

## Evaluation Report of 2018-2019 Home Energy Reports Program

**PACIFIC POWER WASHINGTON**

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## Executive Summary

Since 2012, the Home Energy Reports (HER) program has been sending residential customers of Pacific Power Washington home energy reports, which contain information about their home energy consumption and encourage the adoption of energy-saving behaviors and home improvements. The program used an experimental design called a randomized control trial (RCT) wherein customers were randomly assigned to either a treatment group (recipients of HERs) or a control group (nonrecipients). Treatment group customers were either mailed or emailed the HERs.<sup>1</sup> The program also provides all residential customers (including those in the control group) access to an online energy management portal where they can view details and insights about their home energy use; however, treatment group customers received encouragement in the HERs to use the online portal. Control group customers did not receive the HERs nor encouragement to use the portal, therefore this group's consumption provides a baseline for measuring the program's energy savings.

From 2012 through 2017, Oracle Utilities Opower served as the implementation contractor and delivered the HERs to customers. In 2018, the HER program transitioned to a new implementation contractor, Bidgely. For the 2018-2019 program, Bidgely maintained the treatment and control group assignments that Oracle Utilities Opower had established. All treatment and control group customers belonged to one of three cohorts of customers known as "waves" that were based on when customers began receiving the HERs:

- Legacy wave received first report in 2012
- Expansion wave received first report in 2014
- Refill wave received first report in 2015

In 2018, treatment group customers in all three waves received either three print HERs or five email HERs, depending on the availability of a valid email address. During the transition to Bidgely, there was a gap of seven months in 2018 when customers did not receive HERs. In 2019, treatment group customers in all three waves received either six print HERs or 12 email HERs. The new HERs from Bidgely contained a similar homes comparison, end-use disaggregation by appliance, historical energy consumption trends, and personalized energy-saving tips. All of these report components, except for the end-use disaggregation information, were found in the previous implementation contractor's HERs.

Cadmus and PacifiCorp identified the following research objectives for evaluating Pacific Power Washington's 2018 and 2019 HER program:

- Evaluate program impacts and gain insight on program performance
- Investigate the lift in other Pacific Power energy efficiency program participation and energy savings from the HER program

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<sup>1</sup> Customers with a valid email address receive the HERs via email while customers without a valid email address receive print HERs via mail.

- Understand customers’ satisfaction with the HER program and awareness of their energy consumption and other energy efficiency programs
- Determine if the HER program was cost-effective each year and across both years
- Review the extent to which PacifiCorp implemented recommendations from previous evaluations

Through interviews with program staff, customer surveys, billing analysis, uplift (energy efficiency program participation and savings) analysis, and cost-effectiveness analysis, Cadmus addressed the evaluation research objectives.

## Conclusions and Recommendations

Table 1 shows the program total savings reported by the HER vendor and the program total evaluated savings and total uplift savings estimated by Cadmus for 2018, 2019, and both years combined. Before adjusting savings for uplift, Cadmus evaluated 103% of the reported savings. Across both 2018 and 2019 program years, savings uplift contributed 2.7% to the evaluated savings.

**Table 1. 2018-2019 Program Total Reported and Evaluated Savings**

Program Year	Reported Savings (MWh/yr) [A]	Evaluated Savings (MWh/yr) [B]	Realization Rate [B/A]	Program Uplift Savings		Evaluated Savings Adjusted for Uplift (MWh/yr) [B – C]
				(MWh/yr) [C]	(%) [C/B]	
2018	9,817	9,373	95%	218	2.3%	9,154
2019	8,366	9,364	112%	286	3.1%	9,078
<b>2018-2019 Program</b>	<b>18,183</b>	<b>18,737</b>	<b>103%</b>	<b>505</b>	<b>2.7%</b>	<b>18,233</b>

Cadmus’ evaluation drew the following conclusions and recommendations:

### Savings and Uplift

**In 2018 and 2019, Legacy and Expansion wave customers continued to save at the levels previously observed in 2016 and 2017.** Customers treated in the Legacy wave saved 2.6% and 2.5% of consumption in 2018 and 2019, maintaining the savings they had achieved in 2017. Legacy wave customers, who had received treatment since mid-2012, appeared unaffected by the gap in treatment at the beginning of 2018 when PacifiCorp changed HER vendors. Expansion wave customers achieved savings of 1.5% in both 2018 and 2019. Their savings decreased slightly from 2017 (1.8%), and there is some evidence that the decrease in savings is attributable in part to the gap in treatment.

**The gap in treatment in 2018 affected customers in the Refill wave, and they struggled to recover in 2018 and 2019.** Prior to 2018, there was some evidence of savings ramping up after the wave launched in mid-2015. Savings dropped dramatically from 1.3% in 2017 to 0.6% in 2018 and 0.5% in 2019. However, Cadmus could not detect significant savings (significantly different from 0 kWh/day) in any of the program years.

**Cadmus found low rates of participation and savings uplift between the HER program and Pacific Power’s other downstream rebate programs.** Across waves of treatment, average uplift savings per customer ranged between 0.36 kWh/yr and 5.55 kWh/yr in 2018, and between 3.05 kWh/yr and 8.42 kWh/yr in 2019. Total uplift from downstream programs remained small as a percentage of evaluated program total savings—in 2018, only 0.6% of evaluated program savings resulted from downstream program participation, and in 2019 this increased only slightly to 1.7%.

## Report Engagement and Influence

**Customers appear to be less than fully engaged with the updated HERs provided by the new HER vendor.** Based on the last HER they received, 40% of respondents said they read the report thoroughly, 40% read some of the report, and 19% skimmed the report. A high proportion of respondents agreed with the following statements: the reports are easy to understand (92%), the information in the reports is helpful (84%), the tips were relevant to their home (81%), and they did some of the everyday tips recommended in the reports (76%). However, more respondents tended to say they *somewhat agreed* than *strongly agreed* with these statements, suggesting that the HERs could still be improved to further increase customer engagement.

**Based on customer self-reports, the new HERs did not appear to increase the adoption of energy-saving practices except for one particular practice.** The evaluation found no significant differences between treatment and control group respondents for five of the 10 energy-saving practices listed in the survey.<sup>2</sup> For the remaining five practices that the evaluation found significant differences, four of these practices showed a higher adoption rate among the control group respondents. The one practice that had a significantly higher adoption rate with treatment group respondents (82%) than control group respondents (64%) was turning off electronics or appliances when not in use. These self-reported adoption rates do not align with the evaluation’s impact analysis results, which found significant savings with the treatment group. Even though the evaluation took steps such as randomly selection of the survey sample to minimize bias, it is possible that the control group customers who responded to the survey were more energy-efficient than the treatment group customers who responded.

## Customer Awareness of Energy Efficiency Programs

**Based on customer self-reports, the new HERs did not appear to increase customers’ awareness of Pacific Power energy efficiency programs except for one particular program.** The 2018-2019 HERs did not include a module that promoted other energy efficiency programs offered by Pacific Power, which may explain why the reports did not increase customer awareness of other programs for the most part. Survey results were consistent with findings from the uplift analysis—Cadmus found low rates of

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<sup>2</sup> The energy-saving practices include the following: changed the furnace or air conditioner filter every couple of months, kept the heating thermostat to 68 degrees or lower in winter, installed a low-flow showerhead or aerator, installed a programmable or smart thermostat, and installed high-efficiency heating or cooling equipment.

participation and savings uplift between the HER program and Pacific Power’s other downstream rebate programs.

When asked to identify energy efficiency programs they had heard of, treatment and control group respondents did not significantly differ except for one particular program—a significantly higher proportion of treatment group respondents (52%) had heard of the heat pump water heater incentives compared to the control group (19%). Additionally, the J.D. Power energy service rating questions yielded many “don’t know” responses from treatment group respondents (7% to 41%), especially for the category of the variety of energy efficiency programs offered by Pacific Power. These findings suggest that there is opportunity to promote Pacific Power’s energy efficiency programs to customers.

## Customer Satisfaction

**Customers were highly satisfied with the new HERs, but the reports could provide more relevant and/or novel tips.** This type of program typically receives some of the lowest customer satisfaction results because customers are automatically enrolled and because it does not offer the incentives traditional rebate programs offer. Other utilities’ HER programs that Cadmus has evaluated in recent years have yielded 65% to 78% customer satisfaction. Nevertheless, Pacific Power Washington’s 2018-2019 HER program achieved high customer satisfaction, as 85% of treatment group respondents said they were satisfied with the HERs.<sup>3</sup> More respondents said they were *very satisfied* (50%) than *somewhat satisfied* (35%). Those who were satisfied frequently said the HERs bring awareness about their usage (16%), the HERs are helpful (14%), they liked the similar homes comparison (9%), they liked the tips (8%), and they liked the end-use disaggregation (4%). Those who were not satisfied frequently said the tips were not relevant to them (11%), they disliked the similar homes comparison (10%), the HERs were not accurate (7%), they wanted to see more information and details in the HERs (6%), and they had exhausted all of the tips (4%).

**The new HERs did not increase customer satisfaction with Pacific Power.** No statistically significant differences in customer satisfaction with Pacific Power emerged between the treatment and control groups. A similar proportion of treatment group respondents (92%) and control group respondents (94%) said they were satisfied with Pacific Power. Even when comparing the proportions of *very satisfied* and *somewhat satisfied*, these were similar between treatment and control group respondents.

## Cost-Effectiveness

**Based on the PacifiCorp total resource cost (P-TRC) test, Pacific Power Washington’s HER program was cost-effective in 2018, 2019, and both program years combined.** Cadmus evaluated P-TRC ratios of 1.77 in 2018 (inclusive of program start-up costs), 2.47 in 2019, and over the two-year period, 2.06. That is, for every dollar spent on HER program costs, Pacific Power Washington residents will receive \$2.06 in

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<sup>3</sup> Cadmus could not compare the current survey’s results to the 2016-2017 survey results due to differences in methodology such as the survey mode and analysis.



benefits. Both the TRC and program administrator cost (PAC) tests also yielded cost-benefit ratios above 1.0.

## Recommendations

- Consider promoting other energy efficiency programs in the HERs and the online portal to increase customer awareness of Pacific Power program offerings and encourage participation in other programs.
- Work with the implementation contractor on diversifying and refining the energy-saving tips to increase customer engagement and relevancy. Some ideas include tracking the status of tips at the customer level (e.g., complete, incomplete, or irrelevant), framing tips as social activities rather than energy-saving activities, and integrating customer segmentation and demographic data (e.g., housing type, income, early adopter).
- Consider working with the implementation contractor on adapting the HERs to the changing needs of customers in light of COVID-19. More customers are spending their time at home and have limited opportunities and funds to go out and purchase energy-efficient products. The HER's messaging and tips should reflect this situation, for example by providing no- and low-cost energy-saving tips that customers can easily do while staying at home.
- The program has performed well historically and proved to be cost-effective in 2018 and 2019. However, the savings will change going forward because the program was re-randomized for the 2020 program year. Program administrators should closely monitor program savings and performance in between evaluation years in anticipation of these changes.

## Program Description

Since 2012, the Home Energy Reports (HER) program has been sending residential customers of Pacific Power Washington home energy reports, which contain information about their home energy consumption and encourage the adoption of energy-saving behaviors and home improvements. The program used an experimental design called a randomized control trial (RCT) wherein customers were randomly assigned to either a treatment group (recipients of HERs) or a control group (nonrecipients). Treatment group customers were either mailed or emailed the HERs.<sup>4</sup> The program also provides all residential customers (including those in the control group) access to an online energy management portal where they can view details and insights about their home energy use; however, treatment group customers received encouragement in the HERs to use the online portal. Control group customers did not receive the HERs nor encouragement to use the portal, therefore this group's consumption provides a baseline for measuring the program's energy savings.

From 2012 through 2017, Oracle Utilities Opower served as the implementation contractor and delivered the HERs to customers. In 2018, the HER program transitioned to a new implementation contractor, Bidgely, and customers began receiving the new Bidgely HERs in August 2018. During the transition period between implementation contractors, customers did not receive any HERs for seven months from January 2018 to July 2018. Upon relaunch, Bidgely maintained the treatment and control group assignments that Oracle Utilities Opower had established.

These assignments were further divided into three cohorts of customers known as "waves" that are based on when customers began receiving the HERs:

- Legacy wave received first report in 2012
- Expansion wave received first report in 2014
- Refill wave received first report in 2015

Bidgely maintained these three cohorts during the 2018-2019 program years and did not launch any new waves. Table 2 and Table 3 summarize the program design and implementation for 2018 and 2019, showing the counts of customers who received the program treatments.

Cadmus estimated program savings for each wave and program year in the 2018-2019 evaluation. The estimated savings included the effects of any targeted treatment customers received over the control customers. For the 2018-2019 program year, savings included the effects from customers receiving HERs and the effects from customers receiving encouragement to use the portal.

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<sup>4</sup> Customers with a valid email address receive the HERs via email while customers without a valid email address receive print HERs via mail.

**Table 2. 2018 Home Energy Reports Program Design**

Group and Wave	Program Treatments	Customer Count
<b>Treatment Group</b>		
Legacy Wave	3 print HERs; 5 email HERs; encouragement to use online portal	8,706
Expansion Wave	3 print HERs; 5 email HERs; encouragement to use online portal	24,480
Refill Wave	3 print HERs; 5 email HERs; encouragement to use online portal	3,481
<b>Total Treatment Group</b>		<b>36,667</b>
<b>Control Group</b>		
Legacy Wave	--	8,726
Expansion Wave	--	7,967
Refill Wave	--	3,502
<b>Total Control Group</b>		<b>20,195</b>

**Table 3. 2019 Home Energy Reports Program Design**

Group and Wave	Program Treatments	Customer Count
<b>Treatment Group</b>		
Legacy Wave	6 print HERs; 12 email HERs; encouragement to use online portal	8,339
Expansion Wave	6 print HERs; 12 email HERs; encouragement to use online portal	22,897
Refill Wave	6 print HERs; 12 email HERs; encouragement to use online portal	3,204
<b>Total Treatment Group</b>		<b>34,440</b>
<b>Control Group</b>		
Legacy Wave	--	8,372
Expansion Wave	--	7,468
Refill Wave	--	3,166
<b>Total Control Group</b>		<b>19,006</b>

## Evaluation Objectives and Methodology

Cadmus and PacifiCorp identified the following research objectives for evaluating Pacific Power Washington's 2018 and 2019 HER program:

- Evaluate program impacts and gain insight on program performance
- Investigate the lift in other Pacific Power energy efficiency program participation and energy savings from the HER program
- Understand customers' satisfaction with the HER program and awareness of their energy consumption and other energy efficiency programs
- Determine if the HER program was cost-effective each year and across both years
- Review the extent to which PacifiCorp implemented recommendations from previous evaluations

The subsequent sections provide an overview of the evaluation tasks Cadmus conducted.

### *Program Manager Interviews*

In March 2020, Cadmus conducted interviews with the HER program manager from Pacific Power Washington and the project manager from Bidgely. Interviews focused on capturing any changes to program design and delivery from transferring from Oracle Utilities Opower to Bidgely, how the program performed during 2018-2019, and any implementation challenges and successes.

### *Customer Surveys*

Cadmus conducted an online survey with treatment and control group customers from March 9 to March 20, 2020.<sup>5</sup> A copy of the customer survey instrument is provided in Appendix A.

### *Survey Design*

Cadmus designed the survey to assess the influence of HERs on customers' energy efficiency awareness, engagement with online energy-saving resources, adoption of energy-saving practices, and satisfaction with Pacific Power. To make reasonable comparisons between treatment and control group customers, we drafted a single survey instrument, with appropriate skip patterns, such that the survey included identical questions for both groups. Only treatment group customers were asked questions about their engagement and satisfaction with the HERs.

Cadmus minimized any potential response bias due to self-reporting by doing the following:

- Drafting clear and concise questions that are not leading, ambiguous, or double-barreled (asked about two or more unique concepts in the same question)
- Randomizing list-based survey items to reduce order effects

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<sup>5</sup> The survey fielding overlapped with the COVID-19 pandemic crisis. This did not impact the administration of the customer surveys.

- Designing the survey to last no more than nine minutes to reduce survey fatigue and attrition

## Survey Mode and Administration

The survey was administered online. Because contacting customers solely through email would not have provided a representative sample of the customers in the program—especially those for whom Pacific Power did not have an email address and who only receive print HERs via mail—Cadmus contacted customers by email and postcard. Customers received a postcard survey invitation with a link to the online survey if Pacific Power did not have a valid email address for them and they only received print HERs, and customers received an email survey invitation if Pacific Power had a valid email address for them and they received the email HERs .

The survey took customers five minutes to complete. To encourage customers to respond, Cadmus offered customers who completed the survey the opportunity to enter a drawing for a chance to win a gift card.

## Survey Sampling and Response Rates

Cadmus contacted a random sample of customers stratified by group (treatment or control) and channel (email or postcard). We confirmed that the sample frame was drawn in proportion to the three waves.<sup>6</sup> Table 4 shows the number of customers contacted as well as response rates by group and channel.

**Table 4. Customer Survey Sampling and Response Rates**

Group and Channel	Qualified Survey Population	Number of Customers Contacted	Target Number of Completes	Achieved Number of Completes	Response Rate	Final Sample for Survey Analysis
Treatment - Email	7,056	1,400	70	110	8%	110
Treatment - Postcard	22,482	1,300	65	29	2%	29
Control - Email	6,531	1,400	70	141	10%	64
Control - Postcard	10,882	1,300	65	36	3%	36
<b>Total</b>	<b>46,951</b>	<b>5,400</b>	<b>270</b>	<b>316</b>	<b>6%</b>	<b>239</b>

Initially, the evaluation achieved the target number of survey completes for the email channel for both groups but not for the target number of completes for the postcard channel. Therefore, to collect the remaining number of completes needed to reach the target at the group level, the evaluation oversampled the email channel and collected a total of 316 completes of the target of 270 completes.

During the fielding of the survey, the evaluation team learned that the 2020 HER program had re-randomized the program population and that about 50% of the 2018-2019 control group customers had been reassigned to the treatment group in 2020 and received their first HER in February 2020 before the

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<sup>6</sup> The following is the customer population distribution at the wave level: 24% in the Legacy wave, 66% in the Expansion wave, and 9% in Refill wave. Cadmus' sample frame had the following distribution: 24% in the Legacy wave, 69% in the Expansion wave, and 8% in the Refill wave.

survey launched (March). To minimize confounding effects from treating former control group customers in the survey results, we removed any control-to-treatment group respondents from the sample of completes. The removal reduced the achieved sample size from 316 to 239 completes. The final sample of survey completes produced estimates with  $\pm 5\%$  precision at 90% confidence.

## Survey Analysis

For the survey analysis, Cadmus removed any responses from control group customers who were reassigned to the treatment group in 2020. To analyze the survey data, we 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 the treatment and control groups, we compared survey results at the 90% confidence level (or  $p \leq 0.10$  significance level). Statistical weights were applied to the survey results by group and report delivery channel (email or mail) to reflect actual program population proportions. Weighted survey results are indicated by the notation “nw” in this report.

Cadmus could not compare survey results of its 2018-2019 evaluation to the 2016-2017 evaluation, submitted May 2018,<sup>7</sup> for the following reasons:

- **Differences in survey mode.** Cadmus’ 2018-2019 evaluation conducted online surveys while the 2016-2017 evaluation conducted telephone surveys. Each survey mode can introduce self-selection bias. For example, older customers and/or those who engage in traditional media are more likely to respond to telephone surveys. Younger customers and/or those who engage in online media are more likely to respond to online surveys. We attempted to lessen this bias in the 2018-2019 evaluation by using email and postcard methods of contact.
- **Differences in level of analysis.** Cadmus’ 2018-2019 evaluation reported results at the treatment and control group level. The 2016-2017 evaluation reported results at the wave level and did not roll up results at the group level. Due to the unreported group-level results in the previous evaluation, year-to-year program comparisons could not be made. Instead, we cited satisfaction comparisons to other similar, long-running HER programs.
- **Differences in analytical approach.** The Cadmus 2018-2019 evaluation sampled a random selection of customers representative of the three waves and applied statistical weights to the survey results by group and report delivery channel, thus factoring in all program stratifications. The 2016-2017 evaluation did not appear to have weighted the survey results, though the report does not provide details of its survey analysis methodology. Moreover, survey items that used a rating scale are reported in the 2016-2017 evaluation as statistical means rather than proportions. Cadmus’ 2018-2019 evaluation reports

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<sup>7</sup> ADM Associates, Inc. May 2018. *Evaluation of 2016-2017 Home Energy Reports Program*. Submitted to Pacific Power.  
[https://www.pacificorp.com/content/dam/pcorp/documents/en/pacificorp/environment/dsm/washington/Home\\_Energy\\_Reports\\_2016-2017.pdf](https://www.pacificorp.com/content/dam/pcorp/documents/en/pacificorp/environment/dsm/washington/Home_Energy_Reports_2016-2017.pdf)

proportions for survey items that use a rating scale. Cadmus follows the statistical theory to use proportions rather than means to report qualitative/categorical constructs like satisfaction, engagement, and awareness.

## Savings Estimation

Cadmus estimated program savings following industry best practices for evaluating residential behavior change programs. These methods use a panel regression analysis of customer bills to estimate the HER program’s electricity savings and to control for differences between customers and all naturally occurring, non-programmatic changes in energy consumption. With adequate sample sizes, these models yield robust, unbiased estimates of savings under a randomized control trial (RCT) program design, wherein customers from the same population are randomized into treatment and control groups. We estimated electricity savings during the 2018 and 2019 program years separately for each wave in the Washington HER program.

## Data Collection and Preparation

Cadmus collected monthly billing data from PacifiCorp, program tracking data including wave and group assignments from the program implementer, and weather data from the National Oceanic and Atmospheric Administration (NOAA). Billing data covered all customers in the experimental design and ranged from July 2011, 12 months prior to the launch of Washington’s first wave of treatment, through January 2020. Weather data, which included daily temperature readings from weather stations nearest to customers’ zip codes, spanned the same date range. We calculated total heating- and cooling-degree days (HDDs and CDDs) within billing cycles,<sup>8</sup> then normalized billing usage and monthly HDDs and CDDs to the calendar month for analysis.

Because of the randomized control trial design of the program, we performed limited data screening and customer filtering. We removed customers from the analysis only if the home had fewer than 11 months of pretreatment monthly consumption bills or did not have any bills in the posttreatment period. Details including an attrition table are provided the in *Appendix B*.

## Verification of Group Balance

Cadmus verified that subjects in the randomized treatment and control groups were equivalent in pretreatment energy use. Specifically, we compared average annual pretreatment usage between treatment and control groups in each wave and calculated two-sample t-tests to determine if differences were significant. The randomized design of the program should result in groups with statistically indistinguishable average annual usage before treatment begins.

Table 5 provides the results of the t-tests for significant differences in treatment and control group annual pretreatment consumption. We found that the Legacy and Expansion waves were balanced—no statistically significant differences existed between the pretreatment consumption of treatment and control groups in these waves. We did find statistically significant differences in pretreatment

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<sup>8</sup> Cadmus used 65°F as the base temperature for HDD and CDD calculations.

consumption between groups in the Refill wave. This imbalance probably resulted because the annual pretreatment consumption is sensitive to the customers included in the sample due to small treatment and control group sizes. However, we modeled energy consumption controlling for any differences in pretreatment energy consumption such that savings estimates were not affected by the imbalance.

**Table 5. PY10 Tests for Significant Differences in Annual Pretreatment Consumption**

Wave	Customers		Average Annual Electricity Use per Customer (kWh/yr)			p-value <sup>(1)</sup>
	Treatment Group	Control Group	Treatment Group	Control Group	Difference	
Legacy Wave	8,303	8,347	24,505	24,512	7	0.9440
Expansion Wave	22,006	7,157	13,907	13,954	47	0.5073
Refill Wave	2,390	2,441	5,668	5,852	185	0.0481

<sup>(1)</sup> A p-value >0.05 indicates an insignificant difference at the 5% significance level.

### Billing Analysis

Cadmus used regression analyses of monthly billing data from customers in the treatment and control groups to estimate Washington’s HER Program energy savings. The billing analysis conformed to IPMVP Option C, whole facility,<sup>9</sup> and the approach described in the Uniform Methods Project.<sup>10,11</sup> More specifically, we used a multivariate regression to analyze the energy consumption of customers who had been randomly assigned to treatment and control groups. We tested and compared two general model specifications to check the robustness of savings results:

- The **post-only** model regresses customer average daily consumption on a treatment indicator variable and includes as regressors customers’ pretreatment energy use, month-

<sup>9</sup> Efficiency Valuation Organization. *International Performance Measurement and Verification Protocol, Concepts and Options for Determining Energy and Water Savings, Volume 1*. January 2012. Page 25. (EVO 10000 – 1:2012) Available online: <http://www.evo-world.org/>

<sup>10</sup> Agnew, K., and M. Goldberg. *Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures, Chapter 8: Whole-Building Retrofit with Consumption Data Analysis Evaluation Protocol*. U.S. Department of Energy, National Renewable Energy Laboratory. April 2013. (NREL/SR-7A30-53827) Available online: [http://www1.eere.energy.gov/office\\_eere/de\\_ump\\_protocols.html](http://www1.eere.energy.gov/office_eere/de_ump_protocols.html)

<sup>11</sup> Stewart, J., and A. Todd. *Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures, Chapter 17: Residential Behavior Protocol*. U.S. Department of Energy, National Renewable Energy Laboratory. August 2014. (NREL/SR-7A40-62497) Available online: [http://www1.eere.energy.gov/office\\_eere/de\\_ump\\_protocols.html](http://www1.eere.energy.gov/office_eere/de_ump_protocols.html)



by-year fixed effects and weather.<sup>12</sup> The model is estimated only with posttreatment customer bills.

- The ***difference-in-differences (D-in-D) fixed effects*** model regresses average daily consumption on a treatment indicator variable, month-by-year fixed effects, customer fixed effects, and weather. The model is estimated with pretreatment and posttreatment customer bills.

Cadmus estimated separate program effects for 2018 and 2019 using ordinary least squares and reported Huber-White standard errors adjusted for correlation within homes. The model specification is provided in *Appendix B*.<sup>13</sup> Both models yielded savings estimates that were within each other’s confidence intervals, meaning that their results were not statistically different (illustrated in Figure B-1 in *Appendix B*). We reported the results of the post-only model, consistent with previous evaluations of Washington’s HER program.<sup>14</sup>

## Program Total Savings Estimation

Cadmus estimated program savings for the 2018 and 2019 programs years for each wave’s population of treatment group customers as the product of average daily savings per participant and the total number of days treatment group customer accounts were active in each evaluated program year. We multiplied the estimate of average daily savings per customer by the total number of active account days because the savings were estimated across all treatment group customers, including those customers not explicitly flagged as having received treatment according to the program tracking data.

## Uplift Analysis

As PacifiCorp’s HER program in Washington encouraged customers to participate in its other energy efficiency programs, it was expected that the program increased program participation. The increase in energy efficiency program participation is known as efficiency program uplift.

Cadmus estimated the lift in efficiency program participation and savings from the HER program in Washington. Since savings from efficiency program uplift were measured in both the regression-based estimate of savings (described in the *Savings Estimation* section) and in the impact evaluations of PacifiCorp’s other efficiency programs, the uplift savings will be double-counted unless the savings are subtracted from either the HER program in Washington or the other efficiency programs. We estimated

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<sup>12</sup> Allcott, H., and T. Rogers. “The Short-Run and Long-Run Effects of Behavioral Interventions: Experimental Evidence from Energy Conservation.” *American Economic Review* 104 (10), 3003-3037. 2014.

<sup>13</sup> Evaluators prefer this “post-only” or lagged dependent variable model (over the fixed effects *difference-in-differences* model because the *post-only* model tends to estimate program effects with better precision.

<sup>14</sup> ADM Associates, Inc. May 2018. *Evaluation of 2016-2017 Home Energy Reports Program*. Submitted to Pacific Power.  
[https://www.pacificorp.com/content/dam/pcorp/documents/en/pacificorp/environment/dsm/washington/Home\\_Energy\\_Reports\\_2016-2017.pdf](https://www.pacificorp.com/content/dam/pcorp/documents/en/pacificorp/environment/dsm/washington/Home_Energy_Reports_2016-2017.pdf)

efficiency program uplift and savings for each of the three participant waves and by program year. We subtracted uplift savings from the evaluated HER program savings to avoid double-counting.

The following sections describe how Cadmus estimated uplift from downstream and upstream rebate programs. Definitions of uplift participation and savings are provided in *Appendix B*.

## Estimating Uplift for Downstream Rebate Programs

To estimate the lift in participation and savings provided by Washington’s HER program, Cadmus matched HER treatment and control group customers to PacifiCorp’s efficiency program tracking data. Because many measures included in energy efficiency program portfolios have multiyear measure lives, we collected PacifiCorp’s efficiency program tracking data from when the HER program launched through the end of 2019.<sup>15</sup> Each row of the tracking database corresponded to the installation of a specific efficiency measure (e.g., heat pump water heater, attic ceiling insulation) at a premise on a specific date and included premise ID, customer account, location (e.g., street address, city, zip code), PacifiCorp program name, program measure name, installation date, and verified annual savings.

To estimate savings uplift, we made a few adjustments to verified annual savings for measures in the tracking data:

- Prorated savings of non-weather-sensitive measures based on the installation date
- Prorated savings of weather-sensitive measures based on the installation date
- Prorated savings for customers with accounts becoming inactive during the calendar year

We aggregated the measure-tracking data to the customer, energy efficiency program, and evaluation year, and calculated the impacts on participation and efficiency program savings using the definitions described in *Appendix B*.

## Estimating Uplift for Upstream Rebate Programs

Unlike for downstream programs, Cadmus could not obtain customer-level program tracking data from PacifiCorp’s upstream lighting rebate program because data is collected at the point-of-sale. To estimate the lift in upstream lighting savings due to the HER program, Cadmus surveyed HER treatment and control group customers about their LED bulb purchases and installations in the last 12 months. Differences in treatment and control group responses estimated the number of bulbs purchased and installed motivated by the HER treatment. We adjusted this count by the estimated proportion of LED bulb sales that were program-incented and accounted for the expected portion of the year that each bulb was installed when applying the average annual unit savings as reported in the upstream lighting program tracking data.<sup>16</sup>

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<sup>15</sup> The billing analysis captured savings effects from measures that had not exceeded their estimated useful life in the performance period under evaluation.

<sup>16</sup> We excluded a 98% in-service rate embedded in the RTF per-unit savings values.

Table 6 shows the variables required to calculate upstream lighting (see *Appendix B* for the full equation) and Cadmus’ estimation approach.

**Table 6. Lighting Uplift Data Sources and Estimation Approach**

Variable	Data	Estimation Approach
TE(Q)	Survey responses about quantities of LEDs purchased in the previous 12 months	Compare results from randomized treatment and control group customer surveys
ISR	Survey responses about quantities of LEDs installed in the previous 12 months	Calculate the ratio of the number of installed bulbs over the number of purchased bulbs by group
kWh savings/bulb	PacifiCorp Washington’s upstream lighting program tracking data	Use the average energy savings per bulb claimed in PacifiCorp Washington’s upstream lighting tracking data
Time installed	Assumption	Assume six months, as if bulbs were installed at a constant rate over the year
% incented	Survey responses about the number of LEDs purchased and PacifiCorp Washington’s upstream lighting program tracking data	Estimate the total number of bulbs purchased by the PacifiCorp residential customer population using survey responses and compare to the total number of incented bulbs
Treated customers	PacifiCorp program tracking data	Determine the average number of customers treated, where a customer is considered treated in each month he or she is assigned to the treatment group and has an active account

### Cost-Effectiveness Evaluation

For this report, Cadmus conducted five common cost-effectiveness tests: the total resource cost (TRC) test; the program administrator cost (PAC) test; the ratepayer impact measure (RIM) test; the participant cost test (PCT); and the PacifiCorp-TRC (P-TRC) test, which includes a 10% electric benefit environmental adder. PacifiCorp Washington program stakeholders can use the results of these tests to inform discussions on program planning. Any cost-effectiveness test benefit/cost (B/C) ratio greater than 1.0 indicates a cost-effective program.

Cadmus assessed cost-effectiveness for the 2018 program year, the 2019 program year, and for the two-year period combined. The 2018 program year includes program start-up fees with a new contractor.

We estimated cost-effectiveness based on methods described in the California Standard Practice Manual for assessing energy efficiency programs’ cost-effectiveness.<sup>17</sup> We supplemented this information with PacifiCorp program expenditures, utility-provided economic parameters, and verified energy savings.

PacifiCorp focuses on TRC when considering program design and portfolio decision making. The TRC test estimates the net present value of financial costs and benefits to utilities administering programs and to

<sup>17</sup> *California Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects*. July 2002.

program participants. The P-TRC serves as the other key test for utility staff when evaluating programs. The PCT, PAC and RIM test are helpful for benchmarking program cost-effectiveness from other stakeholder perspectives.

Table 7 summarizes the five tests used in this evaluation, their benefits and/or costs, and the perspective from which each test assesses cost-effectiveness.

**Table 7. Comparison of Benefits and Costs Included in the Cost-Effectiveness Tests**

Test	Perspective	Benefits	Costs
TRC	Society	Present value of electric avoided energy and capacity costs <sup>(1)</sup>	Program administrative and marketing costs, and incremental measure costs (defined as contractor fees to deliver reports to customers)
P-TRC	Society & Environment	All TRC plus a 10% environmental adder benefit	Same as TRC
PCT	Program Participants	Electric bill savings	None (program is provided free to customer)
PAC	Program Administrator	Present value of electric avoided energy and capacity costs <sup>(1)</sup>	Program administrative, marketing, and incentive costs (defined as contractor fees to deliver reports to customers)
RIM	All Ratepayers (participants and nonparticipants)	Present value of electric avoided energy and capacity costs <sup>(1)</sup>	Program administrative, marketing, and incentive costs, plus the present value of lost revenues

<sup>(1)</sup> The present value of electric avoided energy costs includes avoided capacity benefits.

The cost-effectiveness analysis used the following program and measure-level inputs to assess cost-effectiveness:

- Program impacts (energy savings and utility expenditures)
- Avoided energy costs<sup>18</sup>
- Residential electric rates
- Annual discount rates
- Annual inflation rates
- Residential energy load shapes
- Effective useful measure life (EUL) of two years

We used Cadmus’ cost-effectiveness tool, PortfolioProPlus, to calculate the HER program’s cost-effectiveness. PortfolioProPlus is a web-based application that sits on top of a relational database that maintains a single source of data for ease of auditing results from prior analyses; modeling measures, programs, and portfolios; and customizing reports and data visualization.

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<sup>18</sup> Avoided energy costs used in PacifiCorp’s 2017 Integrated Resource Plan, specific to the 2018-2019 biennial evaluation, include capacity price mitigation.

Cadmus' PortfolioProPlus model employs the California Standard Practice Manual methodology to evaluate cost-effectiveness, utilizing a SQL Server database of measures, hourly end-use load shapes, and hourly avoided costs. Its analyses accommodate use of secondary fuel benefits, externalities, and other energy and non-energy benefits.

## Process Evaluation Findings

The following provides detailed process evaluation findings on Pacific Power Washington’s 2018-2019 HER program.

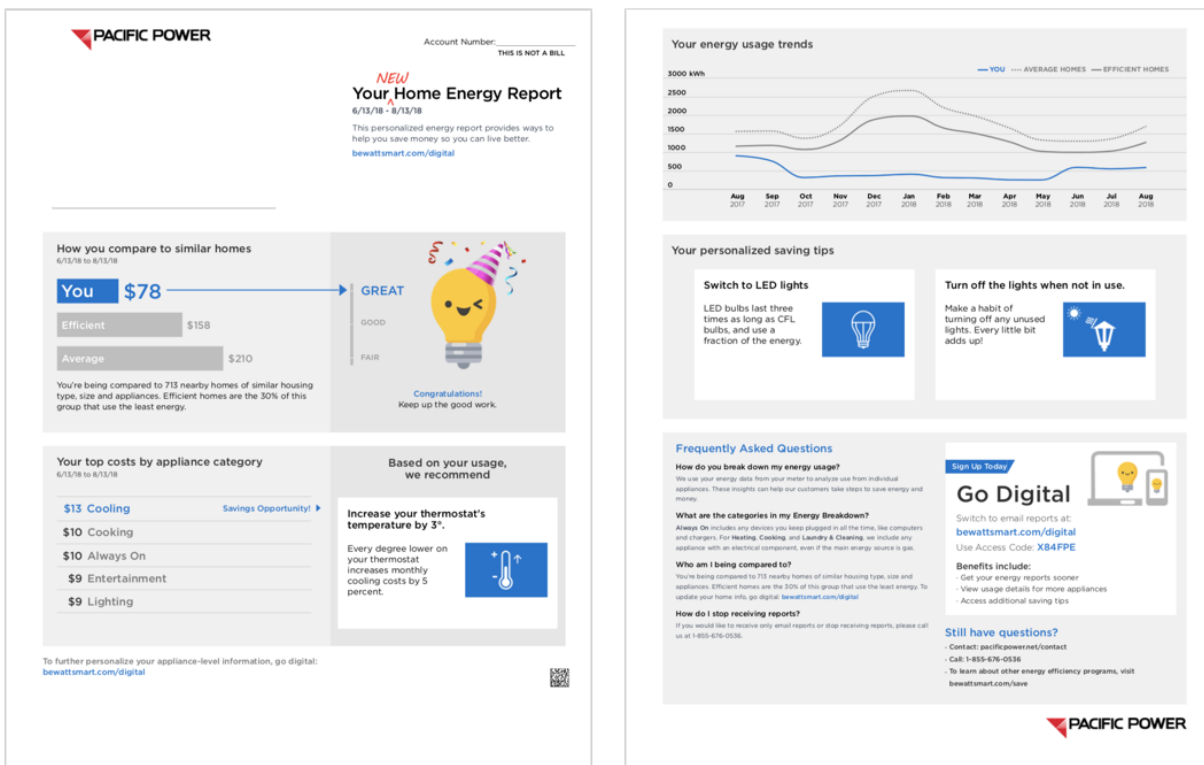
### Program Delivery

Two major program delivery changes occurred since the 2016-2017 program. They involved a new implementation contractor and a new HER product.

In 2018, the HER program made the transition to a new implementation contractor, Bidgely. Treatment customers received the last HERs under the previous implementation contractor (Oracle Utilities Opower) in December 2017 and began receiving the new Bidgely HERs in August 2018. Although Pacific Power’s program manager expressed concern about the seven-month gap in sending reports, the program nevertheless ramped up savings after the relaunch and met its 2018 and 2019 savings goal. Bidgely utilized the same RCT design and waves as the previous implementation contractor, which may have contributed to the program’s continued savings performance.

The new HERs contained a similar homes comparison, end-use disaggregation cost by appliance, historical energy consumption trends, and personalized energy-saving tips (Figure 1).

Figure 1. Copy of 2018-2019 Print Home Energy Report (Front and Back)



All but the end-use disaggregation information were found in the previous implementation contractor’s HERs. The new HERs connect one of the tips to the end-use disaggregation information to help

customers understand where they are using energy and what they can specifically do to reduce consumption. Cadmus could not determine what impact this new end-use disaggregation information had in the program’s savings performance, but, anecdotally, four survey respondents (4% of 99 respondents) mentioned in their open-end comments that they liked seeing the end-use disaggregation information.

Treatment group customers in all three waves received either three print HERs or five email HERs in 2018, depending on the availability of a valid email address. In 2019, treatment group customers in all three waves received either six print HERs or 12 email HERs. Overall, Pacific Power’s program manager was satisfied with the HERs and the work accomplished by Bidgely.

### 2016-2017 Recommendation Status

As part of the process evaluation, Cadmus reviewed the extent to which PacifiCorp implemented recommendations from the previous evaluation. Table 8 lists Pacific Power Washington’s 2016-2017 HER program evaluation recommendations and progress toward addressing those recommendations. To date, PacifiCorp implemented one of the three recommendations from the previous evaluation.

**Table 8. Status of 2016-2017 HER Program Evaluation Recommendations**

Recommendation	Status
Consider developing strategies to modify the control group to better align with the treatment group on an annual or monthly basis.	<b>Recommendation implemented in 2020.</b> Because the program experienced a longer-than-expected transition period to a new implementation contractor and needed a quick path to relaunch, PacifiCorp and Bidgely decided to maintain the same RCT design and waves for the 2018-2019 program. Bidgely refreshed the program population in 2020 by re-randomizing the customers into treatment and control group.
Where possible, tailor program recommendations to demographics.	<b>Recommendation not implemented.</b> Bidgely’s algorithm for generating tips factors in the customer’s energy consumption data, their heating/cooling type, and the appliances used.
Consider cross-referencing treatment customers with known low-income screening tools to spur outreach for Pacific Power low-income programs.	<b>Recommendation not implemented.</b> The 2018-2019 HERs did not include a module to promote other energy efficiency programs from Pacific Power. Low-income customer segmentation was not used in anyway with the HERs.

### Readership of and Reception to the Home Energy Reports

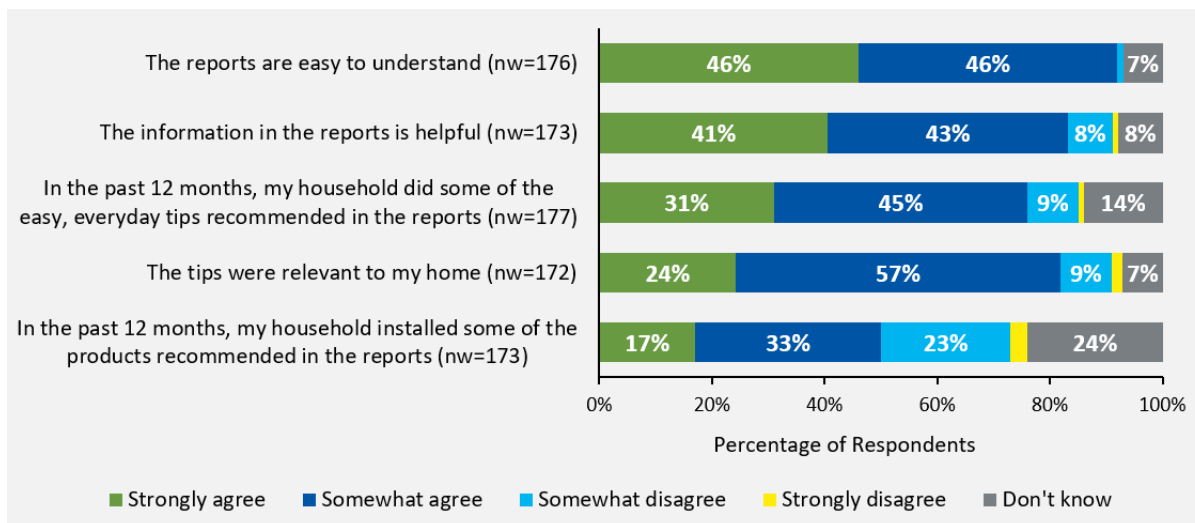
Virtually all treatment group respondents (99%) said they read or skimmed the last HER they received (nw=178).<sup>19</sup> Specifically, 40% of respondents said they read the report thoroughly, 40% read some of the report, and 19% skimmed the report. One percent said they did not read the report.

The survey asked treatment group respondents to indicate their level of agreement on five positive statements about the helpfulness and relevance of the HERs. Figure 2 shows that the majority of respondents agreed with all five statements.

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<sup>19</sup> Weighted survey results are indicated by the notation “nw” in this report.

Figure 2. Agreement Level to Statements about the Home Energy Reports



Source: Survey Question, “To what extent do you agree or disagree with the following statements about the Home Energy Reports?”

Of the five statements, the highest proportion of respondents agreed that the reports are easy to understand (92%), the information in the reports is helpful (84%), the tips were relevant to their home (81%), and they had applied some of the everyday tips recommended in the reports (76%). Fewer respondents agreed with the statement that they installed some of the products recommended in the reports (50%). Notably, more respondents tended to say they *somewhat agreed* than *strongly agreed*, which suggests that the HERs could still be improved to further increase customer engagement.

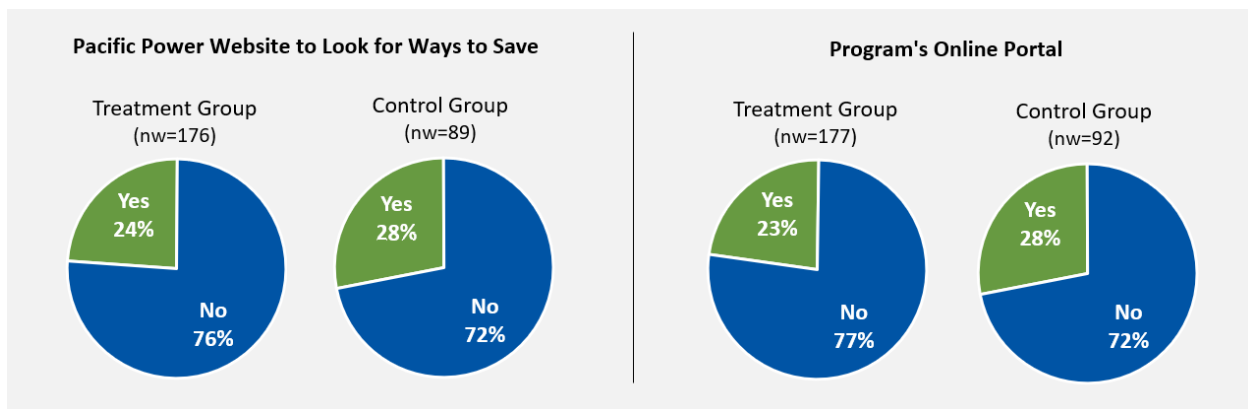
### Online Engagement

Treatment group customers received encouragement in the HERs to visit the Pacific Power website to look for ways to save money on their utility bills and the program’s online portal to view their home’s energy usage and insights. Control group customers did not receive this encouragement but had access to these same online resources. The survey asked treatment and control group customers whether they visited the Pacific Power website and the online portal in the past 12 months. The evaluation expected to see a higher proportion of visits among the treatment group.

Figure 3 shows that the proportion of treatment and control group respondents who visited the two online resources did not significantly differ. Treatment group respondents (24%) and control group respondents (28%) showed similar proportions of visits to the Pacific Power website to look for ways to save. A similar proportion of treatment (23%) and control group (28%) reported visiting the program’s online portal.



Figure 3. Self-Reported Visits to Online Resources in the Past 12 months



Source: Survey Questions, “In the past 12 months, have you visited the Pacific Power website to look for ways to save money on your utility bills?” and “Pacific Power offers its customers access to an online portal where you can see your home’s energy usage along with insights and tips. In the past 12 months, have you accessed this online portal?”

The lack of significant differences may be because treatment and control group customers have equal access to these online resources. Moreover, the program’s online portal from 2018-2019 was located on the Pacific Power website and required a two-step sign-on process for the customer. Bidgely said during the interview that the online portal was hard for customers to find on the Pacific Power website and that its location changed at one point in 2019. Pacific Power and Bidgely improved accessibility in 2020 by embedding a link to the portal in the email HERs so customers are redirected to the portal and have a single sign-on process.

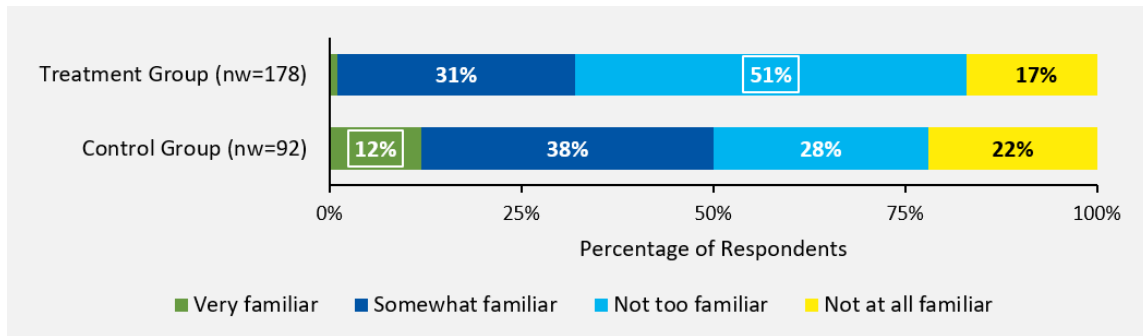
### Awareness of Energy Efficiency Programs

The 2018-2019 HERs did not include any module that promoted other Pacific Power energy efficiency programs. Additionally, the treatment and control groups had access to the same online resources where they could discover these programs. Hence, the evaluation did not expect to see any large differences in awareness of energy efficiency programs between treatment and control group.

When asked about their general familiarity with energy efficiency programs from Pacific Power, more control group respondents than treatment group respondents said they were familiar. As shown in Figure 4, a significantly higher proportion of control group respondents (12%) than treatment group respondents (1%) said they were *very familiar*. Also, when *very familiar* and *somewhat familiar* responses were combined, a significantly higher proportion of control group respondents (50%) said they were familiar compared to treatment group respondents (32%).<sup>20</sup> Regardless of group, the majority of respondents were not familiar with energy efficiency programs offered by Pacific Power.

<sup>20</sup> A significant difference between groups at the 90% confidence level ( $p \leq 0.10$ ).

Figure 4. Familiarity with Energy Efficiency Programs

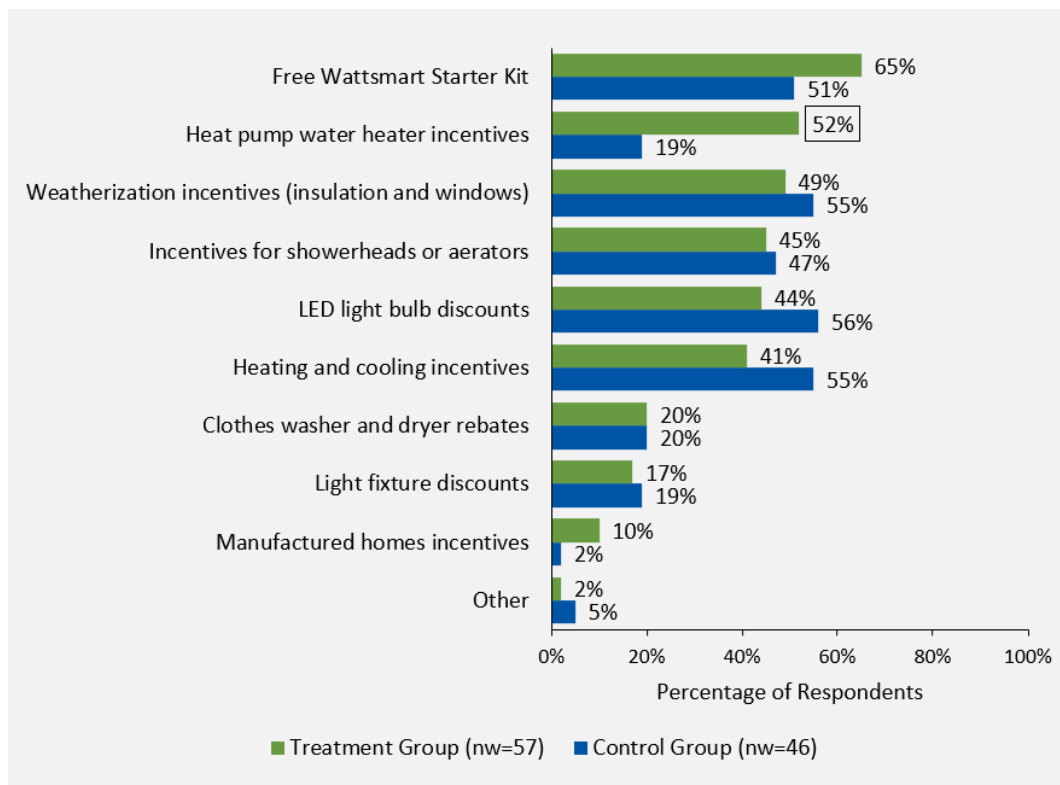


The box indicates a significant difference between groups at the 90% confidence level ( $p \leq 0.10$ ).

Source: Survey Question, “How familiar are you with energy-efficiency rebates or programs offered by Pacific Power to help you use less energy?”

Respondents who said they were *very familiar* or *somewhat familiar* were asked a follow-up question to identify from a list the energy efficiency programs they had heard of. When energy efficiency program familiarity was asked this way, treatment and control group respondents did not significantly differ for the most part. Although Figure 5 shows differences in which programs each group was familiar with, these differences were not statistically significant with one exception. A significantly higher proportion of treatment group respondents (52%) had heard of the heat pump water heater incentives compared to the control group (19%).

Figure 5. Energy Efficiency Programs Customers Have Heard About



The box indicates a significant difference between groups at the 90% confidence level ( $p \leq 0.10$ ).

Source: Survey Question, “Which energy-efficiency rebates or programs from Pacific Power have you heard about? Select all that apply.”

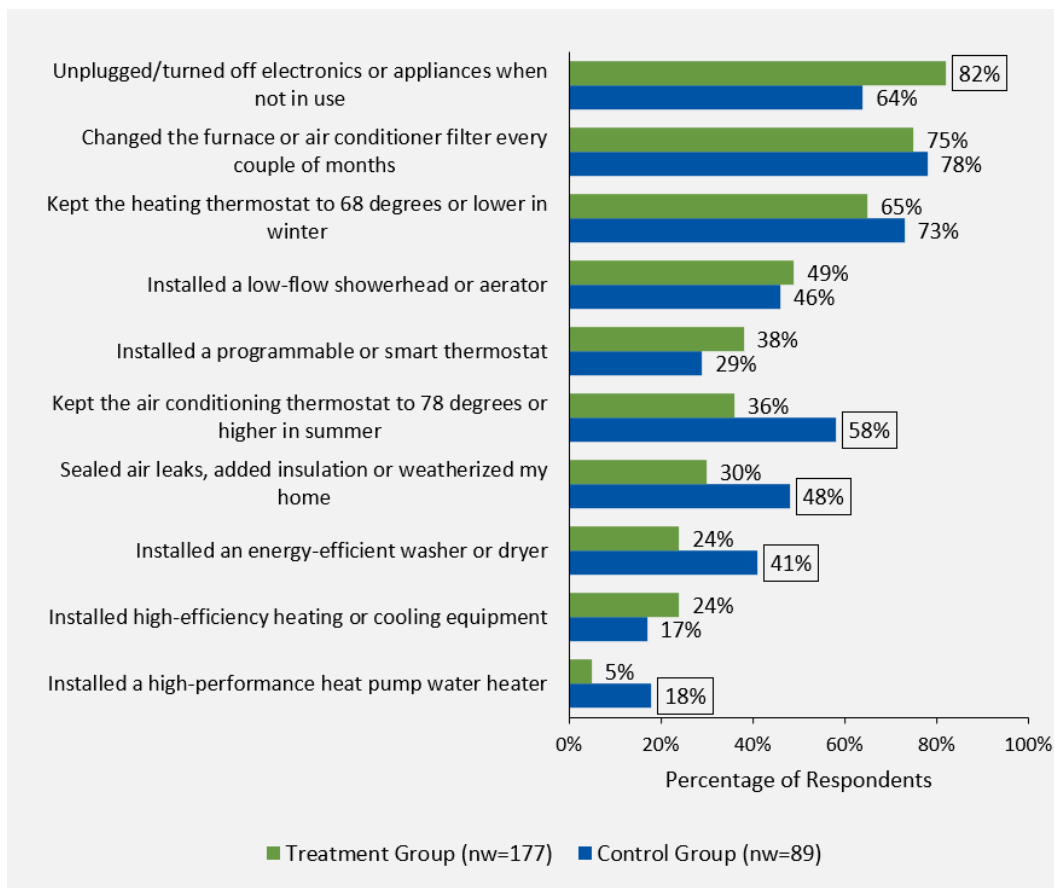
### Self-Reported Adoption of Energy-Saving Practices

The survey asked treatment and control group respondents if in the last 12 months they had adopted any of the 10 energy-saving practices listed in Figure 6. The HERs provided treatment group customers with personalized energy-saving tips; therefore, Cadmus expected to see higher self-reported adoption rates from the treatment group.

For five of the 10 energy-saving practices, we found no significant differences between treatment and control group respondents. For the remaining five practices with significant differences between groups, four showed a higher adoption rate among the control group respondents. Only one practice—turning off electronics or appliances when not in use—had a significantly higher adoption rate with treatment group respondents (82%) than control group respondents (64%).

Moreover, though significantly more treatment group respondents had heard of the heat pump water heater incentives, this did not translate to a higher adoption rate from this group. As Figure 6 shows, significantly more control group respondents (18%) than treatment group respondents (5%) reported installing a high-efficiency heat pump water heater.

Figure 6. Self-Reported Adoption of Energy-Saving Practices in the Past 12 Months



The box indicates a significant difference between groups at the 90% confidence level (p<0.10).

Source: Survey Question, “For each item, please answer yes or no whether you have done this in the past 12 months.”

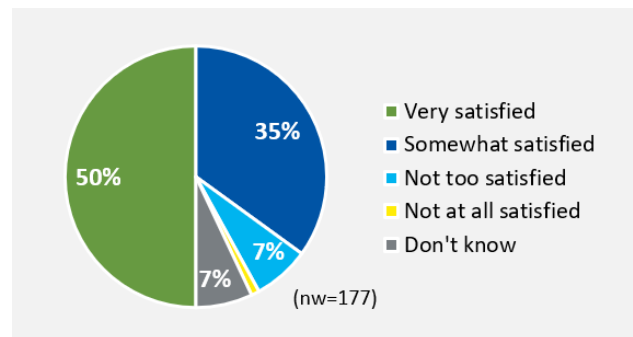
These self-reported adoption rates of energy-saving practices do not align with the evaluation’s impact analysis results, which found significant savings for the treatment group. Self-selection bias (i.e., survey response bias) could be a reason. Even though Cadmus used random sampling to select the sample frame, the decision to complete the survey was up to the customer and not random, and it is possible that control group customers who responded to the survey practiced more energy-efficient activities than the treatment group customers who responded.

### Satisfaction with the Home Energy Reports

As shown in Figure 7, 85% of treatment group respondents said they were satisfied with the HERs. More respondents said they were *very satisfied* (50%) than *somewhat satisfied* (35%). This type of program typically receives some of the lowest customer satisfaction results because customers are automatically enrolled and that it does not offer the incentives that traditional rebate programs offer. Nevertheless, Pacific Power Washington’s 2018-2019 HER program achieved high customer satisfaction compared to other utilities’ HER programs that Cadmus has evaluated in recent years. These other programs have

yielded 65% to 78% customer satisfaction.<sup>21</sup> As noted in the *Survey Analysis* section, Cadmus could not compare the current survey’s results to the 2016-2017 survey results due to differences in methodology.

**Figure 7. Satisfaction with the Home Energy Reports**



Source: Survey Question, “Overall, how satisfied are you with the Home Energy Reports?”

Cadmus found through customer open-end comments that the tips, similar homes comparison, and accuracy were key areas for improvement. The survey asked respondents about their satisfaction reasons in an open-end question, and 99 respondents answered. Those who were satisfied frequently said the HERs bring awareness about their usage (16%), the HERs are helpful (14%), they liked the similar homes comparison (9%), they liked the tips (8%), and liked the end-use disaggregation (4%). Those who were not satisfied frequently said the tips were not relevant to them (11%), they disliked the similar homes comparison (10%), the HERs were not accurate (7%), they wanted to see more information and details in the HERs (6%), and they had exhausted all of the tips (4%).

These customer dissatisfaction reasons with the HERs are not unique to Pacific Power’s program. Other evaluations conducted by Cadmus have found that customer dissatisfaction with the tips, similar homes comparison, and accuracy of the reports are very common for this type of behavior program.

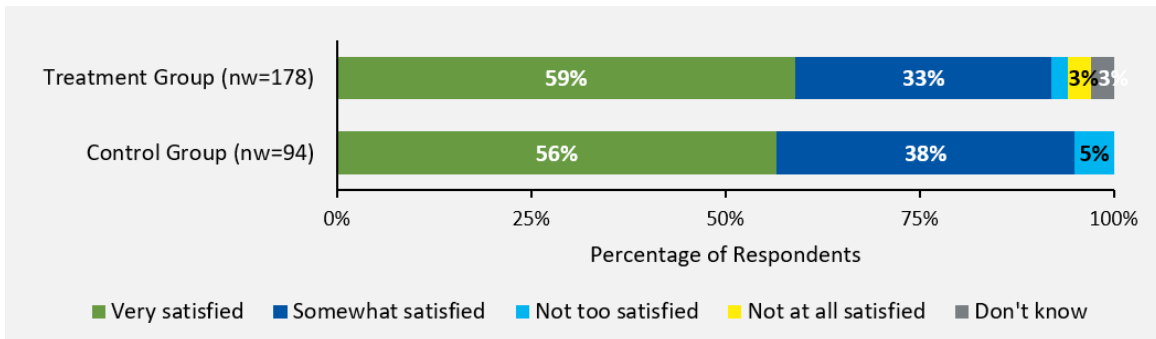
### *Satisfaction with Pacific Power and Energy Services*

Because treatment group customers received the HERs, the evaluation expected to see higher customer satisfaction with Pacific Power from this group than the control group. However, no significant differences emerged between groups. A similar proportion of treatment group respondents (92%) and control group respondents (94%) said they were satisfied with Pacific Power. Even when comparing the proportions of *very satisfied* and *somewhat satisfied*, responses were similar between treatment and control groups (Figure 8).

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<sup>21</sup> The comparison includes long-running HER programs from one Midwest utility and one Mid-Atlantic utility. Oracle Utilities Opower implemented the Midwest utility’s HER program, which achieved 78% customer satisfaction for 2019. Uplight (formerly Tendril) implemented the Mid-Atlantic utility’s HER program, which achieved 65% customer satisfaction for 2018 and 66% customer satisfaction for 2019.

Figure 8. Satisfaction with Pacific Power



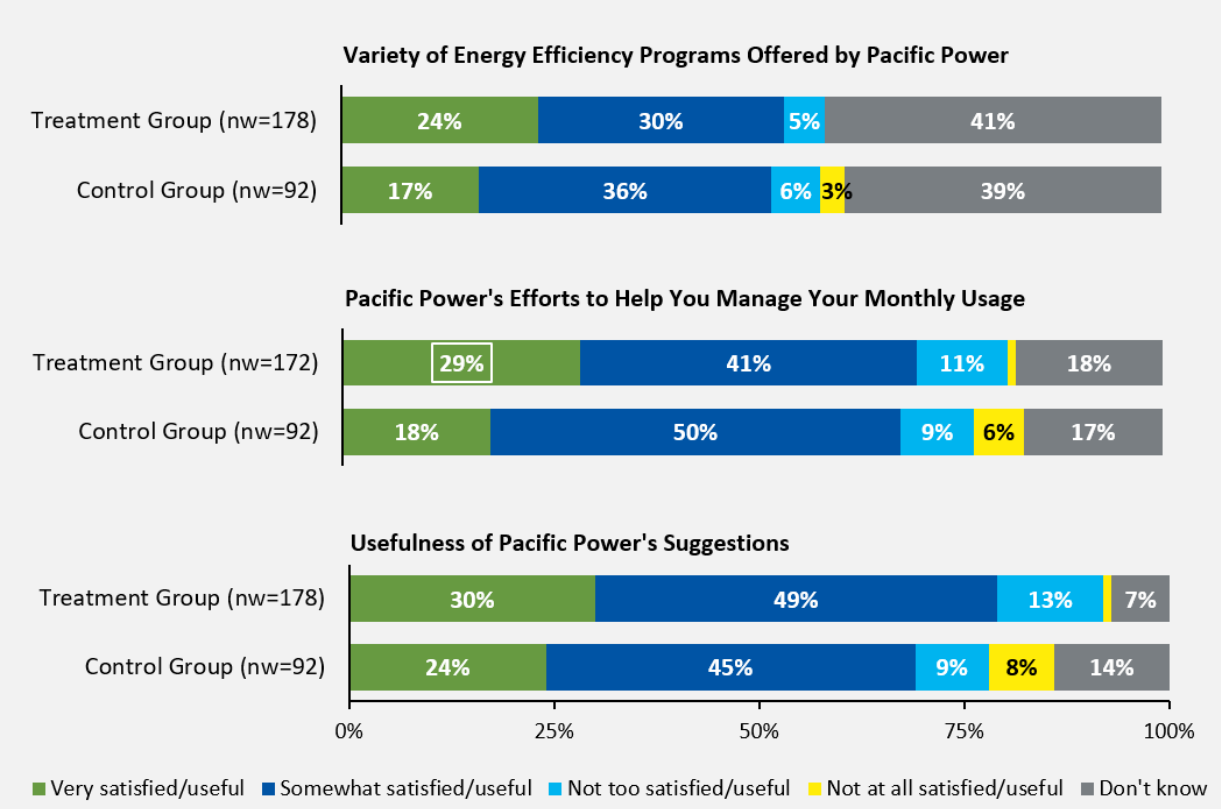
Source: Survey Question, “Overall, how satisfied are you with Pacific Power?”

The survey also asked respondents to rate Pacific Power based on the variety of energy efficiency programs it offers, its efforts to help manage monthly usage, and the usefulness of its suggestions to reduce energy usage—collectively known as the J.D. Power categories. We expected to see treatment group respondents give better ratings compared to the control group respondents because the treatment group received the HERs, which informs energy efficiency, usage, and suggestions.

Figure 9 shows the rating results for the three J.D. Power categories. In all three categories, a slightly higher proportion of treatment group respondents than control group respondents gave better ratings. However, two of these categories detected no significant group differences. The one category that detected a significant group difference was for Pacific Power’s efforts to help manage monthly usage. Significantly more treatment group respondents (29%) said they were *very satisfied* with Pacific Power’s efforts to help manage their monthly usage compared to control group respondents (18%).

Most notably, the J.D. Power rating questions yielded many *don’t know* responses from treatment group respondents (7% to 41%) and control group respondents (14% to 39%), especially for the category of the variety of energy efficiency programs offered by Pacific Power. This corresponds with an earlier finding that the majority of treatment group respondents (68%) and control group respondents (50%) were not familiar with energy efficiency programs offered by Pacific Power (Figure 4). These findings suggest that there is opportunity to increase marketing of Pacific Power’s energy efficiency programs and its online energy management resources to customers.

Figure 9. J.D. Power Categories



The box indicates a significant difference between groups at the 90% confidence level (p≤0.10).

Source: Survey Questions, “How satisfied are you with the variety of energy efficiency programs offered by Pacific Power?”, “How satisfied are you with Pacific Power's efforts to help you manage your monthly usage?”, and “How would you rate the usefulness of Pacific Power's suggestions on ways you can reduce your energy usage and lower your monthly bills?”

## Impact Evaluation Findings

The following provides detailed impact evaluation findings on Pacific Power Washington’s 2018-2019 HER program, including results from the program savings, uplift, and cost-effectiveness analyses.

### Savings Estimation

The following details the results of Cadmus analysis of program energy savings.

### Program Total Savings

Table 9 shows the estimates of the average daily savings per customer and program total savings per year with 90% confidence bounds. Cadmus evaluated 9,373 MWh/yr for the 2018 program year and 9,364 MWh/yr for the 2019 program year. Notable findings are these:

- The Legacy and Expansion waves continued to save at the prior levels in 2018 and 2019, even after treatment ceased for these customer for the first seven months of 2018 (see the *Program Description* section for details).
- Average daily savings per treatment customer were highest for customers in the Legacy wave (2.6% and 2.5% of consumption in 2018 and 2019) in its seventh and eighth years of treatment, while the Expansion wave, which launched two years after the Legacy wave, achieved the second-highest savings per customer, at 1.5% of consumption in both program years under evaluation.
- The Refill wave achieved the smallest savings per customer consistently across years, and neither years’ savings were statistically distinguishable from 0 kWh/day. Table 9 shows that the 90% confidence interval around the Refill wave’s program savings in both 2018 and 2019 include 0 MWh/yr.

**Table 9. Program Savings by Wave and Program Year <sup>(1)</sup>**

Program Year	Wave	Average Daily Savings per Customer		Program Total Savings (MWh/yr)		
		kWh/day	Percentage <sup>(2)</sup>	Program Savings	90% Lower Bound	90% Upper Bound
2018	Legacy	1.53	2.6%	4,740	3,636	5,864
	Expansion	0.52	1.5%	4,507	2,764	6,251
	Refill	0.09	0.6%	115	-236	466
	<b>Program Total</b>	-	-	<b>9,373</b>	<b>5,921</b>	<b>12,824</b>
2019	Legacy	1.63	2.5%	4,819	3,609	6,030
	Expansion	0.55	1.5%	4,458	2,506	6,409
	Refill	0.08	0.5%	87	-290	465
	<b>Program Total</b>	-	-	<b>9,364</b>	<b>5,536</b>	<b>13,192</b>
<b>2019-2019 Program</b>		-	-	<b>18,737</b>	<b>13,583</b>	<b>23,892</b>

<sup>(1)</sup> Program total savings have not yet been adjusted for uplift.

<sup>(2)</sup> Percentage average daily savings per customer are relative to control group consumption.



Cadmus compared evaluated savings to those reported by PacifiCorp for the 2018-2019 biennial program. Table 10 shows the evaluated and reported savings for each wave and program year and the realization rate. For the Legacy and Expansion waves, realization rates were consistently above 100% in 2018 and consistently below 100% in 2019. Evaluated savings remained lower than reported savings in the Refill wave across both program years, with realization rates less than 60%. However, 90% confidence intervals around evaluated savings (in Table 9, above) included the reported savings estimates for each wave and program year, suggesting that evaluated and reported savings were not statistically different.

**Table 10. Program Savings Compared to Reported Savings <sup>(1)</sup>**

Program Year	Wave	Reported Savings (MWh/yr)	Evaluated Savings (MWh/yr)	Realization Rate
2018	Legacy	4,993	4,750	95%
	Expansion	4,626	4,507	97%
	Refill	198	115	58%
	<b>Program Total</b>	<b>9,817</b>	<b>9,373</b>	<b>95%</b>
2019	Legacy	4,357	4,819	111%
	Expansion	3,842	4,458	116%
	Refill	168	87	52%
	<b>Program Total</b>	<b>8,366</b>	<b>9,364</b>	<b>112%</b>
<b>2019-2019 Program</b>		<b>18,183</b>	<b>18,737</b>	<b>103%</b>

<sup>(1)</sup> Program total savings have not yet been adjusted for uplift.

Program total savings evaluated for 2018 and 2019 are slightly lower than savings evaluated in the 2016-2017 evaluation, which the previous evaluator estimated as 9,590 MWh/yr and 12,284 MWh/yr for 2016 and 2017, respectively. Though we found similar average daily savings per customer as evaluated in 2016 and 2017, there were fewer active customers in 2018 and 2019. Some of this difference is a result of expected attrition.

Note that additional customers were dropped when the HER program changed implementers during the 2018 program year. According to the interview, the new implementor removed several customers from the program data because of duplicate premise identifiers and addresses and bad mailing or email addresses.

## Savings over Time

Table 11 shows the average daily savings per customer by wave for each year of treatment. Savings in the Legacy and Expansion waves remain stable in 2018 and 2019 compared to 2017. Although absolute savings decrease for Legacy and Expansion waves in 2018, savings as a percentage of control-group consumption remained stable for both waves, suggesting that non-program related conditions, such as weather, drove the decrease, and not the seven-month gap in treatment. The same cannot be said for the Refill wave, however—savings relative to control-group consumption decreased from 2017 and likely resulted from the gap in treatment.

**Table 11. Average Daily Savings per Customers by Wave and Program Year<sup>(1)</sup>**

Program Year	Legacy		Expansion		Refill	
	kWh/day	Percentage <sup>(2)</sup>	kWh/day	Percentage <sup>(2)</sup>	kWh/day	Percentage <sup>(2)</sup>
2012	0.72 (0.14) ***	1.1%	-	-	-	-
2013	1.26 (0.15) ***	2.0%	-	-	-	-
2014	1.21 (0.17) ***	1.9%	0.09 (0.09)	0.2%	-	-
2015	1.24 (0.18) ***	2.0%	0.43 (0.09) ***	1.2%	0.19 (0.09) **	1.2%
2016	1.19 (0.19) ***	2.0%	0.47 (0.10) ***	1.3%	0.24 (0.13) *	1.5%
2017	1.60 (0.22) ***	2.4%	0.69 (0.12) ***	1.8%	0.23 (0.17)	1.3%
2018	1.53 (0.22) ***	2.6%	0.52 (0.12) ***	1.5%	0.09 (0.18)	0.6%
2019	1.63 (0.25) ***	2.5%	0.55 (0.15) ***	1.5%	0.08 (0.21)	0.5%

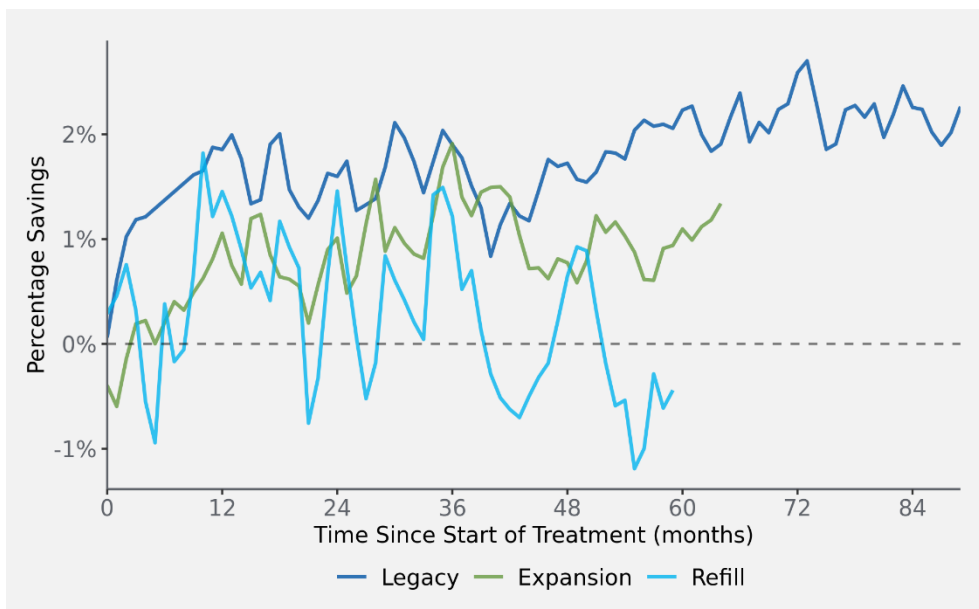
<sup>(1)</sup> Standard errors clustered on customers are presented after the estimated treatment effect in parentheses (\*\*\*) Significant at 1%; \*\* Significant at 5%; \* Significant at 10%). The treatment effects represent the average daily savings per treatment group customer.

<sup>(2)</sup> Percentage average daily savings per customer are relative to control group consumption.

Cadmus investigated how savings for each of the waves compared after receiving treatment for the same amount of time, as shown in Figure 10. The Legacy wave ramped up savings the fastest after receiving treatment for 12 months. The Expansion wave took longer to ramp up—the slower ramp-up period is likely because Expansion wave customers have lower pretreatment period consumption than customers in the Legacy wave. The savings for both Expansion and Legacy waves fluctuated over the years but on average converged toward a savings steady-state. The Legacy wave may have experienced a second ramp-up, though differences in weather conditions over the years may cause changes in savings as well.

The Refill wave savings are more volatile than the other waves' savings, consistent with the small sample size and the evaluation's inability to detect savings. Customers saved consistently for several months in their second year of treatment but subsequently struggled to maintain these savings. These Refill customers were especially affected by the period of suspended treatment in 2018, as seen by the large drop in savings after month 36 of treatment.

Figure 10. Percentage Average Daily Savings by Months since First Treatment



## Uplift Analysis

The following sections provide the evaluated uplift in participation and savings due to customers cross-participating in other Pacific Power efficiency programs.

### Savings Uplift

Table 12 shows the lift in savings from HER program customers participating in other PacifiCorp downstream rebate programs. Consistent with findings from the process evaluation, Cadmus found low savings from cross-participation in each of the waves—savings from cross-participation ranged between 0.36 kWh/yr and 5.55 MWh/yr in 2018 and between 3.05 kWh/yr and 8.42 kWh/yr in 2019. As expected, downstream savings uplift increased in all the waves from 2018 to 2019 as savings from previously installed measures continued to persist while customer cross-participation increased.

Overall, uplift from downstream programs remained small as a percentage of program total savings from the regression analysis. Uplift savings in the Refill wave appear high as a percentage of program total savings, but this is mostly driven by the low program total savings found for these customers—the magnitude of savings uplift from downstream rebate programs is still small.

**Table 12. Downstream Savings Uplift Summary**

Program Year	Wave	Average Uplift Savings per Customer (kWh/yr)			Total Uplift Savings (MWh/yr)	Percentage of Program Total Savings <sup>(1)</sup>
		Treatment Group	Control Group	Difference		
2018	Legacy	126.37	122.76	3.61	31	0.66%
	Expansion	82.96	82.60	0.36	9	0.19%
	Refill	58.40	52.86	5.55	19	16.79%
	<b>Program Total</b>	-	-	-	<b>60</b>	<b>0.64%</b>
2019	Legacy	167.09	159.30	7.79	65	1.35%
	Expansion	108.63	105.58	3.05	70	1.56%
	Refill	77.18	68.76	8.42	27	30.91%
	<b>Program Total</b>	-	-	-	<b>162</b>	<b>1.73%</b>
<b>2019-2019 Program</b>					<b>221</b>	<b>1.18%</b>

<sup>(1)</sup> Percentage uplift savings are based on the program total savings shown in Table 9 and Table 10.

Table 13 contains a summary of the upstream lighting uplift results and total program savings adjusted for upstream and downstream uplift (see *Appendix B* for details on the upstream savings uplift estimations methods). Cadmus estimated that 1.7% and 4.3% of 2018 and 2019 HER program savings came from upstream lighting program bulb purchases, which equates to roughly 2.8% of HER program savings overall.

**Table 13. Upstream Lighting Savings Uplift Summary**

Program Year	Treatment Customers	Program Savings (MWh/yr)	Upstream Uplift Savings per Customer (kWh/yr)	Upstream Uplift Savings (MWh/yr)	Upstream Uplift Savings (%) <sup>(1)</sup>
2018	36,667	9,372	4.3	159	1.7%
2019 <sup>(2)</sup>	34,440	9,364	11.6	399	4.3%
<b>2019-2019 Program <sup>(3)</sup></b>		<b>18,737</b>	<b>-</b>	<b>558</b>	<b>2.8%</b>

<sup>(1)</sup> Percentage upstream uplift savings are relative to program total savings (prior to adjusting for downstream uplift)

<sup>(2)</sup> 2019 upstream uplift includes savings from bulbs purchased in 2018 and 2019.

<sup>(3)</sup> Totals may not equal the sum of savings due to rounding

Table 14 shows the program savings prior to adjusting for uplift, the final downstream and upstream uplift savings, and the resulting program savings after making the uplift adjustments. Overall, uplift savings contributed 2.7% of HER program savings across the 2018 and 2019 program years and should be removed from PacifiCorp Washington’s portfolio of claimed residential program savings to avoid double counting. Across both program years, the HER program saved 18,233 MWh/yr not claimed in other programs.

**Table 14. Program Total Uplift Summary**

Program Year	Program Savings (MWh/yr) <sup>(1)</sup>	Downstream Uplift Savings (MWh/yr)	Upstream Uplift Savings (MWh/yr)	Total Program Uplift Savings (MWh/yr)	Total Program Uplift Savings (%) <sup>(2)</sup>	Program Savings Adjusted for Total Uplift (MWh/yr)
2018	9,373	60	159	218	2.3%	9,154
2019	9,364	162	125	286	3.1%	9,078
<b>2018-2019 Program</b>	<b>18,737</b>	<b>221</b>	<b>283</b>	<b>505</b>	<b>2.7%</b>	<b>18,233</b>

<sup>(1)</sup> Program total savings have not yet been adjusted for uplift.  
<sup>(2)</sup> Percentage uplift savings are relative to program total savings (prior to adjusting for uplift).

### Participation Uplift

Table 15 shows the uplift in participation rates per 1,000 treatment customers and as a percentage of control group participation rates. Across all waves and program years, Cadmus found that for every thousand control group customers, 17.2 of them participated in at least one of PacifiCorp’s energy efficiency programs. Cadmus defined participation in each year by whether a customer installed at least one measure for which an incentive was provided through a PacifiCorp program in Washington.

Across both 2018 and 2019 program years, we found that an additional 2% of treatment customers participated in programs over control group customers. The 2018 participation largely drove the increase in treatment group participation—treatment customers participation was an additional 4% over control group customers in 2018, while in 2019, there was essentially no difference in treatment and control group rates.

Participation uplift as a percentage of control group participation rates varies between waves, largely because control group participation rates are small. Actual participation uplift in magnitude is similar between waves and program years.

**Table 15. Downstream Participation Uplift Summary**

Program Year	Wave	Control Group Participation Rate (per 1,000 Customers)	Participation Uplift (Treatment Effect on Participation Rate)	Percentage Participation Uplift
2018	Legacy	22.8	-1.1	-5%
	Expansion	16.1	2.8	17%
	Refill	12.3	1.8	15%
	<b>Program Total</b>	<b>18.3</b>	<b>0.7</b>	<b>4%</b>
2019	Legacy	19.1	2.4	12%
	Expansion	15.8	-1.1	-7%
	Refill	7.9	2.1	26%
	<b>Program Total</b>	<b>15.9</b>	<b>-0.1</b>	<b>0%</b>
<b>2018-2019 Program</b>		<b>17.2</b>	<b>0.4</b>	<b>2%</b>

*Cost-Effectiveness*

Table 16 presents cost-effectiveness results for the residential HER program in program year 2018, program 2019, and 2018/2019 combined. Based on the PacifiCorp TRC test (P-TRC), the HER program proved cost-effective in both 2018 and 2019 and will generate \$600,858 in net benefits over the life of the installed measures. The HER program was cost-effective in all but the RIM test for both 2018 and 2019. Over the two-year period, the HER program had a P-TRC of 2.06. That is, for every dollar spent on HER program costs, Pacific Power Washington residents will receive \$2.06 in benefits.

These results are lower than the 2016-2017 HER program cost-effectiveness results, which found a combined two-year TRC of 2.47. The diminished cost-effectiveness likely resulted from the additional program start-up costs when switching implementation contractors during the 2018 program year.

**Table 16. Cost-Effectiveness of Residential Home Energy Report Program (2018, 2019, 2018 + 2019)**

Cost-Benefit Test	PV Cost (\$) [A]	PV Electric Benefit (\$) [B]	PV Non-Electric Benefit (\$) [C]	Net Benefit (\$) [B+C] - [A]	B/C Ratio [B+C] / [A]
<b>2018</b>					
TRC	\$334,577	\$538,229	-	\$203,652	1.61
P-TRC	\$334,577	\$538,229	\$53,823	\$257,475	1.77
PCT	-	\$1,660,965	-	\$1,660,965	N/A
PAC	\$334,577	\$538,229	-	\$203,652	1.61
RIM	\$1,995,542	\$538,229	-	(\$1,457,312)	0.27
<b>2019</b>					
TRC	\$233,393	\$524,341	-	\$290,948	2.25
P-TRC	\$233,393	\$524,341	\$52,435	\$343,383	2.47
PCT	-	\$1,632,705	-	\$1,632,705	N/A
PAC	\$233,393	\$524,341	-	\$290,948	2.25
RIM	\$1,866,098	\$524,341	-	(\$1,341,757)	0.28
<b>2018 + 2019</b>					
TRC	\$567,970	\$1,062,570	-	\$494,600	1.87
P-TRC	\$567,970	\$1,062,570	\$106,258	\$600,858	2.06
PCT	-	\$3,293,670	-	\$3,293,670	N/A
PAC	\$567,970	\$1,062,570	-	\$494,600	1.87
RIM	\$3,861,640	\$1,062,570	-	(\$2,799,069)	0.28

## Appendix A. PacifiCorp WA Home Energy Reports Program 2018-2019 Customer Survey

Research Topics	Item Number
Engagement with Pacific Power’s online energy efficiency resources	C1-C2
Awareness of energy efficiency offerings from Pacific Power	C3-C4
LED light bulb purchase and installation	C5-C6
Satisfaction with Pacific Power	D1
Satisfaction with Pacific Power’s energy services (J.D. Power questions)	D2-D4
Readership of Home Energy Reports	E1
Behavior change and product adoption from Home Energy Reports	C7, E2C, E2D
Value and relevance of Home Energy Reports	E2A, E2B, E2E
Satisfaction with Home Energy Reports	E3-E4

**Target Audience:** Pacific Power Washington treatment and control group customers in the program

**Survey Mode:** Online survey using email and postcard distribution

**Target Number of Completes:**

Assignment	First Report Vendor	Email Target	Postcard Target	Target Total
Treatment Group	Opower	70	65	135
Control Group	Opower	70	65	135
<b>Overall Total</b>		<b>140</b>	<b>130</b>	<b>270</b>

### Variables to be Pulled into Sample

- PremiseID
- Utility = Pacific Power
- FirstName
- LastName
- Street Address
- City
- ZIP
- State = WA
- Email
- Phone
- Assignment = Treatment or Control
- FirstVendor = Opower or Bidgely
- FirstBidgelyReportDate
- Channel = Email or Postcard

## *Treatment Group's Email Invitation to Survey*

To: [Email]  
From: Cadmus on behalf of Pacific Power  
Subject: Pacific Power survey offers you a chance for \$100

Dear [FirstName],

Did you receive a Home Energy Report? It's a report that shows your household energy use, energy-savings tips and graphs. Please tell us what you think about the Home Energy Report in a short survey. **When you qualify and complete the survey, you may enter a drawing for a chance to win a \$100 VISA gift card.** Two winners will be randomly selected. Your responses will be kept confidential and will never be shared with other parties.

**Follow this link to the Survey:**

[Survey Link]

Or copy and paste this URL into your internet browser:

[Survey Link]

Pacific Power has asked The Cadmus Group to administer this survey. If you have any questions about this survey or any difficulties taking the survey, please contact Masumi Izawa at (503) 467-7115 or [masumi.izawa@cadmusgroup.com](mailto:masumi.izawa@cadmusgroup.com).

Sincerely,  
Don Jones  
Program Manager, Pacific Power

Follow the link to opt out of future survey emails:  
{!://OptOutLink?d=Click here to unsubscribe}

## *Control Group's Email Invitation to Survey*

To: [Email]  
From: Cadmus on behalf of Pacific Power  
Subject: Pacific Power survey offers you a chance for \$100

Dear [FirstName],

Will you participate in a short survey to help Pacific Power make improvements for customers? We understand your time and responses are valuable. **When you qualify and complete the survey, you may enter a drawing for a chance to win a \$100 VISA gift card.** Two winners will be randomly selected. Your responses will be kept confidential and will never be shared with other parties.



Follow this link to the Survey:

[Survey Link]

Or copy and paste this URL into your internet browser:

[Survey Link]

Pacific Power has asked The Cadmus Group to administer this survey. If you have any questions about this survey or any difficulties taking the survey, please contact Masumi Izawa at (503) 467-7115 or masumi.izawa@cadmusgroup.com.

Sincerely,  
Don Jones  
Program Manager, Pacific Power

Follow the link to opt out of future survey emails:  
{!://OptOutLink?d=Click here to unsubscribe}

*Treatment Group’s Postcard Invitation to Survey*

Side One:

<p>PACIFIC POWER LOGO   CADMUS LOGO</p> <p>Pacific Power has partnered with The Cadmus Group on this research. For any questions about this research or any difficulties taking the survey, please contact Masumi Izawa at (503) 467-7115 or masumi.izawa@cadmusgroup.com</p>	<p>FirstName LastName StreetAddress City, State ZIP</p>
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Side Two:

<p><b>Pacific Power survey offers you a chance for \$100</b></p>	<p>Did you receive a Home Energy Report? It’s a report that shows your household energy use, energy-savings tips and graphs. You are part of a small group invited to give feedback about the Home Energy Report in a short survey. When you qualify and complete the survey, you may enter a drawing for a chance to win a \$100 VISA gift card. Two winners will be randomly selected. Can we count on your response?</p> <p>Take the survey at <a href="http://www.energy.cadmusgroup.com/tpower">www.energy.cadmusgroup.com/tpower</a></p> <p>Survey expires on end of day Friday, March 20, 2020</p>
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Control Group's Postcard Invitation to Survey

Side One:

<p><b>PACIFIC POWER LOGO   CADMUS LOGO</b></p> <p>Pacific Power has partnered with The Cadmus Group on this research. If you have any questions about this research or any difficulties taking the survey, please contact Masumi Izawa at (503) 467-7115 or <a href="mailto:masumi.izawa@cadmusgroup.com">masumi.izawa@cadmusgroup.com</a></p>	<p><b>FirstName LastName</b>  <b>StreetAddress</b>  <b>City, State</b>  <b>ZIP</b></p>
--	--

Side Two:

<p><b>Pacific Power survey offers you a chance for \$100</b></p>	<p>Will you participate in a short survey to help Pacific Power make improvements for customers? You are part of a small group invited to give feedback. When you qualify and complete the survey, you may enter a drawing for a chance to win a \$100 VISA gift card. Two winners will be randomly selected. Can we count on your response?</p> <p>Take the survey at <a href="http://www.energy.cadmusgroup.com/cpower">www.energy.cadmusgroup.com/cpower</a></p> <p>Survey expires on end of day Friday, March 20, 2020</p>
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A. Survey Start Screen



Welcome! This survey will take about 5 minutes to complete. Your responses will remain confidential and will only be used for research purposes. When you qualify and complete the survey, you may enter the drawing for a chance to win a \$100 VISA gift card.

## B. Screener

[Ask if Assignment=Treatment]

- B1. You should have received a document in the mail or your email called a Home Energy Report. This report shows graphs on your home's energy use, comparisons, and energy-savings tips. Do you remember seeing this Home Energy Report? [Forced response]
1. Yes
  2. No [Terminate]

[Ask if Assignment=Control]

- B2. Are you the person who manages or pays the utility bills? [Forced response]
1. Yes
  2. No [Terminate]

**Termination Message:** Those were all the questions. Thank you for your time.

## C. Energy Efficiency Engagement and Awareness

- C1. In the past 12 months, have you visited the Pacific Power website to look for ways to save money on your utility bills?
1. Yes
  2. No

- C2. Pacific Power offers its customers access to an online portal where you can see your home's energy usage along with insights and tips. In the past 12 months, have you accessed this online portal?
1. Yes
  2. No

- C3. How familiar are you with energy-efficiency rebates or programs offered by Pacific Power to help you use less energy?
1. Very familiar
  2. Somewhat familiar
  3. Not too familiar
  4. Not at all familiar

[Ask if C3=1 or 2]

- C4. Which energy-efficiency rebates or programs from Pacific Power have you heard about? Select all that apply. [Multiple answers allowed] [Randomize order 1-10]
1. Heating and cooling incentives
  2. Clothes washer and dryer rebates

3. LED light bulb discounts
4. Light fixture discounts
5. Manufactured homes incentives
6. Incentives for showerheads or aerators
7. Heat pump water heater incentives
8. Weatherization incentives (insulation and windows)
9. Free Wattsmart Starter Kit
10. Other (please describe) [Open-end text entry]
11. Don't know [Exclusive answer]

C5. In the past 12 months, about how many LED bulbs have you purchased? Please count the number of individual bulbs, not the number of boxes or packs.

1. [Numeric text entry 0-999]
2. Don't know

[Ask if C5 answer is greater than 0]

C6. Of the [Answer from C5] LED bulbs you purchased, how many are currently in use at your home?

1. [Numeric text entry 0-999]
2. Don't know

C7. For each item, please answer yes or no whether you have done this in the past 12 months.

[Response choices: 1=Yes, 2=No, 3=Not applicable/Don't know] [Randomize order A-J]

- A. Unplugged/turned off electronics or appliances when not in use
- B. Kept the heating thermostat to 68 degrees or lower in winter
- C. Kept the air conditioning thermostat to 78 degrees or higher in summer
- D. Changed the furnace or air conditioner filter every couple of months
- E. Installed an energy-efficient washer or dryer
- F. Installed high-efficiency heating or cooling equipment
- G. Installed a low-flow showerhead or aerator
- H. Sealed air leaks, added insulation or weatherized my home
- I. Installed a programmable or smart thermostat
- J. Installed a high-performance heat pump water heater

## D. Energy Service Experience

D1. Overall, how satisfied are you with Pacific Power?

1. Very satisfied
2. Somewhat satisfied
3. Not too satisfied
4. Not at all satisfied
5. Don't know

D2. How satisfied are you with the variety of energy efficiency programs offered by Pacific Power?

1. Very satisfied
2. Somewhat satisfied
3. Not too satisfied
4. Not at all satisfied
5. Don't know

D3. How satisfied are you with Pacific Power's efforts to help you manage your monthly usage?

1. Very satisfied
2. Somewhat satisfied
3. Not too satisfied
4. Not at all satisfied
5. Don't know

D4. How would you rate the usefulness of Pacific Power's suggestions on ways you can reduce your energy usage and lower your monthly bills?

1. Very useful
2. Somewhat useful
3. Not too useful
4. Not at all useful
5. Don't know

[Ask section E if Assignment=Treatment]

## *E. Home Energy Reports*

These next questions are about the Home Energy Reports. These are the reports you received in the mail or email that shows your household energy use, energy-savings tips and graphs.

E1. Which of the following statements best describes what you did with the last Home Energy Report you received?

1. I read the report thoroughly
2. I read some of the report
3. I skimmed the report
4. I did not read the report
5. Don't know

E2. To what extent do you agree or disagree with the following statements about the Home Energy Reports? [1=Strongly Agree, 2=Somewhat Agree, 3=Somewhat Disagree, 4=Strongly Disagree, 5=Don't know] [Randomize order A-E]

- A. The reports are easy to understand
- B. The information in the reports is helpful

- C. In the past 12 months, my household did some of the easy, everyday tips recommended in the reports
- D. In the past 12 months, my household installed some of the products recommended in the reports
- E. The tips were relevant to my home

E3. Overall, how satisfied are you with the Home Energy Reports?

- 1. Very satisfied
- 2. Somewhat satisfied
- 3. Not too satisfied
- 4. Not at all satisfied
- 5. Don't know

[Ask if E3≠5]

E4. Please tell us why you gave that satisfaction rating for the Home Energy Reports.

[Open-end text entry]

## F. Gift Card Drawing Entry

F1. Thank you for your time! Before you go, please fill out your name and address to be entered in the drawing for a chance to win a \$100 VISA gift card. Your information will only be used to mail you the gift card in the event that you win. We will not use your information for marketing.

Please complete all the fields below to be entered for the drawing.

- 1. First and Last Name:
- 2. Street Address:
- 3. City:
- 4. State:
- 5. ZIP Code:
- 6. Email Address:
- 7. Phone Number:

**End of Survey Message:**

Your responses have been submitted. Thank you!

You will be notified in a few weeks if you are one of the lucky gift card winners.

## Appendix B. Impact Evaluation Details

### *Detailed Methodology and Findings*

The following section provide additional details on the evaluation methodology and findings.

### *Data Preparation*

After collecting the billing, weather, and program data, Cadmus took the following steps to prepare the data for analysis.

- *Step 1. Adjust billing data for estimated readings.* Though infrequent, a customer's bills may be based on the utility's estimates of monthly consumption when it cannot read the meter. The first meter reading following a set of consecutive estimated monthly bills includes the consumption for that month and any adjustments required for the previous estimated reads. We adjusted customer billing data for estimated meter readings by aggregated the full set of estimated and actual bills.
- *Step 2. Calculate billing cycle weather.* We collected daily weather data from NCDC and calculated the average degree days (cooling and heating degrees) during each customer billing cycle using average hourly temperature and billing cycle end dates.
- *Step 3. Calendarize consumption.* Using the number of days in the billing cycle, we allocated billing cycle electricity consumption and weather to calendar months and expressed each variable in average daily terms. We dropped any months that were only partially covered by the customers' bills.
- *Step 4. Integrate with program data.* We merged the billing and weather data with HER program and customer information, including the dates when the implementer generated and mailed the reports, dates when customer accounts went inactive, and state, group, and wave assignments.

Because PacifiCorp designed the HER program as an opt-out RCT, where customers were randomized and automatically enrolled in the program, we performed minimal data screening to maintain the integrity of the experiment. We only excluded homes from the analysis sample when the home had an insufficient number of pretreatment monthly consumption bills. We also dropped each customer's first and last bills, which may start or end at any point during a calendar month and may not cover electricity consumption for the whole month.

Table B-1 shows the attrition in the 2018 and 2019 analysis sample from the data cleaning steps. The final modeling sample included customers in the tracking data who were not dropped during the billing data cleaning process and included in the regression analysis. These customers had active accounts when delivery of HERs began but they did not necessarily have active accounts at the beginning of treatment in 2018 or 2019. Few customers were dropped during data preparation from the Legacy or Expansion waves. Cadmus dropped over 30% of Refill wave customers, however, because of insufficient pretreatment billing data. We estimated savings for the Refill wave using a relaxed pretreatment billing history requirement to check the sensitivity of results to the sample size, but the treatment effects did not change significantly.

Table B-1. Sample Attrition for Billing Analysis

Step in Attrition	Legacy Wave		Expansion Wave		Refill Wave	
	Treatment	Control	Treatment	Control	Treatment	Control
Included in tracking data	8,746 (100%)	8,768 (100%)	24,577 (100%)	7,993 (100%)	3,505 (100%)	3,527 (100%)
Included in billing data	8,746 (100%)	8,768 (100%)	24,577 (100%)	7,993 (100%)	3,505 (100%)	3,527 (100%)
At least one month of posttreatment bills	8,740 (100%)	8,765 (100%)	24,571 (100%)	7,991 (100%)	3,501 (100%)	3,525 (100%)
At least 11 months of pretreatment bills	8,303 (95%)	8,347 (95%)	22,006 (90%)	7,157 (90%)	2,390 (68%)	2,441 (69%)
<b>Final Modeling Sample</b>	<b>8,303 (95%)</b>	<b>8,347 (95%)</b>	<b>22,006 (90%)</b>	<b>7,157 (90%)</b>	<b>2,390 (68%)</b>	<b>2,441 (69%)</b>

### Model Robustness Checks

Cadmus conducted a billing analysis to estimate average daily savings per customer, as described in the *Billing Analysis* section. We checked if the estimates were robust to changes in model specification, including for the difference-in-differences with customer fixed effects model and the simple-differences post-only, both of which are acceptable methods in the UMP.<sup>22</sup> We tested the sensitivity of the estimates by comparing the resulting average daily saving.

### Model Specifications

The post-only model was specified assuming the average daily consumption ( $ADC_{it}$ ) of electricity of home ‘ $i$ ’ in month-year ‘ $t$ ’ as given by Equation B-1. This equation provides a separate estimate of average savings per customer per day for each year of the treatment period.

Equation B-1

$$ADC_{it} = \sum_j \beta_{1j} PART_i * PY_{jt} + \beta_2 Pre-kWh_{im} \times M_m + \gamma W' + \tau_t + \varepsilon_{it}$$

Where:

- $\beta_{1j}$  = Coefficient representing the conditional average treatment effect of the program on electricity use (kWh per customer per day) in program year  $j, j = 1, 2, \dots, J$ .
- $PART_i$  = Indicator variable that the customer was assigned to the program treatment group (which equals 1 if customer ‘ $i$ ’ is in the treatment group and 0 otherwise).

<sup>22</sup> Stewart, J., and A. Todd. *Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures, Chapter 17: Residential Behavior Protocol*. U.S. Department of Energy, National Renewable Energy Laboratory. August 2014. (NREL/SR-7A40-62497) Available online: [http://www1.eere.energy.gov/office\\_eere/de\\_ump\\_protocols.html](http://www1.eere.energy.gov/office_eere/de_ump_protocols.html)



- $PY_{jt}$  = Indicator variable for each program year  $j, j = 1, 2, \dots, J$ . This variable is equal to 1 if the month-year 't' is in the program year j and 0 otherwise.
- $\beta_2$  = Coefficient representing the conditional average effect of pretreatment electricity consumption on posttreatment average daily consumption (kWh per customer per day).
- $Pre-kWh_{im}$  = Mean household energy consumption of customer 'i' in month 'm' of the pretreatment period.
- $M_m$  = Indicator variable for each month ( $m = 1, 2, \dots, 12$ ) in the posttreatment period. The variable  $M_m$  equals one if period t is in month m and equals zero otherwise.
- $W$  = Vector of heating degree days and cooling degree days variables to control for the impacts of weather on energy use. HDDs and CDDs were calculated using base temperatures of 65° F.
- $\gamma$  = Vector of coefficients representing the average impact of weather variables on energy use.
- $\tau_t$  = Average energy use in month-year 't' reflecting unobservable factors specific to the month. The analysis controls for these effects with month-by-year fixed effects.
- $\epsilon_{it}$  = Error term for customer 'i' in month-year 't.'

The D-in-D fixed effects model was specified assuming the average daily consumption ( $ADC_{it}$ ) of electricity of customer 'i' in month 't' as given by Equation B-2:

**Equation B-2**

$$ADC_{it} = \sum_j \beta_{1j} PART_i * PY_{jt} + \alpha_i + \tau_t + W'\gamma + \epsilon_{it}$$

Where:

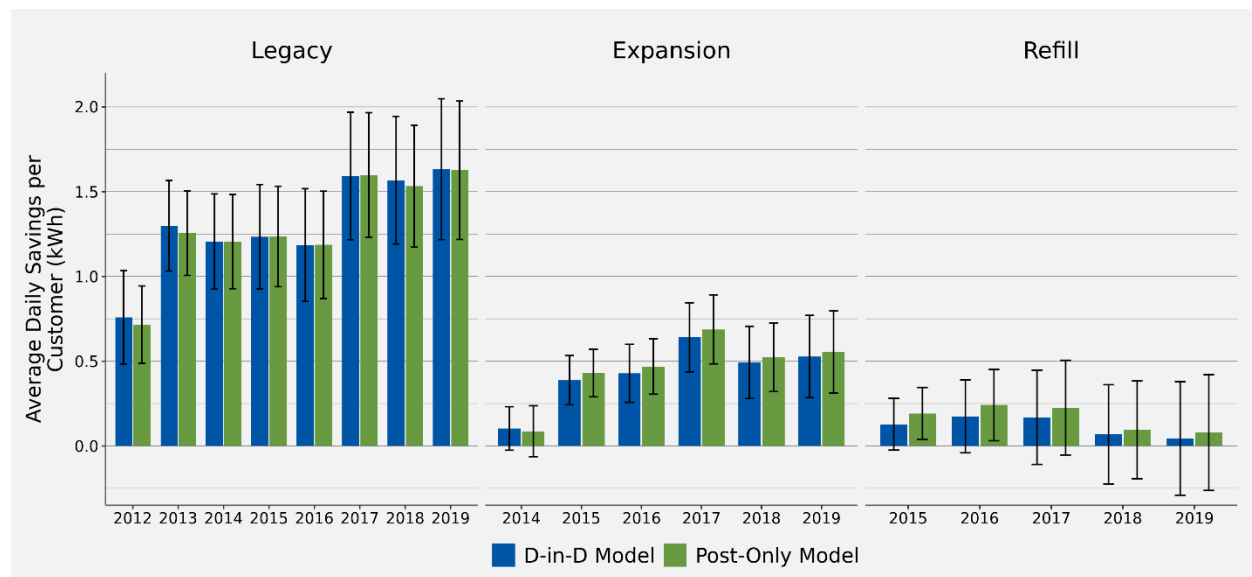
- $\beta_{1j}$  = Coefficient representing the conditional average treatment effect of the program on electricity use (kWh per customer per day) in program year  $j, j = 1, 2, \dots, J$ .
- $PART_i$  = Indicator variable for program participation (which equals 1 if customer 'i' was in the treatment group and 0 otherwise).
- $POST_t$  = Indicator variable for whether month 't' is pre- or posttreatment (which equals 1 if month 't' was in the treatment period and 0 otherwise).
- $W$  = Vector of heating degree days and cooling degree days variables to control for the impacts of weather on energy use. HDDs and CDDs were calculated using base temperatures of 65° F.
- $\gamma$  = Vector of coefficients representing the average impact of weather variables on energy use.

- $\alpha_i$  = Average energy use of customer 'i' reflecting unobservable, non-weather-sensitive, and time-invariant factors specific to the customer. The analysis controlled for these effects with customer fixed effects.
- $\tau_t$  = Average energy use in month-year 't' reflecting unobservable factors specific to the month and year. The analysis controlled for these effects with month-by-year fixed effects.
- $\epsilon_{it}$  = Error term for customer 'i' in month 't'

## Comparison of Model Results

Figure B-1 shows the estimate of average daily savings per customer from both models. The error bars show the 90% confidence intervals. The post-only and the D-in-D estimates are very close, and the confidence intervals for the post-only models include the difference-in-differences estimates across all waves and program years and vice-versa, suggesting that the estimates from the two approaches are not significantly different.

**Figure B-1. Difference-in-Differences and Post-Only Treatment Effects by Wave and Program Year**



For each wave and program year, Table B-2 shows estimates of the average daily treatment effects per customer for both the D-in-D and post-only model specifications. Standard errors around treatment effects are shown in parentheses next to the treatment effects. Both models found statistically significant savings for most years across Legacy and Expansion waves with few exceptions—savings were not estimated precisely in 2013 for the Expansion wave, which is likely because it was customers' first year of treatment. Cadmus was only able to detect significant savings at the 5% and 10% levels for customers in the Refill wave during the first two years of their treatment.

**Table B-2. Treatment effects (kWh/day per customers) by Model Specification <sup>(1)</sup>**

Year	Legacy		Expansion		Refill	
	D-in-D	Post-Only	D-in-D	Post-Only	D-in-D	Post-Only
2012	-0.76 (0.17) ***	-0.72 (0.14) ***	-	-	-	-
2013	-1.30 (0.16) ***	-1.26 (0.15) ***	-	-	-	-
2014	-1.21 (0.17) ***	-1.21 (0.17) ***	-0.10 (0.08)	-0.09 (0.09)	-	-
2015	-1.23 (0.19) ***	-1.24 (0.18) ***	-0.39 (0.09) ***	-0.43 (0.09) ***	-0.13 (0.09)	-0.19 (0.09) **
2016	-1.19 (0.20) ***	-1.19 (0.19) ***	-0.43 (0.10) ***	-0.47 (0.10) ***	-0.17 (0.13)	-0.24 (0.13) *
2017	-1.59 (0.23) ***	-1.60 (0.22) ***	-0.64 (0.12) ***	-0.69 (0.12) ***	-0.17 (0.17)	-0.23 (0.17)
2018	-1.57 (0.23) ***	-1.53 (0.22) ***	-0.49 (0.13) ***	-0.52 (0.12) ***	-0.07 (0.18)	-0.09 (0.18)
2019	-1.63 (0.25) ***	-1.63 (0.25) ***	-0.53 (0.15) ***	-0.55 (0.15) ***	-0.04 (0.20)	-0.08 (0.21)

<sup>(1)</sup> Standard errors clustered on customers are presented after the estimated treatment effect in parentheses (\*\*\*) Significant at 1%; \*\* Significant at 5%; \* Significant at 10%). The treatment effects represent the average daily savings per treatment group customer.

## Savings over Time

Cadmus calculated program total savings for just the years under evaluation, 2018 and 2019, but investigated the changes in average daily savings per customers since each wave launched. The following figures show the point estimates (line) and 90% confidence intervals (blue shaded region) for each month and year of treatment. The vertical line indicates the end of the pretreatment period.

Figure B-2 shows the savings over time for treatment customers in the Legacy wave. The program launched in July 2012. After its first year of treatment, program savings begin to plateau and have remained stable through the current program year, 2019. Despite the discontinuation of treatment during the first 10 months of 2018, savings do not appear to have significantly degraded and appear to have increased slightly since the 2016 program year. This is not necessarily surprising considering that customers had been treated for almost six years when the break in treatment occurred.

**Figure B-2. Average Daily Savings (%) Since Program Launch—Legacy Wave**

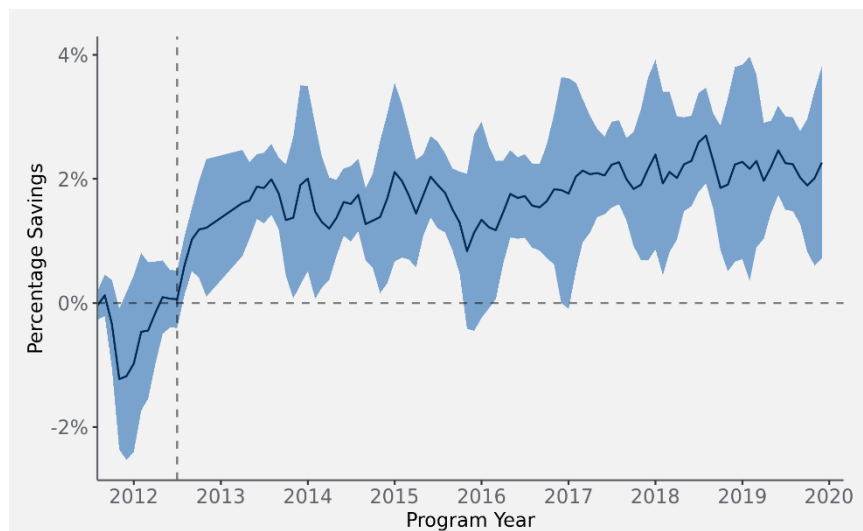


Figure B-3 shows the average daily savings for each month and year of treatment in the Expansion wave. The program launched for these customers in August 2014, and customers ramped up their savings over the next three years, until 2018. Unlike customers in the Legacy wave, customers in the Expansion wave do appear to have experienced some degradation of savings in 2018 because of the lack of treatment, though the wave still achieved savings of 1.5% on average.

**Figure B-3. Average Daily Savings (%) Since Program Launch—Expansion Wave**

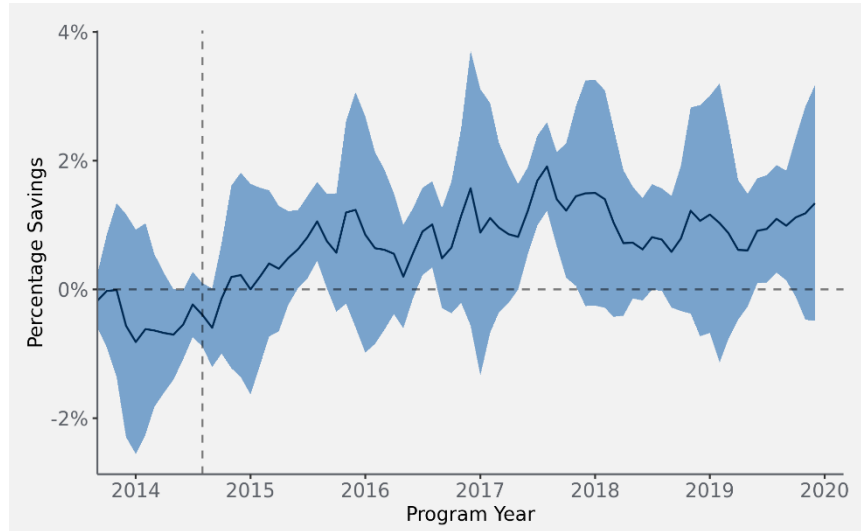
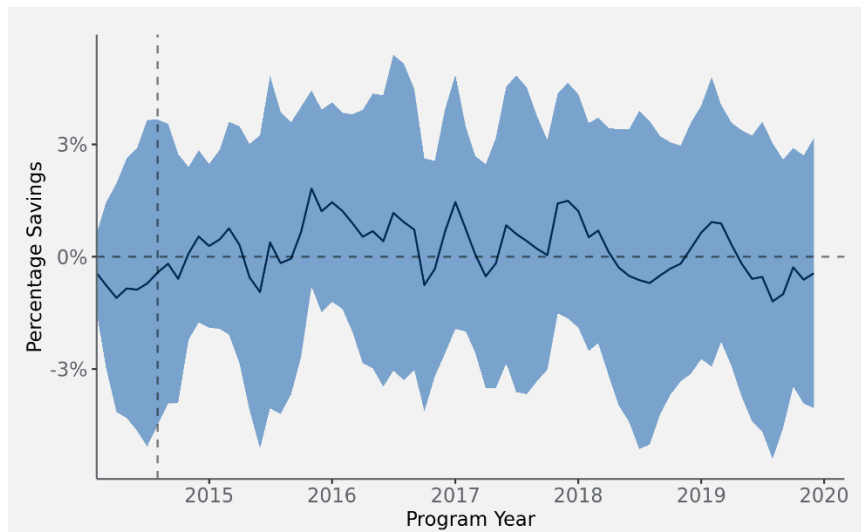


Figure B-4 shows the average daily savings per customer over time for the Refill wave. Unlike the two more mature waves, the Refill wave, which launched in January 2015, never achieved statistically significant savings. Customers in the Refill wave consumed much less on average per day (17 kWh/day) compared to customers in the Legacy (62 MWh/yr) and Expansion (37 kWh/yr) waves in the pretreatment period. It is likely that, given the size of the control group (2,400 customers with adequate pretreatment bills), any savings are too small to detect.

**Figure B-4. Average Daily Savings (%) Since Program Launch—Refill Wave**



## Uplift Participation and Savings Definitions

The following sections details Cadmus’ approach to estimating downstream savings and participation uplift and the uplift from PacifiCorp Washington’s upstream lighting program

### Downstream Participation and Savings Uplift

Cadmus measured the impact of HERs on efficiency program participation as the difference between treatment group customers’ and control group customers’ rates of program participation:

$$\textit{Participation Uplift } (\Delta\rho) = \rho_T - \rho_C$$

Where:

$\rho_j$  = The efficiency program participation rate during treatment for group ‘j’ (where  $j = T$  for treatment customers and  $j = C$  for control customers), with the participation rate defined as the ratio of number of efficiency program participants in the treatment (or control) group to the total number of treatment (or control) group customers

Similarly, we estimated the savings from participation uplift using average efficiency program savings per customer in place of the program participation rate:

$$\textit{Uplift savings per customer } (\Delta\sigma) = \sigma_T - \sigma_C$$

where  $\sigma_j$  is the average efficiency program savings per treated (or control) customer.

Multiplying uplift savings per customer by the number of customers assigned to the treatment group ( $N_T$ ) yielded an estimate of the savings from participation in PacifiCorp’s efficiency program:

$$\textit{Program uplift savings} = \Delta\sigma \times N_T$$

### Upstream Lighting Uplift

To estimate savings uplift form PacifiCorp Washington’s upstream lighting rebates program, Cadmus used the equation shown below. Detail on the data sources is provided in the *Estimating Uplift for Upstream Rebate Programs* in the *Evaluation Objectives and Methodology* section.

$$\begin{aligned} \textit{Lighting Savings Uplift} \\ &= TE(Q) \times ISR \times kWh \frac{\textit{savings}}{\textit{bulb}} \times \textit{Time Installed} \times \% \textit{incented} \\ &\times \textit{Treated Customers} \end{aligned}$$

Where:

TE(Q)	=	Treatment effect of HER Program on quantity of LED bulbs purchased or received for free
ISR	=	In-service rate (the percentage of purchased LED bulbs installed in sockets in the home)
kWh savings/bulb	=	Annual expected savings per LED bulb

- Time installed = Average length of time (in years) that purchased bulbs were installed in the program year
- % incented = Percentage of LED bulbs sold to residential customers that were purchased with a rebate
- Treated customers = Average number of treated customers during the program year

Table 17 shows the values Cadmus used to estimate upstream lighting uplift, including the HER treatment effect on bulbs purchased and installed, the proportion of purchased bulbs incented through the upstream program, and the annual savings per bulb. Uplift savings in 2019 included the savings from bulbs installed in 2018 in the homes of active HER program participants in 2019. We assumed that 2018-purchased bulbs failed uniformly across the 2019 program year at a rate of 7.9% using the average measure life of bulbs in PacifiCorp Washington’s upstream lighting program data.<sup>23</sup>

Cadmus estimated the HER treatment effect on installed bulbs using the results of the treatment and control group customer surveys. On average, the treatment group reported purchasing and installing 2.8 more bulbs than the control group.

**Table 17. Upstream Lighting Savings Uplift Estimation**

Program Year	Year of Bulb Purchase	HER Effect on Bulbs Installed per Participant (Bulbs/yr)	Incented Bulbs (percent of total)	Savings per Bulb (kWh/yr)	Average Time Installed (percent of year)	Average Percent Failed	Upstream Lighting Uplift per Customer (kWh/yr)
<b>2018 Total</b>		<b>2.80</b>	<b>23%</b>	<b>13.3</b>	<b>50%</b>	-	<b>4.3</b>
2019	2018	2.80	23%	13.3	100%	7.9%	8.0
2019	2019	2.80	20%	12.8	50%	-	3.6
<b>2019 Total</b>		<b>5.60</b>	<b>22%</b>	<b>13.1</b>	<b>77%</b>	<b>5.6%</b>	<b>11.6</b>

Cadmus calculated the incented proportion of purchased bulbs as the ratio of incented bulb sales from PacifiCorp Washington’s upstream lighting tracking data over the estimated total number of bulb purchases by PacifiCorp Washington’s residential customer population, shown in Table 18. To estimate the population total bulb purchases in each year, Cadmus applied the survey-gathered LEDs purchased by control-group customers to number of purchased bulbs to PacifiCorp Washington’s residential customer population.

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<sup>23</sup> Cadmus estimated the annual failure as one over by the measure life.

**Table 18. Incented Proportion of Total LEDs Purchased**

Program Year	PacifiCorp WA Residential Electric Customers	Estimated Total LED Bulbs Purchased	Total Incented Bulbs Purchased	Incented Percent of Purchased LEDs
2018	109,499 <sup>(1)</sup>	1,040,692	242,401	23%
2019	109,044 <sup>(2)</sup>	1,030,766	207,227	20%

<sup>(1)</sup> Source: 2018 EIA. Available online: <https://www.eia.gov/electricity/data/eia860/xls/eia8602018.zip>

<sup>(2)</sup> Source: PacifiCorp