Figure 2 shows PTR retention over time as the percentage of customers enrolled in the PTR program on or before July 13, 2019 (during the first Flex 2.0 event season), who remained enrolled. This analysis includes auto-enrolled customers and customers who had previously self-enrolled before this date. The analysis excludes customers whose accounts closed or who were unenrolled because they were ineligible for the program during this period (e.g., enrolled in PGE’s smart thermostat demand response

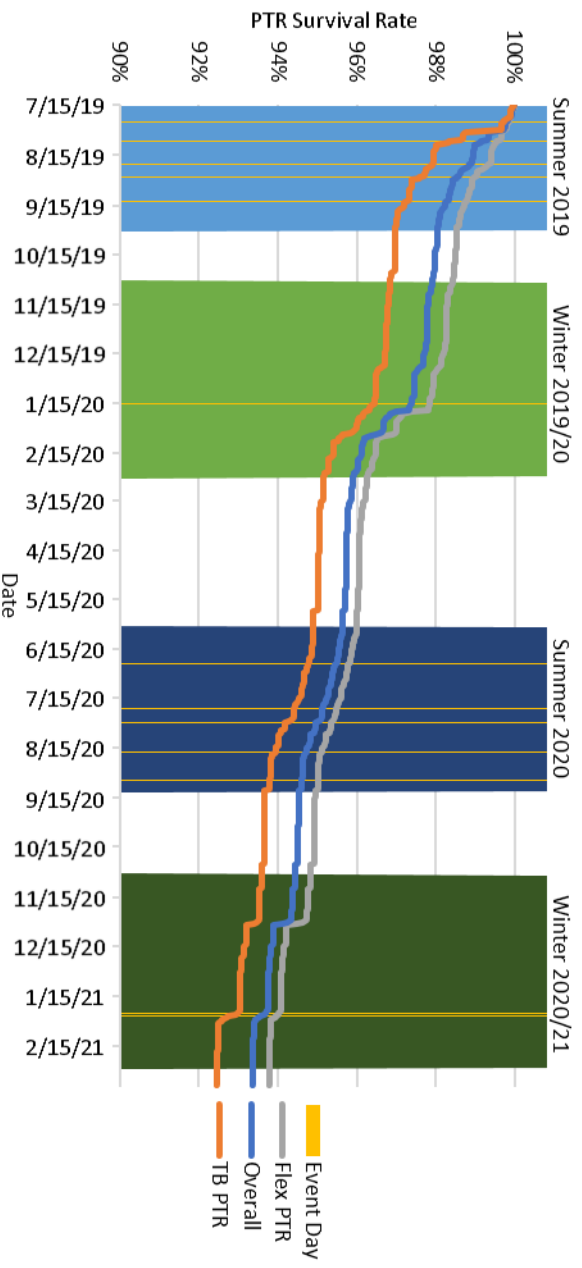
¹⁷ The PTR retention rate was calculated as (ending enrollment)/(total enrollment – number of service account closures).

¹⁸ Note, migration of participants from behavior-based demand response, such as PTR (non-firm) to automated or dispatchable demand response, such as direct load control (DLC) options (firm), is part of PGE’s broader demand response planning strategy.

program). The retention rates by March 11, 2021, were 92.5% for Test Bed PTR participants and 93.8% for Flex PTR participants.¹⁹

The survival rates for Flex PTR and Test Bed PTR customers followed similar trends across most of the analysis period. The only period with a significant difference between the two survival rates was during the first half of the summer 2019 event season, when a larger percentage of auto-enrolled Test Bed customers unenrolled from the PTR program, probably because they did not want to participate. Across the analysis period, unenrollments and declines in enrollment are evident after event days and appear greater for winter than summer events. The decrease in enrollment in December 2020 reflects the unenrollment by PGE of a batch of customers who were deemed ineligible or asked to be unenrolled from the program.

Figure 2. PTR Enrollment Survival Rates for Flex PTR and Test Bed PTR



Event Communications

Through the staff interviews, Cadmus identified these four improvements and successes regarding event communications:

- Full-scale implementation of same-day event reminders via email and text message.** After customers asked for same-day event reminders, PGE developed and tested same-day event email reminders during winter 2019/2020 among the Test Bed PTR customers. The test was successful, so PGE emailed same-day reminders to all PTR customers in summer 2020. During winter 2020/2021, PGE partnered with a text message vendor to send same-day text message reminders. PGE plans to continue sending same-day event reminders via email and text message to customers in future seasons.

¹⁹ The retention or survival rates are higher in Table 8 because they include customers who enrolled after July 13, 2019.

- **Near-time implementation of same-day event reminders via email and text message.** During summer 2020, PGE sent the same-day event reminders during the morning hours. Starting in winter 2020/2021, PGE changed the timing to 3 p.m. so reminders were sent closer to the event start time (usually 4 p.m. or 5 p.m.).
- **Ability to call events on Mondays and weekends.** In prior seasons, PGE could not call events on Mondays and weekends due to a technology issue with the implementation contractor. This issue was resolved and PGE was able to call a Monday summer event on August 17, 2020, and a Monday winter event on January 25, 2021. PGE will be able to call events on weekends starting in summer 2021 when it begins dispatching events in-house.
- **Delivery of post-event results to customers on time.** PGE reported that the implementation contractors (E Source and Oracle) delivered post-event results to PTR customers on time during both seasons. Most customers received an email and/or text with their event results by 8 p.m. the day after the event.

The evaluation identified the following four challenges with event communications:

- **Suspension of events during the wildfires and winter storm.** PGE intended to call more than five events during summer 2020 and more than two events during winter 2020/2021. However, PGE decided to suspend events as a result of Oregon wildfires during summer 2020 and the winter 2021 snow and ice storm. Even though PGE had the technical ability to call events during these crises, it chose not to do so for the sake of its customers.
- **Limitations to calling more events.** The event communications implementation contractor's platform prevented PGE from calling back-to-back events, events in the morning, or on Mondays. To regain control over peak time events, PGE has decided to use its in-house resources to dispatch events and implement event communications starting in summer 2021.
- **Pre- and/or post-event communications not sent to all customers due to ongoing issues with syncing enrollment counts.** In the previous evaluation, Cadmus reported that PGE was having issues with customer enrollment synchronization with its event implementation contractors. Approximately 8,800 participants did not receive pre-event notifications for the first two events during summer 2019. PGE said this synchronization issue continued through the summer 2020 and winter 2020/2021 seasons, though fewer customers were affected (approximately 3,500 customers did not receive a pre- or post-event communication per event). PGE expects that the synchronization issue will be reduced to nominal numbers when event communications are managed with in-house resources.

PTR Load Impacts

Cadmus analyzed residential customer AMI interval consumption data to estimate the PTR load impacts. First, Cadmus employed propensity score matching to identify non-enrollees who had similar propensities to enroll in PTR. The demand of the matched control group constituted the baseline for estimating PTR savings. The savings were then estimated in a panel regression analysis of customer hourly electricity consumption on time-period fixed effects, a control variable for each customer's

average electricity consumption during the same hour on non-event days, the customer’s enrollment propensity score, and an indicator for PTR program enrollment interacted with hour of the event day.

Appendix A describes the methodological details of the analysis and additional results.

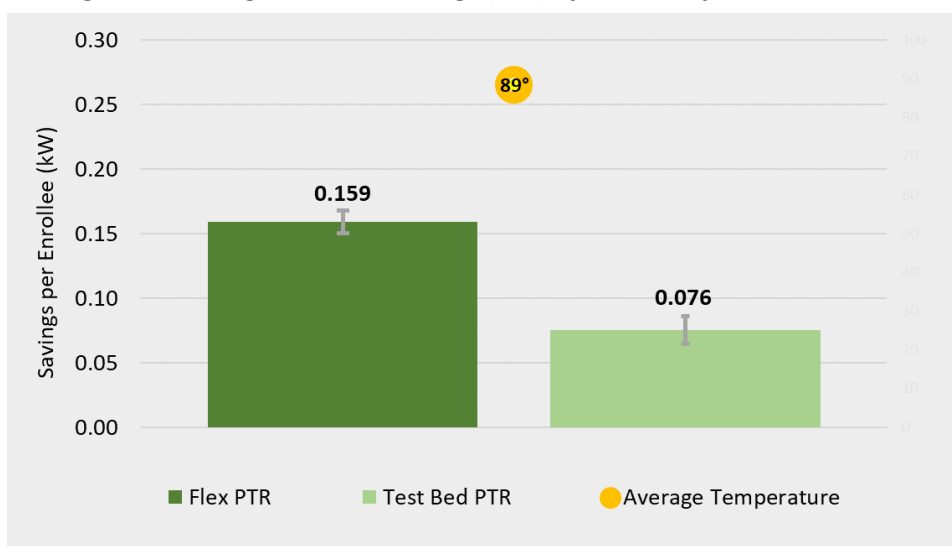
Summer Load Impacts

This section presents estimates of the average demand savings per PTR enrollee, the average demand savings per enrollee by demand response microsegment, and total demand savings for the PTR program for the five events in summer 2020.

Demand Savings Estimates by Event – Summer

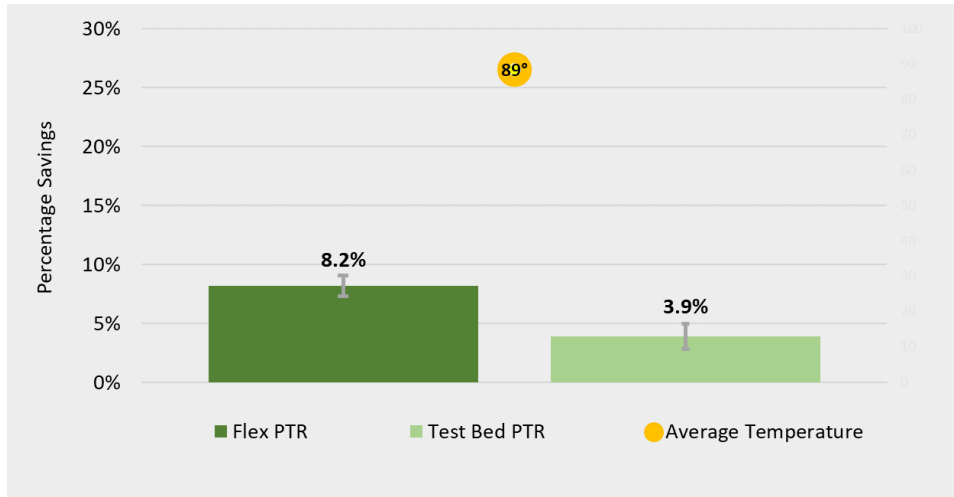
Figure 3 and Figure 4 show the average demand savings and percentage savings per enrollee, respectively, by PTR groups (Flex PTR and Test Bed PTR) and outside temperature during summer 2020 PTR events. The average savings across all summer events were 0.159 kW for Flex PTR and 0.076 kW for Test Bed PTR. All estimates were statistically significant at the 10% level.

Figure 3. Average Demand Savings (kW) by PTR Group – Summer 2020



Notes: Estimates based on Cadmus analysis of AMI meter data for Flex 2.0 PTR enrollees and matched comparison group. Error bars indicate 90% confidence intervals based on standard errors clustered on customers.

Figure 4. Percentage Savings by PTR Group – Summer 2020

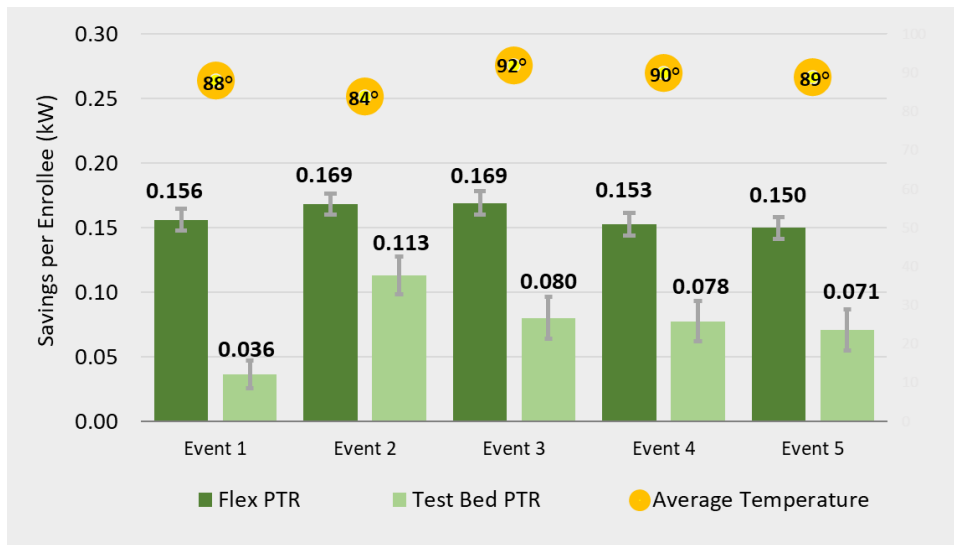


Notes: Estimates based on Cadmus analysis of AMI meter data for Flex 2.0 PTR enrollees and matched comparison group. Percentage savings estimated as kW savings divided by baseline demand. Error bars indicate 90% confidence intervals based on standard errors clustered on customers.

As in 2019, savings for Test Bed enrollees were substantially lower than saving for Flex PTR enrollees, likely because most Test Bed enrollees had been automatically enrolled in PTR and therefore their motivation to save was lower on average.

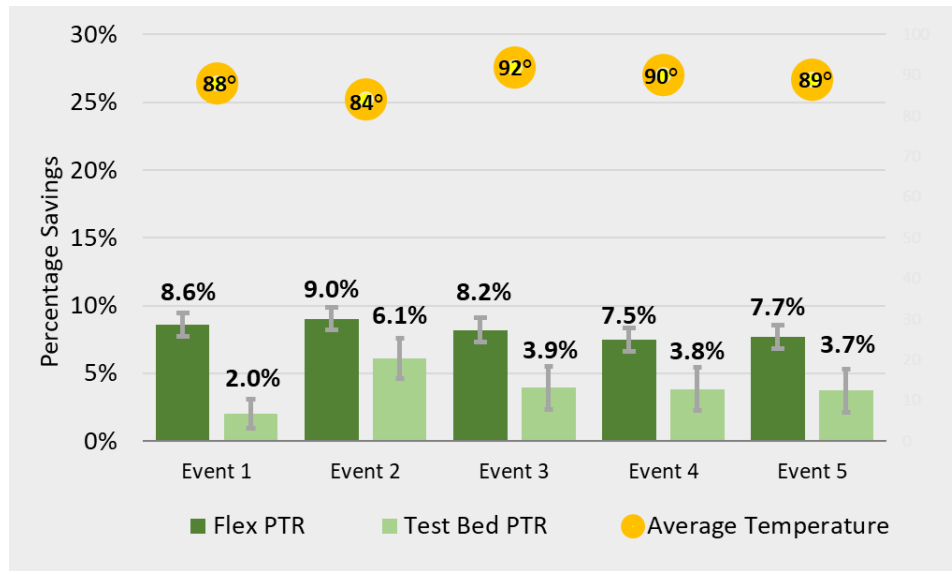
Figure 5 and Figure 6 show the average demand savings and percentage savings per enrollee, respectively, by PTR group and event.

Figure 5. Average Demand Savings (kW) by Event and PTR Group – Summer 2020



Notes: Estimates based on Cadmus analysis of AMI meter data for Flex 2.0 PTR enrollees and matched comparison group. Error bars indicate 90% confidence intervals based on standard errors clustered on customers.

Figure 6. Percentage Savings by Event and PTR Group – Summer 2020



Notes: Estimates based on Cadmus analysis of AMI meter data for Flex 2.0 PTR enrollees and matched comparison group. Percentage savings estimated as kW savings divided by baseline demand. Error bars indicate 90% confidence intervals based on standard errors clustered on customers.

An obvious relationship between outside temperature and PTR demand savings was not evident for either Flex PTR or Test Bed PTR. During 2019, the first summer of Flex 2.0, there was a positive correlation between the estimated demand savings and outdoor temperature. The absence of a relationship in summer 2020 may have been due to the limited range of event temperatures and the statistical uncertainty of the savings estimates. Calling more events during summer 2021 at a wider range of temperatures will help clarify the temperature sensitivity of PTR savings.

Table 9 shows the average demand savings per enrollee by event hour for Flex PTR and Test Bed PTR. There was relatively little variation in demand savings between hours of each event, with savings not varying by more than about 0.03 kW per enrollee for most events.

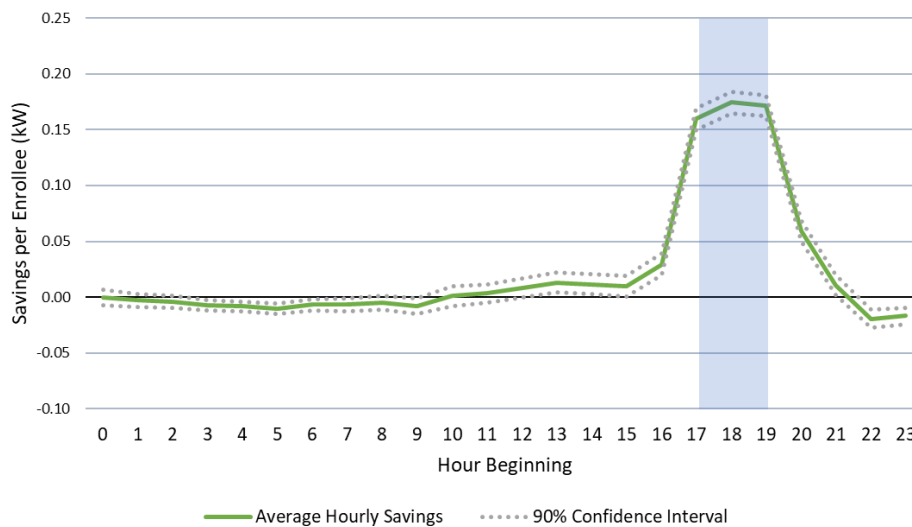
Table 9. Average Demand Savings (kW) by Event Hour and PTR Group– Summer 2020

Program Group	Event	Beginning and Ending Times	Average Demand Savings per Enrollee (kW)			
			Hour 1	Hour 2	Hour 3	Event Average
Flex PTR	Event 1	5 p.m. – 8 p.m.	0.145	0.165	0.158	0.156
	Event 2	5 p.m. – 8 p.m.	0.160	0.174	0.171	0.169
	Event 3	5 p.m. – 8 p.m.	0.143	0.190	0.174	0.169
	Event 4	5 p.m. – 8 p.m.	0.138	0.164	0.157	0.153
	Event 5	5 p.m. – 8 p.m.	0.123	0.159	0.168	0.150
	Average		0.142	0.170	0.166	0.159
Test Bed PTR	Event 1	5 p.m. – 8 p.m.	0.036	0.048	0.025	0.036
	Event 2	5 p.m. – 8 p.m.	0.111	0.118	0.111	0.113
	Event 3	5 p.m. – 8 p.m.	0.076	0.085	0.079	0.080
	Event 4	5 p.m. – 8 p.m.	0.075	0.091	0.067	0.078
	Event 5	5 p.m. – 8 p.m.	0.067	0.073	0.073	0.071
	Average		0.073	0.083	0.071	0.076

Notes: Estimates based on Cadmus analysis of AMI meter data for Flex 2.0 PTR enrollees and matched comparison group. Error bars indicate 90% confidence intervals based on standard errors clustered on customers.

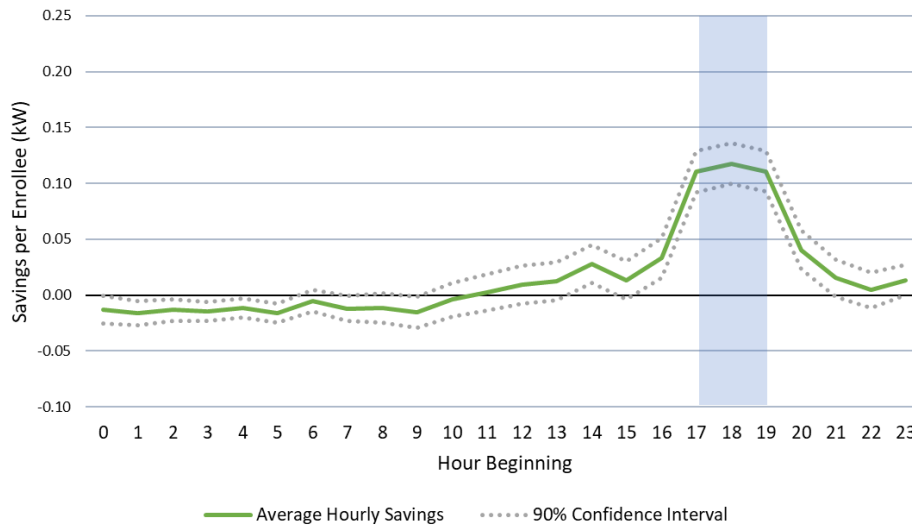
In addition to estimating savings for each event hour (as shown above), Cadmus also estimated savings for each event day hour. Figure 7 presents the average savings per enrollee for Event 2, with 90% confidence intervals, and is typical of the event day PTR savings shape. The event hours are shaded in blue. *Appendix B* provides the corresponding figures for the other event days.

Figure 7. Flex PTR Average Hourly PTR Savings (Event 2) – Summer 2020



Note: Estimates are based on Cadmus analysis of AMI meter data for Flex 2.0 PTR enrollees and matched comparison group. In the Event 2, there were 73,676 Flex PTR enrollees and 15,728 Test Bed PTR enrollees.

Figure 8. Test Bed PTR Average Hourly PTR Savings (Event 2) – Summer 2020



Note: Estimates are based on Cadmus analysis of AMI meter data for Flex 2.0 PTR enrollees and matched comparison group. In the Event 2, there were 73,676 Flex PTR enrollees and 15,728 Test Bed PTR enrollees.

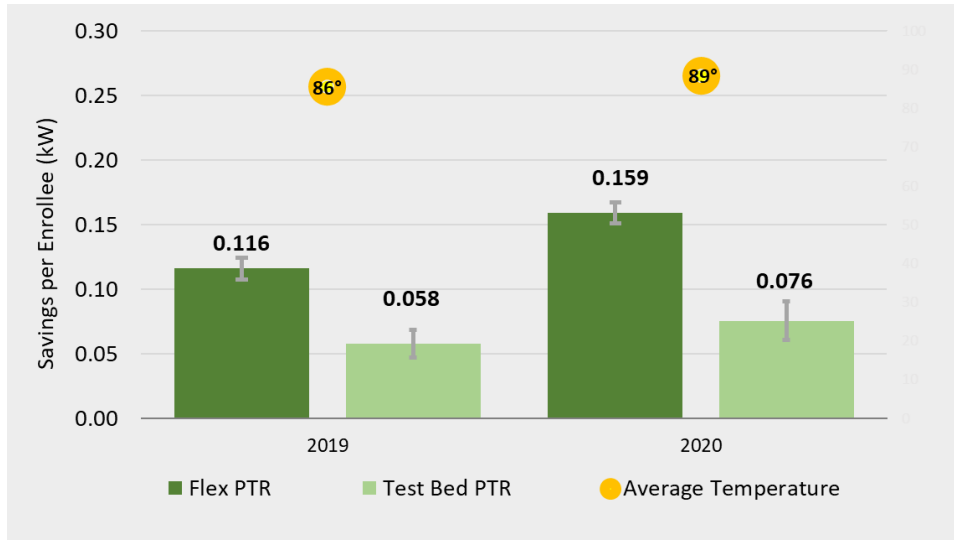
There are two notable aspects of the Flex PTR and Test PTR hourly savings profiles. First, as noted above, the PTR savings are nearly constant across event hours. Second, savings spilled into the hours immediately preceding and following the event window. This pattern occurred for most events for Flex PTR but was much less common for Test Bed PTR. The phenomenon may reflect efforts to save energy that were not precisely targeted during PTR event hours, such as enrollees making changes to their thermostat setpoints earlier in the day, delaying energy-consuming activities to another day, or leaving their homes before the event started and returning after it ended.

Figure 9 compares the average evaluated savings between summer 2019 and summer 2020. Demand savings per enrollee were higher in 2020 than in 2019 for both Flex and Test Bed PTR groups. Average outdoor temperatures during events were also higher in 2020 than in 2019.²⁰ The increase in savings is statistically significant for Flex PTR, but not for Test Bed PTR. However, there was only a slight increase in the overall percentage savings for both PTR groups, and these were not statistically significant changes. Causes of higher savings in 2020 could include greater program awareness, changes to customer pre-event notifications, calling events during residential customer peak demand from 5 p.m. to 8 p.m. instead of 4 p.m. to 7 p.m., changes in the composition of the participant population, and/or

²⁰ In addition, the distributions of enrollees across microsegment groups changed substantially between 2020 and 2019. In 2020, nearly all enrollees had microsegment assignments, unlike in 2019 when up to 44% were missing microsegment assignments. Corresponding with the drop in missing microsegment assignments in 2020 were increases in the Borderliners and Middle Movers segments. Finally, the proportion of Low Engagers among PTR enrollees also decreased in 2020. These changes, however, are not necessarily causal with respect to changes in demand savings, and may reflect changes to the microsegment definitions, or changes in enrollee consumption patterns resulting in microsegment reassignment.

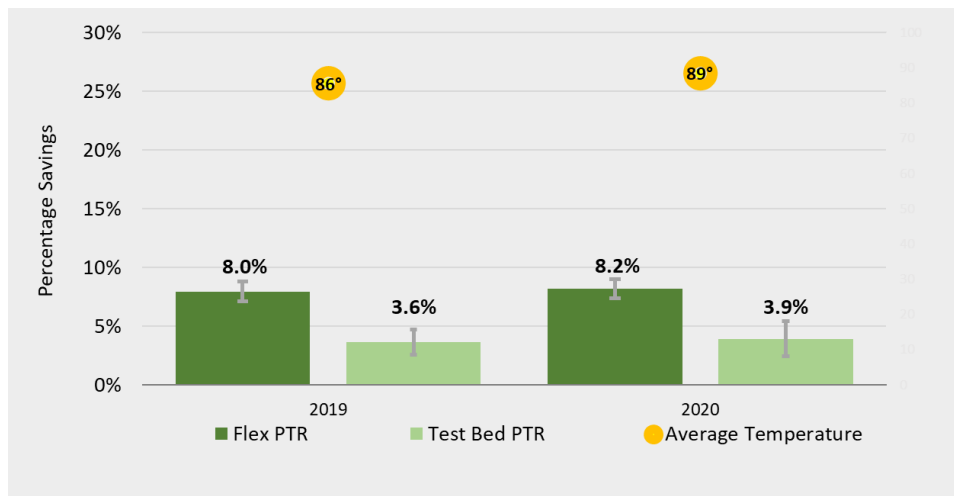
improvements in accuracy of customer rebate calculations that strengthen the link between action and reward.

Figure 9. Average Summer Demand Savings (kW) Savings by Year and PTR Group



Notes: Estimates based on Cadmus analysis of AMI meter data for Flex 2.0 PTR enrollees and matched comparison group. Error bars indicate 90% confidence intervals based on standard errors clustered on customers.

Figure 10. Summer Percentage Savings by Year and PTR Group

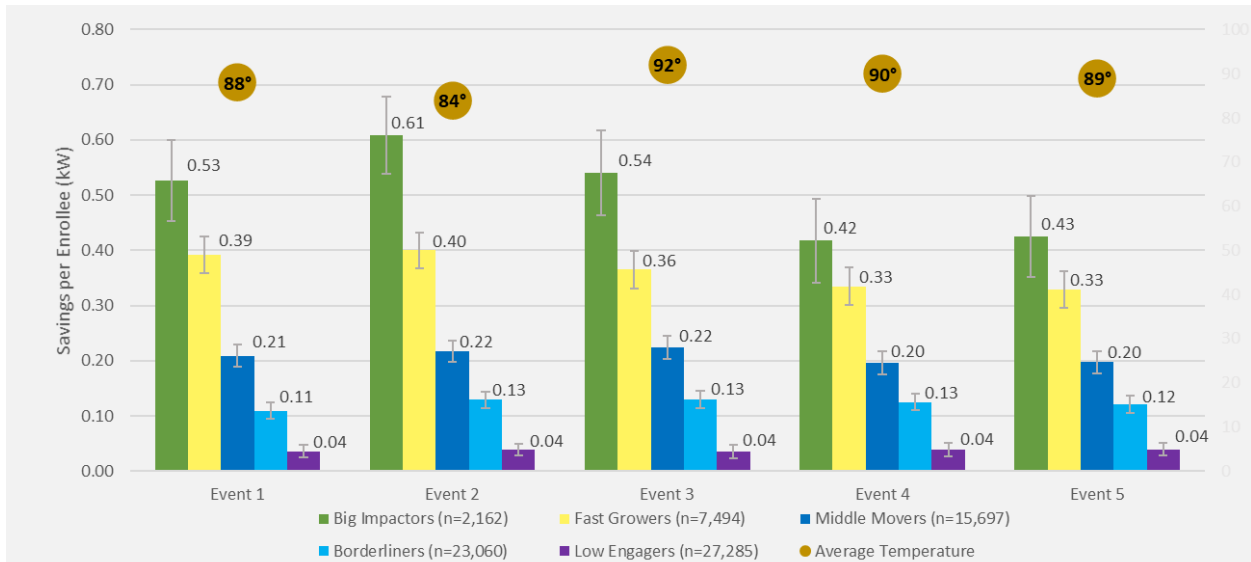


Notes: Estimates based on Cadmus analysis of AMI meter data for Flex 2.0 PTR enrollees and matched comparison group. Percentage savings estimated as kW savings divided by baseline demand. Error bars indicate 90% confidence intervals based on standard errors clustered on customers.

Demand Savings Estimates by Microsegment – Summer

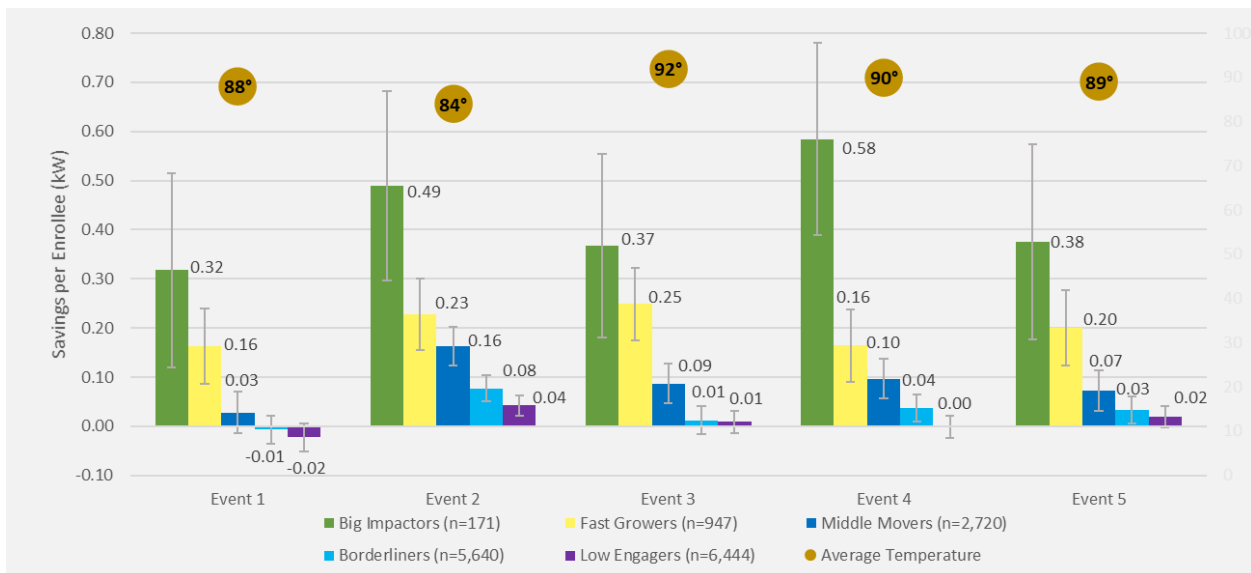
Figure 11 and Figure 12 show the average demand savings per enrollee by event and microsegment for Flex PTR and Test Bed PTR. As shown, there were substantial differences in average PTR savings by microsegment. See Table 7 above for descriptions of these microsegments.

Figure 11. Average Demand Savings (kW) by Event and Microsegment (Flex PTR) – Summer 2020



Notes: Estimates based on Cadmus analysis of AMI meter data for Flex 2.0 PTR enrollees and matched comparison group. Error bars indicate 90% confidence intervals based on standard errors clustered on customers.

Figure 12. Average Demand Savings (kW) by Event and Microsegment (Test Bed PTR) – Summer 2020



Notes: Estimates based on Cadmus analysis of AMI meter data for Flex 2.0 PTR enrollees and matched comparison group. Error bars indicate 90% confidence intervals based on standard errors clustered on customers.

In both PTR groups, Big Impactors, Fast Growers, and Middle Movers consistently achieved higher savings than the other groups, though these differences were not always statistically significant. Savings

per enrollee of these customer segments averaged between approximately 0.20 kW and 0.61 kW for Flex PTR and between 0.03 kW and 0.58 kW for Test Bed PTR. Conversely, Low Engagers achieved substantially lower savings but accounted for over a third of all enrollees in each PTR group, which had the effect of reducing overall average savings.

When excluding low-saving (and missing) segments, the average events savings were approximately 25% higher, at 0.20 kW (8.7%) for Flex PTR and 0.10 kW (4.2%) for Test Bed PTR.

Program-Level Demand Savings – Summer

Table 10 presents the total PTR program-level demand savings during summer 2020 events. The program savings were estimated by multiplying the average evaluated per-enrollee impacts by the reported total number of enrollees.²¹ Evaluated savings are compared to PGE’s reported demand savings estimates, which are based on a matched control group analysis. As shown, evaluated demand savings varied slightly from the reported savings for each event, with the overall seasonal average resulting in slightly higher load impacts (12.57 MW) than the reported values (11.12 MW).

Table 10. PTR Program Total Savings – Summer 2020

Event	Event Times	Avg. Temp. (°F)	Evaluation Avg. Demand Savings per Enrollee (kW)	Reported Enrollees	Evaluation Demand Savings (MW)	Reported Demand Savings (MW)
Event 1	5 p.m. – 8 p.m.	88	0.123	91,690	11.26	11.01
Event 2	5 p.m. – 8 p.m.	84	0.159	89,404	14.20	12.40
Event 3	5 p.m. – 8 p.m.	92	0.153	88,799	13.62	12.10
Event 4	5 p.m. – 8 p.m.	90	0.140	87,090	12.15	9.90
Event 5	5 p.m. – 8 p.m.	89	0.136	85,706	11.64	10.17
Average		89	0.142	88,538	12.57	11.12

Note: Evaluated demand savings were estimated from a panel regression of customer hour interval consumption for enrollees and matched non-enrollees. Evaluated demand savings are weighted by the counts of enrollees in Flex and Test Bed PTR. See *Appendix A* for estimation details.

PGE PTR Payments – Summer

PTR enrollees earned rebates for energy savings measured relative to customer-specific consumption baselines. If a customer’s actual consumption during event hours was below the estimated baseline, they earned a rebate equal to \$1 per kWh of savings. If consumption was above the baseline, they received no rebate and there was no penalty.²² PGE paid customers for any measurable savings,

²¹ PGE provided counts of enrollees for each event.

²² PTR provides asymmetric incentives to save depending on whether a customer’s consumption is above or below the customer’s baseline. Customers face a higher effective marginal price for electricity equal to the sum of the rebate and the standard electricity rate when their consumption is below their baseline and a lower effective marginal price for electricity equal to the standard electricity rate when consumption is above the baseline.

whether the savings were the result of purposeful behaviors, naturally occurring and would have occurred in absence of the event, from random fluctuations in the customer’s consumption, or attributable to an inaccurate calculation of the baseline.²³ Since PGE cannot differentiate between savings caused by the program and attributable to other factors, some overpayment for savings is inevitable. This inherent feature of PTR programs can be mitigated to some extent through greater accuracy of individual customer baseline calculations, which represent expected consumption in the absence of the event.

Table 11 compares Cadmus’ evaluated savings with PGE’s rebated PTR savings for each event and during summer 2020 overall. This comparison shows the average accuracy of the rebates across all customers and not the accuracy for any individual customer. The payment ratio column shows the ratio of the savings PGE paid for to the evaluated savings. Overall, PGE paid 2.45 times more for PTR savings than it would have paid if it only paid for achieved savings (i.e., PGE paid enrollees an average of \$2.45 for every kWh of PTR savings). However, as explained above, overpayment is inherent to PTR programs, and evaluators of other PTR programs have found similar levels of overpayment. For example, Wolak (2006) found that Anaheim Public Utilities PTR program paid participants for seven times the savings the utility achieved.²⁴

Table 11. Summer 2020 PTR Payment Ratios

Event	Rebated Savings (MWh)	Evaluated Savings (MWh)	Payment Ratio (Rebated Savings/ Evaluated Savings)
1	97.38	33.78	2.88
2	63.82	42.59	1.50
3	112.91	40.87	2.76
4	90.24	36.45	2.48
5	97.07	34.92	2.78
Total	461.42	188.61	2.45

Notes: Evaluated savings based on Cadmus analysis of AMI meter data for Flex 2.0. Rebated savings were calculated by PGE (Esource) based on individual customers baselines.

²³ To see how overpayment can arise through random fluctuations in customer demand, suppose that a customer’s true PTR savings were zero, but the savings are measured with uncertainty or error because of random variation in the customer’s consumption. If the savings estimate has a normal distribution with a mean or expectation of zero, 50% of the time the customer will earn a rebate, even though the customer’s true savings were zero.

²⁴ Wolak, Frank (2006). *Residential Customer Response to Real-Time Pricing: The Anaheim Critical-Peak Pricing Experiment*. Center for the Study of Energy Markets working paper 151.
<https://escholarship.org/uc/item/3td3n1x1>

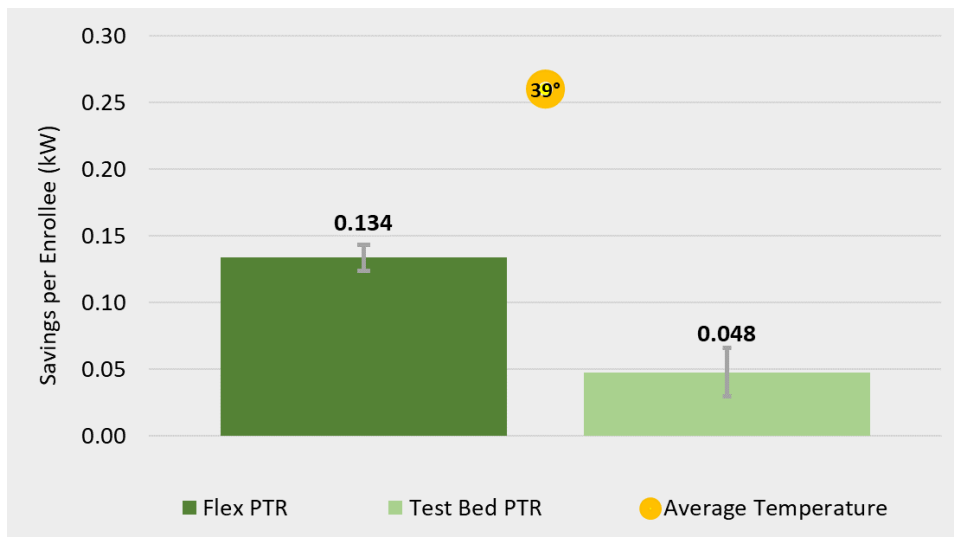
Winter Load Impacts

This section presents estimates of PTR savings for the two events in winter 2020/2021.

Demand Savings Estimates by Event – Winter

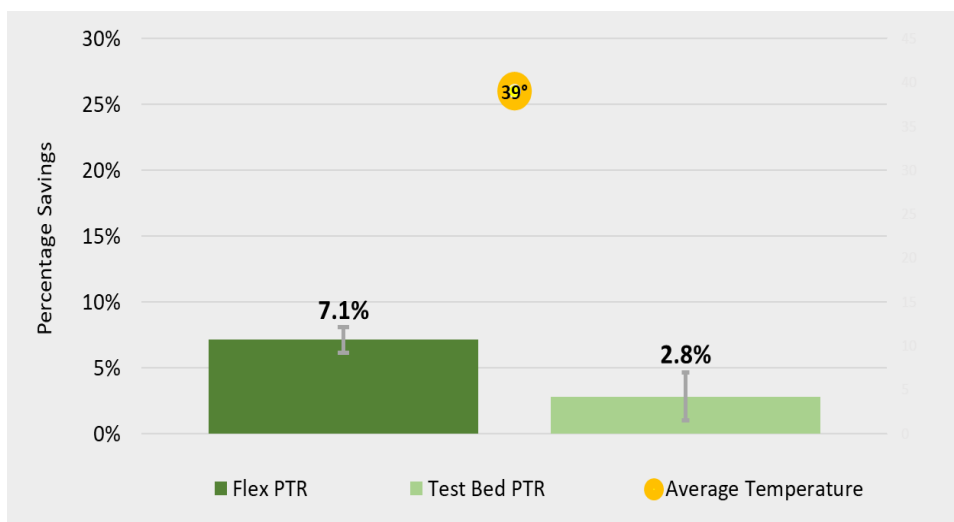
Figure 13 and Figure 14 show the average demand savings and percentage savings per enrollee, respectively, by PTR groups (Flex PTR and Test Bed PTR) and outside temperature during winter 2020/2021 PTR events. The average savings across all winter events were 0.134 kW for Flex PTR and 0.048 kW for Test Bed PTR. All estimates were statistically significant at the 10% level.

Figure 13. Average Demand Savings (kW) by PTR Group – Winter 2019/2020



Notes: Estimates based on Cadmus analysis of AMI meter data for Flex 2.0 PTR enrollees and matched comparison group. Error bars indicate 90% confidence intervals based on standard errors clustered on customers.

Figure 14. Percentage Savings by PTR Group – Winter 2019/2020

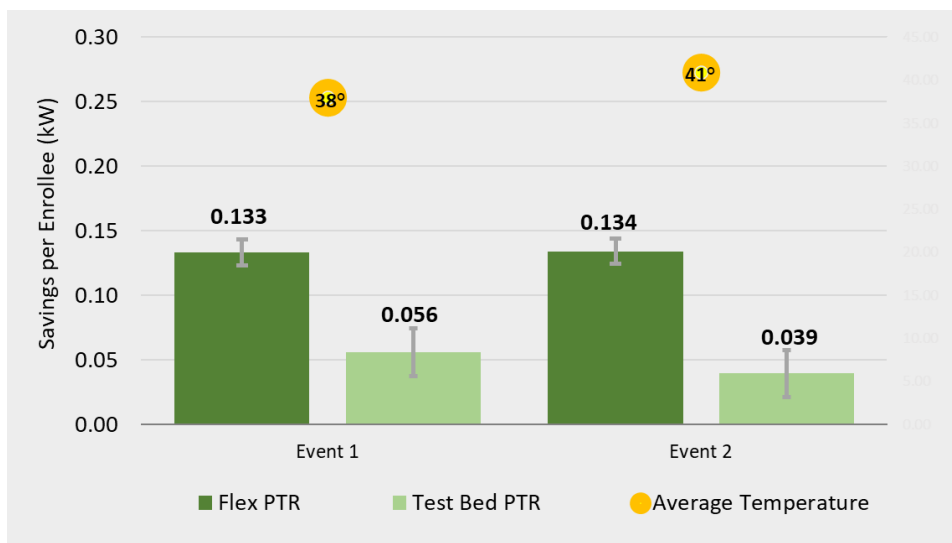


Notes: Estimates based on Cadmus analysis of AMI meter data for Flex 2.0 PTR enrollees and matched comparison group. Percentage savings estimated as kW savings divided by baseline demand. Error bars indicate 90% confidence intervals based on standard errors clustered on customers.

Figure 15 and Figure 16 show the average demand savings and percentage savings per enrollee, respectively, by PTR group and event.

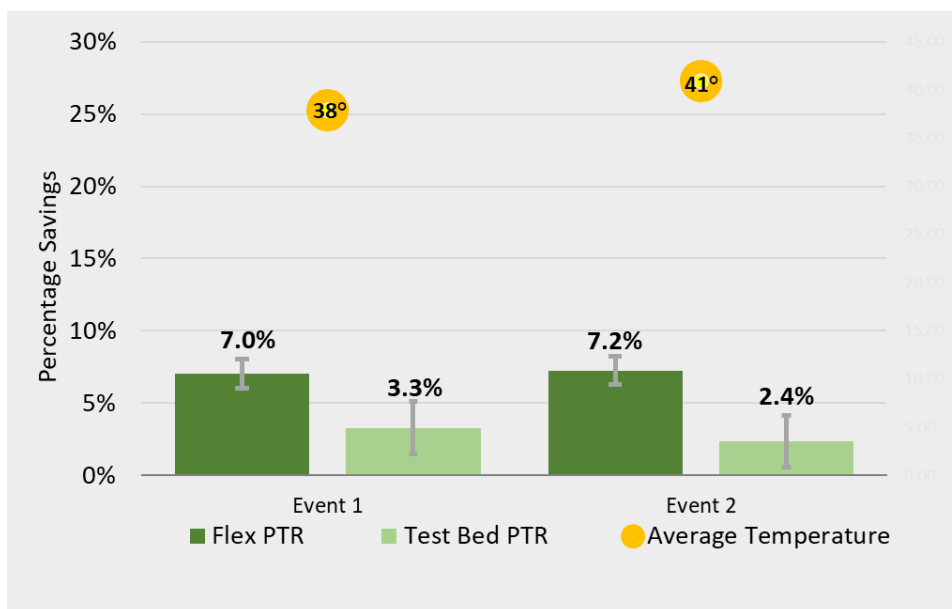
PTR yielded savings for both winter events. However, a limitation of the analysis is that PGE only called two events, which means it was not possible to observe the performance of PTR for a range of weather conditions or during different hours of the day. It is therefore more difficult to draw strong conclusions regarding the effectiveness or reliability of PTR as a winter demand response resource.

Figure 15. Average Demand Savings (kW) by Event and PTR Group – Winter 2019/2020



Note: Estimates are based on Cadmus analysis of AMI meter data for Flex 2.0 PTR enrollees and matched comparison group. Error bars show 90% confidence intervals based on standard errors clustered on customers.

Figure 16. Percentage Savings by Event and PTR Group – Winter 2019/2020



Note: Estimates are based on Cadmus analysis of AMI meter data for Flex 2.0 PTR enrollees and matched comparison group. Percentage savings estimated as kW savings divided by baseline demand. Error bars show 90% confidence intervals based on standard errors clustered on customers.

In addition, the winter demand savings were substantially lower in winter than in summer for Test Bed PTR and Flex PTR enrollees, which aligns with the findings from the Flex 1.0 and Flex 2.0 winter 2019-2020 evaluations. The lower level of savings in winter may reflect fewer options for enrollees to shift or reduce consumption during winter PTR events (e.g., lower saturation of electric heat) or a lack of enrollee understanding about how to save in winter. With information about customer space heating fuels and equipment, PGE could provide more relevant and impactful savings tips to enrolled participants.

Table 12 shows the average demand savings per enrollee by event hour for Flex PTR and Test Bed PTR customers. There was little variation in demand savings— no more than 0.04 kW per enrollee—across the hours of each event for Flex PTR and Test Bed PTR.

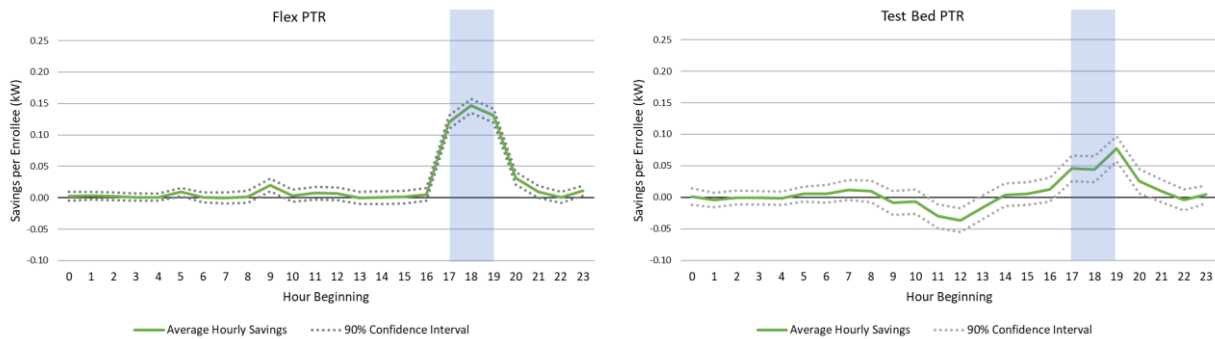
Table 12. Average Demand Savings by Event and PTR Group – Winter 2020/2021

Program Group	Event	Beginning and Ending Times	Average Demand Savings per Enrollee (kW)			
			Hour 1	Hour 2	Hour 3	Event Average
Flex PTR	Event 1	5 p.m. – 8 p.m.	0.120	0.146	0.130	0.132
	Event 2	5 p.m. – 8 p.m.	0.109	0.144	0.143	0.132
Test Bed PTR	Event 1	5 p.m. – 8 p.m.	0.046	0.044	0.077	0.056
	Event 2	5 p.m. – 8 p.m.	0.021	0.062	0.035	0.039

Note: Estimates are based on Cadmus analysis of AMI meter data for Flex 2.0 PTR enrollments and matched comparison group.

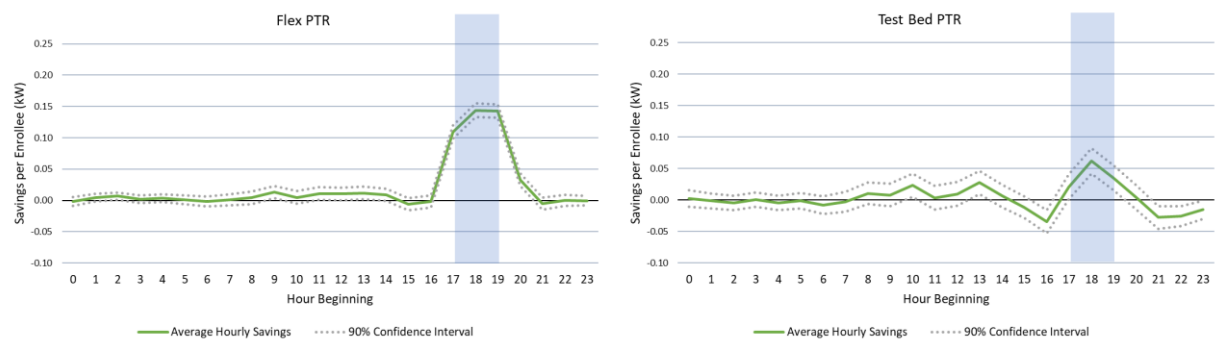
Figure 17 and Figure 18 present the savings per enrollee and 90% confidence intervals for each event day hour in winter 2020/2021. Like in summer, Flex PTR enrollees reduced their demand in the hour following the event, with similar magnitudes and extents of this spillover. However, unlike in summer, Flex PTR and Test Bed PTR enrollees did not save in the hours leading up to winter 2020/2021 events.

Figure 17. Average Hourly PTR Savings (Event 1), by PTR Group – Winter 2020/2021



Note: Estimates are based on Cadmus analysis of AMI meter data for Flex 2.0 PTR enrollees and matched comparison group. There were 74,604 Flex PTR enrollees and 16,741 Test Bed PTR enrollees during the winter event.

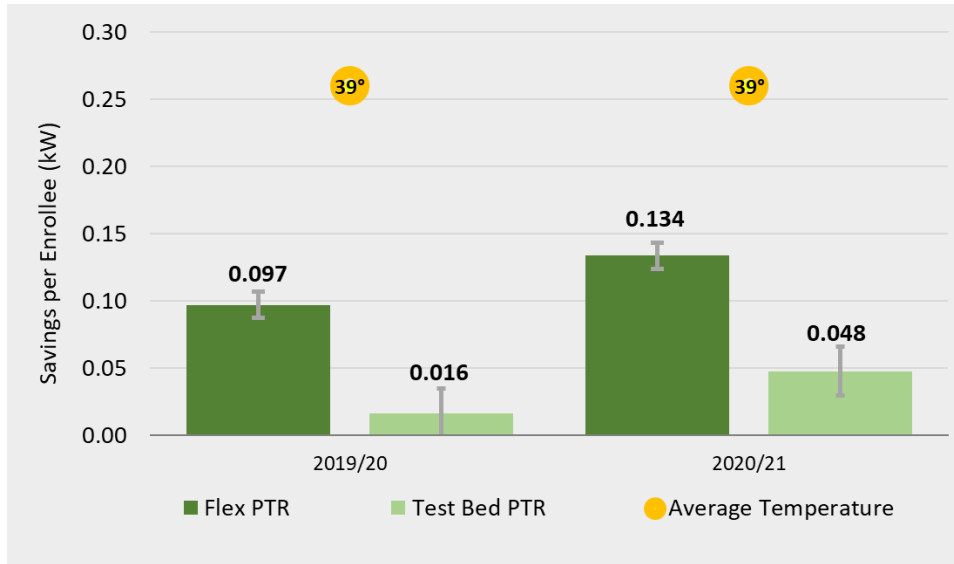
Figure 18. Average Hourly PTR Savings (Event 2), by PTR Group – Winter 2020/2021



Note: Estimates are based on Cadmus analysis of AMI meter data for Flex 2.0 PTR enrollees and matched comparison group. There were 74,484 Flex PTR enrollees and 16,694 Test Bed PTR enrollees during the winter event.

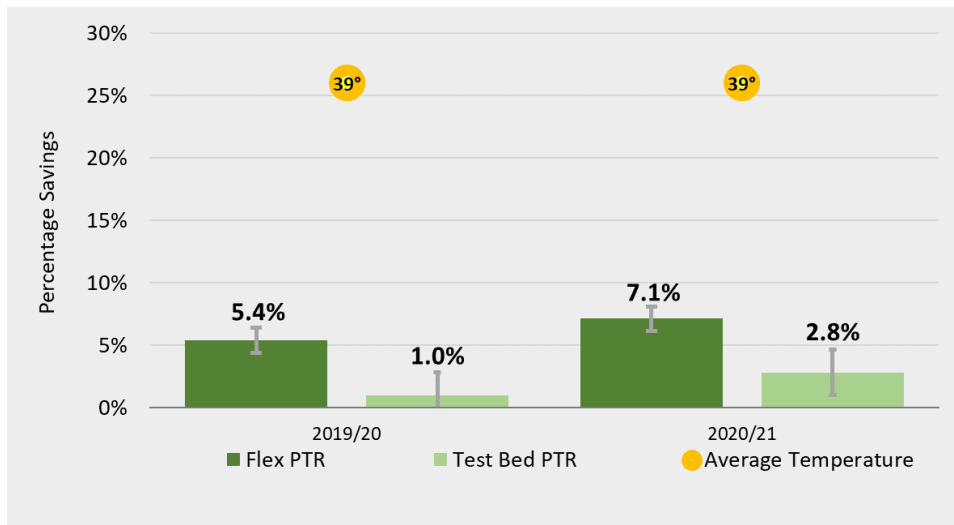
Figure 19 and Figure 20 compares, respectively, the kW and percentage savings between the winter 2019/2020 and winter 2020/2021 seasons. While the average outdoor temperature during events was the same across both event seasons, Flex PTR enrollees experienced an increase in kW and percentage savings. Test Bed PTR savings also increased relative to 2019/2020, though the change was not statistically significant. These increases in winter savings could be attributed to greater enrollee awareness of winter PTR savings strategies following the first winter season.

Figure 19. Average Winter Demand Savings (kW) Savings by Year and PTR Group



Note: Estimates are based on Cadmus analysis of AMI meter data for Flex 2.0 PTR enrollees and matched comparison group. Error bars show 90% confidence intervals based on standard errors clustered on customers.

Figure 20. Winter Percentage Savings (%) by Year and PTR Group



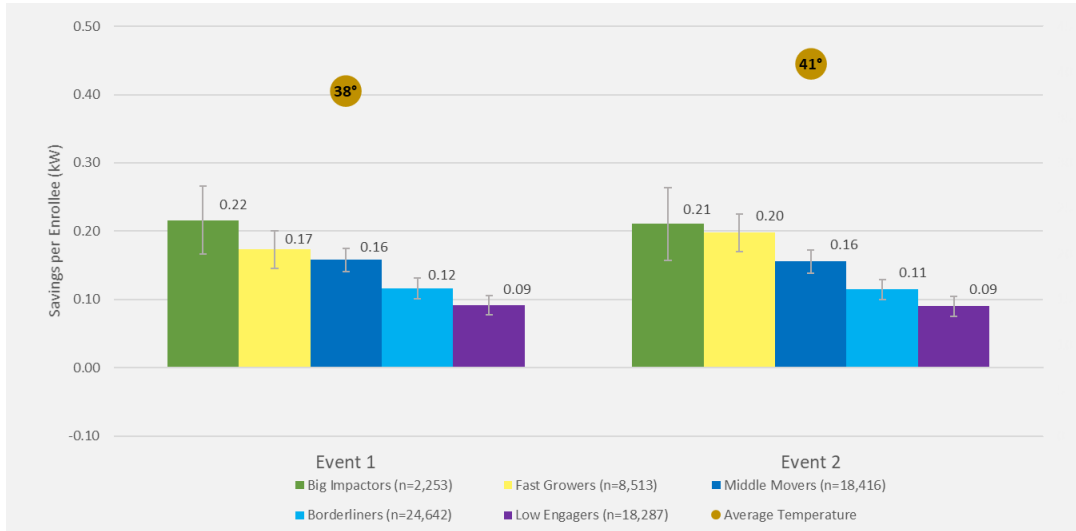
Note: Estimates are based on Cadmus analysis of AMI meter data for Flex 2.0 PTR enrollees and matched comparison group. Percentage savings estimated as kW savings divided by baseline demand. Error bars show 90% confidence intervals based on standard errors clustered on customers.

Winter Demand Savings by Microsegment

Figure 21 and Figure 22 show the average demand savings per enrollee by event and microsegment for the PTR groups. In contrast to summer 2020, there was less variation in demand savings between microsegments in winter 2020/2021. Though the estimated savings for the Flex PTR microsegment followed the expected pattern (Big Impactors saving most, Low Engagers saving least), the differences

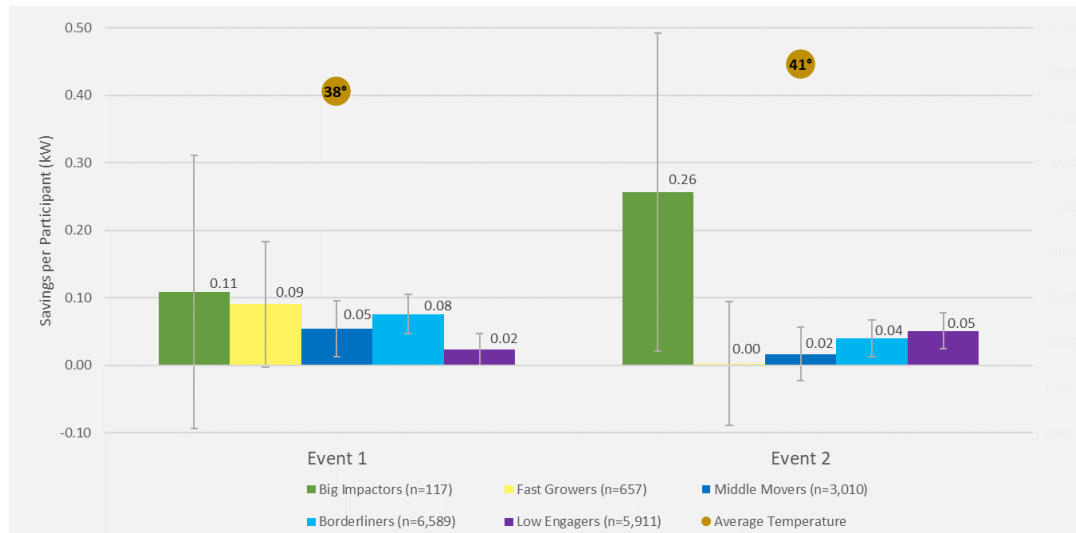
between Big Impactors, Fast Growers, and Middle Movers were not always statistically significant. For Test Bed PTR, there were no statistically significant differences in savings between microsegments, and savings for some groups and events were statistically indistinguishable from zero and each another. The wide confidence intervals for some savings estimates are due to the small sample sizes for some microsegments.

Figure 21. Flex PTR Average Demand Savings (kW) by Microsegment



Notes: Estimates based on Cadmus analysis of AMI meter data for Flex 2.0 PTR enrollees and matched comparison group. Error bars indicate 90% confidence intervals based on standard errors clustered on customers.

Figure 22. Test Bed Average Demand Savings (kW) by Microsegment – Winter 2020/2021



Notes: Estimates based on Cadmus analysis of AMI meter data for Flex 2.0 PTR enrollees and matched comparison group. Error bars indicate 90% confidence intervals based on standard errors clustered on customers.

Program Demand Savings -- Winter

Table 13 presents the evaluated and reported program-level demand savings for the winter events. The program savings were estimated by multiplying the weighted average evaluated per-enrollee impacts by the reported total number of enrollees. The evaluated savings were compared to PGE’s reported demand savings, which are based on a matched control group analysis. As shown, the evaluation estimates that the program achieved demand savings of 10.77 MW, which surpassed the reported savings estimate of 9.76 MW. The 90% confidence interval for the evaluated savings equals 9.74 MW to 11.80 MW, which includes the reported savings.

Table 13. PTR Program Total Savings – Winter 2020/2021

Event	Event Time	Avg. Temp. (°F)	Evaluation Avg. Demand Savings per Enrollee (kW)	Reported Enrollees	Evaluation Demand Savings (MW)	Reported Demand Savings (MW)
Event 1	5 p.m. – 8 p.m.	38	0.119	91,345	10.87	9.49
Event 2	5 p.m. – 8 p.m.	41	0.117	91,178	10.67	10.02
Average		39	0.118	91,262	10.77	9.76

Note: Evaluated demand savings were estimated from a panel regression of customer hour interval consumption for enrollees and matched non-enrollees. See *Appendix A* for estimation details.

PGE PTR Payments – Winter

Table 14 compares Cadmus’ evaluated savings with PGE’s rebated PTR savings for each event and during winter 2020/2021 overall. The payment ratio column shows the ratio of the savings PGE paid for to the evaluated savings. As previously discussed, overpayment is inherent to PTR programs, and evaluators of other PTR programs have found similar levels of overpayment. Overall, PGE paid 2.97 times more for winter PTR savings than it would have paid only for achieved savings (i.e., PGE paid enrollees an average of \$2.97 for every kWh of winter PTR savings).

Table 14. Winter 2020/2021 PTR Payment Ratios

Event	Rebated Savings (MWh)	Evaluated Savings (MWh)	Payment Ratio (Rebated Savings/ Evaluated Savings)
1	102.13	32.61	3.13
2	89.68	32.01	2.80
Total	191.81	64.62	2.97

Notes: Evaluated savings based on Cadmus analysis of AMI meter data for Flex 2.0. Rebated savings were calculated by PGE (Esource) based on individual customers baselines.

PTR Program Performance Metrics

To provide information about Flex 2.0 PTR’s performance that may be useful to PGE grid operators, Table 15 displays additional performance metrics from the summer 2020 and winter 2020/2021 impact evaluations. The table reports the mean, minimum, and maximum kW demand savings across Flex events by event hour as well as the mean load impacts before and after the events. The load impacts are presented in kW and as a percentage of baseline demand.

Table 15. Peak Demand Savings Metrics for Summer 2020 and Winter 2020/2021

Key Metrics		Savings Per Enrollee	
		Summer 2020	Winter 2020/2021
Average kW Savings	Event Hour 1	0.127 kW (6.6%)	0.099 kW (5.5%)
	Event Hour 2	0.152 kW (7.7%)	0.130 kW (6.9%)
	Event Hour 3	0.147 kW (7.5%)	0.125 kW (6.8%)
Min kW Savings	Event Hour 1	0.113 kW (5.9%)	0.096 kW (5.4%)
	Event Hour 2	0.128 kW (6.9%)	0.127 kW (6.7%)
	Event Hour 3	0.126 kW (6.8%)	0.122 kW (6.7%)
Max kW Savings	Event Hour 1	0.151 kW (8.2%)	0.101 kW (5.6%)
	Event Hour 2	0.172 kW (8.2%)	0.133 kW (7.1%)
	Event Hour 3	0.161 kW (8.7%)	0.129 kW (6.9%)
Change in Average Savings (difference from previous hour savings)	Event Hour 1 to 2	0.025 kW (19.6%)	0.031 kW (31.4%)
	Event Hour 2 to 3	-0.005 kW (-3.1%)	-0.004 kW (-3.5%)
Average Savings during Hour before Event Begins		0.024 kW (1.3%)	0.007 kW (0.5%)
Average Savings during Hour after Event Ends		0.042 kW (2.2%)	0.011 kW (0.7%)
Event Day Average Energy Savings		0.465 kWh (1.5%)	0.434 kWh (1.3%)

Note: Mean savings is the average kW demand reduction per enrollee across all event hours. Max kW is the maximum of the event average demand savings per enrollee during each event season, and vice versa for min kW. The percentage savings are the kW savings divided by estimated baseline demand. All impact values are statistically significant at the 10% level.

Customer Experience

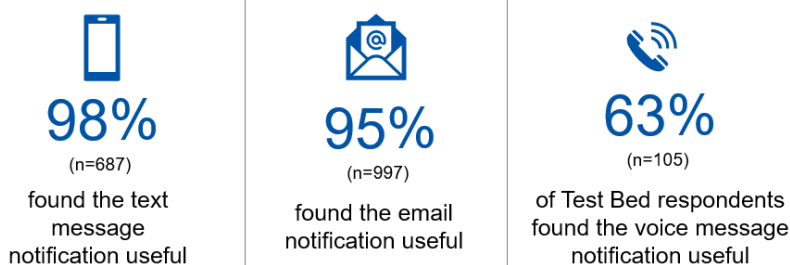
This section presents key findings from the summer 2020 event surveys. Cadmus administered surveys online after the July 21, July 30, and August 17, 2020 events and collected a total of 1,149 respondents. Because only two events were called during winter 2020/2021 and the 2021 winter storm caused power outages, customer surveys were not conducted. See *Appendix A* for a detailed description of the survey methodology.

Usefulness of Pre-Event Notifications

All PTR customers received day-ahead event notifications via text message or email, depending on their communication preferences during summer 2020. PTR customers in the Test Bed also received a voice message the day before the event. Starting in summer 2020, PGE directly emailed all customers event notification reminders on the morning of the event.

Nearly all survey respondents found text message and email event notifications useful, while approximately two-thirds found voice messages useful, as shown in Figure 23. Of the Test Bed respondents who remembered receiving the voice message (n=108), 45% said they want to continue with this type of event notification. PGE rolled out voice notifications to all PTR customers in winter 2020/2021.

Figure 23. Usefulness of Event Notifications



Source: Summer Event Survey Question: “How would you rate the usefulness of the event notification(s) you received?”

Impact of Same-Day Reminders

In Cadmus’ evaluation of the summer 2019 Flex 2.0 PTR program, surveyed customers said they forgot about the peak time events and wanted same-day event reminders. In response, PGE developed and tested same-day event reminders via email during winter 2019/2020 among the Test Bed PTR customers. The test was successful, so PGE emailed same-day reminders to all PTR customers in summer 2020.

Cadmus assessed the customer impact of the same-day reminders by comparing the 2020 and 2019 responses. The survey question asked whether respondents agreed with the statement *my household forgot that the event was happening on the day of the event*. Thirteen percent of summer 2020 respondents agreed with the statement (n=1,137) compared to 25% of summer 2019 respondents (n=976), a statistically significant decrease in the frequency of forgetting an event.²⁵ This suggests that same-day reminders have helped customers remember PTR events.

Summer Event Participation

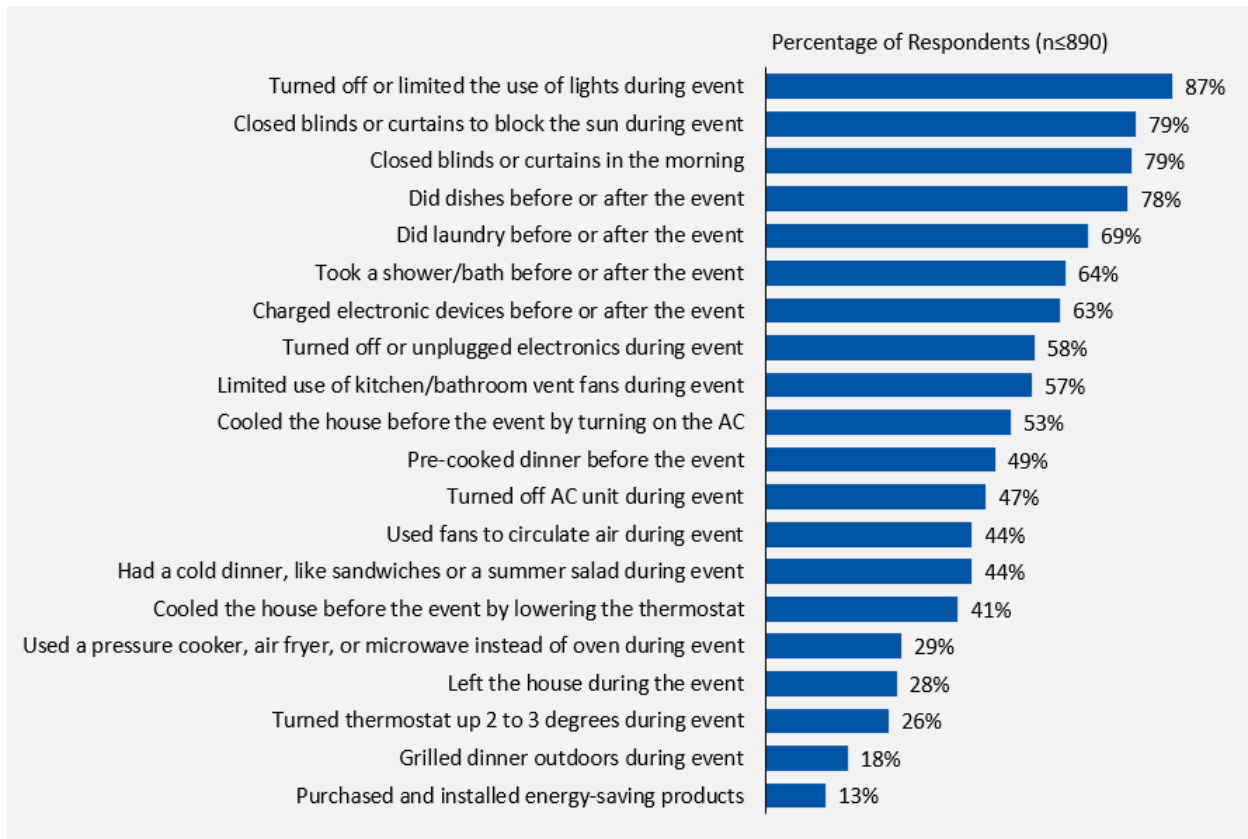
Most respondents (78%, n=1,147) took action to shift or reduce their energy use during a summer 2020 peak time event. As shown in Figure 24, these were the top four actions:

- Turning off/limit the use of lights
- Closing blinds/curtains to block the sun during the event
- Closing blinds/curtains in the morning
- Doing dishes before or after the event

Less than half of the respondents turned off the air conditioner or turned up the temperature on the thermostat during the event—actions that have the highest savings potential.

²⁵ Difference is statistically significant with 90% confidence (p<0.10).

Figure 24. Actions Taken during a Summer 2020 Peak Time Event



Source: Summer Event Survey Question. “Here is a list of things your household may have done to shift energy for the Peak Time Event. For each item, please indicate **Yes** if you did this or **No** if you did not.” Multiple responses allowed.

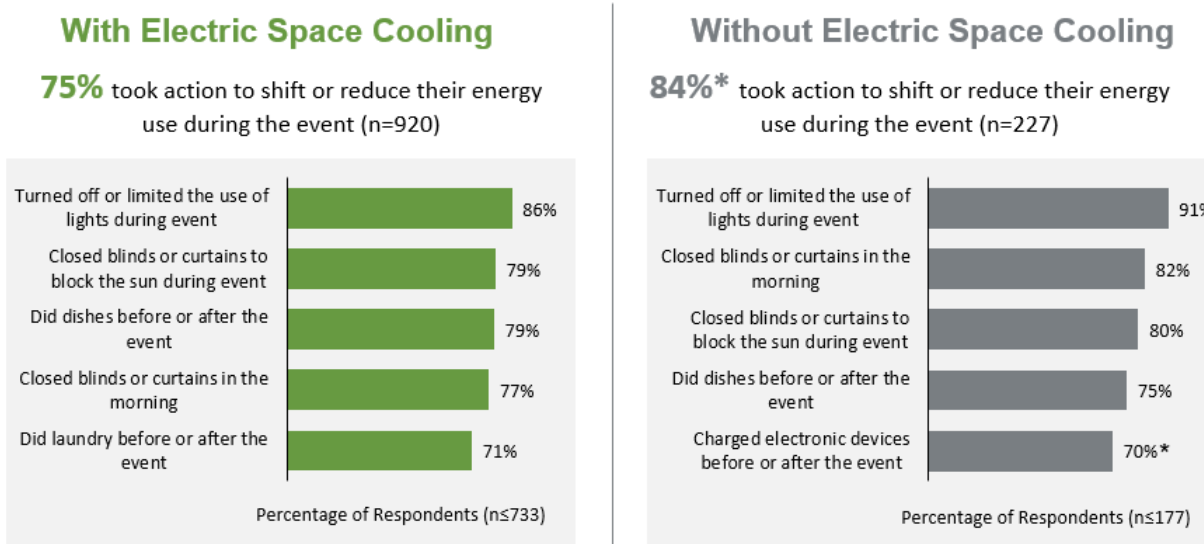
However, Cadmus analyzed responses from those who reported having electric space cooling in their home (n=733) and found the following:

- 77% closed the blinds or curtains to block the sun during the event
- 59% turned off the air conditioner unit during the event
- 50% cooled the house before the event by lowering thermostat
- 36% turned the thermostat up two to three degrees during the event

These results show that a sizeable proportion of respondents with electric space cooling did take one or more of the highest-savings actions during an event.

The evaluation also investigated whether customers with electric space cooling took more actions than customers without such equipment. Respondents without electric space cooling had a significantly higher rate of self-reported event participation (84%) than did respondents with electric space cooling (75%) (Figure 25). Four of the top five actions respondents took to shift or reduce their energy use were the same for respondents with or without electric space cooling.

Figure 25. Summer Event Participation and Top Actions: With vs. Without Electric Space Cooling

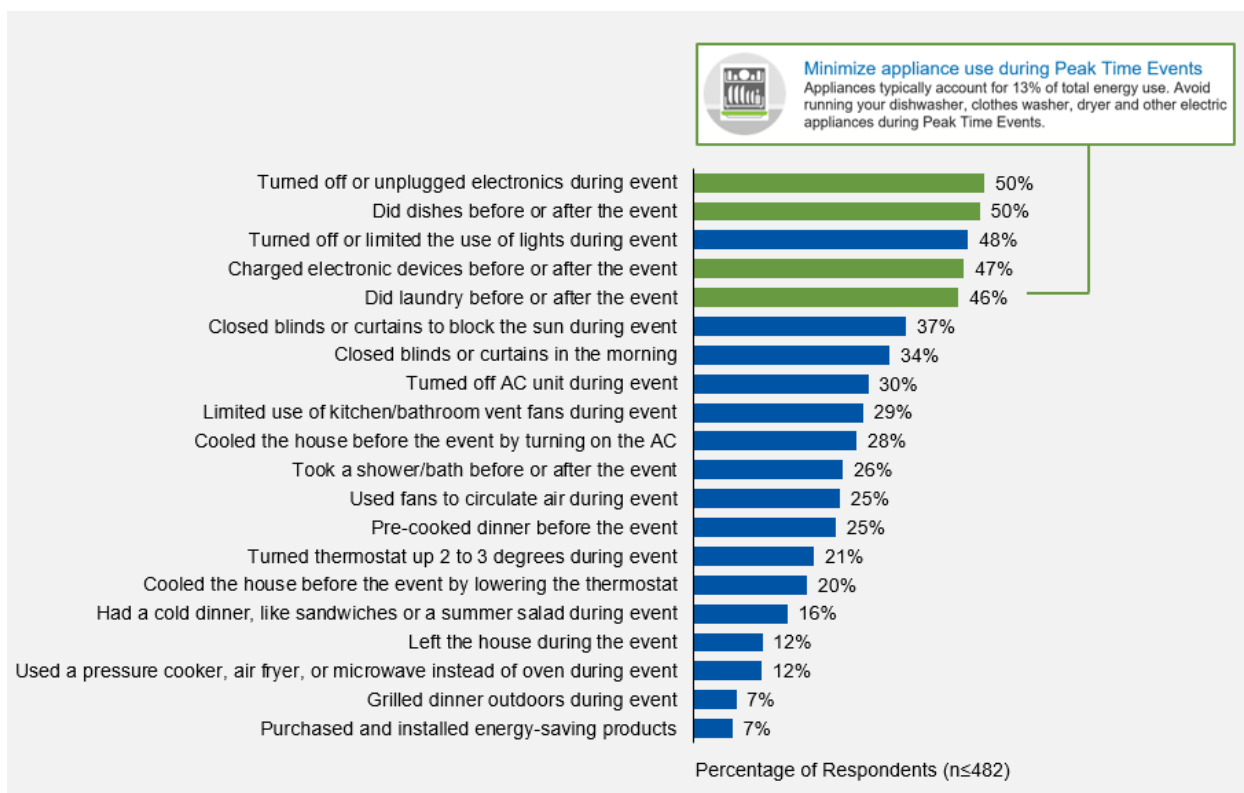


Note: Items with an asterisk indicate a significant difference between respondents with electric cooling and respondents with non-electric cooling, with 90% confidence ($p \leq 0.10$).

Source: Summer Event Survey Question. “Here is a list of things your household may have done to shift energy for the Peak Time Event. For each item, please indicate **Yes** if you did this or **No** if you did not.” Multiple responses allowed.

During summer 2020, PGE emailed customers tips on ways to shift or reduce energy use during events. The tip that PGE promoted the most was to *minimize appliance use during peak time events*, specifically the use of the dishwasher, clothes washer, and dryer. The survey asked respondents what actions they learned from PGE. Figure 26 shows that four of the top five actions that customers learned aligned with the tip PGE promoted the most.

Figure 26. Actions That Customers Learned from PGE



Source: Summer Event Survey Question. “You indicated **Yes** to having done the following things to shift energy for the Peak Time Event. Which of these were tips you learned from PGE? Select all that apply.”

Summer Event Nonparticipation

One in five respondents reported not doing anything to shift or reduce energy use during a summer 2020 event (n=1,147). Of these respondents, 200 provided reasons. These are the three top reasons for not participating in the event:

- Wanted to feel comfortable (33%)
- Rebate was too small (26%)
- Already a low-energy user (22%)

Impact of Sweepstakes

To motivate customers to participate in events and increase their demand impacts, PGE offered an Amazon gift card sweepstakes to customers who earned a rebate during a summer 2020 event. Only 42% of respondents were aware of the sweepstakes. Of these, just over a third said the sweepstakes was an important motivating factor in their event participation (Figure 27). When scaled to the sample population, 15% of respondents were motivated by the sweepstakes.

Figure 27. Awareness of Sweepstakes



Source: Summer Event Survey Question: “Were you aware of the Amazon gift card drawing? This is the sweepstakes where, for every rebate earned, you are entered into a drawing for an Amazon gift card.” And “How important was the Amazon gift card drawing in motivating your household to shift or reduce energy use during the Peak Time Event?”

PGE held another sweepstakes during winter 2020/2021 for gift cards from Fred Meyer and local businesses. Cadmus did not conduct a winter survey to assess the impact of the winter sweepstakes. PGE reported that it did not see a change in customers’ demand impacts. PGE plans to give the sweepstakes activity one more try in summer 2021. In the meantime, PGE is exploring other ideas for customer engagement such as a mobile app game or a customer experience strategy that prioritizes mobile design over desktop design.

Summer Satisfaction

Summer event survey respondents rated their satisfaction with the rebate, the PTR program, and PGE, using a 0 to 10 scale, where 0 meant *extremely dissatisfied* and 10 meant *extremely satisfied*. PGE defines a 6 to 10 rating as *satisfied* and a 9 or 10 rating as *delighted*.

Satisfaction with Rebate and Impact from Rebate Calculation Changes

In the 2019 evaluation, Cadmus found that customer satisfaction with the PTR program was tied to the rebate amount and their perceptions about their level of effort to save. Specifically, some customers believed that their rebates were not commensurate with the effort they made to reduce demand.

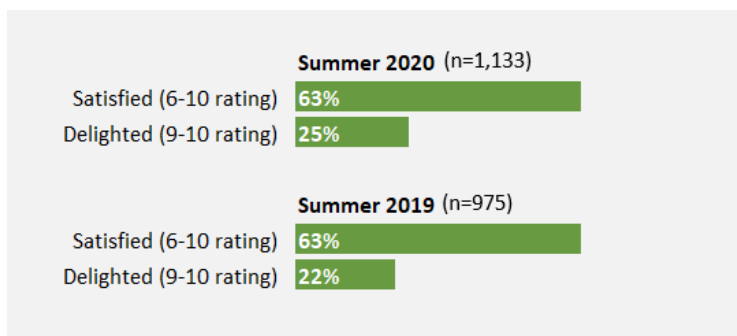
To address these customer concerns, PGE had E Source revise the baseline calculation methodology to improve its accuracy and transparency and the comprehension by customers. Cadmus compared summer 2020 survey responses to 2019 survey responses to determine whether the change had an impact on customer satisfaction with the rebate and perceived accuracy.

As shown in Figure 28, customer satisfaction with the rebate showed similar percentages of satisfied and delighted respondents between 2020 and 2019 despite improving customers’ rebate amount expectations. Significantly more 2020 respondents said their earned rebate amount was higher than expected (19%, n=703) compared to 2019 respondents (7%, n=1,018).²⁶ Also, significantly fewer 2020 respondents said their earned rebate amount was lower than expected (29%, n=703) compared to 2019

²⁶ Difference is statistically significant with 90% confidence (p<0.10).

respondents (42%, n=1,018).²⁷ Customer satisfaction with the rebate remains low compared to customer satisfaction with the program and with PGE, described in the next section.

Figure 28. Satisfaction with Rebate



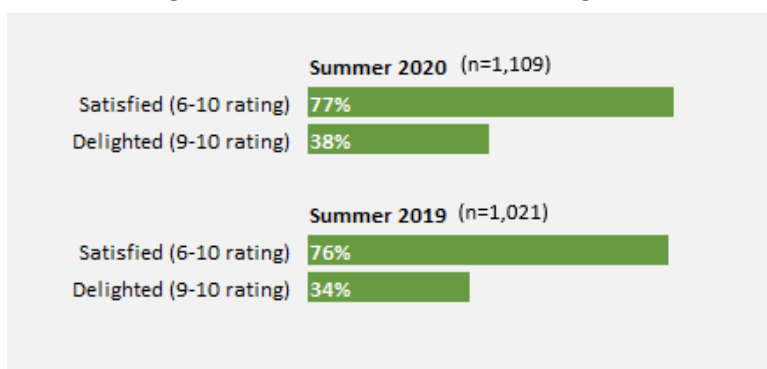
Source: Summer Event Survey Question. “How satisfied are you with the rebate incentive your household earned for this most recent event?”

To assess customers’ perceived accuracy of their level of event participation effort and the rebate earned, the survey asked respondents if they agreed with the statement *the rebate doesn’t seem to be linked to the actions I take*. Thirty-eight percent of 2020 respondents agreed with this statement, not statistically different from 2019 respondents (40%, n=1,133), which suggests that some respondents still perceive a disconnect between the amount of the rebate and the level of effort required to participate.

Satisfaction with PTR Program

Although a majority of summer 2020 respondents were satisfied with the program, PGE did not meet its customer satisfaction goals of 80% satisfied and 60% delighted. As shown in Figure 29, 77% of respondents were satisfied and 38% were delighted, very similar to the 76% satisfied and 34% delighted in 2019.

Figure 29. Satisfaction with PTR Program



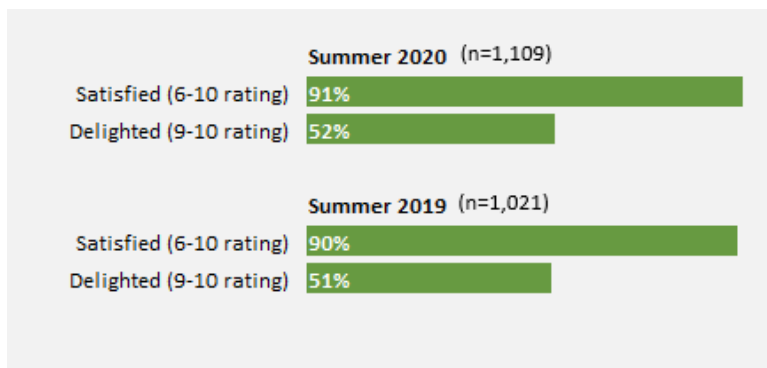
Source: Summer Event Survey Question. “Please rate your overall satisfaction with PGE’s Peak Time Rebates program.”

²⁷ Difference is statistically significant with 90% confidence (p≤0.10).

Satisfaction with PGE

Satisfaction with PGE remains high among PTR customers. Figure 30 shows that 91% of 2020 respondents were *satisfied* and 52% were *delighted* with PGE, similar to 2019 (90% satisfied, 51% delighted).

Figure 30. Satisfaction with PGE



Source: Summer Event Survey Question. “Before we ask you about your program experience, please rate your overall satisfaction with PGE.”

Flex PTR vs. Test Bed PTR Comparisons

Cadmus compared the results of the summer 2020 event survey between Flex PTR and Test Bed PTR respondents, as shown in Table 16. Flex PTR represents the customers who self-enrolled in PTR while Test Bed PTR represents customers who were auto-enrolled in PTR as part of the SGTB project.

PGE nearly met its 80% satisfied satisfaction goal among the Flex PTR respondents (78% satisfied). Flex PTR respondents were more likely to participate and be satisfied than Test Bed PTR respondents, but these differences were not statistically significant. These results align with program design differences (opt-in vs. opt-out), for which greater participation and higher satisfaction is expected with customers who opted in to PTR.

Table 16. Comparison of Summer 2020 Event Survey Results by PTR Group

Survey Topic	Flex PTR Respondents (n≤780)	Test Bed PTR Respondents (n≤367)
Event participation	79% shifted or reduced energy	72% shifted or reduced energy
Rebate earned for event	Average \$1.41	Average \$1.45
Satisfaction with rebates	64% satisfied (6-10 rating) 24% delighted (9-10 rating)	57% satisfied (6-10 rating) 31% delighted (9-10 rating)
Satisfaction with program	78% satisfied 39% delighted	68% satisfied 33% delighted
Satisfaction with PGE	89% satisfied 54% delighted	90% satisfied 51% delighted

Microsegment Comparisons

Cadmus compared the summer 2020 event survey results across the five microsegments—Big Impactors, Fast Growers, Middle Movers, Borderlines, and Low Engagers—as shown in Table 17. Each

microsegment includes Flex PTR and Test Bed PTR survey respondents. Big Impactors had the highest rate of self-reported event participation, highest satisfaction with the rebates and, on average, earned the most. Low Engagers had the lowest satisfaction with the rebates and earned the least.

Table 17. Comparison of Summer 2020 Event Survey Results by Microsegment

Survey Topic	Big Impactors (n≤259)	Fast Growers (n≤226)	Middle Movers (n≤238)	Borderliners (n≤186)	Low Engagers (n≤158)
Event participation	87% shifted or reduced energy	82%	81%	75%	77%
Rebate amount earned for event	Average \$3.32*	\$2.51*	\$1.58*	\$1.50*	\$0.84*
Satisfaction with rebates	79% satisfied 42% delighted	74% 37%	76% 34%	58% 16%	51% 21%
Satisfaction with program	84% satisfied 51% delighted*	84% 47%*	78% 47%*	77% 40%*	74% 29%*
Satisfaction with PGE	92% satisfied 60% delighted	91% 59%	89% 54%	88% 51%	94% 49%

* Asterisk indicates that microsegments significantly differed from each other, with 90% confidence (p≤0.10).

Appendix A. Evaluation Methodology

This appendix describes Cadmus’s methodology for evaluating PGE’s Flex 2.0 Demand Response pilot program.

PTR Load Impact Estimation

Cadmus analyzed residential customer advanced metering infrastructure (AMI) meter interval consumption data to estimate peak time rebates (PTR) load impacts. First, Cadmus employed propensity score matching to identify nonparticipants who were similar to PTR enrollees. Then, in a panel regression analysis of customer hour-interval electricity consumption, demand of the matched control group provided the baseline for estimating PTR savings.

Matched Control Group

Cadmus matched active PTR enrollees with a sample of non-enrollees using propensity score matching. This technique involved matching each enrollee to one non-enrollee with a similar estimated propensity score. Each customer’s propensity score reflected their inclination to enroll in PTR as a function of multiple observable characteristics, including variables from PGE’s customer information system such as preferred bill payment methods or income, and average electricity consumption in various periods obtained from the AMI data.

Cadmus estimated the propensity scores using a least absolute shrinkage and selection operator (LASSO) regression for PTR program participation.²⁸ In this model, the binary response variable was an indicator for PTR participation (equal to 1 if a customer was enrolled in PTR, and 0 otherwise). To select the variables that were most predictive of PTR participation, Cadmus employed a supervised machine learning technique, which tested each of the approximately 100 candidate explanatory variables (a full list can be found in Table A-1 in the next section, *Matching Model Candidate Variables*). The machine learning technique excluded variables from the model that were not predictive of PTR participation or that overlapped too much with other candidate variables. The machine learning technique produced a model specification for PTR participation as a function of the selected candidate variables.

This model produced an estimated propensity score (between zero and one) for each of the more than 700,000 residential customers with sufficient data for the analysis. Cadmus used these scores to match each enrollee to one non-enrollees.²⁹

Cadmus conducted separate non-enrollee matching for winter and summer seasons, because the criteria for a good summer match of non-enrollees could differ substantially from the criteria for a good winter match. This meant that enrollees were matched to different non-enrollees in winter and vice versa. Within each season, the analysis also differentiated between Flex PTR and Test Bed PTR enrollees,

²⁸ In the previous evaluation of Flex 2.0, Cadmus also tested elastic net and ridge regression methods, which yielded similar specifications, but LASSO provided marginally lower prediction error.

²⁹ Cadmus allowed ties in the matching, with some nonparticipants matched to more than one participant

the former having chosen to opt-in to PTR and the latter having been automatically enrolled in PTR, as well as newer PGE customer accounts (who lacked hourly electricity consumption data from previous seasons) and older PGE customer accounts. Therefore, for each season, Cadmus conducted separate matching for each of these four groups:

- Test Bed PTR new accounts
- Test Bed PTR old accounts
- Flex PTR new accounts
- Flex PTR old accounts

This approach controlled for the differences between opt-in and auto-enrolled participants as well as for differences associated with account age. Because most residential customers in the Test Bed were auto-enrolled, these participants were matched primarily with customers outside of the Test Bed.³⁰

Though the matching model estimated each customer's propensity to enroll in PTR, the overall goal of the matching was to assemble a control group of non-enrollees with similar hourly consumption to that of the enrollment groups to establish the counterfactual baseline consumption during load control events. To this end, Cadmus verified that the propensity score matching produced matched control groups without statistically significant consumption differences to the enrollment group.³¹

Matching Model Candidate Variables

Table A-1 lists all candidate explanatory variables for the non-enrollment matching. Columns 1 through 8 denote the top 10 most important variables selected by the LASSO propensity score models with "X."³² Matching population models were divided by season, with four models in each season broken down by data availability.³³ Models 1 through 4 are for the summer season, and 5 through 8 are for the winter season. Within each season, models follow this breakdown—Out of Test Bed Older Accounts, Out of Test Bed Newer Accounts, Test Bed Older Accounts, and Test Bed Newer Accounts (1-4, then 5-8).

³⁰ A small number of customers within the Test Bed were not shown as having been enrolled in PTR, so these non-enrolled customers were also eligible for matching to participants in the Test Bed.

³¹ Cadmus used t-tests to test for statistically significant differences in mean event-window consumption between enrollees and matched control groups after matching (each customer's mean hourly consumption during the 5 p.m. to 8 p.m. period on non-event weekdays within each season.) There were no statistically significant differences.

³² Note that the X denotes only the top 10 most predictive variables selected for each model, based on standardized coefficient magnitudes; full model specifications included the majority of variables shown in this list.

³³ Newer PGE customers did not have a full year of pre-program consumption history, so Cadmus matched these participants in separate models to newer PGE customers who were not PTR enrollees. This approach allowed for different propensity models for newer PGE customers and established PGE customers and ensured that the matched control group included new customers in the baseline estimation.

Table A-1. Non-Enrollment Matching Candidate Variables

Variable	Description	1	2	3	4	5	6	7	8
		Summer				Winter			
		Flex PTR		TB PTR		Flex PTR		TB PTR	
		Old	New	Old	New	Old	New	Old	New
AnnualKWh	Customer’s annual energy consumption								
Any_ETO_program_participation	Indicator if a customer has participated in any ETO program								
AverageMonthlyKWh	Customer’s average monthly consumption		X				X		
AverageMonthlyKWhSummer	Customer’s average monthly consumption during summer months (June-September)	X			X				
AverageMonthlyKWhWinter	Customer’s average monthly consumption during winter months (December-February)		X	X					
AverageMonthlykWhFall	Customer’s average monthly consumption during fall months (October – November)								
AverageMonthlykWhShoulder	Customer’s average monthly consumption (October-November, March-May)								
AverageMonthlykWhSpring	Customer’s average monthly consumption during spring months (March-May)								
DNPDisconnects12MoAcct	Number of disconnections for non-payment in the last twelve months								
FifteenDayNotices12MoAcct	Number of fifteen-day disconnection notices in the last twelve months								
FiveDayNotices12MoAcct	Number of five-day disconnection notices in the last twelve months								
HasEmail	Indicator if a customer has an email account in PGE’s system	X			X	X	X		X
IsTOU	Indicator if a customer participates in time of use pricing	X				X		X	
IsAutoPay	Indicator if a customer has signed up for automatic bill payment								
IsCCBOptOut	N/A							X	
IsEqualPayAcct	Indicator if a customer has enrolled in Equal Pay	X	X			X	X		
IsLowIncome	Indicator if a customer is considered “low-income”				X				X
IsMDBOptOut	Customer has opted-out from mailing database			X					
IsPaperless	Indicator if a customer has signed up for paperless billing	X				X			X
IsPreferredDueDate	Indicator if a customer has enrolled in Preferred Due Date	X				X	X		X
IsRenewable	Indicator if a customer has enrolled in any of PGE’s renewable energy programs	X	X	X	X	X	X	X	

Variable	Description	1	2	3	4	5	6	7	8
		Summer				Winter			
		Flex PTR		TB PTR		Flex PTR		TB PTR	
		Old	New	Old	New	Old	New	Old	New
IsWebRegistered	Indicator if a customer has registered their account online		X	X			X		X
PGECreditRating	Customer's PGE credit rating								
PaymentAgencyAssistance12MoAcct	The amount of payment assistance that a customer has received in the last twelve months								
PgeAccountMonths	Length of time that the account has been active	X							
PgeCustomerMonths	Length of time that a customer has been with PGE						X		
age_of_home	Age of the customer's dwelling				X				X
electricheat	Indicator if a customer has an electric heater in their dwelling						X	X	X
electricwaterheat	Indicator if a customer has an electric water heater in their dwelling							X	
manufacturedhome_or_other	Indicator if a customer's dwelling is a manufactured home or other home type (not single or multifamily)								
mkt_sgmt_simplyservice	Indicator if a customer falls in the "simply service" market segment								
mkt_sgmt_TotallyTech	Indicator if a customer falls in the "totally tech" market segment								
mkt_sgmt_Contin_Connected	Indicator if a customer falls in the "Continuously Connected" market segment								
mkt_sgmt_innov_investors	Indicator if a customer falls in the "Innovative Investor" market segment								
mkt_sgmt_sensiblesavers	Indicator if a customer falls in the "Sensible Savers" market segment								
multifamily	Indicator if the customer's dwelling is a multifamily or single-family unit				X				
paymentassistance	Indicator if a customer has utilized bill-payment assistance programs								
renter	Indicator if a customer is renting their dwelling								
solar	Indicator if a customer has installed solar panels at their dwelling								
Language	Customer's primary language on file with PGE	X		X		X	X	X	
ETO_SmartThermoProg	Indicator if the customer has participated in the ETO Smart Thermostat Program								
HasAirConditioning	Indicator if the customer's dwelling has air conditioning			X	X				X
HasEvCharging	Indicator if the customer's dwelling has electric vehicle charging					X			

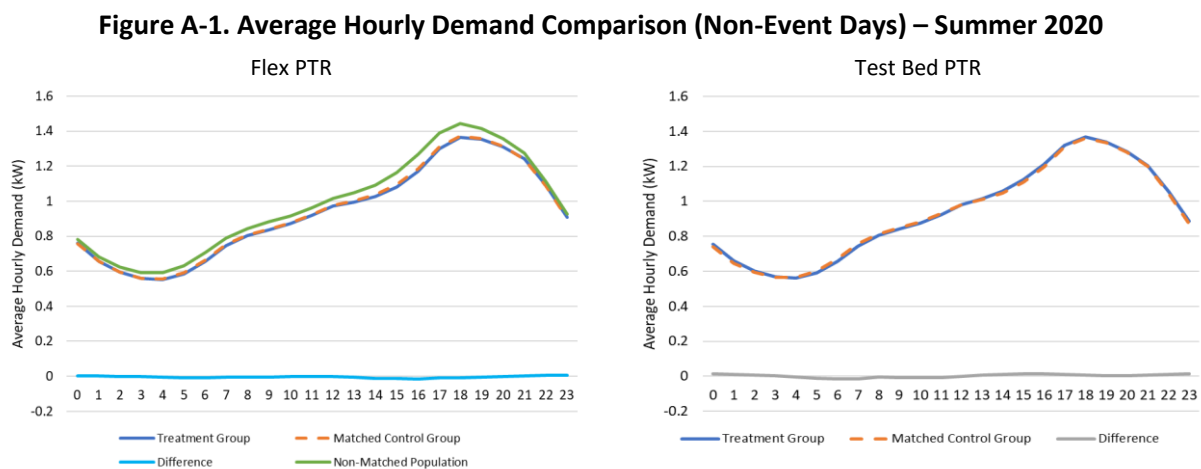
Variable	Description	1	2	3	4	5	6	7	8
		Summer				Winter			
		Flex PTR		TB PTR		Flex PTR		TB PTR	
		Old	New	Old	New	Old	New	Old	New
HasHeatPump	Indicator if the customer’s dwelling has a heat pump system			X	X			X	X
PaymentLastChannelSummary	Customer’s last payment method		X						
AX_EstimatedIncome	An income range to estimate a customer’s income	X	X	X	X	X		X	
AX_Education1st	Education level of the primary account holder								
county	County where the customer’s dwelling lies within the service area						X		
TroveMicroPersona	Customer segment reflecting customers’ predicted potential demand response capacity and likely engagement with demand response programs		X		X			X	X
Race	List the primary account holder’s race							X	
AVG_PTRHOURS_SUMMER2020PRE	Customer’s average consumption during PTR event hours from the beginning of summer to the day before event 1		X						
AVG_MIDPEAK_SUMMER2020PRE	Customer’s average consumption during mid-peak hours as defined by the TOU Rate Schedule from the beginning of summer to the day before event 1		X						
AVG_MIDPEAK_SUMMER2019	Customer’s average consumption during mid-peak hours as defined by the TOU Rate Schedule during the entire summer period			X					
AVG_ONPEAK_SUMMER2019	Customer’s average consumption during on-peak hours as defined by the TOU Rate Schedule during the entire summer period			X					

Validation of Matched Control Group

The goal of the propensity score matching was to assemble a control group of non-enrollees with similar hourly consumption to that of the enrolled groups. To this end, Cadmus verified that the propensity score matching produced matched control groups with energy consumption characteristics similar to those in the enrolled group.³⁴

Figure A-1 and Figure A-2 show the results of the non-enrollee matching, by season and PTR customer group, for all non-event days (excluding holidays and weekends). Figure A-3 and Figure A-4 compare the top ten hottest and coldest temperature non-event days, respectively, during the event seasons (excluding weekends, holidays, and PTR event days).

Across both groups and seasons, the matching method was highly effective in selecting for similar average hourly consumption patterns. The average load shapes for the treatment group and matched control group coincide in most hours of non-event days in summer and winter. Also, the load shape for the general customer population lies above the PTR participant load shape, showing there was self-selection in PTR participation and that a random sample of non-enrollees would not have constituted a valid control group for enrollees.



³⁴ Cadmus used t-tests to test for statistically significant differences in mean event-window consumption between enrollees and matched control groups after matching (each customer’s mean hourly consumption during the 5 p.m. to 8 p.m. period on non-event weekdays within each season). There were no statistically significant differences at 10% significance.

Figure A-2. Average Hourly Demand Comparison (Non-Event Days) – Winter 2020/2021

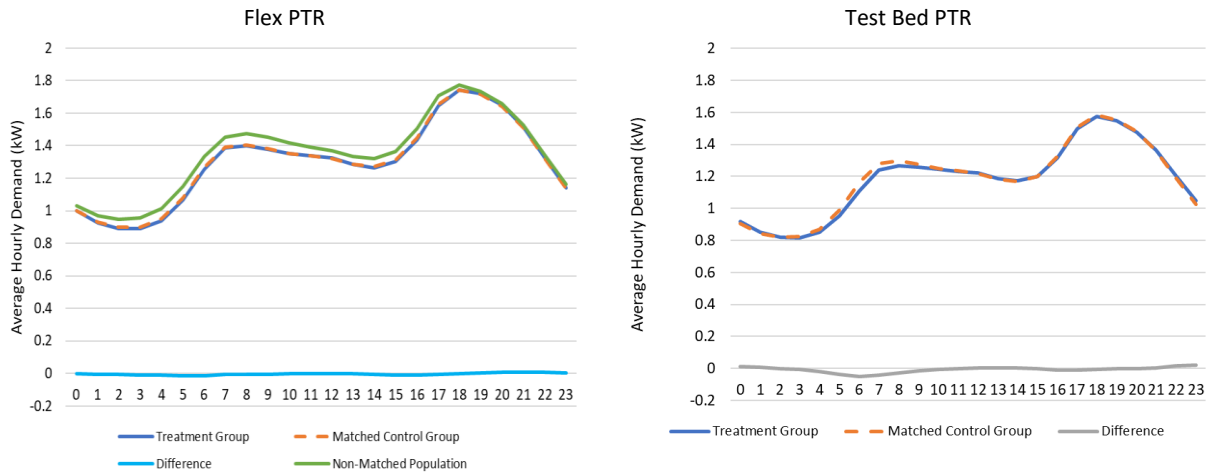


Figure A-3. Average Hourly Demand Comparison (Top 10 High-Temp Days) – Summer 2020

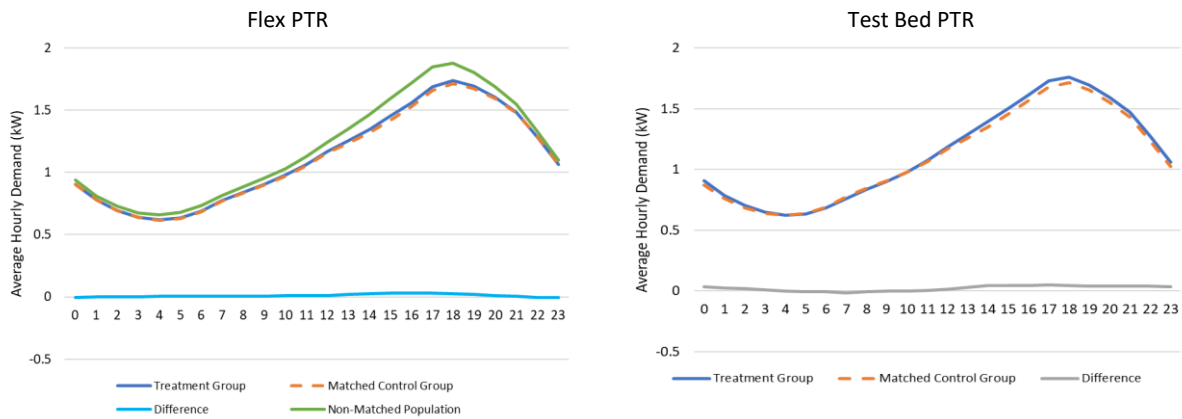
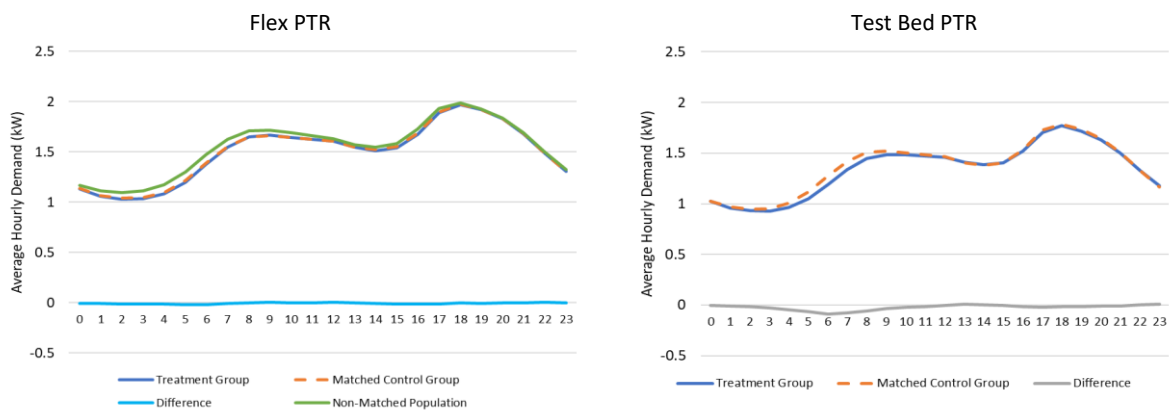


Figure A-4. Average Hourly Demand Comparison (Top Low-Temp Days) – Winter 2020/2021



Analysis Sample

Table A-2 and Table A-3 show summer 2020 and winter 2020/2021 enrollments and the analysis sample sizes after matching enrollees to non-enrollees. Only enrolled customers and matched non-enrollees with active accounts on at least one event day were included in the analysis.³⁵ Attrition because of missing AMI data or missing matching criteria decreased substantially between seasons, following improvements in PGE’s data collection. The final analysis samples included 86,827 enrollees and 79,439 matched non-enrollees in summer and 88,395 enrollees and 85,463 matched non-enrollees in winter.

Table A-2. Summer 2020 PTR Analysis Sample

Screen	Enrollee Count			Pct. Total Remaining
	Flex PTR	Test Bed PTR	Overall	
Total Enrollments	75,761	15,929	91,690	100%
Have CIS Data	75,485	15,860	91,345	99.6%
Meet Enrollment Criteria	73,989	15,860	89,849	98.0%
Have AMI Data	73,935	15,859	89,794	97.9%
Eligible for Matching	71,235	15,613	86,848	94.7%
Total Analysis Sample	71,235	15,592	86,827	94.7%
Total Matched Comparison Group	64,239	15,200	79,439	

Note: An enrollee was a residential customer enrolled in the PTR program during the season with an active account on at least one event day.

Table A-3. Winter 2020/2021 PTR Analysis Sample

Screen	Participant Count			Pct. Total Remaining
	Flex PTR	Test Bed PTR	Overall	
Total Enrollments	74,604	16,741	91,345	100%
Have CIS Data	74,469	16,698	91,167	99.8%
Meet Enrollment Criteria	72,411	16,372	88,783	97.2%
Have AMI Data	72,397	16,371	88,768	97.2%
Eligible for Matching	72,329	16,346	88,675	97.1%
Total Analysis Sample	72,111	16,284	88,395	96.8%
Total Matched Comparison Group	68,714	16,749	85,463	

Note: An enrollee was a residential customer enrolled in the PTR program during the season with an active account on at least one event day.

Impact Estimation

Cadmus estimated the demand savings from PTR by comparing demand during Flex 2.0 events of customers in the treatment and matched control groups. Using data for event hours during the winter and summer seasons, Cadmus estimated a multivariate panel regression of customer hourly energy

³⁵ Multiple PTR enrollees could be matched to the same non-enrolled customer. Customers were also ineligible for matching and inclusion in the analysis sample if they had insufficient historical AMI data or were missing key variables from the PGE Customer Information System (CIS) data.

demand on control variables for pretreatment hourly average demand, hour-of-sample fixed effects, each customer’s propensity score, and PTR treatment. Cadmus estimated separate models for customers in and out of the Test Bed (Test Bed PTR and Flex 2.0 PTR, respectively). The pretreatment demand variables controlled for average differences in electricity demand between customers during Flex 2.0 event hours.

Cadmus calculated separate, customer-specific pretreatment mean demand for each hour (0 to 23) of each season, using AMI interval data from non-event weekdays within the season.³⁶ The hour-of-sample fixed effects controlled for weather and other unobserved factors specific to each event hour. Cadmus estimated the models by ordinary least squares (OLS) and clustered the standard errors on customers to account for correlation over time in customer demand. Cadmus estimated alternative model specifications to test the estimates’ robustness to specification changes, and found the results were very robust. Cadmus tested specifications that included weather, excluded propensity scores, and alternated the periods used to calculate pre-treatment mean consumption.

Regression Model Specification

Cadmus estimated separate regression models using this specification for each season and for Test Bed PTR and Flex PTR participants. Equation A-1 shows the final regression model specification Cadmus used to estimate PTR impacts for the summer season, while Equation A-2 does the same for the winter season. For estimates of savings in each hour, Cadmus replaced the event hour indicator described here with indicators for each hour of the day.

Equation A-1. Summer 2020 Regression Model Specification

$$kWh_{it} = \beta_1 Eventhour_t * Participant_i + \beta_2 Summer2020All_{it} + \beta_3 PropensityScore_i + \beta_4 PropensityScore_i * NewCustomer_i + \tau_t + \varepsilon_{it}$$

- kWh_{it} – electricity consumption for customer i in datetime t .
- β_1 – A coefficient indicating average PTR treatment effect (in kWh) per customer per hour.
- $Eventhour_t * Participant_i$ – the interaction of an event hour indicator (equal to 1 during PTR events or 0 in the hours before or after PTR events) with an indicator for PTR participation (1 for PTR participants or 0 for non-participants in the matched control group).
- β_2 – A coefficient indicating the average effect of non-event day consumption on consumption during PTR events.

³⁶ For the summer season, Cadmus restricted these days to only those occurring before the first event day (July 25, 2019) to avoid biasing the results with any potential non-event-day treatment effects of PTR, such as permanent changes to thermostat schedules. For the winter season, Cadmus included all non-event weekdays, as most participants had already been enrolled in the summer season. Cadmus tested both approaches for pre-treatment demand (days before the first winter event, and all days in the winter 2019/2020 season) and found that the savings estimates did not change substantially with either approach.

- $Summer2020All_{it}$ – A variable containing each customer’s individual hourly mean consumption during PTR non-event, non-holiday weekdays across the full summer season.
- $\beta_3 PropensityScore_i + \beta_4 PropensityScore * NewCustomer_i$ – controls for each customer’s propensity score, allowing this effect to differ for new customers (who were estimated in a separate propensity score model)
- τ_t – Error term for hour t of the analysis period. Cadmus captured these effects with hour-of-the-sample fixed effects (i.e., a separate dummy variable for each PTR event day hour).
- ε_{it} – an error term for consumption of customer i and hour t .

Equation A-2. Winter 2020/2021 Regression Model Specification

$$kWh_{it} = \beta_1 Eventhour_t * Participant_i + \beta_2 W21NEkWh_{it} + \beta_3 PropensityScore_i + \beta_4 PropensityScore_i * NewCustomer_i + \tau_t + \varepsilon_{it}$$

- kWh_{it} – electricity consumption for customer i in datetime t .
- β_1 – A coefficient indicating average PTR treatment effect (in kWh) per customer per hour.
- $Eventhour_t * Participant_i$ – the interaction of an event hour indicator (equal to 1 during PTR events or 0 in the hours before or after PTR events) with an indicator for PTR participation (1 for PTR participants or 0 for non-participants in the matched control group).
- β_2 – A coefficient indicating the average effect of top 10 coldest non-event day consumption on consumption during PTR events.
- $W21NEkWh_{it}$ – A variable containing each customer’s individual hourly mean consumption based on the top 10 coldest non-event, non-holiday weekdays during the winter season.
- $\beta_3 PropensityScore_i + \beta_4 PropensityScore * NewCustomer_i$ – controls for each customer’s propensity score, allowing this effect to differ for new customers (who were estimated in a separate propensity score model).
- τ_t – Error term for hour t of the analysis period. Cadmus captured these effects with hour-of-the-sample fixed effects (i.e., a separate dummy variable for each PTR event day hour).
- ε_{it} – an error term for consumption of customer i and hour t .

Staff Interviews

During spring 2021, Cadmus conducted interviews with the PGE program manager, PGE program marketing lead, and E-Source implementation staff. The interviews focused on documenting how the program operated during summer 2020 and winter 2020/2021, any implementation challenges, and any successes or lessons learned to date. Cadmus used information obtained from the interviews to provide context for the current evaluation.

Customer Surveys

Cadmus designed and administered three event surveys online with customers enrolled in Flex 2.0 PTR during the summer 2020 season:

- Survey 1 for July 21, 2020, event
- Survey 2 for July 30, 2020, event
- Survey 3 for August 17, 2020, event

The evaluation was scheduled to administer winter surveys during February 2021. Due to a limited winter season (two events) and power outages from the 2021 snow and ice storm, surveys were not conducted for the winter 2020/2021 season.

Survey Design

To provide PGE with timely customer feedback, Cadmus administered the event survey 48 hours after PGE called an event. Each event survey asked participants about their awareness of event notification, participation in the event, motivators, and satisfaction with the rebate, program, and PGE. The event survey took respondents less than eight minutes to complete. Respondents did not receive an incentive for completing the survey.

Survey Sampling and Response Rates

Cadmus contacted a random sample of Flex PTR and Test Bed PRT customers stratified by microsegment. Due to the small number of Big Impactors and Fast Growers in the Test Bed population, Cadmus contacted some of the same customers twice, though we excluded anyone who had previously completed an event survey. Table A-4 shows the total number of customers contacted and response rate for the three event surveys. On average, the three surveys achieved a response rate of 10%.

Table A-4. Flex 2.0 PTR Summer 2020 Event Survey Samples and Response Rates

	Population	Sample Frame*	Survey Completes (Achieved Sample)	Response Rate
PTR Group				
Test Bed PTR	15,970	5,639	367	7%
Flex PTR	76,821	5,544	782	14%
Test Bed PTR x Microsegment				
Big Impactors	232	276**	30	11%
Fast Growers	791	914**	78	9%
Middle Movers	2,545	1,418	93	7%
Borderliners	5,479	1,418	80	6%
Low Engagers	6,756	1,418	77	5%
Null (no microsegment)	167	195	9	5%
Flex PTR x Microsegment				
Big Impactors	2,629	924	230	25%
Fast Growers	7,002	924	148	16%
Middle Movers	15,355	924	146	16%
Borderliners	22,664	924	106	11%
Low Engagers	26,955	924	81	9%
Null (no microsegment)	2,216	924	71	8%
Overall	92,791	11,183	1,149	10%

* The table combines all three event surveys.

** Due to the small number of Big Impactors and Fast Growers in the Test Bed population, Cadmus contacted some of the same customers twice, though we excluded anyone who had previously completed an event survey.

Survey Data Analysis

To analyze the survey data, Cadmus compiled frequency outputs, coded open-end survey responses according to the thematic similarities, and ran statistical significance tests. To determine whether survey results significantly differed between groups, Cadmus compared survey results at the 90% confidence level (or $p \leq 0.10$ significance level). When applicable to the analysis, Cadmus applied statistical weights to the survey results by microsegment and/or PTR group to reflect actual program population proportions. Open-end survey items were not weighted.

Appendix B. Event Day Load Shapes

The following figures compare the average event day load shapes between treatment and matched control group customers for all seven of the event days (summer 2020 events 1 to 5 and the winter 2020/2021 events 1 and 2). For all events, the treatment group displays a lower average consumption during the event hours when compared to the matched control group, reflecting PTR impacts before controlling for other factors in the regression models.

Load Shape Comparison by PTR Group

Summer 2020

Figure B-1. Participant Load Shape Comparison – Summer 2020, Event 1

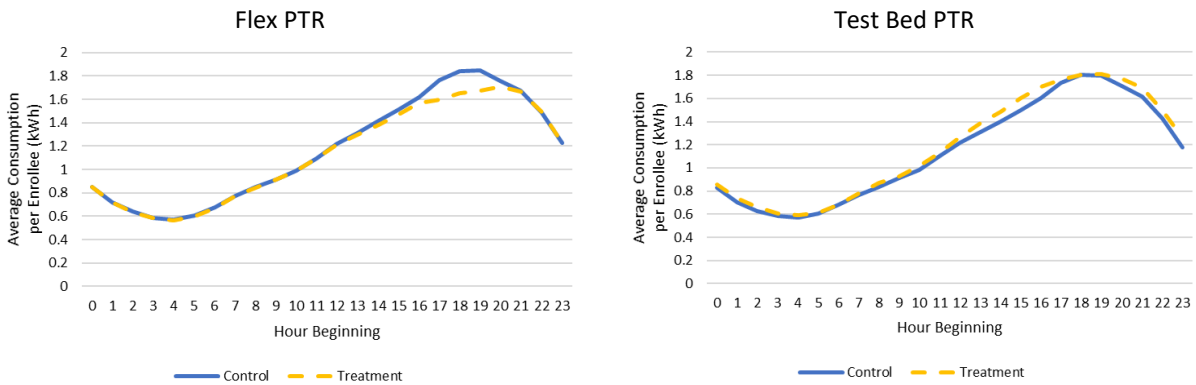


Figure B-2. Participant Load Shape Comparison – Summer 2020, Event 2

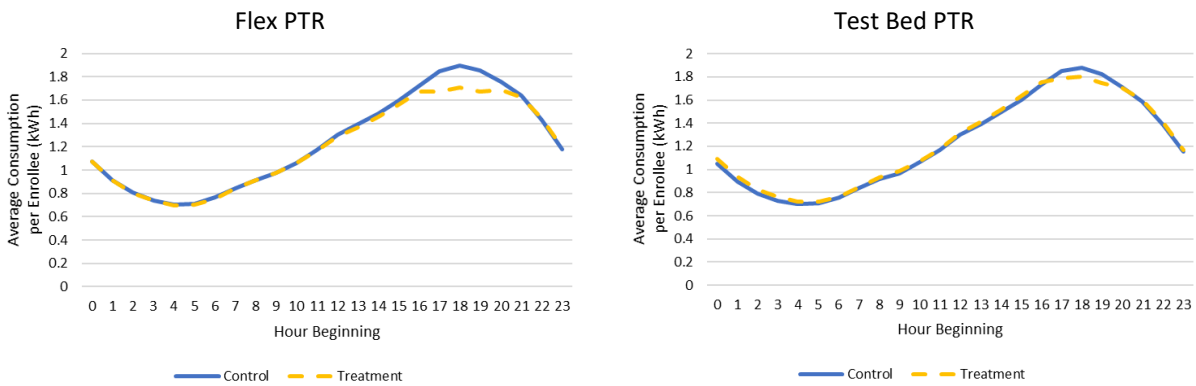


Figure B-3. Participant Load Shape Comparison – Summer 2020, Event 3

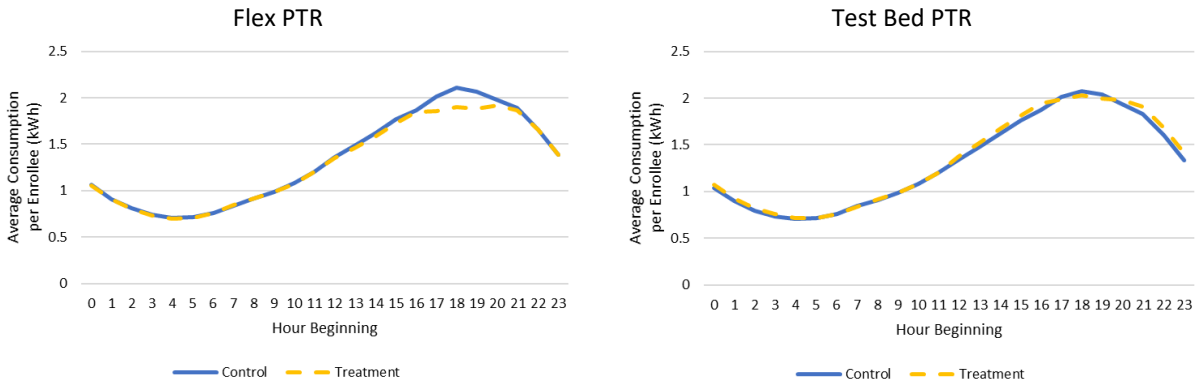


Figure B-4. Participant Load Shape Comparison – Summer 2020, Event 4

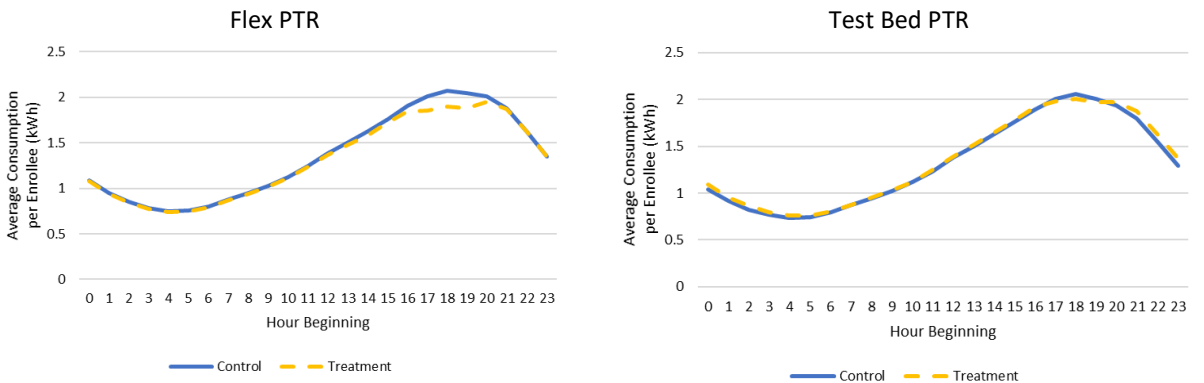
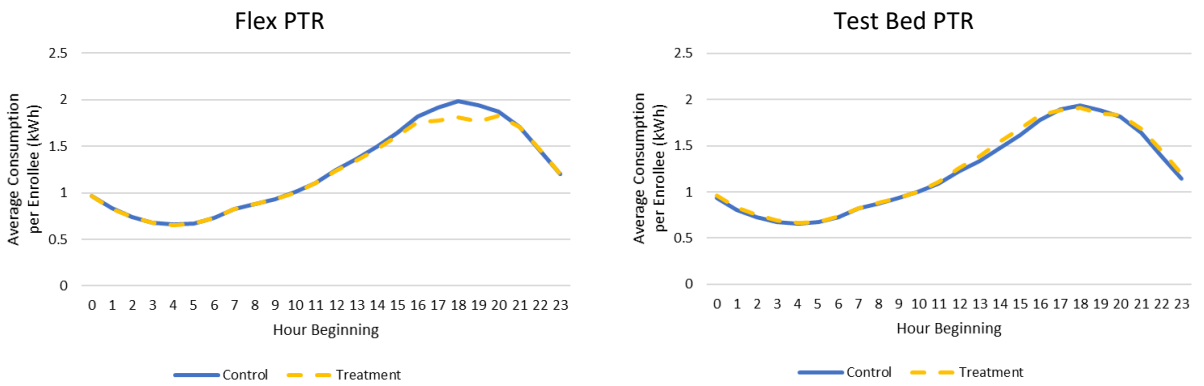


Figure B-5. Participant Load Shape Comparison – Summer 2020, Event 5



Winter 2020/2021

Figure B-6. Participant Load Shape Comparison – Winter 2020, Event 1

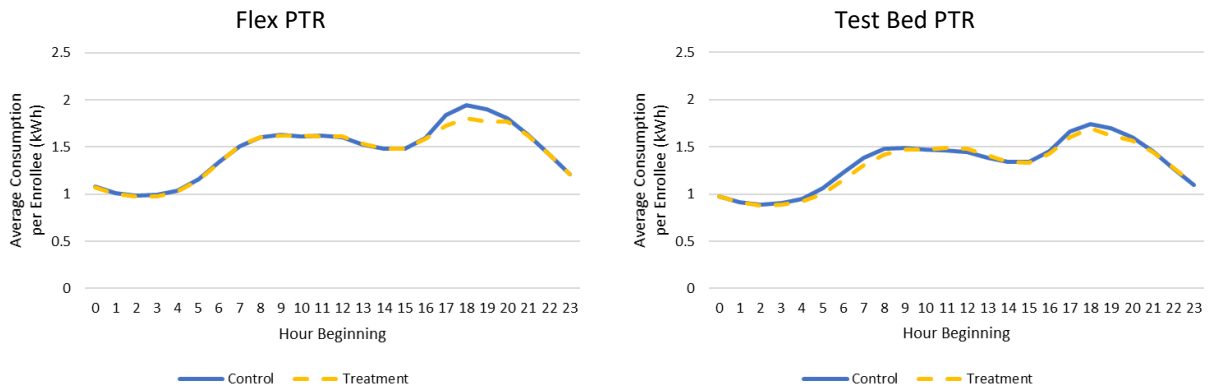
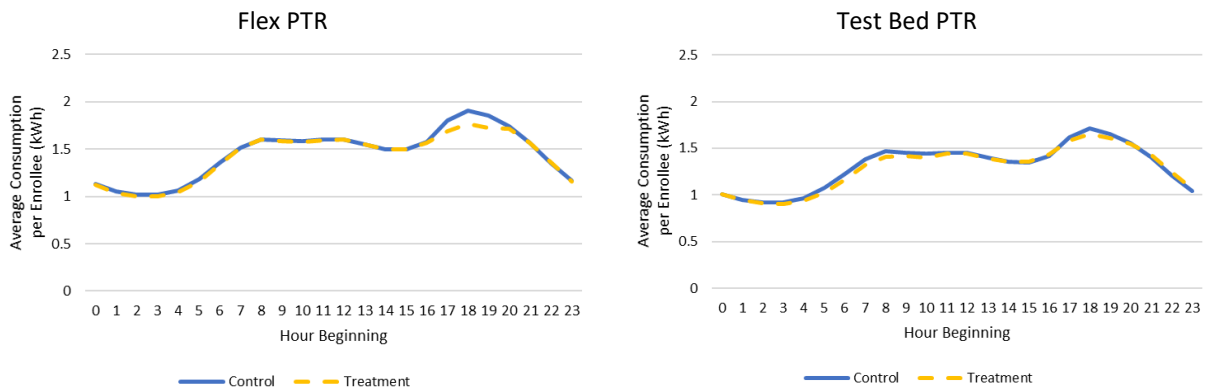


Figure B-7. Participant Load Shape Comparison – Winter 2020, Event 2



Appendix C. Additional Impact Findings

This appendix provides additional summaries of impact findings by season, event (day and hour), and PTR group. In Table C-1 and Table C-2, savings are provided by event and hour, along with the standard errors of the estimates and the number of customers from the analysis sample. Table C-3 shows participant populations by event and PTR group. Figure C-1 through Figure C-7 graphically depict the information found in the first two tables—hourly savings over the course of the full event day and the associated confidence interval using the standard error of the estimate.

Table C-1. PTR Event Savings by Hour – Flex PTR Enrollees

Date	Hour Beginning	Savings Estimate (kWh)	Standard Error	Analysis Sample Size (Treatment)
June 23, 2020	5 p.m.	0.145	0.006	75,761
	6 p.m.	0.165	0.006	
	7 p.m.	0.158	0.006	
July 21, 2020	5 p.m.	0.160	0.006	73,676
	6 p.m.	0.174	0.006	
	7 p.m.	0.171	0.006	
July 30, 2020	5 p.m.	0.143	0.006	73,143
	6 p.m.	0.190	0.006	
	7 p.m.	0.174	0.006	
August 17, 2020	5 p.m.	0.138	0.006	71,633
	6 p.m.	0.164	0.006	
	7 p.m.	0.157	0.006	
September 3, 2020	5 p.m.	0.123	0.006	70,434
	6 p.m.	0.159	0.006	
	7 p.m.	0.168	0.006	
January 25, 2021	5 p.m.	0.120	0.007	72,111
	6 p.m.	0.146	0.007	
	7 p.m.	0.130	0.007	
January 27, 2021	5 p.m.	0.109	0.006	72,057
	6 p.m.	0.144	0.007	
	7 p.m.	0.143	0.006	



Table C-2. PTR Event Savings by Hour –Test Bed PTR Enrollees

Date	Hour Beginning	Savings Estimate (kWh)	Standard Error	Analysis Sample Size (Treatment)
June 23, 2020	5 p.m.	0.036	0.012	15,929
	6 p.m.	0.048	0.012	
	7 p.m.	0.025	0.012	
July 21, 2020	5 p.m.	0.111	0.011	15,728
	6 p.m.	0.118	0.011	
	7 p.m.	0.111	0.011	
July 30, 2020	5 p.m.	0.076	0.012	15,656
	6 p.m.	0.085	0.012	
	7 p.m.	0.079	0.012	
August 17, 2020	5 p.m.	0.075	0.012	15,457
	6 p.m.	0.091	0.012	
	7 p.m.	0.067	0.011	
September 3, 2020	5 p.m.	0.067	0.012	15,272
	6 p.m.	0.073	0.012	
	7 p.m.	0.073	0.012	
January 25, 2021	5 p.m.	0.046	0.012	16,284
	6 p.m.	0.044	0.013	
	7 p.m.	0.077	0.012	
January 27, 2021	5 p.m.	0.021	0.012	16,245
	6 p.m.	0.062	0.012	
	7 p.m.	0.035	0.012	

Table C-3. Program Participant Population by Event and PTR Group

Event	Test Bed PTR Participant Count	Flex PTR Participant Count
Summer 2020		
Event 1	15,896	75,599
Event 2	15,722	73,601
Event 3	15,649	73,084
Event 4	15,454	71,594
Event 5	15,270	70,403
Winter 2020/2021		
Event 1	16,741	74,604
Event 2	16,694	74,484

Figure C-1. Average Hourly PTR Savings (Event 1), by PTR Group – Summer 2020

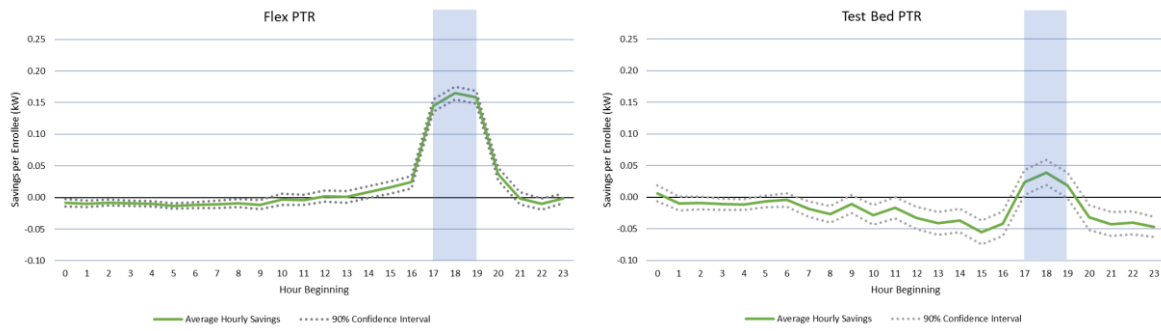


Figure C-2. Average Hourly PTR Savings (Event 2), by PTR Group – Summer 2020

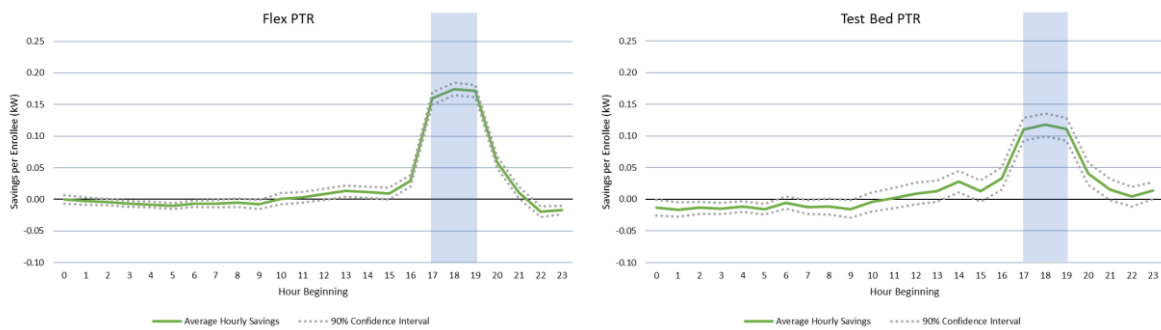


Figure C-3. Average Hourly PTR Savings (Event 3), by PTR Group – Summer 2020

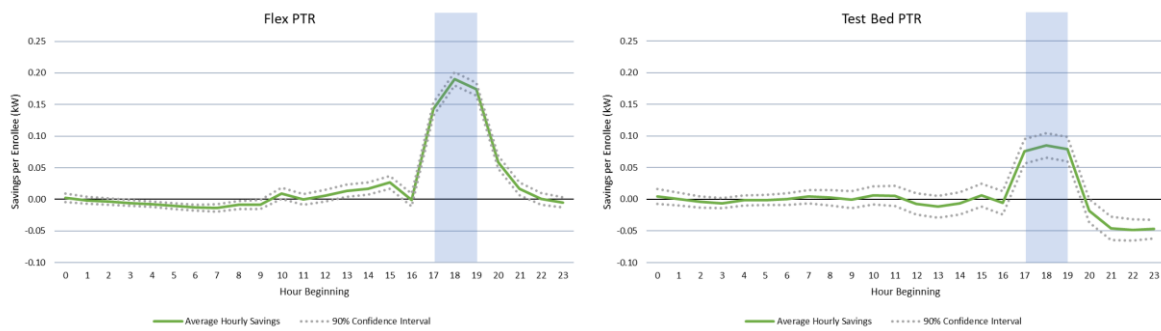


Figure C-4. Average Hourly PTR Savings (Event 4), by PTR Group – Summer 2020

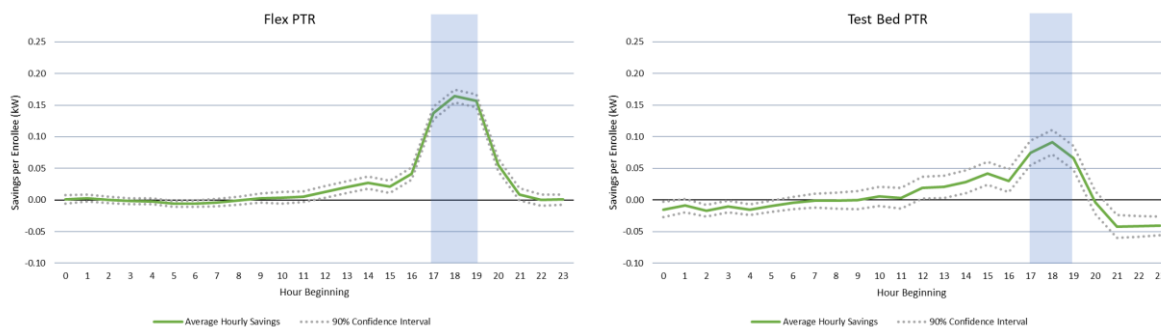


Figure C-5. Average Hourly PTR Savings (Event 5), by PTR Group – Summer 2020

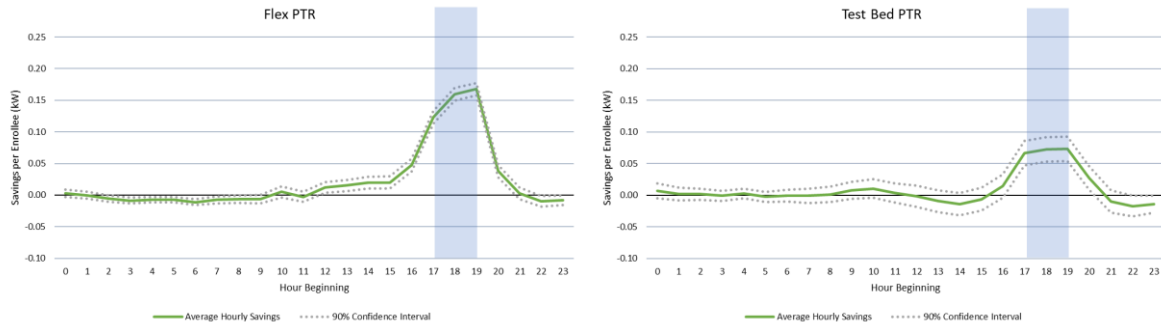


Figure C-6. Average Hourly PTR Savings (Event 1), by PTR Group – Winter 2020/2021

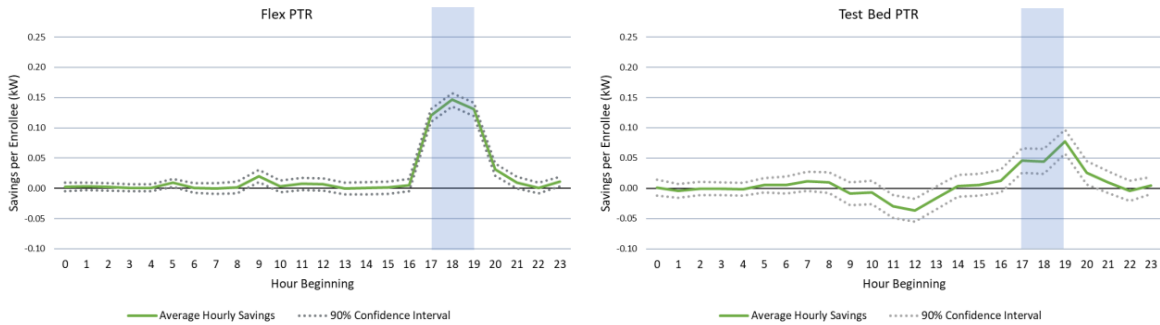


Figure C-7. Average Hourly PTR Savings (Event 2), by PTR Group – Winter 2020/2021

