
PGE

Portland General Electric
121 SW Salmon Street · Portland, Ore. 97204

August 10, 2020

***Via Electronic Filing***

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

**Re: UM 1708: Residential Pricing and Behavioral Demand Response (DR) Pilot (Flex 2.0) 2019/2020 Evaluation**

Dear Filing Center:

Enclosed is the Year One evaluation of Portland General Electric Company's (PGE's) Residential Pricing and Behavioral DR Pilot (Flex 2.0). 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 2019 and winter 2019/2020 seasons.

The Flex 2.0 Peak Time Rebates (PTR) evaluation highlights the innovative ways PGE is building strong customer engagement by offering a no-risk program that gives customers more choice and control in how they manage their energy use and reduce system peak demand. New PTR micro-segments[1] and learnings from customer focus groups (conducted virtually in April 2020) are informing PGE's communication, education, and retention efforts and support its customer-focused data strategy.

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

- Simplified the baseline methodology by moving to an industry-standard, X-in-Y model with a weather adjustment.
- Introduced same-day email notifications on PTR Event days as 25% of customers reported forgetting about the events without a day-of reminder. Enablement of same-day text messaging is in process and recorded voice messaging is also being tested.
- Expanded savings tips and tools giving customers more data-driven and specific ways to help them reduce energy use and save during PTR events.

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

If you have any questions or require further information, please contact Alina Nestjorkina at (503) 464-2144. Please direct all formal correspondence and requests to the following e-mail address pge.opuc.filings@pgn.com.

Sincerely,

/s/ *Jaki Ferchland*
Jaki Ferchland
Manager, Regulatory Affairs

*Enclosure*

cc: UM 1938 Service List
Eric Shierman, OPUC

# Flex 2.0 Demand Response Pilot Program

## EVALUATION REPORT

June 23, 2020

**Prepared for:**

Portland General Electric
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# Acronyms, Terms, and Definitions

| Acronym/Term | Definition |
|---|---|
| AMI | Advanced metering infrastructure |
| BDR | Behavioral demand response |
| Control Group | Control group refers to nonparticipants matched to participants through propensity score matching (see *Appendix A* for details). The electricity demand of the control group provided a baseline for measuring the PTR event demand impacts. |
| CSR | Customer service representative |
| DLC | Direct load control |
| HVAC | Heating, ventilation, and air conditioning |
| IRP | Integrated Resource Plan |
| kW | Kilowatt |
| kWh | Kilowatt-hour |
| Micro-Persona | Five PGE customer segments characterizing demand response potential: Big Impactors, Borderliners, Fast Growers, Low Engagers, and Middle Movers. |
| MW | Megawatt |
| NOAA | National Oceanic and Atmospheric Administration |
| 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 |
| RCT | Randomized controlled trial |
| 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) and outside of the Test Bed (Flex PTR). |
| 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 rebate (PTR) to residential customers in April 2019 through the Flex 2.0 pilot.

PTR is a behavioral, event-based, demand response resource. Flex 2.0 PTR pays customers to reduce their electricity consumption during summer and winter peak demand events. PGE notifies participants one day 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 their baseline consumption during events. PGE called five PTR events in summer 2019 and one event in winter 2019/2020.[4]

At the end of February 2020, PGE had enrolled approximately 89,675 customers into the Flex 2.0 PTR program track. Using this evaluation's estimates of per-participant demand savings for summer and

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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 (4 p.m. through 7 p.m.) on the following weekday, non-holiday dates: 7/25/19, 8/6/19, 8/20/19, 8/28/19, 9/12/19, and 1/15/20.

winter, PGE possesses approximately 7.4 MW of winter demand response capacity and 9.2 MW of summer demand response capacity from Flex 2.0 PTR.[5]

This report focuses on evaluation of Flex 2.0 PTR from its launch in April 2019 through the first two event seasons (summer 2019 and winter 2019/2020). The evaluation covers PTR participants who opted into the program and participants in PGE's Test Bed project who were automatically enrolled in PTR in July 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 Test Bed project as *Test Bed PTR*.

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

Through meter data analysis, interviews with program staff, customer surveys, and a logic model review, 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
- Track changes in customer awareness and comprehension of demand response
- Track the customer values of PGE's demand response offerings
- Measure demand impacts of demand response event by season and micro-persona
- Assess the bill credits customers received for participating in PTR events
- Document customer targeting and marketing effectiveness
- Assess the impacts of customer educational materials on load shifting
- Identify Flex 2.0 implementation successes and challenges and improvement opportunities
- Assess any differences in demand impacts and program experience between Flex PTR and Test Bed PTR participants

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[5] For this calculation, Cadmus used the average demand savings per participant across all event hours for each season (0.103 kW in 2019 summer and 0.083 kW in 2019/2020 winter) and multiplied these by the 89,675 customers enrolled at the end of February 2020.

[6] Note, based on Flex 1.0 evaluation findings, PTR opt-in participants achieved higher average demand savings than opt-out participants. The Test Bed project used opt-out enrollment in PTR to support other research objectives that will be documented in a separate evaluation. 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.

## *Key Findings*

Table 1 presents peak demand savings for summer 2019 and winter 2019/2020 and customer satisfaction results for summer 2019.[7] In summer, the demand savings per participant averaged 0.058 kW for Test Bed PTR participants and 0.116 kW for Flex PTR participants. Event demand savings achieved a maximum of 0.085 kW per Test Bed PTR participant and 0.176 kW per Flex PTR participant during the fourth event, when the outside temperature was 94°F. Overall customer satisfaction was 78% to 79% for Test Bed PTR and Flex PTR participants, respectively. In winter, average savings per participant were 0.016 kW for Test Bed PTR participants and 0.097 kW for Flex PTR participants. There was only one winter event.

**Table 1. Key Findings from the Flex 2.0 Evaluation**

| PTR Group | Demand Savings | | | | | | Program Satisfaction | |
|---|---|---|---|---|---|---|---|---|
| | Summer 2019 | | | | Winter 2019/2020 | | | |
| | Mean kW | Percentage | Max kW | Percentage | kW | Percentage | Satisfied (6-10) | Delighted (9-10) |
| Flex PTR | 0.116** | 8%** | 0.176** | 10%** | 0.097** | 5%** | 79% | 40% |
| Test Bed PTR | 0.058** | 4%** | 0.085** | 4%** | 0.016* | 1%* | 78% | 28% |

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 for events 1-5. For Flex PTR and Test Bed PTR, the maximum savings occurred during event 4. The percentage savings are the kW savings divided by estimated baseline demand. ** indicates statistically significant at the 5% level and * indicates at the 10% level. Satisfaction reflects participant responses from summer 2019 experience survey. Satisfaction values reflect the percentage of survey respondents who rated their program satisfaction on a 0 to 10 rating scale.

## *Conclusions and Recommendations*

Based on the evaluation findings, Cadmus came to the following conclusions and recommendations.

### Load Impacts

**The PTR program reduced demand during summer PTR events, and the demand savings varied between events and with outside temperature.**

In summer, the PTR program achieved average demand savings per participant of 0.116 kW (8% of baseline consumption) for Flex PTR participants and 0.058 kW (4%) for Test Bed PTR participants. These estimates were statistically significant at the 5% level. The PTR program averaged savings of 5.7 MW across all summer event hours.

The average demand savings per participant varied between events and were correlated with outside temperature. The maximum demand savings per participant of 0.085 kW for Test Bed PTR participants and 0.176 kW for Flex PTR participants were achieved during event 4, when the outdoor temperature was 94°F. The minimum demand savings per participant of 0.020 kW for Test Bed PTR participants and 0.062 kW for Flex PTR participants were achieved during event 5, when the outside temperature was

[7] Note that because of the single event during the winter season, PGE decided to cancel the customer surveys for winter.

only 79°F. These findings suggest that demand response capacity from PTR is weather-dependent and that PGE can expect greater capacity when the weather is hot and system loads are high. However, since PGE only called five events in summer 2019 and the outside temperature during some events was relatively mild, there is more to learn about how outside temperature influences PTR demand savings. PGE can learn more about the PTR program's performance by calling additional events during hot summer days in 2020.

**PGE dispatched an insufficient number of winter events to draw strong conclusions regarding the capabilities of PTR as a demand management resource in winter. However, the one event showed PTR reduced winter peak demand.**

PGE dispatched only one event during the winter 2019/2020 season.[8] The PTR program achieved average demand savings per participant of 0.097 kW (5% of baseline consumption) for Flex PTR participants and 0.016 kW (1%) for Test Bed PTR participants. These estimates were statistically significant at the 5% and 10% levels, respectively. The PTR program saved an average of 7.0 MW across the winter event hours.

**PTR participants reduced their demand in the hours immediately preceding and following the demand response events.**

Statistically significant demand savings from PTR occurred in the hours before and after the event window for all summer season events and the winter season event for Flex PTR participants. This was the case for most events across both seasons (with winter Test Bed impacts as an exception). These savings reflect efficiency behaviors geared toward event participation that spilled over to hours outside the event window (e.g., making changes to thermostat set points in the morning before a customer leaves for work).

**In summer, demand savings from PTR differed significantly between demand response micro-persona groups.**

PGE assigned most residential customers to one of five customer segments (micro-personas) representing 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, participants in the Big Impactors, Fast Growers, and Middle Movers micro-persona groups achieved higher savings than other micro-persona groups. In general, the savings per participant of these groups averaged between about 0.2 kW and 0.5 kW for Flex PTR participants and between 0.1 kW and 0.5 kW for Test Bed PTR participants.

**The *Low Engager* customer segment constituted the majority of PTR participants but had small average demand savings per participant in summer, which reduced the average for the program.**

In summer, Low Engagers saved about 0.11 kW (11%) per Flex PTR participant and 0.03 kW (4%) per Test Bed PTR participant. Because Low Engagers represented 33% of the program population, they

[8] A delay in the start of the winter event season and mild winter temperatures limited opportunities for PGE to call PTR events.

significantly reduced the average demand savings per participant for the whole program. When Low Engagers and those with missing micro-personas were omitted from the savings analysis, the average demand savings per participant increased to 0.23 kW (16%) per Flex PTR participant and 0.11 kW (8%) per Test Bed PTR participant. In winter, the average demand savings per Flex PTR participant of Low Engagers (0.10 kW, 7%) aligned with those of most other demand response micro-persona groups except for Big Impactors (0.20 kW, 5%).

**The average demand savings per PTR participant were lower in Flex 2.0 than in Flex 1.0; however, on average, some micro-persona groups in Flex 2.0 saved as much or more than Flex 1.0 participants.** Flex 1.0 PTR participants saved an average of 0.41 kW (18%) per participant during summer PTR events and 0.13 kW (7%) during winter afternoon events—more than the savings achieved by Flex 2.0 participants. However, Big Impactors in both Flex PTR and Test Bed PTR saved as much as 0.55 kW during some summer 2019 events. Likewise, Big Impactors in Flex PTR saved 0.20 kW during the winter 2019/2020 event.

**Load Impact Recommendations**[9]

- PGE can increase the average savings per PTR participant by targeting customers in micro-persona segments with high average demand savings. Increasing the participation of customers in the highest saving micro-persona segments (e.g., Big Impactors and Fast Growers) would maximize demand savings and improve the program's cost-effectiveness.
- PGE may be able to increase savings of existing participants by educating customer about ways to save during events. This education may be particularly beneficial for Low Engagers, who have the lowest average savings per participant.
- Specifically, PGE should consider providing personalized demand-savings tips to customers based on their demographic and home characteristics, prioritizing actions that should result in highest electric savings per season. Contingent upon data availability, this approach will help customers take actions based on their HVAC fuel source and increase their demand savings.
- PGE should call more events in winter to obtain greater certainty about the performance of PTR in winter.
- Weather conditions permitting, PGE should call more events on hot summer days to gain greater certainty about the performance of PTR when system demand for electricity and need for this resource are greatest.
- PGE should consider the Test Bed PTR project as separate from the Flex 2.0 PTR program and evaluate them accordingly. Test Bed customers were automatically enrolled in PTR and received Test Bed-specific promotions and educational materials, making Test Bed PTR a fundamentally different experience than Flex 2.0 PTR.

[9] Note: As of June 2020, PGE is actively working to implement these recommendations, including recent approval to increase the Flex 2.0 enrollment cap (to 160,000 from 110,000) to increase targeted participation and in developing education materials to help customers to maximize savings for summer PTR events.

## Implementation

**PGE surpassed its Flex 2.0 PTR enrollment goals for 2019.**
PGE exceeded its 2019 year-end goal of enrolling 55,000 customers in Flex 2.0 PTR. PGE enrolled 86,753 customers by the end of 2019, of whom 14,897 were located in the Test Bed distribution areas. PGE led the marketing and content creation, employing multiple marketing activities and channels to meet its enrollment goals.

**PGE successfully applied financial messaging in its marketing to motivate customers to enroll in Flex 2.0 PTR.** Having learned from marketing Flex 1.0 that customers were more responsive to financial messaging (i.e., earning rebates, saving money, and saving on bills) compared to environmental or community stewardship messaging, PGE used financial messaging throughout the Flex 2.0 PTR marketing. In addition, PGE used a simple three-step phrase—get notified, shift use, and earn rebates—to explain how the PTR program works, rather than the technical term *demand response*. Marketing materials frequently repeated this three-step phrase, further reinforcing the financial messaging. The financial messaging likely resonated with customers as most respondents (89%) from the recruitment survey indicated *to reduce my energy bill by earning bill credits* as a reason for enrolling in PTR.

**PGE is currently meeting its participant retention goal for Flex 2.0 PTR.** After approximately one year of the program, 97% of the 93,521 customers that were enrolled in Flex 2.0 PTR to date have remained in the program. PGE, therefore, is currently meeting its participant retention goal of 95%. Flex PTR (97%) and Test Bed PTR (96%) showed similar retention rates.

**PGE called fewer events than planned in summer and winter because of technological limitations with its event dispatch system coupled with mild weather conditions.**
PGE intended to call six to 10 events per season but called only five in summer 2019 and one in winter 2019/2020. Technological limitations affected the time of day PGE could call events and prevented PGE from sending same-day event notifications to participants. This effectively reduced the number of available times which PGE could call events within a given season; however, a mild summer and winter also contributed to the small numbers of events.

**PGE could reduce the amount of overpayment for PTR savings by paying rebates to customers at the end of the month based on aggregate demand reduction across all events during the month.** In summer 2019, PGE paid rebates for savings equal to 3.5 times the savings the program achieved. Overpayment of rebates is inherent to PTR programs because utilities cannot differentiate between savings caused by the rebate and savings that would have occurred in absence of the event using individualized customer baseline estimates. PGE could reduce overpayment by paying customers at the end of the month based on their total demand reductions across all event hours during the month. Paying customers for their total demand savings, as was done in the Flex 1.0 pilot, would reduce payments for naturally occurring savings for some events, as these savings will be counterbalanced by naturally occurring increases in consumption for other events.

**Errors in calculating customer baselines and savings calculations may have negatively impacted participant satisfaction with the program**. Some participants experienced a disconnect between their

participation effort and the rebate they earned. The summer experience survey found that 40% of respondents agreed with the statement *the rebates don't seem to be linked to the actions I take*, and 65% agreed with the statement *the actions I took during events were similar but my event results differed*. The evaluation also found mentions of the disconnect in the survey's open-end comments and in feedback provide directly to PGE through the customer call center. In the evaluation of the Flex 1.0 PTR, Cadmus did not find any customer mentions of the disconnect between their participation effort and the rebate amount earned.

Providing customers the rebate results at the monthly level or at the end of the season and improving the accuracy of the baseline calculations may increase participant satisfaction.

**Implementation Recommendations**

- Focus on retaining participants to maintain PTR's high number of enrollments. Retention efforts can include ongoing customer education and encouragement messaging to keep customers informed and engaged with PTR.
- Build on the marketing success of PTR by applying learnings to the recruitment of customers for the Time of Use (TOU) offering scheduled for 2021. Consider applying successful strategies such as financial messaging and the customer call center incentive program.
- Work with the implementation contractors and PGE teams on developing technological solutions that will help increase the number of events called.
- Consider methods for improving payment accuracy and customer satisfaction, including providing customers their savings results and rebate payments based on total savings over all event hours at the end of the month. Paying out at the end of the month would improve the accuracy of the payouts, reduce rebate overpayments, and possibly improve customer satisfaction.

## Customer Experience

**Flex 2.0 PTR achieved high customer engagement and participation during summer events.** Ninety-eight percent of summer experience survey respondents remembered being notified of events in advance. The high percentage of respondents who remembered receiving event notifications suggests that customers were attentive to the events. The majority of respondents reported participating in at least one summer event (87%) and most said it was *very easy* or *somewhat easy* to participate (87%). Respondents most frequently reported taking simple, low-savings actions such as doing chores before or after the events and turning off the lights to shift or reduce energy use.

**Flex 2.0 PTR increased awareness of demand response among the customers who were auto-enrolled into the program.** Prior to the first summer event, 88% of Flex PTR respondents (who opted-in to the program) said they were already aware of the concept of demand response compared to 58% of Test Bed PTR respondents (who were auto-enrolled). Nonetheless, after one summer season, Test Bed PTR respondents' awareness of demand response significantly increased to 86%, catching up with the Flex PTR respondents. Increased awareness of demand response suggests PGE's marketing, corporate

demand response campaign, customer education and the experience of participating in Flex 2.0 PTR (such as receiving peak time event notifications and results) is having its intended effects.

**PGE did not meet its customer satisfaction goals for Flex 2.0 PTR.** The majority of respondents were satisfied with the program. Nevertheless, PGE did not meet its customer satisfaction goals. Based on the overall weighted results, 76% of respondents were *satisfied*, in comparison to the goal of 80% *satisfied*, and 34% were *delighted*, in comparison to the goal of 60% *delighted*. The program achieved similar customer satisfaction results between Flex PTR participants (79% *satisfied,* 40% *delighted*) and Test Bed PTR participants (78% *satisfied,* 28% *delighted*).

**Customers' perceptions that the rebates were not accurate negatively impacted program satisfaction. Many participants felt their rebates were not commensurate with their effort to save.** To ascertain possible reasons that PGE did not achieve higher customer satisfaction, Cadmus reviewed the summer experience survey's open-end comments. Respondents' negative comments emphasized the disconnect participant's felt between their participation effort and rebate amount earned, with comments that the rebate amount was too small (14%), the effort was not worth it or made no difference (9%), and the results/rebates did not match efforts (7%). Consequently, this disconnect between participation effort and rebate amount negatively impacted customer satisfaction with the program.

**The high proportion of the Low Engagers micro-persona segment, who were the least engaged and satisfied, also negatively impacted program satisfaction.** Several statistically significant differences emerged between micro-personas, particularly with Low Engagers. The evaluation found that Low Engagers lived up to their name; compared to the other groups, Low Engagers had the lowest self-reported event participation rate (82%), were the least satisfied (59%) and delighted (18%) with the rebate amount, and were the least satisfied (74%) and delighted (28%) with the program. Because Low Engagers made up 33% of the program population, improving their experience will be key to improving satisfaction.

**Customer Experience Recommendations**

- Provide customers with personalized tips on how to shift/reduce during events that will help them increase their rebate earning potential. This would require home or customer profile data. To collect such data, run a promotion that encourages customers to complete an online home energy audit survey (such as ETO's Online Home Energy Review).
- Focus efforts to improve the customer experience of Low Engagers.
- Consider targeting Low Engagers for Direct Load Control (DLC) initiatives. PTR has a large number of Low Engagers in the program population (33%) that may benefit from automated demand response, reducing the reliance of behavior-based load shifting and potentially optimizing demand savings potential. DLC options may also provide opportunities to keep this customer segment enrolled and engaged, if there is concern they may be more likely to opt out of PTR. Review the demand savings and cost-effectiveness of both programs by micro-persona to confirm appropriateness of targeting Low Engagers for DLC options.

# Introduction

PGE's 2016 Integrated Resource Plan called for reducing its dependence on coal-based generation and increasing its use of renewable energy resources while maintaining system reliability.[10] The plan identified residential dynamic pricing as presenting a large and cost-effective opportunity for PGE to achieve these goals.[11] 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 350 MW of power contracts in the mid-2020s.[12]

To help meet its goals and building on learnings from the Flex 1.0 pilot, in April 2019, PGE launched the Flex 2.0 pilot program, which started with an opt-in peak time rebate (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.

Flex 2.0 PTR is an event-based, behavioral demand response program. To reduce residential peak demand during summer and winter months, PGE calls peak time events, notifying participants of the event one day in advance. PGE called five events in summer 2019 and one event in winter 2019/2020. PGE calculates a PTR participant's savings by comparing their metered consumption to their estimated baseline consumption. Participants receive a rebate of $1 per kWh of demand savings during peak time events.

At the same time as the Flex 2.0 pilot, PGE launched the Test Bed project—a neighborhood smart grid initiative aimed at accelerating the development of demand response resources.[13] The Test Bed project field tests and evaluates various demand response offerings, new technologies, and customer value propositions in three local neighborhoods (referred to as Hillsboro, Milwaukie, and North Portland),

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[10] 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

[11] 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.

[12] Portland General Electric. July 19, 2019. *2019 Integrated Resource Plan*. https://www.portlandgeneral.com/our-company/energy-strategy/resource-planning/integrated-resource-planning. PGE's 2019 IRP calls for adding 211 MW of summer demand response capacity and 141 MW of winter demand response capacity by 2025. These aggressive capacity goals aim to address the expected expiration of power contracts for 350 MW in the mid-2020s, support the planned integration of 150 MW of renewable resources by 2023, and provide new system capacity and reliability services.

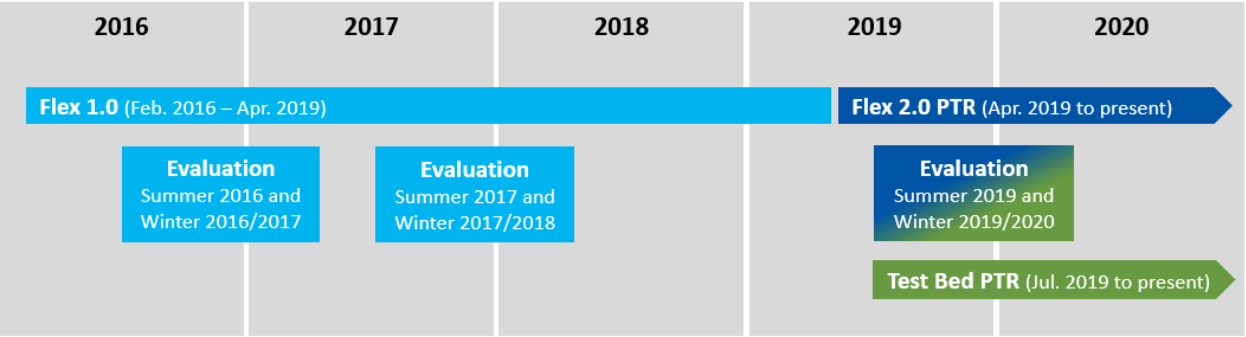
[13] Portland General Electric. October 2018. *PGE Testbed Proposal.* https://edocs.puc.state.or.us/efdocs/UAC/adv859uac113045.pdf

whose boundaries are defined by distinct distribution substation service areas. As part of the Test Bed project, PGE auto-enrolled residential customers in these three neighborhoods in July 2019 in opt-out PTR. In addition to having been auto-enrolled, Test Bed customers received different promotional and educational materials than PGE residential customers who opted into the pilot.

This report focuses on evaluation of the Flex 2.0 PTR program from its launch in April 2019 through the first two event seasons (summer 2019 and winter 2019/2020). The evaluation covers PTR participants who opted into the program and participants in PGE's Test Bed project who were automatically enrolled in PTR in July 2019 if they had not previously enrolled. This report refers to the opt-in PTR program outside the Test Bed as *Flex PTR* and the PTR component of the Test Bed project as *Test Bed PTR*. Impact estimates for the Test Bed project in this report pertain to all PTR customers in the Test Bed as a single group, whether they enrolled themselves or were automatically enrolled by PGE.There is a separate Test Bed project evaluation that focuses on other Test Bed-specific research objectives.

Figure 1 shows a timeline for Flex 1.0, Flex 2.0 PTR, and the Test Bed project and their evaluations to date.

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




### *Flex 1.0 Pilot*

The design and implementation of the Flex 2.0 pilot built on lessons from PGE's Flex 1.0 pilot, which ran from March 2016 to June 2018. The Flex 1.0 pilot enrolled approximately 14,000 residential customers in one of 12 different pricing and behavior-based program treatments: three opt-in time-of-use (TOU) rate treatments, three opt-in peak time rebates (PTR) treatments, an opt-out behavioral demand response (BDR) treatment, four opt-in hybrid treatments (TOU pricing with PTR or BDR), and opt-out BDR and opt-out PTR treatments.

Cadmus' evaluation of the Flex 1.0 pilot uncovered these key findings regarding PTR:[14]

- Opt-in PTR reduced demand per participant more than opt-out PTR and produced higher customer satisfaction.

[14] 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

- Larger PTR incentives did not yield more demand savings, but they did increase customer satisfaction.
- Opt-out designs significantly increased the number of participants, aggregate MW load reduction potential, and participant retention.
- Opt-in and opt-out PTR savings were greater in summer than winter.

PGE learned from its Flex 1.0 pilot that residential customers can be relied upon to shift load with the help of compelling incentives, messaging, and education. Findings from the evaluation helped inform the design of the Flex 2.0 pilot. For example, PGE chose a rebate of $1 per kWh of savings for the Flex 2.0 pilot as there were not statistically significant differences in average savings per participant between participants receiving rebates of $0.80, $1.55, and $2.25 per kWh of savings.

# 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 2019 and winter 2019/2020. The evaluation includes impacts from Test Bed PTR participants who were auto-enrolled in Flex 2.0 PTR.

PGE specified these nine objectives for the Flex 2.0 Pilot Program evaluation:

1. Track customer enrollment, retention, and satisfaction levels with the PTR offering
2. Track changes in customer awareness and comprehension of demand response
3. Track the customer values of PGE's demand response offerings
4. Measure demand impacts of demand response event by season and micro-persona
5. Assess the bill credits customers received for participating in PTR events
6. Document customer targeting and marketing effectiveness
7. Assess the impacts of customer educational materials on load shifting
8. Identify Flex 2.0 implementation successes and challenges and improvement opportunities
9. 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 advanced metering infrastructure (AMI) interval consumption data for individual customers in the treatment and matched control groups. The *Appendix A. Evaluation Methodology* provides details about the approaches for the propensity score matching and the savings estimation.

## *Evaluation Activities*

Table 2 lists the evaluation activities Cadmus conducted and how each activity addressed the evaluation objectives. (*Appendix A* describes each evaluation activity in more detail.) Note that because of the single event during the winter season, PGE decided to cancel the customer surveys for winter.

**Table 2. Flex 2.0 Evaluation Activities**

| Activity | Description | Corresponding Objective(s) | Outcome |
|---|---|---|---|
| Research Design | Quasi-experimental design using matched comparison group to estimate baseline consumption | 4 | 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 | 4 | Final analysis sample for estimation of load impacts |
| Load Impact Analysis | Regression analysis of individual customer AMI meter interval consumption data | 4, 9 | Estimates of demand savings by event, hour, PTR group (Flex, Test Bed), and by customer micro-persona segment |
| PTR Overpayment Analysis | Comparison of evaluated savings to PGE's load impact estimates used for rebate calculation | 5 | Estimate of the level of PTR overpayment for the summer 2019 season |
| Participation Analytics | Reporting of enrollment, retention, and demographic distribution of participants | 2, 9 | Summary statistics of program participant |
| Staff Interviews | Interviews with PGE and implementation staff to understand program processes, successes, and challenges | 6, 7, 8 | Thorough understanding and documentation of the program design and implementation |
| Customer Surveys | Recruitment, summer event, and summer experience surveys with participants | 1, 2, 3, 6, 7, 8, 9 | Findings on marketing, event notification, event participation, satisfaction, and value perceptions |
| Logic Model Review | Assessment of whether the program operated and produced results as theorized | 1, 2, 3, 4, 6, 7, 8 | Documentation of what is and what is not producing the theorized results |

# Pilot Program Description and Implementation

In April2019, PGE launched Flex 2.0 peak time rebates (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 enrolled in PTR voluntarily, were auto-enrolled as part of the Test Bed project, or were transferred over from Flex 1.0 pilot PTR treatment groups. PGE partnered with Oracle and TROVE Predictive Data Science (TROVE) to serve as the program's implementation contractors and selected Cadmus as the evaluator.

PGE set the following goals for Flex 2.0 PTR:

- Enroll 55,000 customers by the end of 2019 and 159,000 customers by the end of 2020
- Retain 95% of enrolled customers in 2019 and beyond
- Reduce demand by 13.3 MW in summer 2019 and 6.5 MW in winter 2019/2020
- 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
- Be a landlord
- 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 270,000 Schedule 7 Basic Service rate customers. There is no enrollment cap for Schedule 7 TOU rate customers.

## *Marketing*

PGE led the marketing and content creation for Flex 2.0 PTR, employing multiple marketing activities to meet its enrollment goals. Marketing activities differed according to whether customers voluntarily enrolled in PTR (i.e., opt-in PTR, the majority of whom are Flex PTR participants outside of the Test Bed) or were auto-enrolled as part of the Test Bed project (i.e., opt-out, the majority of whom are Test Bed PTR participants).

### Flex PTR (Opt-In)

Marketing to encourage opt-in enrollments in Flex 2.0 PTR began in late April 2019 and continued through winter 2019. PGE employed the six different marketing activities described in Table 3.

**Table 3. Summary of Flex PTR (Opt-In) Marketing Activities**

| Marketing Channel | Description of Marketing Activity |
|---|---|
| Email | PGE sent multiple PTR emails to customers. |
| Direct Mail | PGE sent PTR brochures and bill inserts to customers. |
| PGE Website | PGE promoted PTR on its website and created a dedicated PTR webpage with program information. |
| Paid Media | PGE promoted PTR in local newspapers, local movie theaters, Pandora Radio, and social media. |
| In-Market Promotions (promotions conducted live in the field among people) | • (PGE ran an Earth Day promotion, giving customers a chance to win a two-night stay at Pelton Park in exchange for enrolling in PTR.<br>• From July to August 2019, PGE offered customers the chance to win a Portland Timbers VIP experience, promoting the offer via TV, radio, web, social media, and the soccer stadium.<br>• For two months in summer 2019, PGE ran PTR ads on tricycles that also gave away free ice cream.<br>• PGE partnered with Green Mountain Energy Group to recruit customers at local events. |
| PGE Call Center | PGE ran an incentive program with its customer service representatives (CSRs) where they received 75 cents per customer enrollment in PTR. CSRs recruited during inbound calls. |

## Test Bed PTR (Opt-Out)

In mid-June 2019, PGE mailed customers within the Test Bed territories a brochure announcing the launch of the Test Bed project and subsequent auto-enrollment into PTR (scheduled for the following month). PGE conducted additional marketing activities with Test Bed PTR customers during 2019, specifically to investigate customer value proposition messaging. Details on these marketing activities will be documented in an upcoming evaluation report of the Test Bed project.

## *Enrollment Process*

The enrollment process for Flex 2.0 PTR differed by how the customer was recruited. PGE customers outside of the Test Bed, who were the primary account holders, 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 on July 13, 2019, September 25, 2019, December 13, 2019, and January 21, 2020. PGE identified customers who had premise IDs located within the Hillsboro, Milwaukie, and North Portland substation distribution areas for the Test Bed PTR auto-enrollments. The majority of Test Bed PTR participants were auto-enrolled on July 13, 2019, while the remaining three auto-enrollment dates served to add any new customers who had moved into the three substation distribution areas or in cases where substation boundaries shifted. PGE sent a confirmation email to these customers within the Test Bed a few days later. Upon enrollment, the primary account holders selected their event communication preferences (text, email, or both).

Flex 1.0 PTR legacy customers (treatment groups only) were switched over to Flex 2.0 PTR; these legacy customers received communication about their transition in May or June of 2019. These customers had their rebate amount changed from the legacy Flex 1.0 rebates of $0.80/kWh, $1.55/kWh, or $2.25/kWh to $1 per kWh, according to the Flex 2.0 program design.

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

## *Customer Education*

PGE learned from Flex 1.0 that educating customers was critical for program success because the program relies on customers to shift or reduce their energy consumption during peak time events. Therefore, PGE employed efforts such as training the customer service representatives (CSRs) at the call center along with season-ready emails, direct mail brochures, and in-market promotions to educate customers about PTR. These focused on explaining the timing and frequency of peak time events as well as the reasons and benefits of participation. PGE encouraged participation with statements such as "by reducing your energy consumption during these peak times, you can save money and allow more renewable energy options to support a cleaner, brighter energy future."

During the same time, PGE launched a corporate demand response campaign to increase customer awareness of demand response and help customers understand the why of demand response. The campaign allowed PGE to significantly scale back the marketing spent on PTR.

## *Event Management*

Flex 2.0 PTR had two peak time event seasons—summer (June through September 2019) and winter (November 2019 through February 2020). PGE called five events in summer 2019 and one event in winter 2019/2020, as shown in Table 4. Each event lasted three hours. Events were called only on non-holiday weekdays Tuesday through Friday. Because of implementation constraints, PGE was unable to dispatch events during the morning. Additionally, each season experienced slight operational delays: in summer, the program became operationally ready to begin calling events in late June 2019; and in winter, changes to the customer baseline calculation delayed the start of the event season until January 2020.

**Table 4. Flex 2.0 Summer 2020 and Winter 2019/2020 Peak Time Events**

| Season | Event | Day of week | Date | Avg. Outdoor Temp. (°F)* | Start Time | Duration (hours) |
|---|---|---|---|---|---|---|
| **Summer 2019** | 1 | Thursday | 7/25/2019 | 90° | 4 p.m. | 3 hours |
| | 2 | Tuesday | 8/6/2019 | 84° | 4 p.m. | 3 hours |
| | 3 | Tuesday | 8/20/2019 | 81° | 4 p.m. | 3 hours |
| | 4 | Wednesday | 8/28/2019 | 94° | 4 p.m. | 3 hours |
| | 5 | Thursday | 9/12/2019 | 79° | 4 p.m. | 3 hours |
| **Winter 2019/2020** | 1 | Wednesday | 1/15/2020 | 39° | 4 p.m. | 3 hours |

* 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.[15] Event notifications, sent via email and/or text, came with tips on how to shift or reduce energy usage during the event. By 8 p.m. the day after the event, the majority of customers received an email and/or text with their event results. All post-event notifications were sent within three days.

Customers learned if they saved energy during the event and, for those customers who did, 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

Flex 2.0 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 TROVE to calculate the baseline energy consumption for each customer, the customer's energy savings, and rebates resulting from the peak time events. TROVE 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.

For summer 2019, each customer's baseline energy consumption was calculated using one of four methods (referred to collectively as the *ensemble* baseline approach): regression, day-matching, machine learning, or nonparticipant matching. Using an adaptive approach, as new data became available over the summer, individual customer's baseline calculation methods would change as the relative accuracy of the methods were determined to change. For winter 2019/2020, PGE revised the baseline calculation approach to apply a 5-in-10 day day-matching method to all participants. This change was made to simultaneously improve baseline calculation accuracy, repeatability, and comprehension by participants.

## Micro-Personas

Before summer 2019, TROVE also segmented PGE customers into one of five micro-personas. As Table 5 describes, the definitions of these micro-personas reflected customers' predicted potential demand response capacity and likely engagement with demand response programs. Below, these are ranked in order of potential demand response value, from highest (Big Impactors) to lowest (Low Engagers). This customer segmentation was developed specifically for the Flex 2.0 pilot to facilitate targeted marketing and more detailed evaluation results.

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[15] PGE developed same-day event reminder emails and tested this with Test Bed customers during the one winter event on January 15, 2020.

**Table 5. Micro-Persona Segments**

| Micro-Persona | Description |
|---|---|
| Big Impactors (3%) | Larger single-family dwellings, with high income ranges, and subsequent billing metrics, busy and have likely digital subscription activity |
| Fast Growers (4%) | Tends to track tightly with Big Impactors, except shows the most engaged with technology behaviors |
| Middle Movers (8%) | Will track with Fast Growers, proportionally lower values on housing sizes, income, notably close with respect to technology |
| Borderliners (14%) | Individuals in this group are split, some may tend by value to lean into Low Engagers, while some are lined more with Middle Movers, a key may be viewing this group as potential Middle Movers, tend to rent |
| Low Engagers (33%) | Most likely to interact with newspapers, flyers and traditional media, least technologically, tendencies to live, smaller square foot housing, lower household income and comparatively older demographic |

Source: TROVE

Note: Micro-persona proportions of 89,675 participants still enrolled as of February 29, 2020. The remaining 40% of participants did not have a micro-persona indicated. Percentages do not sum to 100% due to rounding.

# Evaluation Findings

This section presents the major evaluation findings on Flex 2.0 PTR. Sections are sequenced in the order of program flow, from enrollment and delivery through savings achievement and customer experience. Findings concern these topics:

- Customer enrollment and retention
- Program marketing
- Customer education
- Customer awareness of demand response
- Event communications
- Event rebate calculations
- Load impacts
- Customer experience
- Logic model review

Additional impact findings are presented in *Appendix C*.

## *Enrollment and Retention*

Table 6 presents the factors that affected PTR enrollments, including counts of opt-outs, account closures, and gross and net enrollment values. As of February 29, 2020, 89,675 customers were enrolled in Flex 2.0 PTR. Additionally, PGE exceeded its 2019 enrollment target (55,000 customers), ending the year with 87,605 customers in Flex 2.0 PTR.

The PTR retention rate was 96% for Test Bed PTR participants and 97% for Flex PTR participants.[16] When the definition of retention was refined to exclude PTR participants who migrated to the smart thermostat demand response program, the retention rates increased to 97% for Test Bed PTR participants and 98% for Flex PTR participants.[17] PGE is therefore meeting its participant retention goal of 95% overall and individually for both PTR customer types.

**Table 6. Flex 2.0 PTR Enrollment and Unenrollment Rates**

| Category | Group | Participant Counts | |
|---|---|---|---|
| | | Test Bed PTR | Flex PTR |
| Enrollments | Beginning Enrollees (as of Test Bed auto-enrollment date: July 13, 2019) * | 14,016 | 32,183 |
| | New Enrollees through Feb 29, 2020 | 3,890 | 52,836 |
| | **Total Enrollments (Gross) - by Feb 29, 2020**** | **17,906** | **85,019** |
| Unenrollments | Opt Outs (total) | 685 | 2,519 |
| | Opt Out - migrated | 168 | 1,050 |
| | Opt Out - non-migrated | 517 | 1,469 |

[16] The PTR retention rate was calculated as: (net enrollment)/(gross enrollment – number of participants with service account closures).

[17] Note, migration of participants from behavior-based demand response, such as PTR (non-firm) to automated or dispatchable demand response, such as DLC options (firm), is part of PGE's broader demand response planning strategy.

| Category | Group | Participant Counts | |
|---|---|---|---|
| | | Test Bed PTR | Flex PTR |
| | Account Closures | 1,571 | 8,475 |
| | **Total Unenrollments (from July 13, 2019 to February 29, 2020)** | **2,256** | **10,994** |
| **Net Enrollment** | **Net Enrollment (Feb 29, 2020)** | **15,650** | **74,025** |
| | **Retention Rate** | **95.8%** | **96.7%** |
| | **Retention Rate (adjusted for smart thermostat migration)** | **96.8%** | **98.1%** |

Source: PGE program tracking data
* Note: Approximately 154 participants were legacy Flex 1.0 PTR participants. Additionally, a total of 1,083 customers within the Test Bed opted in to Flex 2.0 PTR prior to PGE's first auto-enrollment date of July 13, 2019.
** Net enrollment by the end of 2019 totaled 87,605 customers, of whom 14,785 were located in the Test Bed.

## *Marketing*

Based on staff interviews, program materials, and customer surveys, the high enrollment in opt-in PTR can be attributed to PGE's marketing. PGE enhanced the effectiveness of the marketing by applying the insights gained from the Flex 1.0 pilot. Specifically, PGE learned from marketing Flex 1.0 that customers were more responsive to financial messaging (i.e., earning rebates, saving money, and saving on bills) compared to environmental or community stewardship messaging. Therefore, PGE used this type of messaging throughout the Flex 2.0 PTR marketing materials.

In addition, PGE used a simple three-step phrase—get notified, shift use, and earn rebates—to explain how the PTR program works, rather than the technical term *demand response*. Marketing materials frequently repeated this three-step phrase, as shown in Figure 2, further reinforcing the financial messaging.

**Figure 2. PTR Movie Advertisement Featuring the Three-Step Phrase**


The financial messaging was an apt choice. Approximately 89% of respondents from the recruitment survey indicated *to reduce my energy bill by earning bill credits* as a reason for enrolling in PTR

($n_w$=718).[18] Other reasons for enrolling included *to avoid emissions from peak generation* (47%), *to support more use of renewables* (46%), *to reduce the need to build new power plants* (30%), and *because of a positive experience with another PGE program* (14%).

Participants first heard about the PTR program in different ways. According to the recruitment survey conducted with customers who opted in to PTR (Flex PTR) ($n_w$=718), 46% of respondents heard about PTR through email, 32% through the PGE website, and 18% through mail.

Only 8% of participants learned about the PTR program through a CSR. Nevertheless, CSRs were highly effective at enrolling participants. PGE reported that over 12,000 enrollments came from the call center. The CSRs helped customers understand PTR, as 75% of recruitment survey respondents who interacted with a CSR ($n_w$=115) agreed with the statement *the customer service representative was knowledgeable about the program*.

## *Customer Education*

PGE deployed customer call center training, season-ready emails, direct mail brochures, and in market promotions to educate customers about PTR. Educational efforts were generally effective, as 75% of recruitment survey respondents ($n_w$=703) agreed with the statement *how the program works was clear to me*.

However, when asked how PGE can improve the PTR enrollment experience, 77% of recruitment survey respondents who answered the open-end question (n=43) mentioned to improve customer education, especially detailed information about how the program works.

In response to these requests for detailed information, PGE sent enrolled customers a FAQ sheet that explained the following program details:

- Why PGE is launching PTR?
- Ways on how customers can shift their energy use during peak time events?
- How customers' savings and rebates are calculated?
- How much customers can expect to save per event?
- When and where rebates/bill credits will appear?
- Various reasons why customers may not earn a rebate?
- Where customers can view their historical event results and usage data?

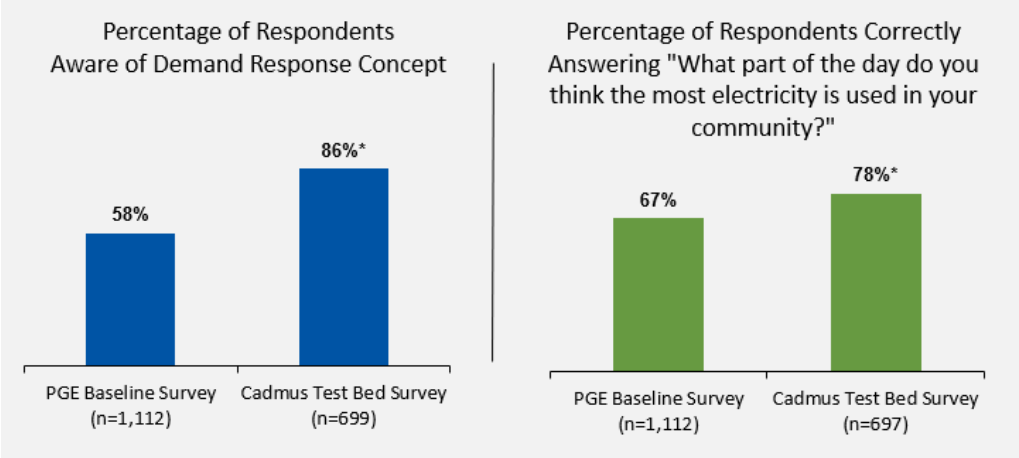
[18] Throughout this report, the notation $n_w$ indicates that the survey results were weighted by micro-persona and/or PTR group.

## *Customer Awareness of Demand Response*

Cadmus conducted the recruitment survey with customers who opted in to PTR and asked about their familiarity with demand response prior to enrollment.[19] The survey found that 88% of respondents ($n_w$=715) said they were aware of the concept of demand response.

To assess the familiarity of Test Bed PTR participants with demand response, Cadmus analyzed results from a separate baseline survey (fielded by PGE) and post-implementation survey (conducted by Cadmus for the Test Bed project evaluation).[20] In Figure 3 (left), the proportion of respondents who were aware of the concept of demand response significantly increased from the baseline survey (58%) to the Cadmus survey (86%). In Figure 3 (right), the proportion of respondents correctly answering the question about peak time also showed a significant increase from the PGE's baseline survey (67%) to the Cadmus survey (78%). Increased awareness of demand response suggests PGE's marketing, corporate demand response campaign, customer education efforts, and the experience of participating in Flex 2.0 PTR (such as receiving peak time event notifications and results) is having its intended effects.

**Figure 3. PGE Baseline Survey vs. Cadmus Test Bed Survey:**
**Test Bed PTR Participants' Knowledge of Demand Response**




* Difference is significant with 90% confidence (p≤0.10). Source: The PGE baseline survey and Cadmus Test Bed survey posed this demand response concept question: "Electric utilities sometimes offer programs that reward customers for making small shifts in when and how they use energy. Doing this helps avoid spikes in energy usage for the community as a whole. These energy spikes occur for just a few hours on the hottest and coldest days of the year. And without energy spikes, utility companies can keep prices lower. Were you previously aware of this concept?" The PGE baseline survey and Cadmus Test Bed survey also asked: "What part of the day do you think the most electricity is used in your community?" Respondents chose between the following options: midnight-4 a.m., 4 a.m.-8 a.m., 8 a.m.-noon, noon-4 p.m., 4 p.m.-8 p.m., and 8 p.m.-midnight.

[19] Note, of the 24 total survey respondents are customers located in the Test Bed that enrolled in PTR prior to being auto enrolled in July 2019 through the Test Bed project.

[20] Prior to launching the Test Bed project (July 2019), PGE conducted a baseline survey of demand response awareness with Test Bed customers. In January 2020, Cadmus surveyed Test Bed customers as part of the Test Bed evaluation and asked some of the same questions as PGE's baseline survey.

The evaluation also compared awareness of demand response between Flex PTR and Test Bed PTR participants. In the recruitment survey, 88% of Flex PTR respondents (who opted-in to the program) said they were already aware of demand response compared to 58% of Test Bed PTR respondents (who were auto-enrolled). Nonetheless, after one summer season, 86% of Test Bed PTR respondents reported awareness, catching up with the Flex PTR respondents.

## *Event Communications*

Event communications involved notifying participants of upcoming events and sending them post-event results. PGE was mostly successful with meeting its goal of notifying all participants the day before each event but experienced pre-event notification issues. Notably, an issue pertaining to the alignment of active participant lists resulted in approximately 8,800 participants (18% of total participants at that time) not receiving pre-event notifications for the first two events during the summer 2019 season. PGE reported that the implementation contractors successfully delivered post-event results to participants on time during summer and winter seasons.

PGE intended to call six to 10 events per season but called only five in summer 2019 and one in winter 2019/2020. A number of technological limitations affected the time of day PGE could call events and when it could send pre-event notifications to participants. This effectively reduced the absolute number of available times for which PGE could call events within a given season; however, weather (a mild summer and winter) also contributed to PGE decisions to call events. Table 7 lists the technological limitations and the solutions PGE is considering with its event communications implementation contractor.

**Table 7. Technological Limitations and Solutions to Event Communications**

| Issue | Description | Solution Considered/Implemented |
|---|---|---|
| Same-day event notification reminders | Oracle sends event notifications to customers the day before but has no ability to send same-day event reminders. Cadmus' summer experience survey found that 25% of respondents ($n_w$=976) agreed with the statement "My household forgot that events were happening on the day of the events." Moreover, around 72% of summer experience survey respondents ($n_w$=1,017) said they would like PGE to send them a same-day event reminder. | PGE internally developed same-day event reminder emails and tested this with Test Bed PTR participants during the one winter event on January 15, 2020. PGE plans to dispatch same-day email reminders in summer 2020. |
| Customized tips | Oracle has an established tips library that its platform draws on to publish in the event notification emails. PGE has limited ability to modify or customize these tips to be specific to PGE customers or service territory. | PGE provided customers with tips specific to the Pacific Northwest on its PTR webpage, FAQ sheet, and other PGE communications. |
| Multiple household contacts on event communications | Only one person on the account can be listed as the contact to receive the event reminders and event results. | PGE is working on how to include multiple contacts on a single account. |
| Ability to call morning events | Due to PGE's internal IT challenges, PTR events can be called only from 4 p.m. to 7 p.m. PGE has no ability to call morning events, which is problematic in winter because peak periods can occur in the morning. | PGE has addressed this issue. |

## *Event Rebate Calculations*

During summer 2019, PGE encountered two major issues with the event rebate calculations:

- PGE found errors with the rebate calculations for Event 4 (August 28, 2019), in which some 20,000 customers were underpaid and some 20,000 customers were overpaid. This was based on an erroneous rebate calculation (based on the 5 p.m. to 8 p.m. period, instead of the 4 p.m. to 7 p.m. event window) for a sample of participants. Upon identifying and correcting this calculation error, PGE sent emails to underpaid customers informing them of the error and issued a bill credit for the corrected rebate amount.
- Some customers reported that the rebate amount they earned was not commensurate with their efforts to save. Based on analysis of the survey responses, the evaluation found the following:
  - 65% of respondents ($n_w$=807) agreed with statement "The actions I took during events were similar but my event results differed."
  - 40% of respondents agreed with the statement "The rebates don't seem to be linked to the actions I take ($n_w$=910)."

Customer perceptions that their efforts to save were not reflected in their calculated savings and rebate may have lowered customer satisfaction with the Flex 2.0 program and the motivation to save. These customer perceptions are described more in the *Customer Experience* section.

After the summer 2019 season, PGE worked with TROVE to revise the baseline calculation method and tested the 5-of-10 day, day-matching approach for the winter 2019/2020 season. After switching, PGE reported receiving fewer customer calls concerning the rebates.[21]

## *PTR Load Impacts*

Cadmus analyzed residential customer AMI meter interval consumption data to estimate the PTR load impacts. First, Cadmus employed propensity score matching to identify nonparticipants who were similar to PTR participants. Then, in a panel regression analysis of customer hour-interval electricity consumption, demand of the matched control group constituted the baseline for estimating PTR savings. This section summarizes the main findings of the impact analysis. The *Appendix A* describes the methodological details of the analysis and additional results.

### Analysis Sample

Table 8 and Table 9 show the analysis sample sizes after matching participants to nonparticipants for summer and winter. Attrition because of missing AMI data or missing matching criteria decreased

[21] Cadmus does not have any survey findings to report impacts to the customer experience of the new calculation methodology. Following PGE's decision, Cadmus did not conduct a winter experience survey.

substantially between seasons, following improvements in PGE's data collection. The final analysis samples included 53,264 participants and 48,419 nonparticipants in summer and 85,759 participants and 77,938 nonparticipants in winter.

**Table 8. Summer 2019 PTR Analysis Sample**

| Screen | Participant Count | | | Pct. Total Remaining |
|---|---|---|---|---|
| | Flex PTR | Test Bed PTR | Overall | |
| **Total Enrollments** | **51,345** | **13,335** | **64,680** | **100%** |
| Missing AMI | 5,310 | 1,331 | 6,641 | 90% |
| Missing Matching Criteria | 4,557 | 194 | 4,751 | 82% |
| Missing Data Required for Regression | 24 | 0 | 24 | 82% |
| **Total Analysis Sample** | **41,454** | **11,810** | **53,264** | **82%** |
| **Total Matched Comparison Group** | **37,760** | **11,442** | **48,419** | |

Note: A participant was a residential customer enrolled in the Flex 2.0 PTR program. For evaluating savings for individual events, only enrolled customers with active accounts on the event day were included in the analysis. Multiple PTR participants could be matched to the same nonparticipant.

**Table 9. Winter 2019/2020 PTR Analysis Sample**

| Screen | Participant Count | | | Pct. Total Remaining |
|---|---|---|---|---|
| | Flex PTR | Test Bed PTR | Overall | |
| **Total Enrollments** | **71,836** | **14,442** | **86,278** | **100%** |
| Missing AMI | 13 | 1 | 14 | ~ |
| Missing Matching Criteria | 305 | 49 | 354 | 99.6% |
| Missing Data Required for Regression | 0 | 0 | 0 | 99.6% |
| **Total Analysis Sample** | **71,518** | **14,392** | **85,910** | **99.6%** |
| **Total Matched Comparison Group** | **63,519** | **14,409** | **77,938** | |

Note: A participant was a residential customer enrolled in the Flex 2.0 PTR program with an active account on the event day. For evaluating savings for individual events, only enrolled customers with active accounts on the event day were included in the analysis. Multiple PTR participants could be matched to the same nonparticipant.

## Validation of Matched Control Group

Though the matching model estimated each customer's propensity to enroll in PTR, the ultimate goal of the matching was to assemble a control group of nonparticipants with similar hourly consumption to that of the participant groups. To this end, Cadmus verified that the propensity score matching produced matched control groups with energy consumption characteristics similar to those in the participant group.[22]

[22] Cadmus used t-tests to test for statistically significant differences in mean event-window consumption between participants and matched control groups after matching (each customer's mean hourly consumption during the 4 p.m. to 7 p.m. period on non-event weekdays within each season). There were no statistically significant differences at 10% significance.

Figure 4 and Figure 5 show the results of the nonparticipant matching, by season and Test Bed grouping, for all non-event days (excluding holidays and weekends). As these figures show, across both groups and seasons Cadmus' matching method was highly effective in selecting nonparticipants with similar hourly consumption patterns to participants. 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 nonparticipants would not have constituted a valid control group for participants.

**Figure 4. Average Hourly Demand Comparison (Non-Event Days) – Summer 2019**

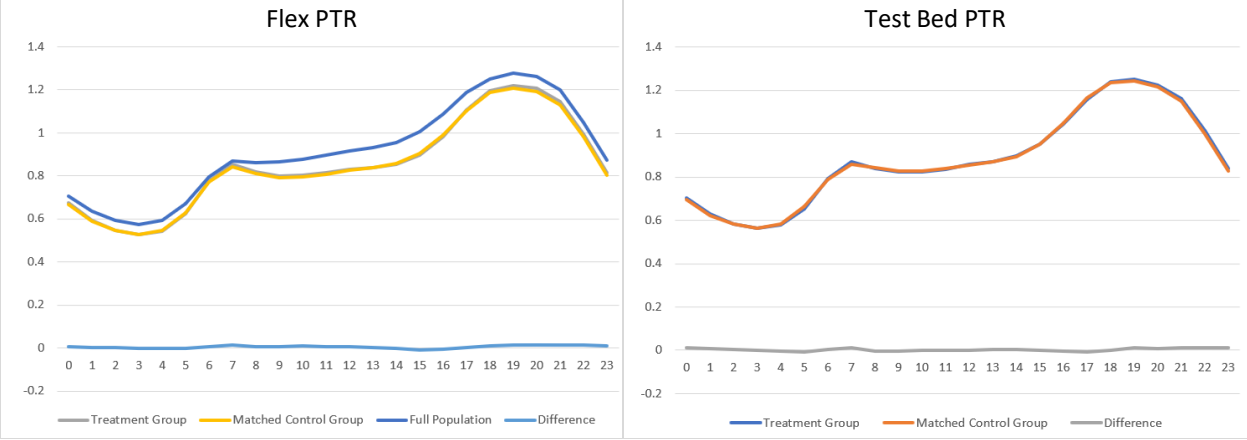
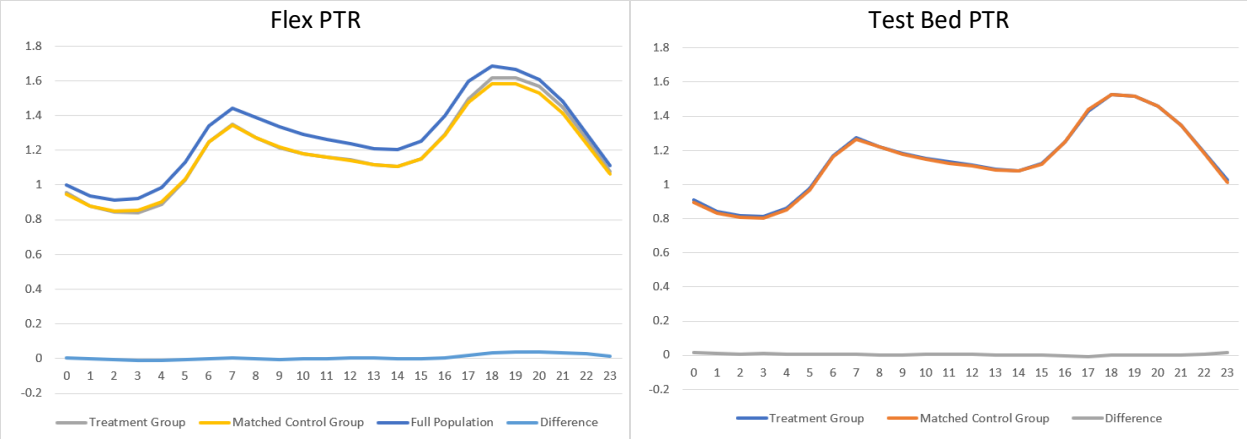



**Figure 5. Average Hourly Demand Comparison (Non-Event Days) – Winter 2019/2020**




## Summer Load Impacts

This section presents estimates of the average demand savings per PTR participant, the average demand savings per participant by DR micro-persona, and total demand savings for the program for five PTR events in summer 2019.

### *Demand Savings Estimates by Event – Summer*

Figure 6 shows the average demand savings per participant by PTR group (Flex PTR and Test Bed PTR) and outside temperature during summer 2019 PTR events. PTR events achieved average demand savings per participant of between 0.06 kW (6% of baseline demand) and 0.18 kW (10%) for Flex PTR participants, and 0.02 kW (2%) and 0.09 kW (5%) for Test Bed PTR participants over the season, depending on the event.

All estimates were statistically significant at the 10% level. Events 1 and 2 experienced dispatch issues resulting in approximately 8,800 participants (18%) not having received advance notifications of the events, which reduced the average savings per participant for these events.[23]

The highest savings occurred during the hottest summer 2019 event day (Event 4, 94°F), and the lowest savings occurred on the coolest event day (Event 5, 79°F).[24] This suggests that demand savings were correlated with outside temperature, but a larger number of PTR events would be needed to measure the relationship precisely.

Savings on the other three event days did not clearly correlate with temperature, likely due to the event notification issues associated with the first two events. Savings among participants in the Test Bed were substantially lower than those of participants outside the Test Bed, likely because most Test Bed participants had been automatically enrolled in PTR. Participants outside of the Test Bed had opted-in to the PTR program, and their higher savings may reflect a higher motivation to save.

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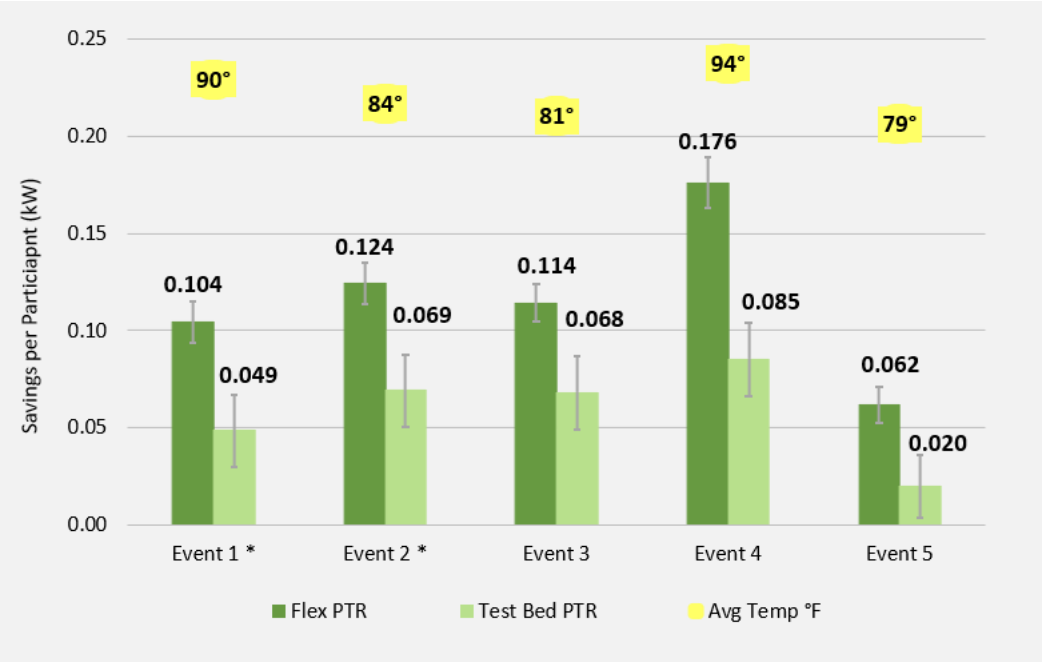
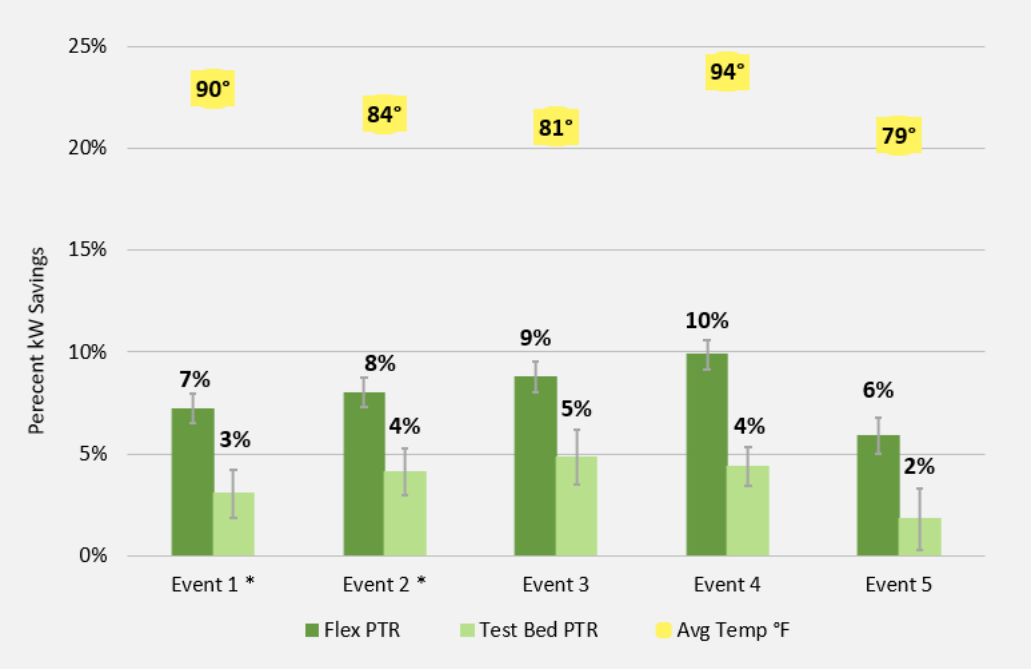
[23] Dividing the estimate of savings for Event 1 and Event 2 in Table 6 by the percentage of participants sent notifications (82%) provides an estimate of the average savings per participant who was sent a notification. For Event 1, the average savings per notified participant = 0.104/0.82=0.13 kW. For Event 2, the average savings per notified participant = 0.124/0.82 = 0.16 kW.

[24] The fifth event also occurred in September when school was back in session and household daytime electricity demand for air conditioning may have decreased.

**Figure 6. Average Demand Savings (kW) and Percentage Savings by Event and PTR Group – Summer 2019**




Note: Estimates are based on Cadmus analysis of AMI meter data for Flex 2.0 PTR participants and matched comparison group. In the above figures, an asterisk is denoted for Events 1 and 2 because they experienced dispatch issues in which approximately 8,800 (18%) participants did not receive notification. Error bars show 90% confidence intervals based on standard errors clustered on customers.

Table 10 shows the average demand savings per participant by PTR group and event hour. The average savings across all summer 2019 events was 0.116 kW for Flex PTR and 0.058 kW for 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 participant.

The lower savings during Event 5 were likely attributable to several factors, including a relatively low event day temperature and reduced household demand for air conditioning as well as a resumption of schools, which may have altered household electricity demand and reduced the potential for demand savings.[25] The savings during Event 5 are likely not predictive of the demand savings PGE would obtain from calling PTR events during summer peak hours.

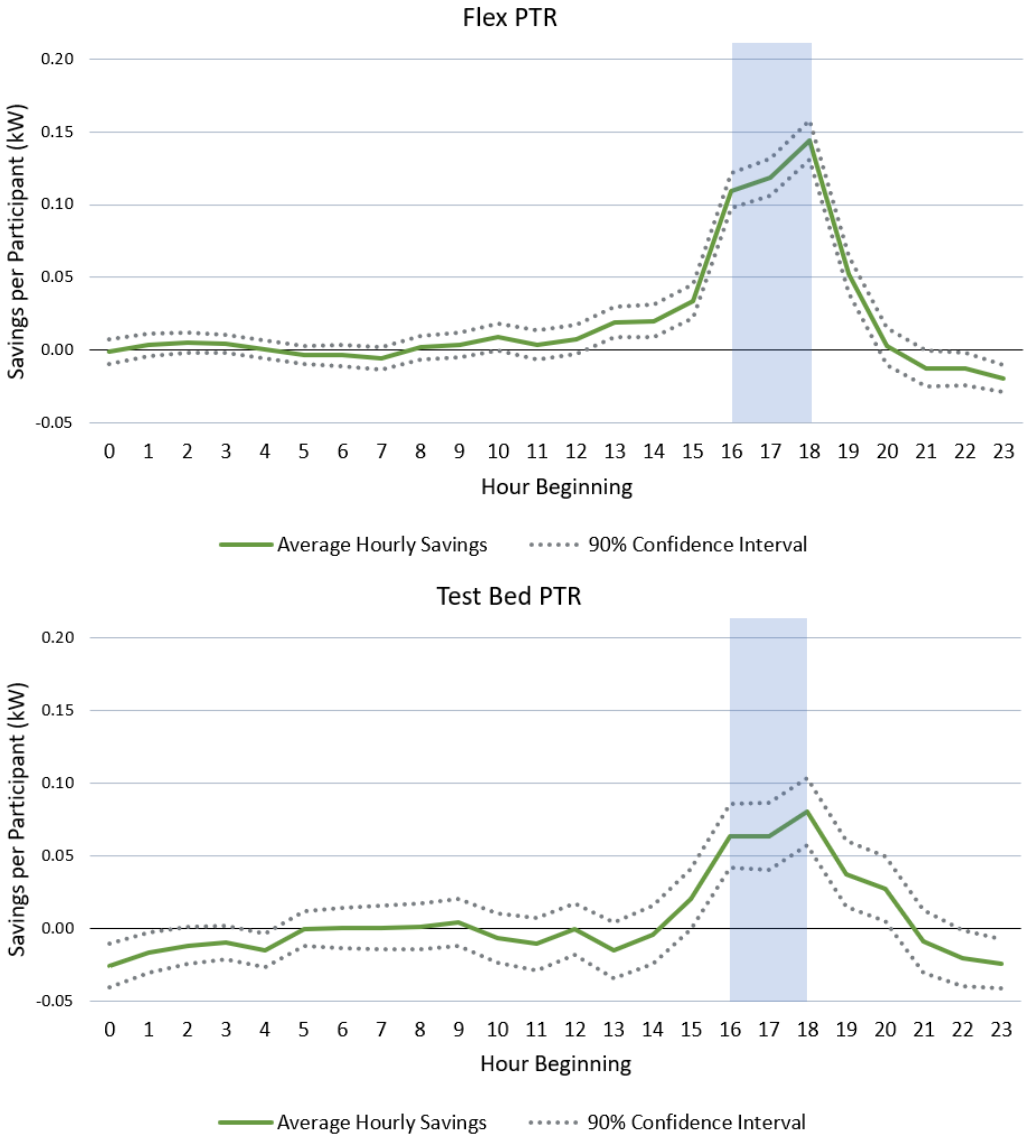
**Table 10. Average Demand Savings by Event and PTR Group– Summer 2019**

| Program Group | Event | Beginning and Ending Times | Average Demand Savings per Participant (kW) | | | |
|---|---|---|---|---|---|---|
| | | | Hour 1 | Hour 2 | Hour 3 | Event Average |
| Flex PTR | Event 1 | 4 p.m. – 7 p.m. | 0.087 | 0.114 | 0.112 | 0.104 |
| | Event 2 | 4 p.m. – 7 p.m. | 0.110 | 0.119 | 0.145 | 0.124 |
| | Event 3 | 4 p.m. – 7 p.m. | 0.098 | 0.126 | 0.119 | 0.114 |
| | Event 4 | 4 p.m. – 7 p.m. | 0.158 | 0.184 | 0.186 | 0.176 |
| | Event 5 | 4 p.m. – 7 p.m. | 0.052 | 0.068 | 0.065 | 0.062 |
| | **Average** | | **0.100** | **0.122** | **0.125** | **0.116** |
| Test Bed PTR | Event 1 | 4 p.m. – 7 p.m. | 0.021 | 0.056 | 0.068 | 0.048 |
| | Event 2 | 4 p.m. – 7 p.m. | 0.064 | 0.063 | 0.081 | 0.069 |
| | Event 3 | 4 p.m. – 7 p.m. | 0.047 | 0.076 | 0.081 | 0.068 |
| | Event 4 | 4 p.m. – 7 p.m. | 0.074 | 0.103 | 0.079 | 0.085 |
| | Event 5 | 4 p.m. – 7 p.m. | 0.029 | 0.017 | 0.013 | 0.020 |
| | **Average** | | **0.047** | **0.063** | **0.064** | **0.058** |

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

[25] Consistent with the differences in event temperature and household electricity demand for air conditioning, average baseline demand per participant was 1.76 kW during Event 4 and 1.03 kW during Event 5.

**Figure 7. Average Hourly PTR Savings (Event 2), by PTR Group – Summer 2019**



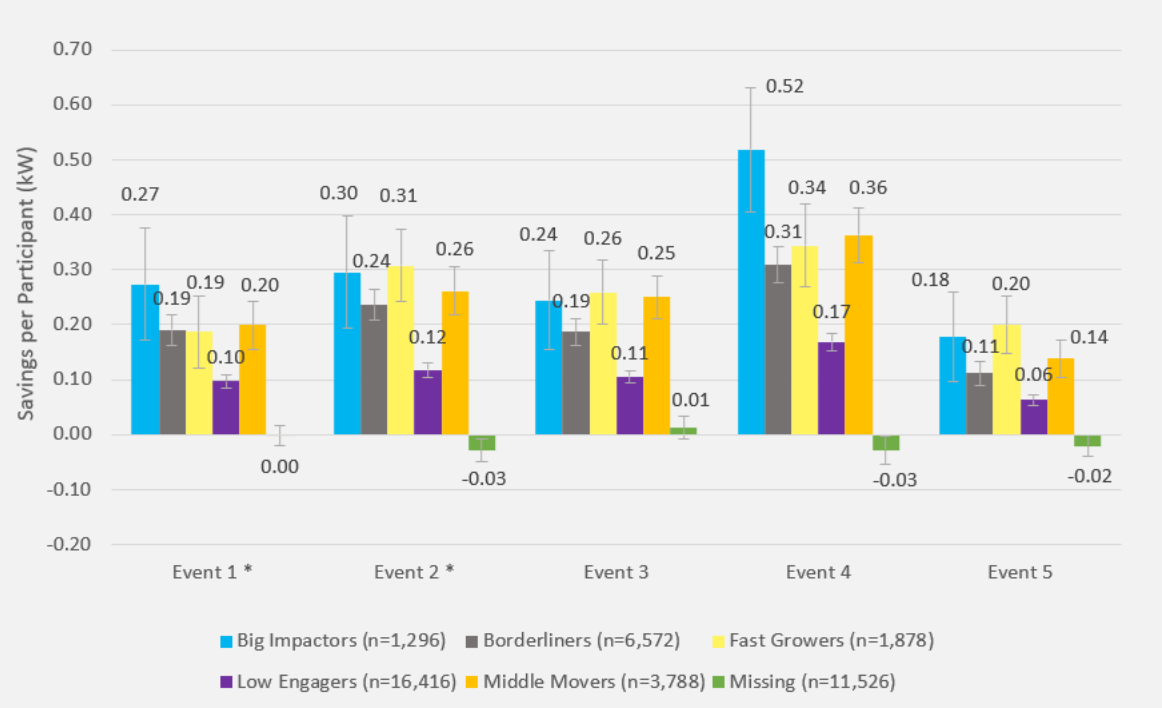

Note: Estimates are based on Cadmus analysis of AMI meter data for Flex 2.0 PTR participants and matched comparison group. In the Event 2, there were 38,207 Flex PTR participants and 12,896 Test Bed PTR participants.

As shown, statistically significant PTR savings spilled over into the hours preceding and following the event window. This pattern occurred for all events and may reflect efforts to save energy that were not precisely targeted to save during PTR event hours, such as participants making changes to their thermostat setpoints before leaving work, delaying energy-consuming activities to another day, or leaving their homes before the event started and returning after it ended. There is also evidence for a small amount of snapback (an increase in demand above normal levels) between 9 p.m. and midnight following each event.

### *Demand Savings Estimates by Micro-Persona*

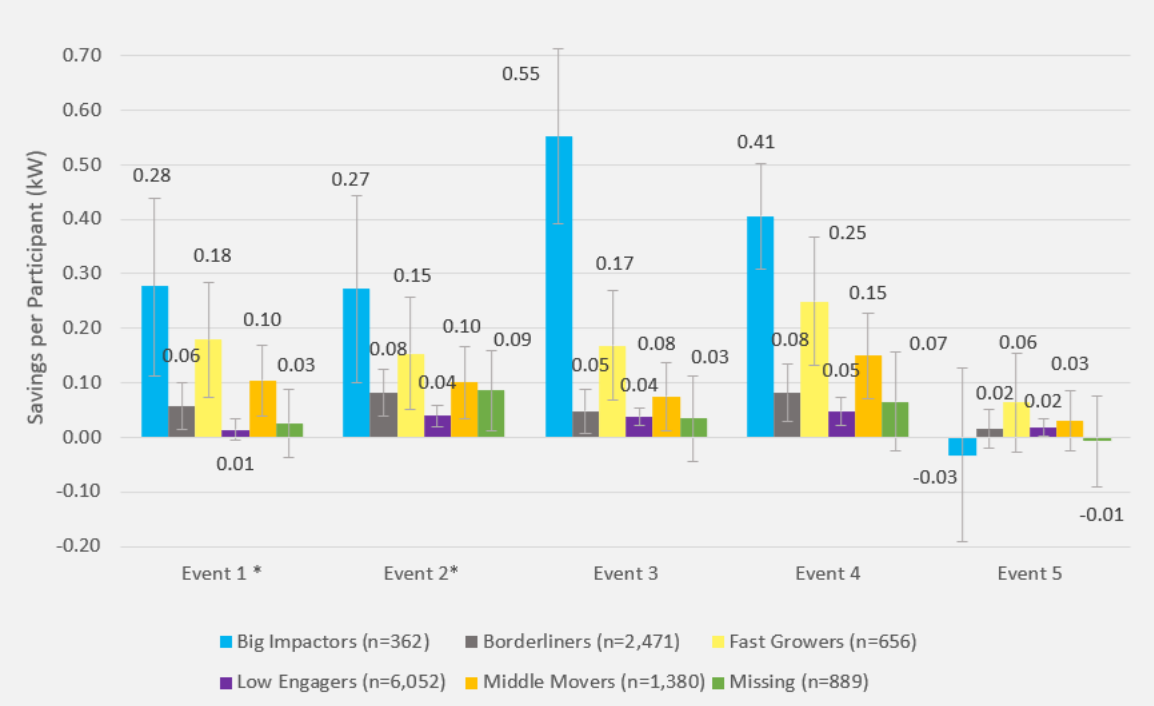
Figure 8 and Figure 9 show the average demands savings per participant by event, PTR group, and micro-persona segment. As shown, there were substantial differences in average PTR savings by micro-persona. This heterogeneity in PTR treatment effects was significant in and outside of the Testbed. See Table 5 above for descriptions of these micro-persona.

**Figure 8. Average Demand Savings (kW) by Event and Micro-Persona (Flex PTR) – Summer 2019**




Estimates based on Cadmus analysis of AMI meter data for Flex 2.0 PTR participants and matched comparison group. Error bars indicate 90% confidence intervals based on standard errors clustered on customers. In the figure, an asterisk is denoted for Events 1 and 2 because they experienced dispatch issues in which approximately 8,800 (18%) participants did not receive notification.

**Figure 9. Average Demand Savings (kW) by Event and Micro-Persona (Test Bed PTR) – Summer 2019**




Estimates based on Cadmus analysis of AMI meter data for Flex 2.0 PTR participants and matched comparison group. Error bars indicate 90% confidence intervals based on standard errors clustered on customers. In the figure, an asterisk is denoted for Events 1 and 2 because they experienced dispatch issues in which approximately 8,800 (18%) participants did not receive notification.

For both PTR groups, Big Impactors, Fast Growers, and Middle Movers achieved higher savings than the other groups. In general, the savings per participant of these groups averaged between about 0.2 kW and 0.5 kW for Flex PTR participants and between 0.1 kW and 0.5 kW for Test Bed PTR participants. Conversely, Low Engagers and participants with unassigned micro-persona (i.e., Missing) achieved substantially lower savings and accounted for over half of all participants in each PTR group, effectively weighing the overall average savings downward. In the absence of these low-savings segments, average events savings for the other micro-persona groups (0.23 kW [16%] for Flex PTR and 0.11 kW [8%] for Test Bed PTR) approached or surpassed summer-season impacts observed during the Flex 1.0 pilot (approximately 0.4 kW [18%] savings for the PTR1 treatment group).[26]

### *Program-Level Demand Savings – Summer*

Table 11 presents the total PTR program-level demand savings during summer 2019 events, aggregating per-participant impacts by event to assess the MW value of the PTR resource. Evaluated savings are compared to PGE's reported demand savings estimates (based on a matched control group analysis). As shown, evaluated demand savings varied slightly from the reported savings by each event, with the

[26] Cadmus. *Flex Pricing and Behavioral Demand Response Pilot Program – Evaluation Report.* Prepared for Portland General Electric. June 2018.

overall seasonal average resulting in slightly higher load impacts (5.72 MW) than the reported values (5.06 MW).

**Table 11. PTR Program Total Savings – Summer 2019**

| Event | Event Times | Avg. Temp. (°F) | Evaluation Avg. Demand Savings per Participant (kW) | Evaluation Participant Count | Evaluation Demand Savings (MW) | Reported Demand Savings (MW) |
|---|---|---|---|---|---|---|
| Event 1 | 4 p.m. – 7 p.m. | 90 | 0.089 | 47,163 | 4.20 | 4.83 |
| Event 2 | 4 p.m. – 7 p.m. | 84 | 0.110 | 51,103 | 5.64 | 5.68 |
| Event 3 | 4 p.m. – 7 p.m. | 81 | 0.104 | 57,497 | 5.97 | 4.74 |
| Event 4 | 4 p.m. – 7 p.m. | 94 | 0.156 | 59,723 | 9.33 | 7.31 |
| Event 5 | 4 p.m. – 7 p.m. | 79 | 0.053 | 63,421 | 3.37 | 2.74 |
| **Average** | | **86** | **0.103** | **55,781** | **5.72** | **5.06** |

Note: Evaluated demand savings were estimated from a panel regression of customer hour interval consumption for participants and matched non-participants. See Appendix A for estimation details. The Reported demand savings are PGE's estimate of program savings based on a matched control group analysis.

### *PGE PTR Payments – Summer*

PTR participants 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, there was no penalty.[27] PGE paid customers for any measurable savings, whether the savings were caused by the intentional efforts to save energy, were naturally occurring and would have occurred in absence of the event, were from random fluctuations in the customer's consumption, or were attributable to an inaccurate baseline.[28] Since PGE cannot differentiate between savings caused by the program and savings 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.

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[27] 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.

[28] 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.

Table 12 compares Cadmus' evaluated savings with PGE's rebated PTR savings for each event and during summer 2019 overall. The payment ratio column shows the ratio of the savings PGE paid for to the evaluated savings. Overall, PGE paid 3.55 times more for PTR savings than it would have paid if it only paid for achieved savings. Said another way, PGE paid participants an average of $3.55 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. Wolak (2006) found that Anaheim Public Utilities peak time rebate program paid participants for seven times the savings the utility achieved.[29]

**Table 12. Summer 2019 PTR Payment Ratios**

| Event | Rebated Savings - Ensemble Method (MWh) | Evaluated Savings (MWh) | Payment Ratio (Rebated Savings/Evaluated Savings) |
|---|---|---|---|
| 1 | 53.3 | 12.6 | 4.23 |
| 2 | 51.9 | 16.9 | 3.07 |
| 3 | 60.3 | 17.9 | 3.37 |
| 4 | 80.3 | 29.0 | 2.77 |
| 5 | 61.0 | 10.1 | 6.02 |
| **Total** | **306.8** | **85.5** | **3.59** |

One approach to improve the accuracy of savings estimates and reduce overpayments would be to calculate rebate payments at the end of the season based on total demand savings across all event hours. With this approach, naturally occurring savings for one event would tend to be offset by naturally-occurring increases in consumption in another event. Also, calculating savings at the end-of-season might improve the accuracy of the baseline calculation by basing the calculation on a full season of consumption data. This is noted in a 2012 study of San Diego Gas & Electric's PTR program, which found that providing customer bill credits for monthly savings, rather than by event, increased payment accuracy.[30]

## Winter Load Impacts

This section presents estimates of the average demand savings per PTR participant, the average demand savings per participant by micro-persona, and total demand savings for the program for one PTR event from winter 2019/2020.

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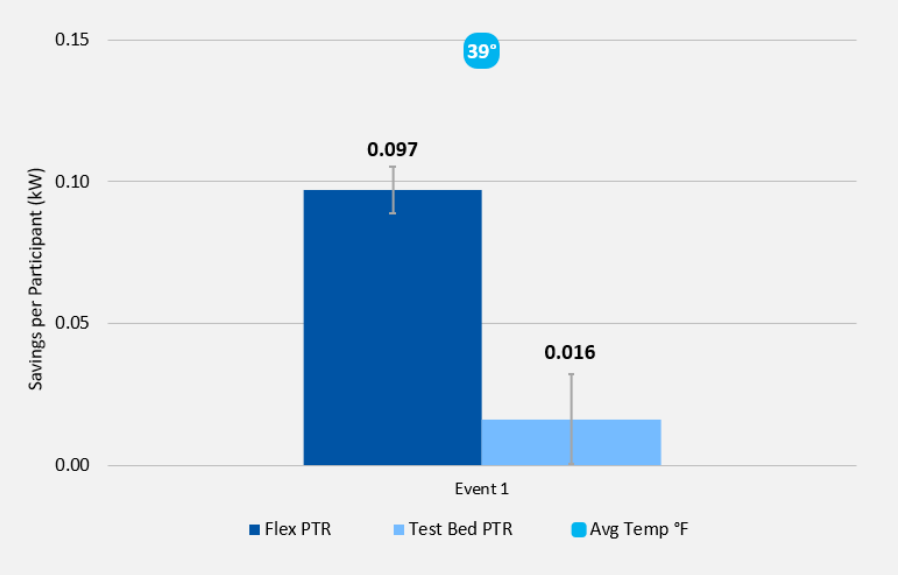
[29] Wolak, Frank (2006). *Residential Customer Response to Real-Time Pricing: The Anaheim Critical-Peak Pricing Experiment*. Center for the Study of Energy Markets working paper 151. https://escholarship.org/uc/item/3td3n1x1

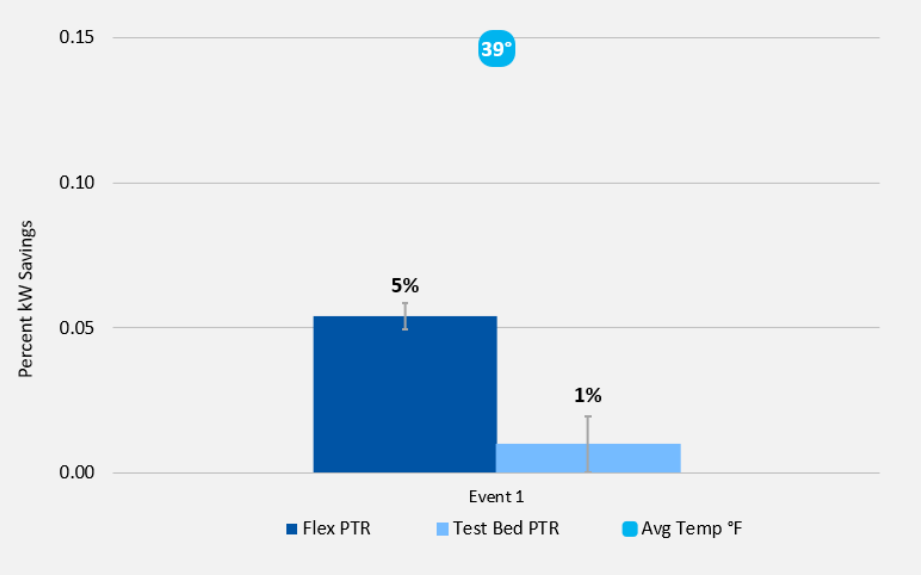
[30] Freeman, Sullivan & Co. (2013). *2012 San Diego Gas & Electric Peak Time Rebate Baseline Evaluation*. http://www.calmac.org/publications/SDGE_PTR_Baseline_Evaluation_Report_-_Final.pdf

### *Demand Savings Estimates by Event – Winter*

Figure 10 shows the average demand savings per participant for the winter PTR event by Flex PTR and Test Bed PTR. Flex PTR participants achieved average demand savings per participant of 0.097 kW (5% of baseline demand). Test Bed PTR participants achieved small and marginally significant average savings per customer of 0.016 kW (1%).

**Figure 10. Average Demand Savings (kW) and 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 participants and matched comparison group. Error bars show 90% confidence intervals based on standard errors clustered on customers.

Flex PTR participant savings were much higher than Test Bed PTR participant savings, which aligns with the expectation that customers who opted into PTR were more motivated to save. In contrast, the Test Bed primarily contained customers automatically enrolled in PTR who were probably less motivated to save. In addition, the winter demand savings were substantially lower in winter than in summer for Test Bed PTR and Flex PTR participants, which the Flex 1.0 evaluation also found. The lower level of savings in winter may reflect fewer options for participants to shift or reduce consumption during winter PTR events (e.g., many PTR participants have air conditioning but heat their homes with natural gas) or a lack of participant understanding about how to save in winter.

Table 13 shows the average demand savings per participant by PTR group and hour of the event. There was little variation in demand savings—less than 0.02 kW per participant—across the event hours for Flex PTR and Test Bed PTR.

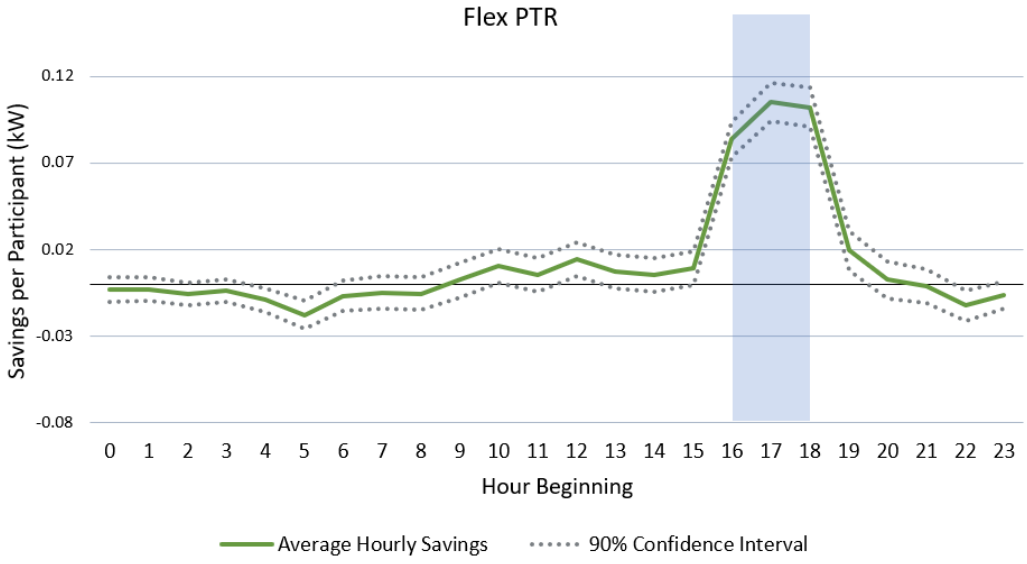
**Table 13. Average Demand Savings by Event and PTR Group – Winter 2019/2020**

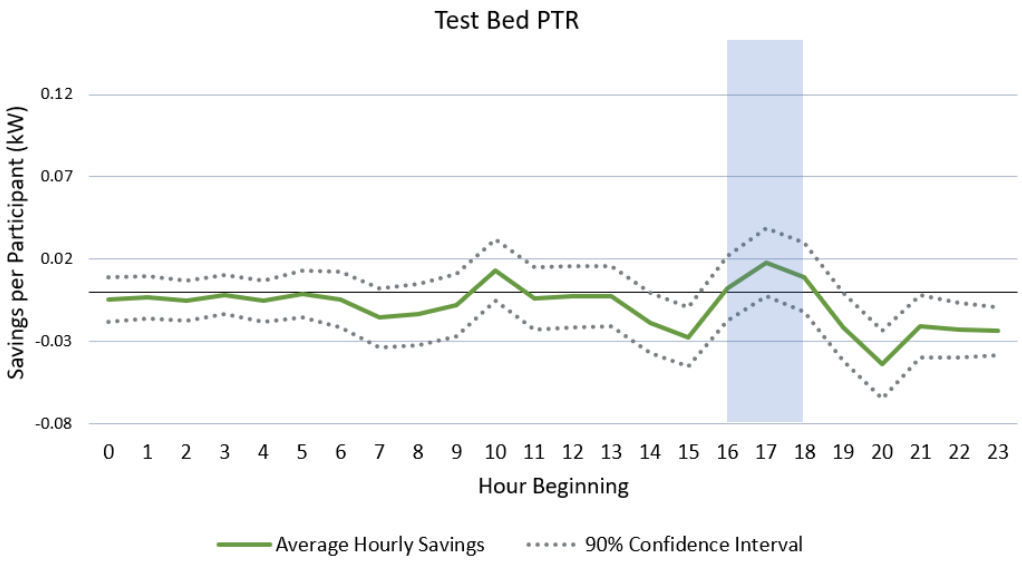
| Program Group | Event | Beginning and Ending Times | Average Demand Savings per Participant (kW) | | | |
|---|---|---|---|---|---|---|
| | | | Hour 1 | Hour 2 | Hour 3 | Event Average |
| Flex PTR | Event 1 | 4 p.m. – 7 p.m. | 0.084 | 0.106 | 0.102 | 0.097 |
| Test Bed PTR | Event 1 | 4 p.m. – 7 p.m. | 0.013 | 0.025 | 0.011 | 0.016 |

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

Figure 11 presents the savings per participant and 90% confidence intervals for each hour of the winter 2019/2020 event day. Like in summer, Flex PTR participants also achieved demand savings in the hour following the event, but unlike in summer, the magnitude and extent of this spillover was more limited. Test-bed PTR participants showed statistically significant increases in demand in the hour before and the hour following the event.

**Figure 11. Average Hourly PTR Savings (Event 1), by PTR Group – Winter 2019/2020**






Note: Estimates are based on Cadmus analysis of AMI meter data for Flex 2.0 PTR participants and matched comparison group. There were 71,836 Flex PTR participants and 14,442 Test Bed PTR participants during the winter event.

Given PGE called only one winter event, it is not possible to draw strong conclusions regarding the effectiveness or reliability of PTR as a winter demand response resource. However, the savings for the event were measured very precisely because of the large number of participants in the analysis.

The Flex 2.0 PTR savings in winter of 5% were close to the winter PTR savings from the Flex 1.0 pilot. The Flex 1.0 evaluation found winter average savings per customer of 0.13 kW (7%) for opt-in PTR participants and 0.10 kW (6%) for opt-out PTR participants.[31]

### *Winter Demand Savings by Micro-Persona Segmentation*

Figure 12 and Figure 13 show the average demand savings per participant by PTR group and micro-persona segmentation. In contrast to summer 2019, there was little variation between micro-persona groups in winter demand savings. Savings for Low Engagers and participants without micro-persona classifications were generally similar to other micro-persona groups. For Flex PTR, only Big Impactors savings differed and were nearly double those of the other micro-persona groups. For Test Bed PTR, savings for all groups were statistically indistinguishable from zero and each another.

[31] Note, the Flex 1.0 savings from winter 2017/2018 reflected only afternoon events. The opt-in PTR savings are from the PTR1 treatment group, which received a rebate of $0.80/kWh. Opt-out PTR2 participants received a rebate of $1.55/kWh. Of the six afternoon events from winter 2017/2018 season, only two opt-in PTR events and three opt-out PTR events demonstrated statistically significant savings.

**Figure 12. Flex PTR Average Demand Savings (kW) by Micro-Persona**

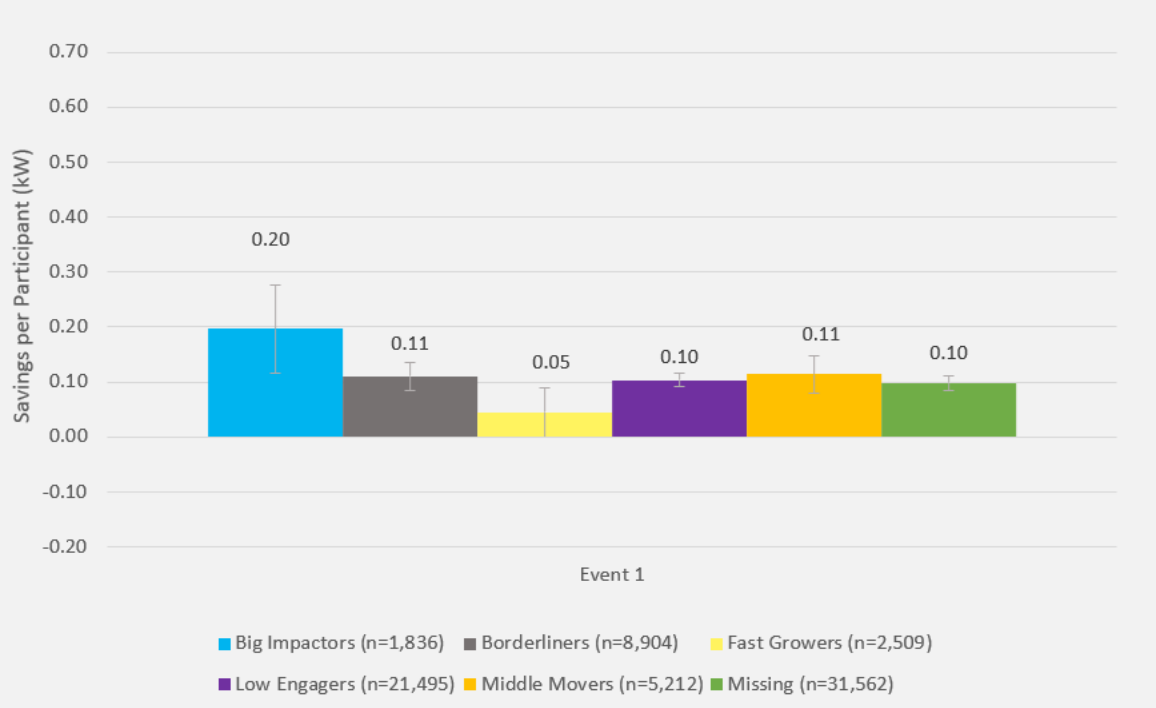
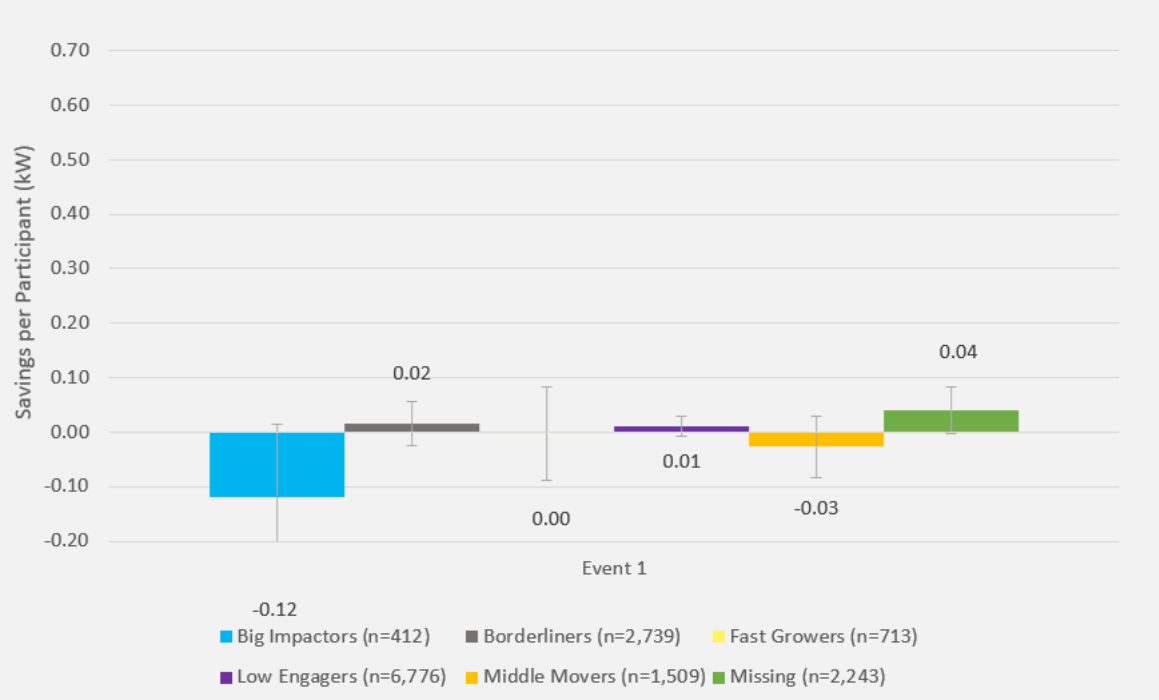



**Figure 13. Test Bed Average Demand Savings (kW) by Micro-Persona – Winter 2019/2020**




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

### *Program Demand Savings -- Winter*

Table 14 presents the evaluated and reported program-level demand savings for the winter event. The program demand savings were obtained by multiplying the evaluated average savings per participant by total number of participants. The evaluated savings were compared to PGE's reported demand savings. As shown, the evaluation estimates that the program achieved demand savings of 7.22 MW, which surpassed the reported savings estimate of 4.35 MW. The 90% confidence interval for the evaluated savings equals 6.54 MW to 7.83 MW, which does not include the reported savings.

**Table 14. PTR Program Total Savings – Winter 2019/2020**

| Event | Event Time | Average Load Impact per Participant/ Event (kW) | Evaluation Participant Count | Evaluation Demand Savings (MW) | Reported Demand Savings (MW) |
|---|---|---|---|---|---|
| Event 1 | 4 p.m. – 7 p.m. | 0.084 | 85,910 | 7.216 | 4.346 |

Note: Evaluated demand savings were estimated from a panel regression of customer hour interval consumption for participants and matched non-participants. See Appendix Afor estimation details. The Reported demand savings are PGE's estimate of program savings based on a matched control group analysis.

## *Customer Experience*

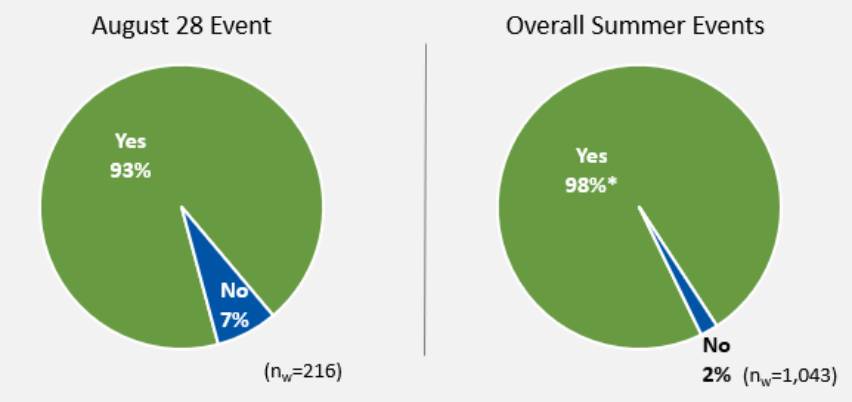
This section provides the key findings from the summer 2019 event survey and summer 2019 experience survey. Due to a limited winter season with only one event, customer surveys were not conducted for the winter season. See *Appendix A* for a detailed description of the survey methodology.

### Summer Event Notification

PGE called five events during the summer 2019 season. Seventy-five percent of summer experience survey respondents reported having received notifications about peak time events via email and 63% via text ($n_w$=1,018). The summer experience survey asked respondents whether they remembered being notified prior to events. Ninety-eight percent ($n_w$=1,043) remembered being notified prior to summer events. The high percentage of respondents who remembered receiving event notifications suggests that customers were attentive to the events.

The evaluation also found that customers were more likely to remember event notifications in the experience survey than the event survey. More respondents remembered receiving event notifications when asked in the context of a whole season compared to a single event. Cadmus administered a summer event survey the day after the August 28 event. As shown in Figure 14, a significantly higher percentage of respondents remembered receiving the event notification when asked in the context of the whole season (98%) compared to the single August 28 event (93%).

**Figure 14. Flex 2.0 PTR Summer 2019: Receipt of Event Notifications**



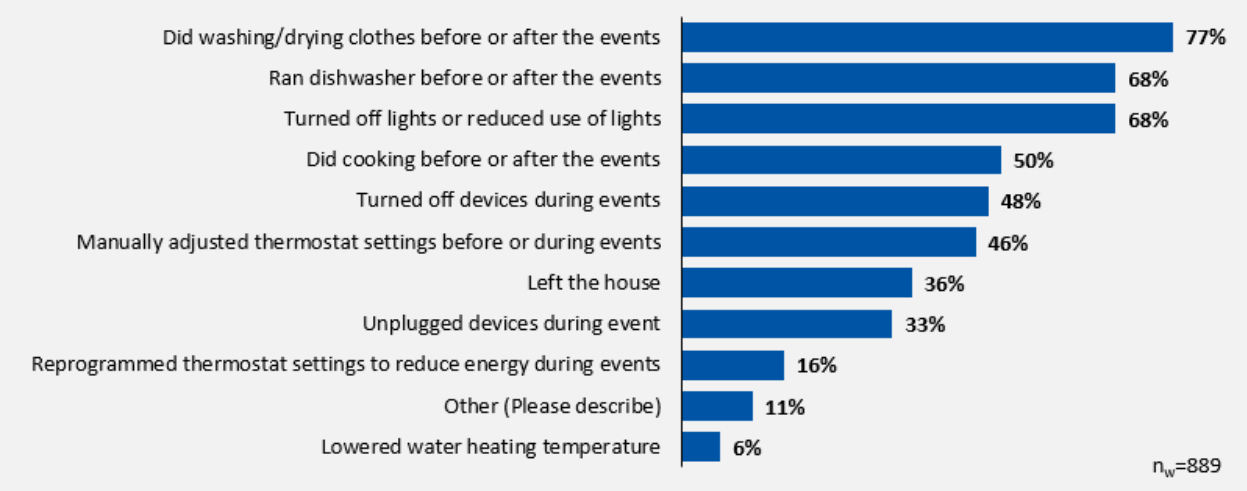

* Difference is significant with 90% confidence (p≤0.10).

Source: Summer Event Survey Question. "Do you remember receiving advanced notification of this past Wednesday's Peak Time Event?" Summer Experience Survey Question. "Do you remember receiving advanced notifications about Peak Time Events this past summer? These were the notifications sent one day before the Peak Time Events that showed you the start and end times."

## Summer Event Participation

The majority of respondents reported participating in at least one summer event (87%, $n_w$=1,018). The summer experience survey asked how easy it was to participate and what actions participants took. Eighty-seven percent of respondents said it was *very easy* or *somewhat easy* to shift or reduce energy use during the summer events ($n_w$=889). Respondents most frequently reported taking simple, low-savings actions such as doing chores before or after the events and turning off the lights to shift or reduce energy use, as shown in Figure 15. In particular, respondents most often reported shifting laundry and dishwashing chores, which were the actions commonly recommended to participants in the summer event notifications and customer education materials.

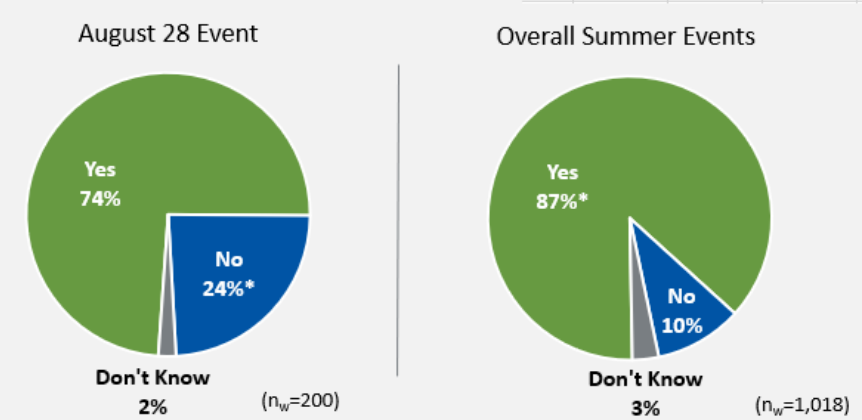
**Figure 15. Flex 2.0 PTR Summer 2019: Actions Taken to Shift or Reduce Energy Use**




Source: Summer Experience Survey Question. "How did your household shift or reduce energy use during the summer events? Select all that apply."

A significantly higher percentage of survey respondents self-reported participating in the events when asked about their actions over the summer season than when asked about their actions in response to a single event. As shown in Figure 16, 87% percent of survey respondents self-reported shifting or reducing their energy use over the summer season compared to 74% of survey respondents who were asked about their actions in response to the August 28 event.

**Figure 16. Flex 2.0 PTR Summer 2019: Self-reported Event Participation – Single Event Compared to Overall Season**




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

Source: Summer Event Survey Question. "Did you or others in your household do anything to shift or reduce energy use during Wednesday's Peak Time Event?" Summer Experience Survey Question. "Did you or others in your household do anything to shift or reduce energy use during the summer events?"

## Summer Event Nonparticipation

According to the summer experience survey, 10% of respondents reported not doing anything to shift or reduce energy use during events ($n_w$=1,018). These respondents ($n_w$=98) gave the following top reasons for not participating in the events:

- Already a low energy consumer (35%)
- Not home during the events (30%)
- Rebate was too small (28%)

Cadmus asked these respondents an open-end question on what would motivate them to shift or reduce energy use during events. Of the 63 who answered, the reasons were increasing the rebate amount (27%), providing more ideas of ways to shift or reduce energy use (19%), and changing the timing of events (11%). For the upcoming summer 2020 season, PGE plans to provide participants with more ideas on ways to shift/reduce energy use and change the timing of events.

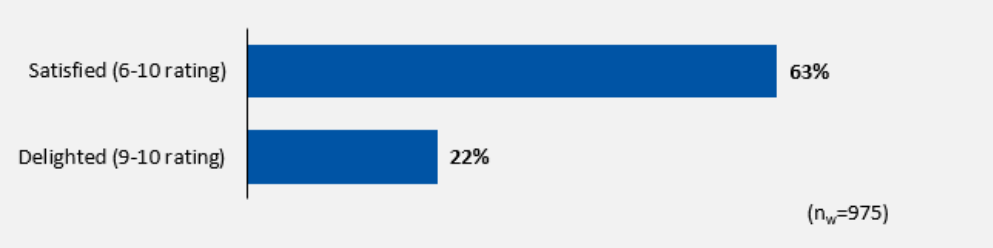
## Summer Satisfaction

The summer experience survey respondents rated their satisfaction with the rebates, 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 Rebates*

As shown in Figure 17, customers had low satisfaction with the rebates, 63% of respondents were satisfied with the rebates they earned during the summer, but only 22% were delighted.

**Figure 17. Flex 2.0 PTR Summer 2019: Satisfaction with Rebates**




Source: Summer Experience Survey Question. "How satisfied are you with the rebate incentives your household earned this past summer through the Peak Time Rebates program?"

The evaluation found two possible reasons for customers' low satisfaction with the rebates:

- **Customers may have expected to earn more in exchange for their participation.** In the summer experience survey, 42% of respondents said rebates were lower than expected while only 7% said rebates were higher than expected ($n_w$=1,018). According to the program tracking data, Summer experience survey respondents earned on average $6.56 during the summer, with a median of $6.09 ($n_w$=1,033). PGE's marketing and educational materials said customers could save $2 to $3 per event, with a footnote explaining that actual savings may vary. Therefore, customers may have expected $10 to $15 from the five events called in summer 2019.
- **Some customers experienced a disconnect between their participation effort and the rebate they earned.** The survey found that 40% of respondents agreed with the statement *the rebates don't seem to be linked to the actions I take* ($n_w$=910), and 65% agreed with the statement *the actions I took during events were similar but my event results differed* ($n_w$=807). The evaluation found mentions in customers' open-end comments. One respondent explained, "I love the idea of this but we turned off and unplugged everything we could for the first event and only got $0.05. It made the hassle not really worth the effort. We continued and did not run any appliances during other events and it did not get us any rebate at all."

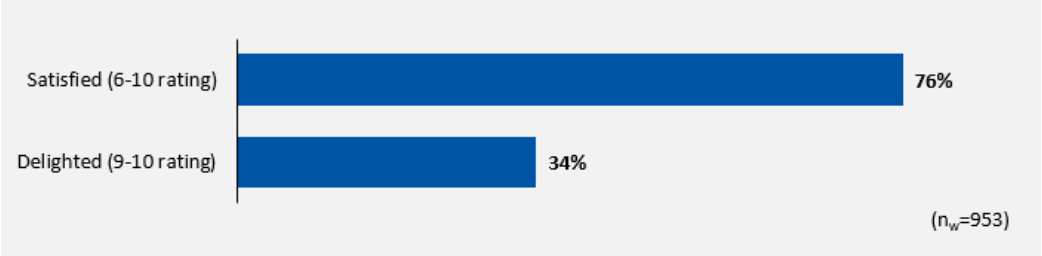
In the evaluation of the Flex 1.0 PTR, Cadmus did not find any customer mentions of the disconnect between their participation effort and the rebate amount earned. In Flex 1.0 PTR, customers received their event energy savings results the day after the event; the rebate amount was calculated in aggregate based on savings across all events after the season ended and then reported to customers in an end-of-season report.

In Flex 2.0 PTR, PGE changed the program design to deliver the results of energy savings and the rebate amount to customers the day after each event. Providing detailed, post-event results was intended to encourage participation and engagement but may have also made it easier for customers to notice any discrepancy between their actions and the rebate. Providing customers the rebate results at the monthly level or at the end of the season may alleviate dissatisfaction by making any discrepancy between event participation effort and the rebate amount less noticeable.

### *Satisfaction with PTR Program*

The majority of respondents were satisfied with the program. Nevertheless, PGE did not meet its customer satisfaction goals. Seventy-six percent of respondents were *satisfied*, in comparison to the goal of 80% *satisfied*, and 34% were *delighted*, in comparison to the goal of 60% *delighted* (Figure 18). The program achieved similar customer satisfaction results between Flex PTR participants (79% *satisfied,* 40% *delighted*) and Test Bed PTR participants (78% *satisfied,* 28% *delighted*).

**Figure 18. Flex 2.0 PTR Summer 2019: Satisfaction with Program**




Source: Summer Experience Survey Question. "Please rate your overall satisfaction with PGE's Peak Time Rebates program."

To ascertain possible reasons that PGE did not achieve high customer satisfaction, Cadmus reviewed the summer experience survey's open-end comments. The survey asked respondents an open-end question to explain their program satisfaction rating. Of the 632 respondents who answered, many had positive things to say about the program. They frequently mentioned that they liked the program in general (23%), the program helps the environment, community, and/or grid (9%), and they like receiving rebates (8%).

On the other hand, respondents' negative comments reiterated the disconnect between participation effort and rebate amount, with comments that the rebate amount was too small (14%), the effort was not worth it or made no difference (9%), and the results/rebates did not match efforts (7%). Consequently, this disconnect between participation effort and rebate amount may have negatively impacted customer satisfaction with the program.

### *Satisfaction with PGE*

Customer satisfaction with the program did not have a negative impact on satisfaction with PGE. Figure 19 shows that 90% of respondents were *satisfied* and 51% were *delighted* with PGE.

**Figure 19. Flex 2.0 PTR Summer 2019: Satisfaction with PGE**

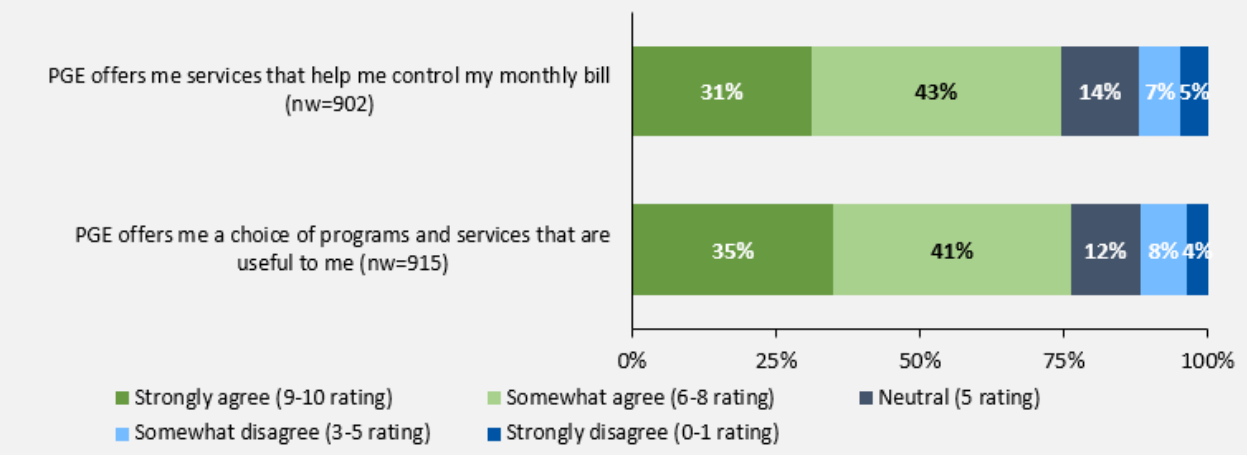

Source: Summer Experience Survey Question. "Before we ask you about your program experience, please rate your overall satisfaction with PGE."

## Value Perceptions of PGE's Offerings

Demand response represents a fundamental shift in a utility's relationship with its customers. Therefore, understanding the value perceptions of PGE's customer offerings is important to demonstrate how participants can reliably provide peak capacity to utilities, not just consume utility-supplied electricity.

The summer experience survey asked respondents how much they agreed (on a scale of 0 to 10, where 0 is *strongly disagree* and 10 is *strongly agree*) with two statements regarding PGE's customer offerings. As Figure 20 shows, 74% agreed, with 31% who said they *strongly agree,* with the statement *PGE offers me services that help me control my monthly bill*. A similar percentage (76%) of respondents agreed, with 35% who said they *strongly agree*, that PGE programs and services are useful to them.

**Figure 20. Flex 2.0 PTR Summer 2019: Value Perceptions of PGE Offerings**




Source: Summer Experience Survey Question. "As our final question, please tell us how much you agree with the following statements about PGE: PGE offers me a choice of programs and services that are useful to me. PGE offers me services that help me control my monthly bill."

Results did not significantly differ between Flex PTR respondents and Test Bed PTR respondents. As shown in Table 15, 76% of customers in both groups agreed (6-10 rating) with the statement *PGE offers me a choice of programs and services that are useful to me.* A similar percentage of Flex PTR respondents (75%) and Test Bed PTR respondents (71%) agreed (6-10 rating) with the statement *PGE offers me services that help me control my monthly bill*. Cadmus will document more about customer values in the Test Bed project evaluation.

**Table 15. Flex 2.0 Summer 2019: Value Perceptions of PGE Offerings by PTR Group**

| PGE offers me a choice of programs and services that are useful to me | Flex PTR ($n_w$=738) | Test Bed PTR ($n_w$=177) |
|---|---|---|
| Strongly Agree (9-10 rating) | 36% | 32% |
| Agree (6-10 rating) | 76% | 76% |
| **PGE offers me services that help me control my monthly bill** | **Flex PTR ($n_w$=731)** | **Test Bed PTR ($n_w$=170)** |
| Strongly Agree (9-10 rating) | 32% | 28% |
| Agree (6-10 rating) | 75% | 71% |

Source: Summer Experience Survey Question. "As our final question, please tell us how much you agree with the following statements about PGE: PGE offers me a choice of programs and services that are useful to me. PGE offers me services that help me control my monthly bill."

## Flex PTR vs. Test Bed PTR Comparisons

Cadmus compared the summer experience PTR participant survey results between Flex PTR and Test Bed PTR respondents, as shown in Table 16. Several statistically significant differences emerged between the two groups. Flex PTR respondents exhibited a higher self-reported event participation rate and were more delighted with the rebate and the program compared to the Test Bed PTR respondents. These differences align with the expectation that customers who opt into a program (as does the Flex PTR group) are typically more engaged and satisfied than customers who are auto-enrolled into a program (as in the Test Bed PTR group).

**Table 16. Flex 2.0 PTR Summer 2019: Experience Survey Results by PTR Group**

| Survey Topic | Flex PTR (n≤693) | Test Bed PTR (n≤352) |
|---|---|---|
| Pre-event notifications | 97% remembered notifications | 97% remembered notifications |
| Event participation | 90% shifted or reduced energy* | 82% shifted or reduced energy |
| Total rebates earned | Average $8.61<br>Median $6.14 | Average $8.41<br>Median $6.05 |
| Satisfaction with rebates | 65% satisfied (6-10 rating)<br>26% delighted (9-10 rating)* | 62% satisfied (6-10 rating)<br>20% delighted (9-10 rating) |
| Satisfaction with program | 79% satisfied<br>40% delighted* | 78% satisfied<br>28% delighted |
| Satisfaction with PGE | 90% satisfied<br>51% delighted | 89% satisfied<br>54% delighted |

Note: Unweighted results and counts are shown.

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

## Micro-Persona Comparisons

Cadmus compared the summer experience PTR participant survey results between the five micro-personas—Big Impactors, Fast Growers, Middle Movers, Borderlines, and Low Engagers—as shown in Table 17. Each micro-persona includes both Flex PTR and Test Bed PTR survey respondents.

Several statistically significant differences emerged between micro-personas, particularly with Low Engagers. The evaluation found that Low Engagers lived up to their name; compared to the other

groups, Low Engagers had the lowest self-reported event participation rate (82%), were the least satisfied (59%) and delighted (18%) with the rebate amount, and were the least satisfied (74%) and delighted (28%) with the program.

**Table 17. Flex 2.0 PTR Summer 2019: Experience Survey Results by Micro-Persona**

| Survey Topic | Big Impactors (n≤179) | Fast Growers (n≤206) | Middle Movers (n≤164) | Borderliners (n≤176) | Low Engagers (n≤169) |
|---|---|---|---|---|---|
| Pre-event notifications | 96% remembered notifications | 97% | 98% | 98% | 98% |
| Event participation | 88% shifted or reduced energy | 88% | 85% | 90%* | 82%* |
| Satisfaction with rebates | 65% satisfied<br>24% delighted | 69%*<br>30%* | 66%<br>26% | 65%<br>23% | 59%*<br>18%* |
| Satisfaction with program | 81% satisfied<br>38% delighted | 83%*<br>43%* | 79%<br>40% | 79%<br>34% | 74%*<br>28%* |
| Satisfaction with PGE | 89% satisfied<br>51% delighted | 92%<br>51% | 93%<br>56% | 89%<br>47% | 90%<br>55% |

Note: Unweighted results and counts are shown.
*Difference is statistically significant 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 AMI meter interval consumption data to estimate the PTR load impacts. First, Cadmus employed propensity score matching to identify nonparticipants who were similar to PTR participants. 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 participants with a sample of nonparticipants using propensity score matching. This technique involved matching each participant to one nonparticipant with a similar estimated propensity score. Each customer's propensity score reflected their propensity 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 LASSO regression for PTR program participation.[32] 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 ~100 candidate explanatory variables (a full list of variables can be found in Table A-1). 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 600,000 residential customers with sufficient data for the analysis. Cadmus used these scores to match each participant to one nonparticipant.[33]

Cadmus conducted separate nonparticipant matching for winter and summer seasons, because the criteria for a good summer nonparticipant match could differ substantially from the criteria for a good winter match. This meant that participants were matched to different nonparticipants in winter, and vice versa. Within each season, the analysis also differentiated between Flex PTR and Test Bed PTR participants, the latter having been automatically enrolled in PTR and the former having chosen to opt-

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[32] Cadmus also tested elastic net and ridge regression methods, which yielded similar specifications, but LASSO provided marginally lower prediction error.

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

in to 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 account
- Test Bed PTR old account
- Flex PTR new account
- Flex PTR old account

This approach controlled for the differences between opt-in and auto-enrolled participants, as well as differences associated with account age. Because the majority of residential customers in the Test Bed were auto-enrolled, participants in the Test Bed were matched primarily with customers outside of the Test Bed.[34]

Though the matching model estimated each customer's propensity to enroll in PTR, the ultimate goal of the matching was to assemble a control group of nonparticipants with similar hourly consumption to that of the participant 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 participant group.[35]

## Matching Model Candidate Variables

Table A-1 shows the full list of candidate explanatory variables for the nonparticipant matching. Columns 1-8 denote the top ten most important variables selected by the LASSO propensity score models with "X."[36] Matching population models were divided by season, with four models in each season broken down by data availability.[37] Models 1-4 are for the summer season and 5-8 are for the

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[34] However, there were also a small number of customers within the Test Bed who were not shown as having been enrolled in PTR, and so these nonparticipant customers were also eligible for matching to participants in the Test Bed.

[35] Cadmus used t-tests to test for statistically significant differences in mean event-window consumption between participants and matched control groups after matching (each customer's mean hourly consumption during the 4-7 PM period on non-event weekdays within each season.) There were no statistically significant differences.

[36] Note that the X denotes only the top ten most predictive variables selected for each model, based upon standardized coefficient magnitudes; full model specifications included the majority of the variables shown in this list.

[37] Newer PGE customers did not have a full year of pre-program consumption history, so Cadmus matched these participants in separate models to new PGE customers who were not PTR participants. 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.

winter season. Within each season, models follow the breakdown: Out of Test Bed ’18, Out of Test Bed ’19, Test Bed ’18, and Test Bed ’19 (1-4, then 5-8).

**Table A-1. Nonparticipant Matching Candidate Variables**

| Variable | Description | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| AnnualKWh | Customer’s annual energy consumption | X | X | | | | X | | |
| Any_ETO_program_participation | Indicator if a customer has participated in any ETO program | | | | | | | | X |
| AverageMonthlyKWh | Customer’s average monthly consumption | | | | | | | | |
| AverageMonthlyKWhSummer | Customer’s average monthly consumption during summer months (June-September) | | | | | | X | | |
| AverageMonthlyKWhWinter | Customer’s average monthly consumption during winter months (December-February) | | | | | | X | | |
| AverageMonthlykWhFall | Customer’s average monthly consumption during fall months (October – November) | | | | | | | | |
| AverageMonthlykWhShoulder | Customer’s average monthly consumption (October-November, March-May) | X | X | | | X | | | |
| 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 | | |
| 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” | | | | | | | | |
| IsMDBOptOut | Customer has opted-out from mailing database | | X | X | | X | | | |
| IsPaperless | Indicator if a customer has signed up for paperless billing | X | X | | | 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 | | |

| Variable | Description | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| IsWebRegistered | Indicator if a customer has registered their account online | X | 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 | | | | | | | | |
| PgeCustomerMonths | Length of time that a customer has been with PGE | | | | | | | | |
| age_of_home | Age of the customer's dwelling | | | | | | | | X |
| electricwaterheat | Indicator if a customer has an electric water heater in their dwelling | | | | | | | | |
| 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 | X | | | X | | | | |
| HasAirConditioning | Indicator if the customer's dwelling has air conditioning | | | X | X | | | X | |
| HasEvCharging | Indicator if the customer's dwelling has electric vehicle charging | | | | | | | | |
| HasHeatPump | Indicator if the customer's dwelling has a heat pump system | | | X | X | | | X | |
| PaymentLastChannelSummary | Customer's last payment method | | | X | | X | X | X | |

| Variable | Description | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| AX_EstimatedIncome | An income range to estimate a customer's income | | 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 | X | | | X | X |
| AVG_PTRHOURS_WINTER2018/2019 | Customer's average consumption during PTR event hours | | | | | | | | |
| AVG_ONPEAK_WINTER2018/2019 | Customer's average consumption during on-peak hours as defined by the TOU Rate Schedule 007 | | | | | | | | |
| AVG_MIDPEAK_WINTER2018/2019 | Customer's average consumption during mid-peak hours as defined by the TOU Rate Schedule 007 | | | | | | | | |
| AVG_OFFPEAK_WINTER2018/2019 | Customer's average consumption during off-peak hours as defined by the TOU Rate Schedule 007 | | | | | | | | |
| RATIO_ONPEAK_WINTER2018/2019 | Ratio of on-peak average to off-peak average | | | | | | | | |
| RATIO_MIDPEAK_WINTER2018/2019 | Ratio of mid-peak average to off-peak average | | | | | | | | |

## Impact Estimation

Cadmus estimated the demand savings from PTR by comparing demand during Flex events of customers in the treatment and matched control groups. Using data for event hours during the winter and summer seasons, we estimated a multivariate panel regression of customer hourly energy demand on control variables for pretreatment hourly average demand, hour-of-sample fixed effects, each customer's propensity score, and PTR treatment. We estimated separate models for customers in and out of the Test Bed (Test Bed PTR and Flex PTR, respectively). The pretreatment demand variables controlled for average differences in electricity demand between customers during Flex event hours.

Cadmus calculated separate, customer-specific pretreatment mean demand for each hour (0-23) of each season, using AMI interval data from non-event weekdays within the season.[38] The hour-of-sample fixed effects controlled for weather and other unobserved factors specific to each event hour. We estimated the models by ordinary least squares (OLS) and clustered the standard errors on customers to account for correlation over time in customer demand. We estimated alternative model specifications to test the

[38] 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.

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

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

**Equation 1. Regression Model Specification**

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

- $kWh_{it}$ – electricity consumption for customer *i* in datetime *t.*
- $\beta_1$ – 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.)
- $\beta_2$ – A coefficient indicating the average effect of non-event day consumption on consumption during PTR events.
- $Pre_{it}$ – A variable containing each customer's individual hourly mean consumption during PTR non-event, non-holiday weekdays. For the summer season, this included only days before the first PTR event. For the winter season, this included days before and after the PTR event. For each customer, this variable had 24 distinct values.
- $\beta_3 PropensityScore_i + \beta_4 PropensityScore * NewCustomer_i$ – controls for each customer's propensity score, allowing this effect to differ for new customers (who were estimated in a separate propensity score model)
- $\tau_t$ – 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).
- $\varepsilon_{it}$ – an error term for consumption of customer *i* and hour *t.*

## *Staff Interviews*

During fall 2019, Cadmus conducted interviews with the PGE program manager, PGE program marketing lead, Oracle implementation staff, and TROVE implementation staff. The interviews focused on documenting how the program operates, any implementation challenges, and any successes or lessons learned to date. Cadmus used information obtained from the interviews to design the customer surveys and review the logic model.

## *Customer Surveys*

Cadmus designed and administered three online surveys with customers enrolled in Flex 2.0 PTR:

- Recruitment survey (fielded June 2019)
- Summer event survey (fielded August 2019)
- Summer experience survey (fielded November 2019)

### Survey Design

Cadmus designed the **recruitment survey** to ask enrollees how they heard about the program, their motivations for enrolling, pre-participation concerns, awareness of and interest in demand response, and satisfaction with PGE.

To provide PGE with timely customer feedback, Cadmus administered an **event survey**, 24 hours after the August 28, 2020, event. The event survey asked participants about their awareness of event notification, event participation, results, and intention for future participation as well as their satisfaction with the rebate, program and PGE.

After the summer event season, Cadmus administered an **experience survey**. The experience survey asked participants about their awareness of event notification, event participation and participation barriers, event results and rebate expectations, future participation, value perceptions and satisfaction with the program and PGE.

All of these surveys took respondents less than seven minutes to complete. Respondents did not receive an incentive for completing the surveys.

### Survey Sampling and Response Rates

Based on the number of available at the time of the survey, Cadmus either contacted the census or a random sample of enrolled customers with an active PGE account. Table A-2. through Table A-4. show the number of customers contacted and response rate for the three surveys. The table notes describe whether the survey employed the census or random sampling. On average, the three surveys achieved a response rate of 15%.

**Table A-2. Flex 2.0 PTR Recruitment Survey Samples and Response Rates**

| | Population | Original Sample Frame* | Adjusted Sample Frame (Successfully Emailed) | Number of Completes (Achieved Sample) | Response Rate |
|---|---|---|---|---|---|
| **By Enrollment Channel** | | | | | |
| Online | 11,959 | 2,619 | 2,608 | 569 | 22% |
| Phone | 7,606 | 1,664 | 1,626 | 117 | 7% |
| Green Mountain | 189 | 46 | 45 | 5 | 11% |
| Conversion or Other | 606 | 147 | 146 | 27 | 18% |
| **By Micro-Persona** | | | | | |
| Big Impactors | 753 | 726 | 718 | 99 | 14% |
| Fast Growers | 1,062 | 750 | 743 | 119 | 16% |
| Middle Movers | 2,272 | 750 | 746 | 140 | 19% |
| Borderliners | 3,956 | 750 | 743 | 142 | 19% |
| Low Engagers | 10,528 | 750 | 740 | 141 | 19% |
| Null (no persona) | 1,789 | 750 | 735 | 77 | 10% |
| **By PTR Group**** | | | | | |
| Flex PTR | 19,802 | 4,362 | 4,313 | 694 | 16% |
| Test Bed PTR - Delaware | 221 | 35 | 35 | 7 | 20% |
| Test Bed PTR - Island | 231 | 51 | 51 | 11 | 22% |
| Test Bed PTR - Roseway | 106 | 28 | 26 | 6 | 23% |
| **Overall** | **20,360** | **4,476** | **4,425** | **718** | **16%** |

* Cadmus selected a random sample of 4,476 records stratified by micro-persona for the survey.

** The survey sample frame only included customers who self-enrolled in PTR and did not include any Test Bed customers who were auto-enrolled in PTR.

**Table A-3. Flex 2.0 PTR Summer 2019 Event Survey Samples and Response Rates**

| | Population | Original Sample Frame* | Adjusted Sample Frame (Successfully Emailed) | Number of Completes (Achieved Sample) | Response Rate |
|---|---|---|---|---|---|
| **By PTR Group** | | | | | |
| Test Bed PTR | 13,388 | 825 | 800 | 91 | 11% |
| Flex PTR | 48,371 | 825 | 817 | 124 | 15% |
| **By Micro-Persona** | | | | | |
| Big Impactors | 2,109 | 52 | 51 | 6 | 12% |
| Fast Growers | 3,222 | 95 | 93 | 10 | 11% |
| Middle Movers | 6,666 | 195 | 190 | 25 | 13% |
| Borderliners | 11,978 | 334 | 328 | 43 | 13% |
| Low Engagers | 32,901 | 866 | 850 | 119 | 14% |
| Null (no persona) | 4,883 | 108 | 105 | 12 | 11% |
| **Overall** | **61,759** | **1,650** | **1,617** | **215** | **13%** |

* Cadmus selected a random sample of 1,650 records stratified by PTR group for the survey.

**Table A-4. Flex 2.0 PTR Summer 2019 Experience Survey Samples and Response Rates**

| | Population | Original Sample Frame* | Adjusted Sample Frame (Successfully Emailed) | Number of Completes (Achieved Sample) | Response Rate |
|---|---|---|---|---|---|
| **By PTR Group** | | | | | |
| Test Bed PTR | 14,156 | 2,599 | 2,592 | 352 | 14% |
| Flex PTR | 62,193 | 4,361 | 4,349 | 693 | 16% |
| **By Micro-Persona – Test Bed PTR** | | | | | |
| Big Impactors | 440 | 306 | 305 | 36 | 12% |
| Fast Growers | 751 | 538 | 537 | 54 | 10% |
| Middle Movers | 1,644 | 500 | 498 | 68 | 14% |
| Borderliners | 3,012 | 500 | 500 | 76 | 15% |
| Low Engagers | 7,549 | 499 | 497 | 87 | 18% |
| Null (no persona) | 760 | 256 | 255 | 31 | 12% |
| **By Micro-Persona – Flex PTR** | | | | | |
| Big Impactors | 2,130 | 727 | 725 | 143 | 20% |
| Fast Growers | 3,173 | 728 | 724 | 152 | 21% |
| Middle Movers | 6,460 | 728 | 726 | 96 | 13% |
| Borderliners | 11,586 | 727 | 727 | 100 | 14% |
| Low Engagers | 33,472 | 727 | 724 | 82 | 11% |
| Null (no persona) | 5,372 | 724 | 723 | 120 | 17% |
| **Overall** | **76,349** | **6,960** | **6,941** | **1,045** | **15%** |

* Cadmus selected a mix of stratified random sampling and census of records for the 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, statistical weights were applied to the survey results by micro-persona and/or PTR group to reflect actual program population proportions. Open-end survey items were not weighted. Weighted survey results are indicated by the notation $n_w$ in this report.

# 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 six of the event days (Summer 2019 events 1-5 and the winter 2019/2020 event.) 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 2019

**Figure B-7. Participant Load Shape Comparison – Summer 2019, Event 1 (Flex PTR)**

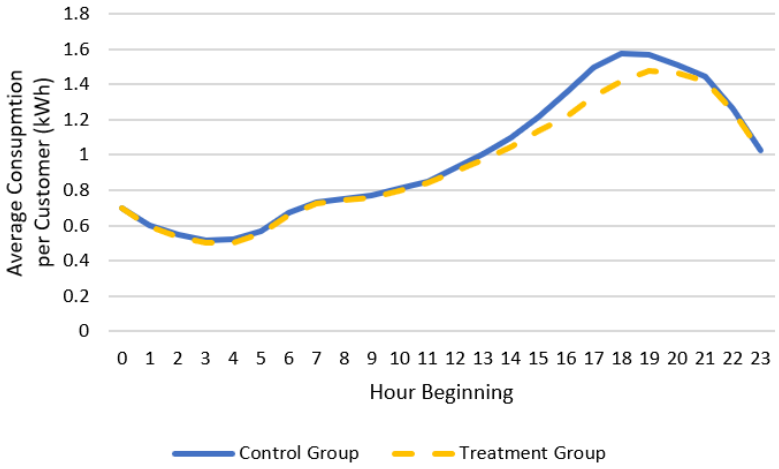



**Figure B-8. Participant Load Shape Comparison – Summer 2019, Event 1 (Test Bed PTR)**

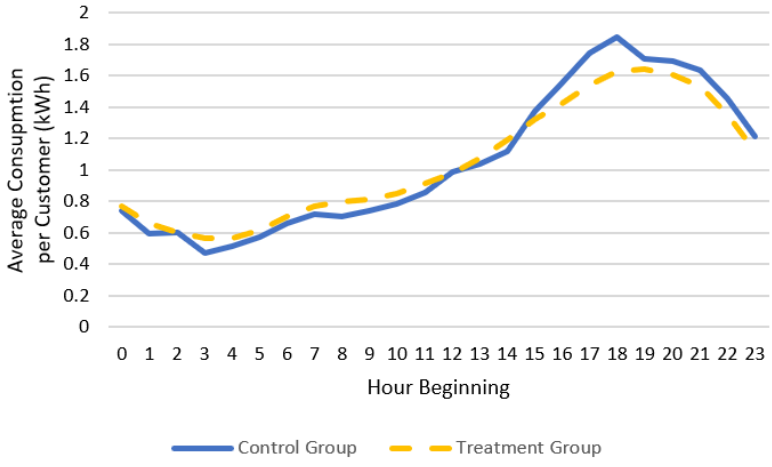


**Figure B-9. Participant Load Shape Comparison – Summer 2019, Event 2 (Flex PTR)**

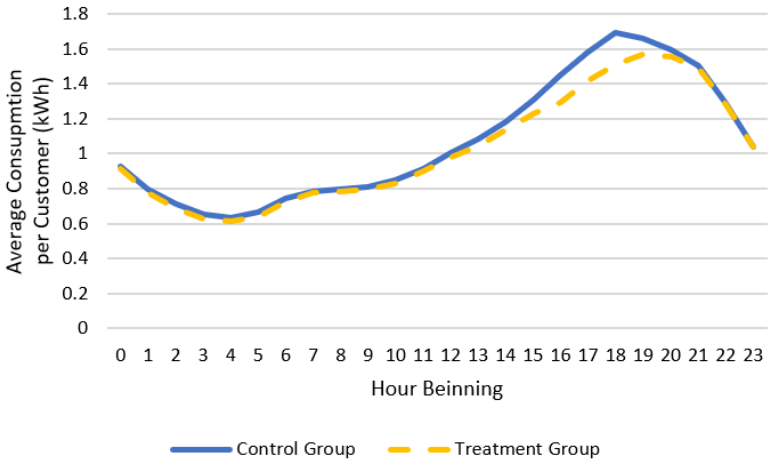



**Figure B-10. Participant Load Shape Comparison – Summer 2019, Event 2 (Test Bed PTR)**

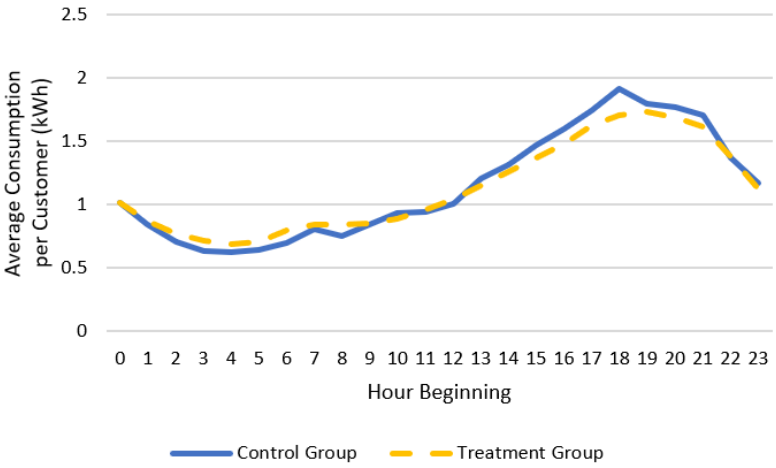



**Figure B-11. Participant Load Shape Comparison – Summer 2019, Event 3 (Flex PTR)**

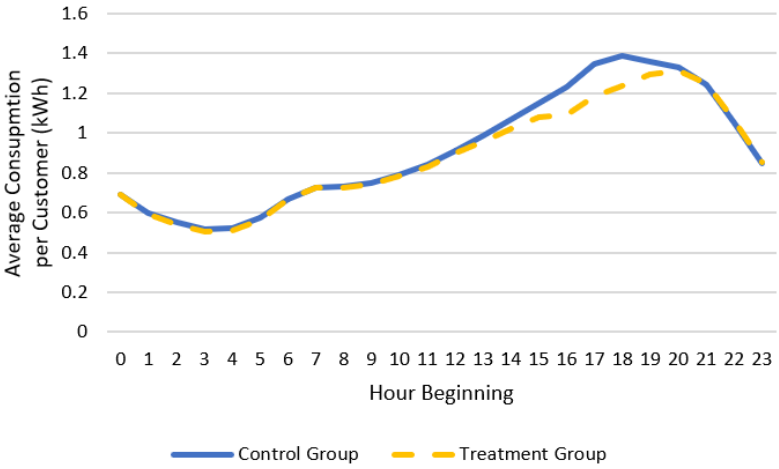


**Figure B-12. Participant Load Shape Comparison – Summer 2019, Event 3 (Test Bed PTR)**

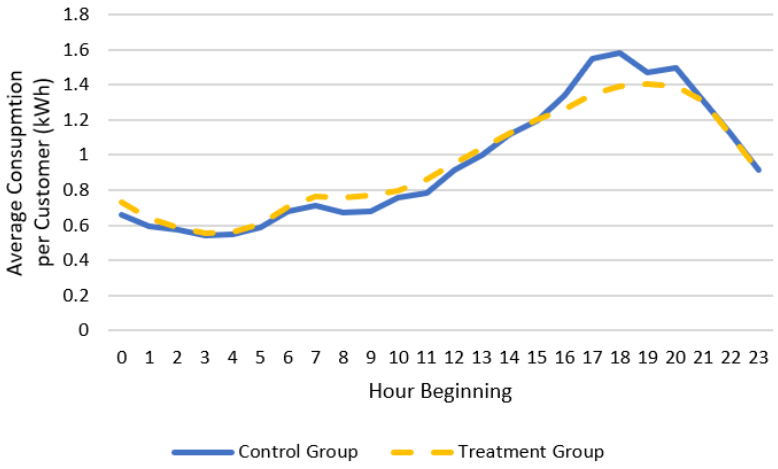



**Figure B-13. Participant Load Shape Comparison – Summer 2019, Event 4 (Flex PTR)**

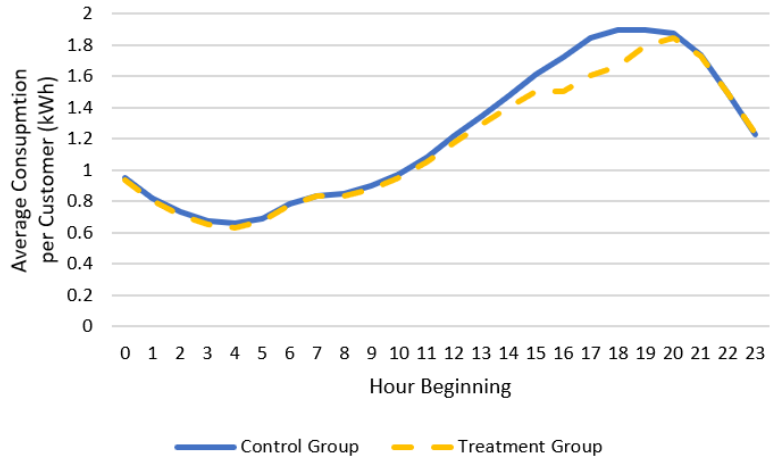



**Figure B-14. Participant Load Shape Comparison – Summer 2019, Event 4 (Test Bed PTR)**

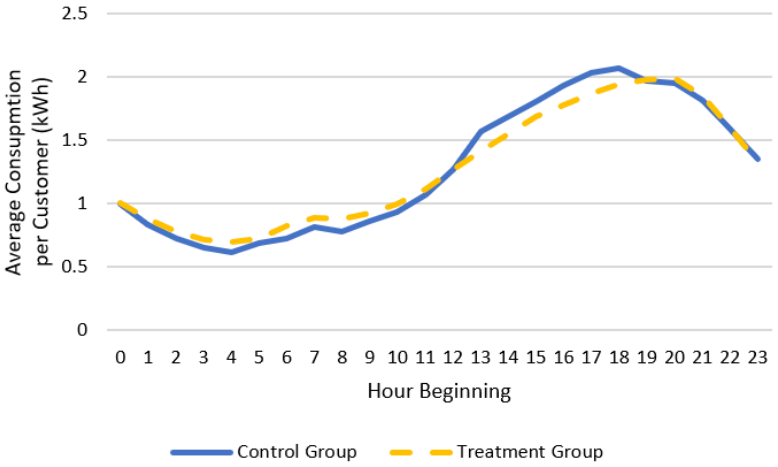


**Figure B-15. Participant Load Shape Comparison – Summer 2019, Event 5 (Flex PTR)**

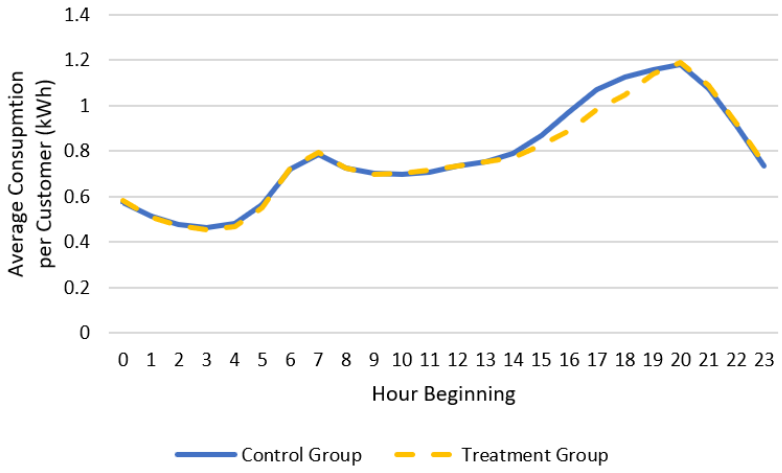
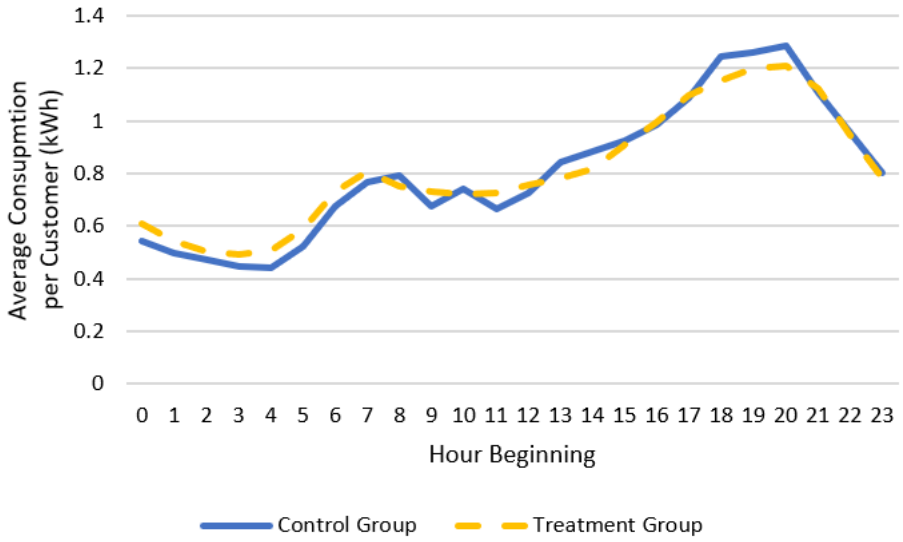



**Figure B-16. Participant Load Shape Comparison – Summer 2019, Event 5 (Test Bed PTR)**



## Winter 2019/2020

**Figure B-17. Participant Load Shape Comparison – Winter 2019, Event 1 (Flex PTR)**

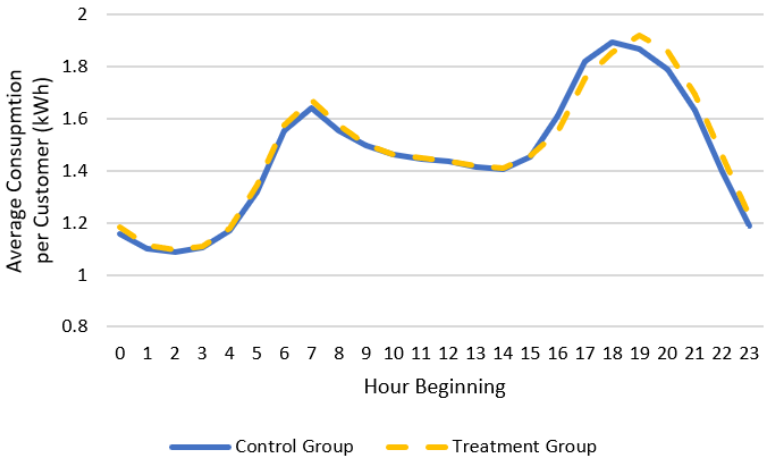
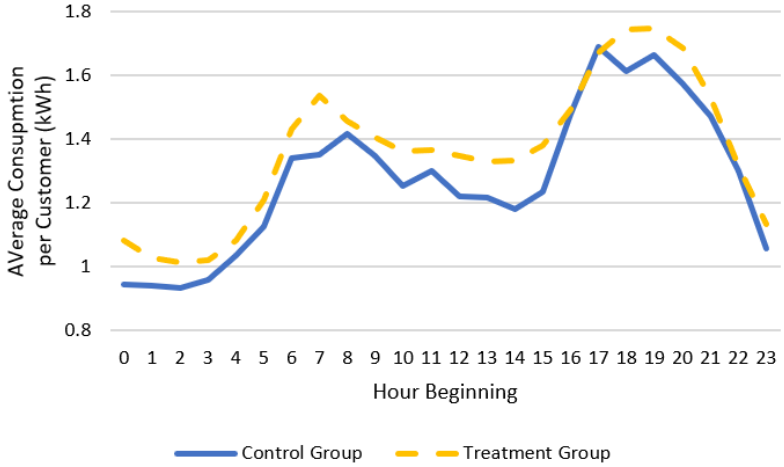



**Figure B-18. Participant Load Shape Comparison – Winter 2019, Event 1 (Test Bed PTR)**



# 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 provide by event and hour, along with the standard errors of the estimates and the number of customers from the analysis sample. Figure C-1 through Figure C-5. 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 Participants**

| Date | Hour Beginning | Savings Estimate (kWh) | Standard Error | Analysis Sample Size (Treatment and Control) |
|---|---|---|---|---|
| July 25, 2019 | 4 pm | 0.087 | 0.007 | 71,929 |
| | 5 pm | 0.1139 | 0.0075 | |
| | 6 pm | 0.1122 | 0.0078 | |
| August 6, 2019 | 4 pm | 0.1096 | 0.0074 | 75,961 |
| | 5 pm | 0.1188 | 0.0078 | |
| | 6 pm | 0.1445 | 0.0081 | |
| August 20, 2019 | 4 pm | 0.0976 | 0.0068 | 82,327 |
| | 5 pm | 0.1262 | 0.0072 | |
| | 6 pm | 0.1189 | 0.0074 | |
| August 28, 2019 | 4 pm | 0.1576 | 0.0086 | 84,541 |
| | 5 pm | 0.1838 | 0.0089 | |
| | 6 pm | 0.1864 | 0.009 | |
| September 12, 2019 | 4 pm | 0.0521 | 0.0064 | 88,211 |
| | 5 pm | 0.0678 | 0.0067 | |
| | 6 pm | 0.0654 | 0.0069 | |
| January 15, 2020 | 4 pm | 0.0836 | 0.0063 | 135,355 |
| | 5 pm | 0.1059 | 0.0067 | |
| | 6 pm | 0.1021 | 0.0069 | |

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

| Date | Hour Beginning | Savings Estimate (kWh) | Standard Error | Analysis Sample Size (Treatment and Control) |
|---|---|---|---|---|
| July 25, 2019 | 4 pm | 0.0211 | 0.0129 | 24,432 |
| | 5 pm | 0.0561 | 0.0136 | |
| | 6 pm | 0.0682 | 0.0141 | |
| August 6, 2019 | 4 pm | 0.0637 | 0.0134 | 24,338 |
| | 5 pm | 0.0632 | 0.014 | |
| | 6 pm | 0.0805 | 0.0142 | |
| August 20, 2019 | 4 pm | 0.0469 | 0.0124 | 24,638 |
| | 5 pm | 0.076 | 0.013 | |
| | 6 pm | 0.081 | 0.0132 | |
| August 28, 2019 | 4 pm | 0.0742 | 0.0158 | 24,378 |
| | 5 pm | 0.1031 | 0.0161 | |
| | 6 pm | 0.0785 | 0.0162 | |
| September 12, 2019 | 4 pm | 0.0289 | 0.0118 | 24,407 |
| | 5 pm | 0.0173 | 0.0119 | |
| | 6 pm | 0.0132 | 0.0123 | |
| January 15, 2020 | 4 pm | 0.0134 | 0.012 | 28,851 |
| | 5 pm | 0.025 | 0.0129 | |
| | 6 pm | 0.0109 | 0.0128 | |

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

| Event | Test Bed PTR Participant Count | Flex PTR Participant Count |
|---|---|---|
| **Summer 2019** | | |
| Event 1 | 12,990 | 34,173 |
| Event 2 | 12,896 | 38,207 |
| Event 3 | 12,926 | 44,571 |
| Event 4 | 12,936 | 46,787 |
| Event 5 | 12,965 | 50,456 |
| **Winter 2019** | | |
| Event 1 | 14,442 | 71,836 |

**Figure C-1. Average Hourly PTR Savings (Event 1), by PTR Group – Summer 2019**

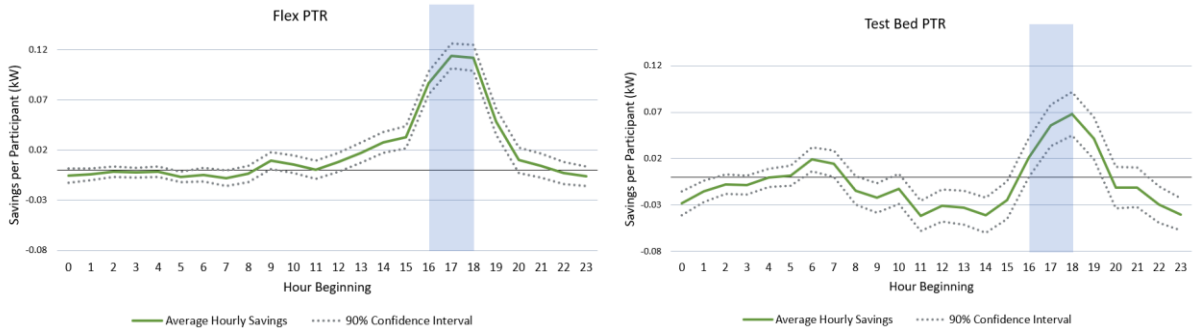


**Figure C-2. Average Hourly PTR Savings (Event 2), by PTR Group – Summer 2019**

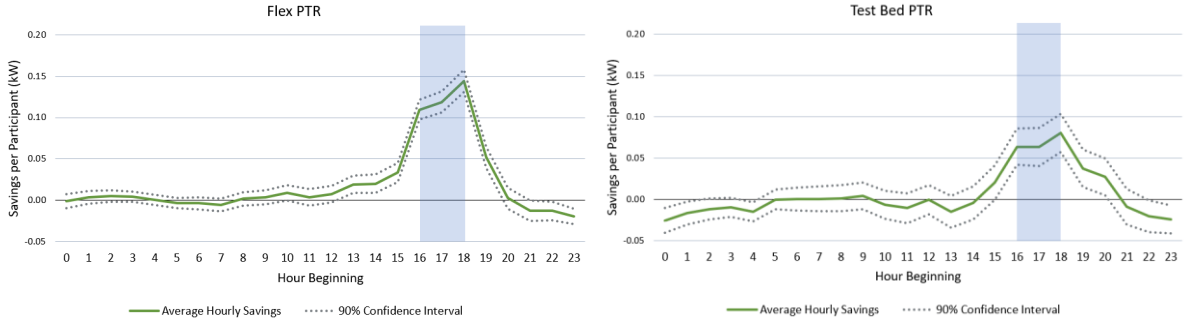



**Figure C-3. Average Hourly PTR Savings (Event 3), by PTR Group – Summer 2019**

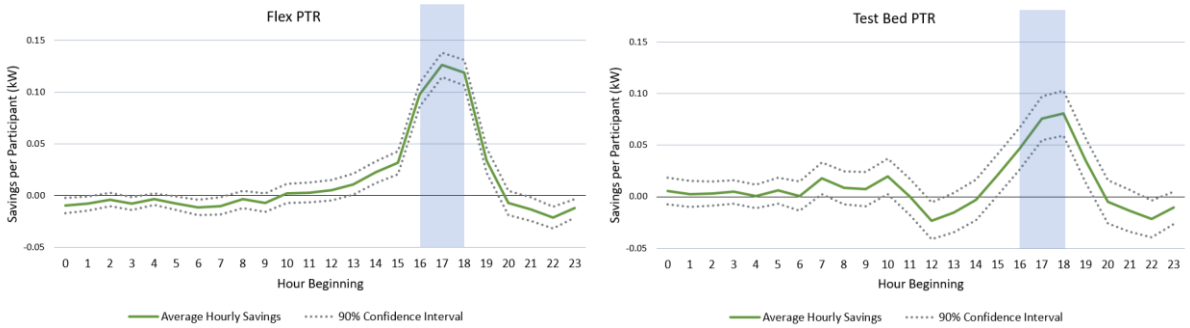



**Figure C-4. Average Hourly PTR Savings (Event 4), by PTR Group – Summer 2019**

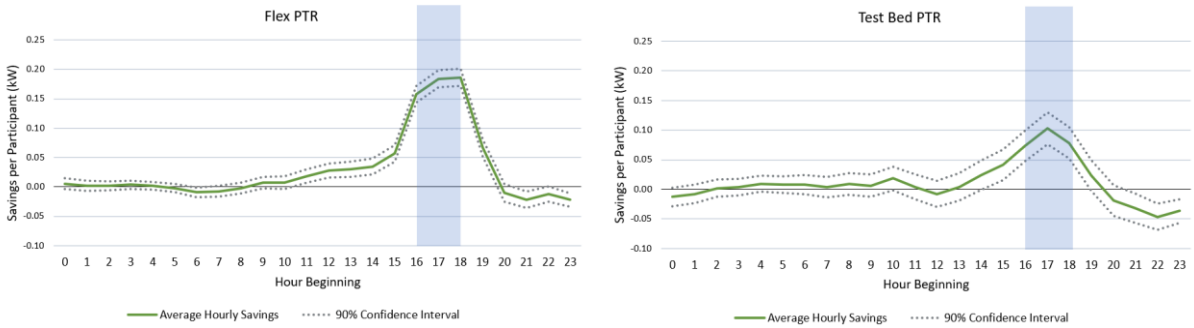



**Figure C-5. Average Hourly PTR Savings (Event 5), by PTR Group – Summer 2019**

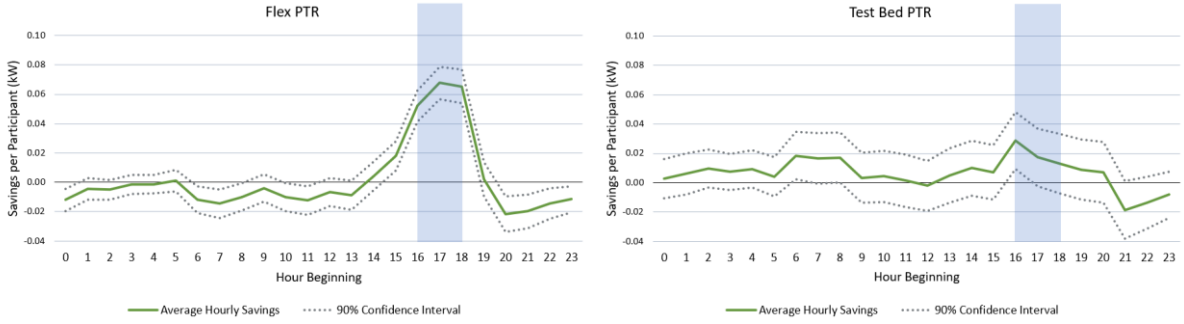
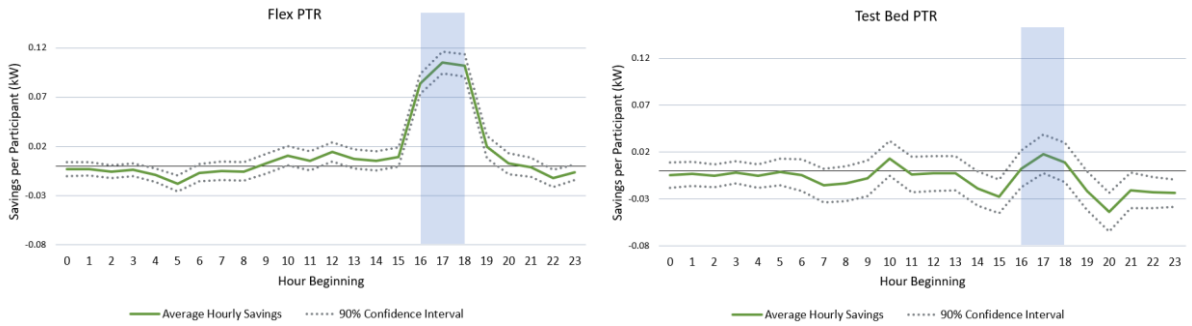


**Figure C-6. Average Hourly PTR Savings (Event 1), by PTR Group – Winter 2019/2020**



# Appendix D. Logic Model

A logic model explains how a program should be expected to succeed, given its design, by graphically presenting the relationships between program activities, outputs, and expected outcomes. The logic model is a useful tool for program staff, implementers, and evaluators to determine whether the program's activities and outputs are producing the outcomes as theorized.

In 2019, PGE began drafting the logic model for the Flex 2.0 pilot program and made revisions to the logic model based on Cadmus' feedback. Table D-1 shows the current working version of the logic model with program activities, outputs, and outcomes fully identified. This logic model mostly focuses on PTR.

As part of the evaluation, Cadmus reviewed the logic model using staff interview findings, customer survey findings, and impact results. The review aimed to determine whether Flex 2.0 PTR operated as described in the logic model and produced the expected outcomes.

Cadmus found that PGE executed all program activities and outputs as described in the logic model, shown in Table D-1. As noted in earlier sections of this report, PGE successfully executed marketing, enrollment, and customer education activities. However, event management and rebate processing activities did not go as smoothly as planned. PGE and its implementation contractors encountered event dispatch IT limitations, event communication errors, rebate calculation errors, and customer dissatisfaction with the rebates. These challenges were also accurately captured in the barriers listed in the program logic model (including *insufficient IT implementation resources* and *customers want to earn higher-value rebates*).

**Table D-1. PGE's Working Draft of Flex 2.0 Pilot Program Logic Model**

<table>
<tr><td>Barriers</td><td colspan="9">• Lack of customer-specific household data (heating/cooling type) limit ability to deliver personalized, relevant messages and savings tips to customers<br>• Timing of peak time events may not align with customers' home schedule or lifestyle<br>• Customers want to earn higher-value rebates which may be restricted by their household profile<br>• Lack of insights on how customers can be successful in the program<br>• Organizationally, insufficient/constrained implementation resources (specifically IT) restrict ability to implement needed program enhancements</td></tr>
<tr><td>Program Activities</td><td>Customer analytics and behavioral profiling</td><td>PGE customer needs and values research</td><td>Program marketing and customer communications</td><td>Customer assistance</td><td>Enrollment system</td><td>Event management</td><td>Incentives processing</td><td>PGE billing system updates</td><td>Third-party evaluation</td></tr>
<tr><td>Outputs to Program Activities</td><td>Micro-Personas identified and customer targeting strategy developed</td><td colspan="2">Marketing messages developed and tested; marketing materials distributed; webpages updated; Test Bed learnings</td><td>PTR webpages available to customers; CSR staff trained</td><td>CSR and online enrollment systems available</td><td>Event alerts/tracking; customer event feedback capabilities developed</td><td>Systems established to process incentives</td><td>Billing systems changed to support program (PTR bill credits)</td><td>Evaluation reports document-ing program perfor-mance</td></tr>
<tr><td rowspan="2">Short-term Outcomes (Year 1)</td><td colspan="2" rowspan="2">1. Customers learn about demand response and program offerings</td><td rowspan="2">2. Program value propositions resonate with customers</td><td colspan="2" rowspan="2">3. Customers enroll in PTR</td><td colspan="4">4. Customers get pre-event alerts; customers remember to participate; customers shift loads for events</td></tr>
<tr><td colspan="4">5. Rebates calculated quickly and correctly; rebate results sent and posted accurately to customer bills; customers are satisfied and remain in program</td></tr>
<tr><td>Mid-term Outcomes (Year 2)</td><td colspan="2">6. Customer profiling enhanced; target customer groups (high demand response value) enrolled</td><td colspan="3">7. Customers perceive high value in PGE offers</td><td>8. Customer event communications improved</td><td>9. Customers become loyal program advocates by promoting the program to others</td><td>10. Eligible PTR customers enroll in DLC programs (e.g., Smart Thermostat); additional load shifting</td></tr>
<tr><td rowspan="3">Long-term Outcomes (Year 3+)</td><td colspan="9">11. Customer profiles optimized for personalization (i.e., PGE tailors event communications based on micro-persona data)</td></tr>
<tr><td colspan="9">12. Load shifting becomes the norm for customers</td></tr>
<tr><td colspan="9">13. MW goals attained</td></tr>
</table>

Note: Bolded numbers correspond to the key performance indicators.