EVALUATION OF 2020 HOME ENERGY REPORTS

Draft Report
2020 Impact Evaluation Results and 2020-2021 Process Evaluation Findings Report

Puget Sound Energy

Date: February 16, 2022

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1 EXECUTIVE SUMMARY

1.1 Introduction

Puget Sound Energy (PSE) launched the Home Energy Reports (HER) program in 2008. The HER program aims to reduce residential energy consumption by motivating no- to low-cost energy conservation actions. Participating households receive periodic reports which offer a mix of energy usage information, energy consumption benchmarking, and personalized advice for saving energy. The reports are designed to encourage energy conservation behavior for electric and gas customers.

1.2 Impact Evaluation Approach

The HER program was structured as a randomized controlled trial (RCT) where the eligible population was randomly assigned to treatment and control groups. The RCT design results in precise and unbiased estimates of savings per household since the only systematic difference between randomly assigned treatment and control households is treatment.

The number of households and the composition of PSE HER groups have changed over time.

- The initial HER legacy group consisted of around 84,000 dual fuel, single family homes. Of these, 40,000 were randomly selected to receive the report while the remaining 44,000 homes were randomly assigned as the control group and did not receive the report. All households in the treatment group received the report either monthly or quarterly for two years.
- At the start of the third year, approximately 10,000 HER legacy treatment group households were randomly selected to stop receiving the reports. This created a second treatment group (suspended) designed to test the persistence of report-based savings after the termination of reports. The rest of the households in the treatment group (legacy current households) still receive the home energy reports either monthly or quarterly. In program year 2020, about 16,500 of the original treatment population remain as current or suspended HER treatment participants. Program attrition is due to customer moveouts.
- In March 2014, PSE expanded the HER program to include 140,000 additional households. The HER expansion program targeted relative high users, non-urban, and electric only groups. Like the HER legacy program, the HER expansion program followed an experimental design with 105,000 randomly selected treatment households and 35,000 randomly selected control group households. In 2020, about 52,000 treatment households remain in the program.
- In May 2015, PSE added a refill group numbering about 25,000 treatment households and 10,500 control households to replace households lost due to customer attrition since the start of the program. Of these, close to 60% of the treatment households remain in the program in 2020.
- In May 2019, PSE added two new electric only groups: a second refill group (65,000 treatment households and 25,000 control households) and manufactured home customers (37,977 treatment households and 9,494 control households). About 54,000 treatment households remain in the second refill group and 32,000 treatment households remain in the manufactured home group.
- In January 2020, PSE added another dual-fuel refill group (henceforth referred to as “refill 2020”) numbering 90,000 treatment household and 30,000 control households. While this report only covers 2020 programs, it is worth noting that PSE added a gas-only digital wave starting in September 2021 with approximately 85,000 treatment customers. This new wave will be evaluated as part of the 2021 evaluation.

Table 1-1 shows the count of active customers at the beginning of 2020.

Table 1-1. Count of Active Customers as of January 2020

HER treatment group	Treatment	Control
Legacy - Current	11,039	20,776
Legacy - Suspended	5,479	
Legacy - Unmatched	3,112	
Expansion – Non-urban	22,399	7,532
Expansion - High relative user	14,800	4,982
Expansion - Electric only	16,722	5,562
Expansion - Refill	15,247	6,461
Expansion - Refill Electric only	57,116	22,019
Expansion - Manufactured Homes	33,745	8,413
Expansion - Refill 2020	89,459	29,850
Total	269,118	105,595

1.3 Impact Evaluation Results

Table 1-2 shows the credited electric savings for the 2020 HER program. Overall, the HER program saved about 46.5 million kWh after accounting for joint savings. Customers in the legacy group who continue to receive the report have continued reducing their electricity consumption for 11 years, while customers who stopped receiving the report saved a statistically insignificant amount of electricity. The bulk of electric savings come from customers in the Expansion Refill Electric only group, which has both one of the largest number of treatment customers and generates one of the highest per household savings amount. The three most recent Expansion groups (Refill Electric only, Manufactured Homes, and Refill 2020) are expected to generate even more savings in the coming years, assuming they follow the same trajectories as the older groups.

Table 1-2. Total credited electric savings for 2020 HER program (kWh)

	Per Household				Total		
HER treatment group	Measured Savings	Joint Savings	Claimed Savings	No. in group	Total savings	Lower limit 90% CI	Upper limit 90% CI
Legacy - Current	167.69	8.06	159.63	11,039	1,762,163	912,918	2,611,408
Legacy - Suspended	40.36	2.26	38.10	5,479	208,749	(330,295)	747,792
Legacy - Unmatched^			156.99	3,112	488,549	249,138	727,959
Expansion - Electric only	271.27	46.77	224.50	16,722	3,754,031	1,520,748	5,987,313
Expansion - High relative user	417.54	24.51	393.03	14,800	5,816,849	3,987,058	7,646,639
Expansion – Non-urban	166.93	34.41	132.52	22,399	2,968,229	1,040,928	4,895,531
Expansion - Refill	248.64	14.26	234.38	15,247	3,573,535	2,010,177	5,136,893
Expansion - Refill Electric only	352.82	14.10	338.73	57,116	19,346,733	16,044,803	22,648,663
Expansion - Manufactured Homes	178.45	9.42	169.03	33,745	5,703,884	3,360,153	8,047,616
Expansion - Refill 2020	38.30	5.21	33.09	89,459	2,960,177	565,232	5,355,122
Total			173.09	269,118	46,582,898	40,443,277	52,722,519

^Note that we calculated the unmatched per household savings by multiplying the legacy current per household savings as a percentage of consumption (1.6%) by the average household consumption of the unmatched group (9,612 kWh).

Table 1-3 shows the credited gas savings for the 2020 HER program. Overall, customers saved about 994 thousand therms. Customers in the legacy group continued to reduce their gas consumption (although they did not continue to reduce electric consumption as mentioned above). The most recent Expansion Refill 2020 group generated the largest share of gas savings due to having the largest group of HER recipients.

Table 1-3. Total credited gas savings for 2020 HER program (therms)

	Per Household				Total		
HER treatment group	Measured Savings	Joint Savings	Claimed Savings	No. in group	Total savings	Lower limit 90% CI	Upper limit 90% CI
Legacy - Current	10.80	1.67	9.13	11,039	100,778	47,337	154,219
Legacy - Suspended	9.80	0.00	9.80	5,479	53,674	19,331	88,018
Legacy - Unmatched^			10.22	3,112	31,820	16,754	46,885
Expansion - High relative user	12.47	2.08	10.39	14,800	153,779	57,416	250,143
Expansion – Non-urban	6.22	0.39	5.83	22,399	130,601	33,175	228,026
Expansion - Refill	10.69	0.84	9.85	15,247	150,185	73,265	227,105
Expansion - Refill 2020	4.20	0.02	4.18	89,459	373,608	266,977	480,239
Total			6.16	161,535	994,445	793,630	1,195,261

^Note that we calculated the unmatched per household savings by multiplying the legacy current per household savings as a percentage of consumption (1.4%) by the average household consumption of the unmatched group (858 therms).

1.4 Process Evaluation Approach

The process evaluation is designed to provide information on how the HER program creates savings and how it might increase those savings. This year's evaluation included two components:

1. an interview of PSE HER program staff
2. a large-scale online survey of HER recipients and non-recipients to understand their behaviors and attitudes.

The program staff interview was designed to understand challenges and opportunities from the perspective of a PSE program manager. This interview included suggestions from program staff for program process improvements to reduce challenges, a description of any recent program changes and discussion of whether those changes impacted the program positively, a discussion of project components that staff find useful, and a compilation of suggestions for process improvement opportunities.

The online survey was sent to a large sample of HER recipients and non-recipients from different survey waves to better understand customer behaviors that affect energy use, their attitudes toward the home energy reports, and how these might vary between different types of customers. We focused, specifically, on questions to determine how customer behaviors changed during the COVID-19 pandemic, differences between HER recipient and non-recipient energy usage behavior, attitudes toward HERs, and how these behaviors and attitudes may be different for low-income customers.

1.5 Process Evaluation Results

Evaluators asked PSE's HER program manager about key recent program changes during the program staff interview. In January 2020, PSE added a new group of Home Energy Report recipients, which included 90,000 treatment dual-fuel households and 30,000 control households. In September 2021, PSE added 85,000 recipients, which were gas-only households.

As mentioned in the previous section, DNV launched an online survey to gauge level of awareness, engagement, and satisfaction with HERs, among other research objectives. Program participants who responded to the online survey were asked if they remembered receiving a HER from PSE in the past three months. A large majority (91%) of respondents stated they did remember receiving the HER.

In the next part of the survey, all respondents who said they did remember receiving the reports were asked, in general, what they have done with them. Most of the participants either read some of the content (46%) or read the reports thoroughly (32%). Only 3% of the respondents said they did not look at them at all. This suggests that a vast majority of respondents have at least a moderate level of engagement with the HER reports they receive. However, when asked about tips from the report that they remembered,[1] fewer than half of recipients remembered seeing any message other than the recommendation to replace lightbulbs with LEDs.

Program participants were also asked to think about the home energy reports and then decide if they agree or disagree with various statements about these reports. A large majority of respondents agreed that they liked the home energy reports (80%) and the energy efficiency tips within the report were useful (74%). Fewer respondents, though still a majority, agreed that the comparisons to similar homes were fair (57%) or that the reports helped them make better energy-related decisions (57%).

In addition to examining awareness and satisfaction, the online survey explored the potential mechanisms for the savings found in the impact evaluation. Results from comparing technology adoption and energy-savings behaviors suggest that the differences between HER recipients and non-recipients are small. Very few comparisons yielded statistically significant

[1] We note that PSE no longer has any HER lighting-focused modules, and these questions were focused on whether recipients remembered tips included in the reports from Oracle's library of tips. We think that simple messages that customers have heard repeatedly over time are the most likely to be remembered, and this is probably the reason they remember lighting messaging so well.

differences. One potential mechanism for HER savings is very small differences between groups. While these will not be statistically significant, over many behavior and technology types, the small differences can add up to meaningful savings.

We also examined any potential effects of home energy reports on equity. The program appears to be an effective method to promote equity in energy savings. Low-income report recipients are 8% more likely to thoroughly read the reports compared to non-low income customers (40% vs. 32%) and are 4% more likely to find them useful to help save energy (80% compared to 76%).

Finally, the online survey asked customers questions about their pre, during, and post-COVID-19 pandemic behaviors to explore potential program improvements based on behavioral change. PSE customers expect that, on average, they will continue to stay home more often in the post-pandemic world (for a total average of about 6% more time at home). This may mean that energy-saving interventions focused on times when homes are occupied will be more effective.

1.6 Findings and Recommendations

We present key findings and recommendations below.

1.6.1 Findings

Key findings from the impact evaluation are as follows:

- Total PSE HER 2020 electric savings are 46.6 million kWh and gas savings are 994,445 therms.
- After averaging more than 300 kWh savings per household for six years, the legacy current group has been generating fewer and fewer electric savings since 2018. Its measured gas savings has also been declining for the past four years.
- The suspended legacy group's electric savings continue to be statistically insignificant while its gas savings is nearly equal to the current legacy group's. This suggests that electric savings have not persisted without messaging from HERs while gas savings continue to maintain some level of persistence. Continued gas savings may be due to the installation of more efficient equipment, which persist after HERs are discontinued, while electric savings may be more dependent on behavioral changes, such as turning off lights and unplugging discretionary loads, which may be more short-lived.
- All previous expansion groups continue to save electricity and gas, with the high-user group generating an increase in electric savings from the previous year and generating nearly the same amount of gas savings as the previous year.
- The two new expansion waves from 2019, the electric only refill and the manufactured homes, show an increase in electric savings in 2020, following similar trajectories as the original expansion trio.
- Evaluators uncovered some extreme values in the consumption data, particularly within gas consumption data. These may be caused by errors at the meter level.

Key findings from the process evaluation include the following:

- Ninety-one percent of HER recipients are aware they receive the report, and 66% are aware of PSE's energy efficiency programs. More than three-quarters of recipients (78%) reported reading at least some of the report. However, fewer than half of recipients remembered seeing any message other than the recommendation to replace light bulbs with LEDs (55% recalled messaging about replacing light bulbs). Additionally, one-third of respondents do not recall any of the messages from HERs.

- Eighty percent of recipients liked the reports and 92% reported that, after receiving the reports, their opinion of PSE was either unchanged or more favorable.

- Home energy reports appear to be an effective method to promote equity in energy savings. Of low-income report recipients, 40% report reading the reports thoroughly, as compared to 32% of non-low-income customers. Low-income recipients are also more likely to find the reports useful to help save energy; eighty percent of low-income recipients report that the energy efficiency tips in the reports are useful compared to 76% of non-low-income recipients.

- PSE customers expect that, on average, they will continue to stay home for about 6% more hours (about 8 hours more per week) in 2022.

- Results show minimal difference in the energy savings behaviors and technologies examined in the survey. It is possible that differences too small to show statistical significance, over many behaviors and technologies, yield the meaningful savings found in the impact evaluation.

1.6.2 Recommendations

- PSE should consider further investigating the source of and reasons for extreme values that appear in the daily consumption data. This could ultimately produce more accurate consumption data and reduce the need to remove extreme values from the analysis.

- Because PSE customers expect that they will continue to spend more time at home after the pandemic, technologies and behaviors that save energy by reducing use when customers are away from their homes may be somewhat less important. In contrast, technologies and behaviors that reduce energy use while customers are at home, especially while running work-from-home electronics, may be more important or present increased savings opportunities.

  HERs are both an effective way to save energy and are broadly popular. Simple messages are remembered best. If PSE's goals adjust to focus on decarbonization instead of energy efficiency, a similar report recommending simple actions to achieve decarbonization is likely to be effective and popular. However, it is important to note that electrification will increase load and, if unaddressed in the impact evaluation methodology, subsequent evaluations would report lower energy savings. Therefore, if PSE choses to message electrification measures, it should simultaneously develop an energy savings methodology in coordination with evaluators and the stakeholder groups to ensure it does not unfairly affect its energy savings estimates.

2 INTRODUCTION

In this section, we provide an overview of Puget Sound Energy's (PSE) Home Energy Reports program, research objectives, impact evaluation methods, and process evaluation methods.

2.1 Program Overview

The Home Energy Report (HER) program delivers customized information on energy consumption to participating households and compares the households' energy consumption to that of similar neighboring homes. In addition, the report provides personalized tips on how to save energy based on the energy usage and housing profile of recipients. The HER program was designed to motivate households to reduce energy consumption through behavioral changes and participation in other PSE energy efficiency programs.

PSE first implemented the HER program in 2008. The program was structured as a randomized controlled trial (RCT) where the eligible population was randomly assigned to treatment and control groups. The RCT design results in precise and unbiased estimates of savings per household, since the only systematic difference between randomly assigned treatment and control households is treatment.

Since the launch of the program, the number of households and the composition of PSE HER groups have changed over time.

- The initial HER legacy group consisted of around 84,000 dual fuel, single family homes. Of these, 40,000 were randomly selected to receive the report while the remaining 44,000 homes were randomly assigned as the control group and did not receive the report. All households in the treatment group received the report either monthly or quarterly for two years.
- At the start of the third year, approximately 10,000 HER legacy treatment group households were randomly selected to stop receiving the reports. This created a second treatment group (suspended) designed to test the persistence of report-based savings after the termination of reports. The rest of the households in the treatment group (legacy current households) still receive the home energy reports either monthly or quarterly. In program year 2020, about 16,500 of the original treatment population remain as current or suspended HER treatment participants. Program attrition is due to customer moveouts.
- In March 2014, PSE expanded the HER program to include 140,000 additional households. The HER expansion program targeted relative high users, non-urban, and electric only groups. Like the HER legacy program, the HER expansion program followed an experimental design with 105,000 randomly selected treatment households and 35,000 randomly selected control group households. In 2020, about 52,000 treatment households remain in the program.
- In May 2015, PSE added a refill group numbering about 25,000 treatment households and 10,500 control households to replace households lost due to customer attrition since the start of the program. Of these, close to 60% of the treatment households remain in the program in 2020.
- In May 2019, PSE added two new electric only groups: a second refill group (65,000 treatment households and 25,000 control households) and manufactured home customers (37,977 treatment households and 9,494 control households). About 54,000 treatment households remain in the second refill group and 32,000 treatment households remain in the manufactured home group.
- In January 2020, PSE added another dual-fuel refill group (henceforth referred to as "refill 2020") numbering 90,000 treatment household and 30,000 control households.

2.2 Research Objectives

2.2.1 Impact Evaluation

The main goal of the impact evaluation is to estimate HER legacy and expansion program savings for 2020. Specifically, the objectives are to:

1. Measure the reduction in electric and natural gas consumption for the HER treatment groups.
2. Quantify joint savings from HER-related increased uptake of other PSE energy efficiency programs, which may be present in the measured consumption reduction, including an increase in the number of participants and/or extent of participation in PSE rebate programs due to HER. Lighting savings were based on a survey which asked PSE customers about their 2020 lighting purchase history, while all other types of savings were based on the 2020 tracking data.
3. Provide an estimate of 2020 HER credited savings for legacy and expansion programs adjusted for joint savings resulting from participation in PSE.
4. Provide an estimate of electric and natural gas savings for an additional legacy treatment group that had been previously excluded from savings estimates due to lack of a randomly assigned control group (the unmatched treatment group).

This evaluation used historical consumption data to measure the difference in consumption between the treatment and control groups. We measured savings estimates for the different treatment sub-groups, namely, the current and suspended groups for the HER legacy program and the relative high users, non-urban, electric only, refill, manufactured home, and refill 2020 groups for the HER expansion program. To quantify joint savings, DNV used the PSE program tracking data for downstream programs and fielded a survey for upstream lighting purchases.

2.2.2 Process Evaluation

The goal of the process evaluation is to understand the program better, so that it can be changed to better achieve current or future goals, the benefits can be better understood, and/or its benefits can be more accurately projected into the future. The main objectives of this HER process evaluation were as follows:

1. Understand how customer behavior has changed during the COVID-19 pandemic and whether any changes are expected to persist after the pandemic
2. Understand how energy savings behaviors and technologies are different between customers who receive HERs and those who do not
3. Quantify the level of awareness and satisfaction among recipients of HERs
4. Determine whether low-income recipients find HERs useful and their level of engagement with the reports.

2.3 Impact Evaluation Overview

2.3.1 Measured Savings

Our evaluation used daily household energy consumption data to calculate the reduction in energy consumption of the treatment group relative to the control group. Consumption reduction is the full measure of savings caused by receipt of home energy reports and is referred to here as measured savings. We used a pooled fixed-effects model to estimate savings.

The fixed effects methodology is a flexible characterization of the effect of the treatment on household consumption. It allows us to estimate the effect of the treatment over time while controlling for household and time-specific characteristics, which results in more precise estimates. Further, it allows us to estimate savings from partial-year treatment participants.

The fixed effects model specification estimates program savings by comparing consumption of the treatment and control groups before and after program implementation. The change that occurs in the treatment group is adjusted to reflect any change that occurred in the control group to isolate changes attributable to the program.

2.3.2 Joint Savings

The HER program has a secondary objective of promoting other PSE energy efficiency programs. If HER is successful in achieving this objective, the measured consumption reduction will include the savings from any increased uptake of these other energy efficiency programs. We refer to this as joint program savings since credit for these savings is shared by both the HER program and other PSE rebate programs.

Joint savings can occur when HER recipients:

- Install rebate program measures in greater numbers,
- Install rebate program measures generating greater savings, and/or
- Install any rebate program measures earlier than control households, regardless of the level of savings.

Since the rebate programs claim the savings, we deduct joint savings from the HER measured savings to avoid double counting. The measured savings with joint savings removed are referred to as “credited savings” in this report. The following two sections go into further detail about how we calculated the downstream rebate and upstream lighting joint savings.

2.3.2.1 Downstream Rebate

We used PSE tracking and end-use load shape data to quantify energy savings for HER participants through PSE rebate programs. HERs generate a flow of savings throughout a program year that increases or decreases as the consumption of the treatment group changes compared to the control group. On the other hand, rebate savings are generally reported on an annual basis and do not account for when measures were installed, how long they last, or when during the year savings from such measures happen.

To account for rebate program savings in a way that is consistent with the measured HER program savings, we took into consideration:

- When savings started (installation dates for downstream; rebate year for upstream),
- When during the year savings occurred (load shape of yearly savings), and
- How long the savings will last (persistence of savings or measure life).

Savings for all measures start on the day of installation (or rebate date) and are projected forward from that day based on daily load shapes and measure life. At present, the measure lives for the majority of installed measures are greater than the ten years the HER program has been in place.

We calculated the stream of savings from PSE rebate programs for HER treatment and control group households by summing the savings achieved in 2020, including measures installed in prior years that are expected to be still in use. The rebate portion of joint savings is the difference between the treatment and control groups’ savings. We removed this difference from the HER measured savings.

2.3.2.2 Upstream Lighting

DNV administered an online survey to collect information from program participants about the purchase and installation of LED bulbs, fixtures, linear tube lamps, and outdoor string lights during the 2020 program year. We used survey results to calculate the number of purchased LEDs incentivized by the upstream program for the HER treatment and control groups. These results were used to estimate joint savings associated with PSE's upstream LED lighting programs.

In particular, the difference in the average number of LEDs purchased by treatment and control households of each wave provided the uplift in efficient lighting due to the HER program. We multiplied savings per LED by the estimated uplift to generate upstream joint savings in 2020. Since efficient lighting products (compact fluorescents and LEDs) have measure lives of five years or more, total program year 2020 upstream savings were based on cumulative LED savings of the past five years.

Upstream joint savings calculated in this manner were used to generate credited savings per household.

2.4 Legacy Unmatched Savings Estimates

The legacy treatment group includes a small subset of households, concentrated in the 98006-zip code, that have received HER reports since the start of the program. These households were randomly selected to receive the reports but were not assigned a random control group. Savings from this group were not included in program totals until the 2016 program year.

In 2016 and 2017, we explored the possibility of capturing savings from this customer group by creating a matched comparison group to arrive at measured savings. We could not create a satisfactory comparison group because most PSE customers in this geographic region were receiving the HER treatment.

In this analysis, we use percent savings per household of the legacy current group to estimate the savings of the unmatched group. We found this approach to provide a reasonable estimate of credited savings for the 3,112 customers that remained in the unmatched group in 2020.

2.5 Process Evaluation Overview

The process evaluation is designed to provide information on how the HER program creates savings and how it might increase those savings. This year's evaluation included two components:

1. an interview of PSE HER program staff
2. a large-scale survey of HER recipients to understand their behaviors and attitudes.

The program staff interview was designed to understand challenges and opportunities from the perspective of a program administrator. This interview generated suggestions for program process improvements to reduce challenges, a description of any recent program changes and discussion of whether those changes impacted the program positively, a discussion of project components that staff find useful, and a compilation of suggestions for process improvement opportunities.

The online survey was sent to a large sample of HER recipients and customers from the control group from different survey waves to better understand customer behaviors that affect energy use, their attitudes toward the home energy reports, and how these might vary between different types of customers. We focused, specifically, on questions to determine how customer behaviors changed with COVID, differences between HER recipient and non-recipient behavior, attitudes toward HERs, and how these behaviors and attitudes may be different for low-income customers.

2.6 Report Overview

We have organized the remainder of this report as follows:

- Section 3 describes the evaluation's data sources.
- Section 4 details the results of the impact evaluation.
- Section 5 provides the results of the process evaluation.
- Section 6 includes the evaluation's key findings and recommendations.
- Appendix A details the sample design used for the online surveys.
- Appendix B includes the data collection instrument used for the online surveys.
- Appendix C provides additional details on the impact evaluation methods, including the Fixed Effects Model.
- Appendix D contains additional tables of demographic results from the online survey.

3 DATA SOURCES

Below we provide the data sources used to support the HER impact and process evaluations.

3.1 Program Participants

PSE provided premise numbers, customer account numbers, electric and gas meter numbers, and treatment assignment of HER program participants. These data served as the original roster of program participants for the HER evaluation and were used in conjunction with the Program Tracking data and daily consumption data.

3.2 Program Tracking Data

PSE provided the 2020 rebate program tracking data, which we used to calculate rebate program joint savings. The tracking data included participant information, account numbers, program name, measures installed, installation dates, and claimed savings. PSE also provided us with end-use load shapes when we first began evaluating the HER program, which we used to determine when savings occurred during the year for each measure installed.

3.3 Daily Consumption Data

DNV received daily consumption data from January 2020 to December 2020 from Oracle to facilitate the impact analysis. This dataset included premise numbers, customer account numbers, meter numbers, daily consumption reads, read dates, and the type of reading (actual or estimated).

3.4 Program Staff Interview

The program staff interview took place in June of 2021 and included the home energy reports program manager as well as two additional PSE staff members. The primary goals of the program staff interview were to understand any recent and planned program changes, barriers preventing HER recipients from saving more energy, and opportunities for increasing savings through the HER program.

3.5 Online Consumer Survey Data

As part of the process evaluation, DNV sent surveys via email to 83,630 customers enrolled in the HER program ("treatment" customers) and 38,939 customers who are not enrolled ("control" customers); see Table 3-1. Of the customers who received a survey, 11% of control group and 12.3% of treatment customers responded, for a total of 4,808 responses from control and 9,239 responses from treatment customers. Overall, DNV sent out 122,569 surveys of which 14,047 were completed, representing an 11.5% response rate.

Table 3-1. Online Survey Responses and Response Rates

Recipient Type	Surveys Sent	Surveys Completed	Response Rate
Treatment	83,630	9,239	12%
Control	38,939	4,808	11%
Total	122,569	14,047	12%

Data collected from the survey included questions on lifestyle changes due to the COVID-19 pandemic, specifically questions intended to determine changes in household occupancy, which could change total energy use. It also included questions on different energy saving technology purchases/ownership, with in-depth questions on heating and cooling behavior, as this represents a large fraction of energy use. HER recipients saw questions on their awareness of, attitudes

toward, and satisfaction with the reports, and whether they found them useful. Finally, all survey participants answered questions on demographics, including questions on income and education.

4 IMPACT EVALUATION RESULTS

4.1 Overview

Below we present the measured, joint, and credited impact evaluation savings results for the 2020 HER program.

4.2 Results

DNV's primary goal for the impact evaluation is to develop the 2020 PSE HER program credited savings. The estimated credited savings have two components. The first is the HER program's measured savings that reflect the program's impact on average household consumption. It is the average reduction in energy consumption of HER treated households. The second component is the joint savings, which is comprised of downstream rebate and upstream lighting savings. To avoid double counting, we calculated credited savings by removing the downstream rebate joint savings and upstream lighting savings from the HER measured savings. The downstream rebate joint savings are calculated from PSE tracking data. The upstream lighting savings are calculated from a customer survey while also incorporating the savings from the previous four years (lighting savings are assumed to have a 5-year lifespan).

The credited savings DNV estimates include savings estimates for a group of legacy treatment households, mostly concentrated in the 98006-zip code, which were not assigned a random control group, but have received HER reports since the start of the program. Initially numbering close to 5,000, the current analysis is based on 3,112 unmatched households that have remained at the same premise since the start of the program. We estimated the unmatched group's 2020 HER savings by applying the percentage savings of the legacy current group to the baseline consumption of the unmatched group.

Table 4-1 and Table 4-2 provide the group-level and overall electric and gas savings estimates, respectively. The overall electric savings were estimated at 90/13 precision and the gas savings were estimated at 90/20 precision. Legacy suspended customers showed positive, yet statistically insignificant electric savings in 2020. The electric-only refill group generated the most electric savings among all the treatment groups. Overall, PSE HER electric customers saved 46.5 million kWh in 2020.

Table 4-1. Total credited electric savings for 2020 HER programs (kWh)

HER treatment group	Per Household				Total		
	Measured Savings	Joint Savings	Claimed Savings	No. in group	Total savings	Lower limit 90% CI	Upper limit 90% CI
Legacy - Current	167.69	8.06	159.63	11,039	1,762,163	912,918	2,611,408
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Legacy - Unmatched^			156.99	3,112	488,549	249,138	727,959
Expansion - Electric only	271.27	46.77	224.50	16,722	3,754,031	1,520,748	5,987,313
Expansion - High relative user	417.54	24.51	393.03	14,800	5,816,849	3,987,058	7,646,639
Expansion – Non-urban	166.93	34.41	132.52	22,399	2,968,229	1,040,928	4,895,531
Expansion - Refill	248.64	14.26	234.38	15,247	3,573,535	2,010,177	5,136,893
Expansion - Refill Electric only	352.82	14.10	338.73	57,116	19,346,733	16,044,803	22,648,663
Expansion - Manufactured Homes	178.45	9.42	169.03	33,745	5,703,884	3,360,153	8,047,616
Expansion - Refill 2020	38.30	5.21	33.09	89,459	2,960,177	565,232	5,355,122
Total			173.09	269,118	46,582,898	40,443,277	52,722,519

^Note that we calculated the unmatched per household savings by multiplying the legacy current per household savings as a percentage of consumption (1.6%) by the average household consumption of the unmatched group (9,612 kWh).

On the gas side, treatment customers from all cohorts generated statistically significant savings. Overall, PSE HER customers saved 994 thousand therms in 2020.

Table 4-2. Total credited gas savings for 2020 HER programs (therms)

HER treatment group	Per Household				Total		
	Measured Savings	Joint Savings	Claimed Savings	No. in group	Total savings	Lower limit 90% CI	Upper limit 90% CI
Legacy - Current	10.80	1.67	9.13	11,039	100,778	47,337	154,219
Legacy - Suspended	9.80	0.00	9.80	5,479	53,674	19,331	88,018
Legacy - Unmatched^			10.22	3,112	31,820	16,754	46,885
Expansion - High relative user	12.47	2.08	10.39	14,800	153,779	57,416	250,143
Expansion – Non-urban	6.22	0.39	5.83	22,399	130,601	33,175	228,026
Expansion - Refill	10.69	0.84	9.85	15,247	150,185	73,265	227,105
Expansion - Refill 2020	4.20	0.02	4.18	89,459	373,608	266,977	480,239
ALL			3.70	161,535	994,445	793,630	1,195,261

^Note that we calculated the unmatched per household savings by multiplying the legacy current per household savings as a percentage of consumption (1.4%) by the average household consumption of the unmatched group (858 therms).

The summary measured savings per household and joint savings results for legacy programs are presented in Table 4-3. The legacy current treatment group produced credited electric and gas savings of 159.6 kWh or 1.6% and 9.1 therms or 1.2%, respectively. These savings were statistically significant. The suspended group had a statistically significant average reduction of 9.8 therms (1.3% savings per household) and no statistically significant kWh change. Gas savings from the program may be due to installation of more efficient hardware, while electric savings may depend more on behavioral

changes, such as turning off lights and unplugging discretionary load. Efficient gas hardware remains after the program, while discretionary behaviors may attenuate.

Table 4-3. Summary of credited savings per household for PSE HER Legacy, 2020

Treatment Groups	Consumption	HER measured savings	Downstream Joint savings	Upstream Joint savings	Credited savings	Percent credited savings
Electric (kWh)						
Current	9,774	167.7* (91.1, 244.3)	8.1* (0.7, 15.4)	0.0	159.6* (82.7, 236.6)	1.6%
Suspended		40.4 (-57.6, 138.3)	2.3 (-7.0, 11.5)	0.0	38.1 (-60.3, 136.5)	0.4%
Gas (therms)						
Current	766	10.8* (6.1, 15.5)	1.7* (0.6, 2.8)		9.1* (4.3, 14.0)	1.2%
Suspended		9.8* (3.7, 15.9)	0.0 (-1.3, 1.3)		9.8* (3.5, 16.1)	1.3%

*Indicates statistically significant at 90% confidence level. Values in parentheses show upper and lower bounds at 90% confidence level.

Each expansion group generated statistically significant credited electric savings, while only the high user group generated statistically significant gas savings (Table 4-4). Among the expansion groups, the high user group generated the largest credited electric and gas savings. The electric only group generated the largest joint electric savings, mostly because the HER program has a substantive impact on the uptake of upstream lighting measures for single fuel, electric only households. Although the 2020 survey indicated the control group purchased more energy-savings bulbs than the treatment group, savings are cumulative for the assumed 5-year effective useful life of the rebated bulbs and thus leaves a sizeable amount of upstream savings for this cohort. The same can be said about the non-urban group of customers. Prior year upstream savings that remain will continue to be deducted until the remaining useful life of rebated bulbs expire.

Table 4-4. Summary of credited savings per household for PSE HER Expansion, 2020

Treatment Groups	Consumption	HER measured savings	Downstream Joint savings	Upstream Joint savings	Credited savings	Percent credited savings
Electric (kWh)						
Electric Only	14,145	271.3 (140.5, 402.0)	12.9 (-9.3, 35.1)	33.9 (17.9, 49.9)	224.5 (90.9, 358.1)	1.6%
High User	11,371	417.5 (295.3, 539.8)	19.6 (10.5, 28.7)	4.9 (-11.4, 21.2)	393.0 (269.4, 516.7)	3.5%
Non-urban	10,024	166.9 (82.2, 251.7)	14.2 (8.1, 20.3)	20.2 (6.5, 33.9)	132.5 (46.5, 218.6)	1.3%
Refill	12,291	248.6 (146.3, 351.0)	14.3 (7.6, 21.0)	-15.1 (-34.2, 3.9)	234.4 (131.8, 336.9)	1.9%
Refill Electric only	21,280	352.8 (299.0, 406.6)	7.7 (3.8, 11.7)	6.3 (-14.4, 27.1)	338.7 (280.9, 396.5)	1.6%
Manufactured Homes	14,377	178.4 (109.9, 247.0)	7.1 (-4.1, 18.3)	2.3 (1.7, 2.9)	169.0 (99.6, 238.5)	1.2%
Refill 2020	10,229	38.3 (16.7, 59.9)	0.0 (0.0, 0.0)	5.2 (-10.6, 21.0)	33.1 (6.3, 59.9)	0.3%
Gas (therms)						
High User	747	12.5 (6.1, 18.9)	2.1 (1.0, 3.2)		10.4 (3.9, 16.9)	1.4%
Non-urban	689	6.2 (1.9, 10.5)	0.4 (-0.3, 1.1)		5.8 (1.5, 10.2)	0.8%
Refill	812	10.7 (5.7, 15.7)	0.8 (0.2, 1.5)		9.9 (4.8, 14.9)	1.2%
Refill 2020	684	4.2 (3.0, 5.4)	0.0 (0.0, 0.1)		4.2 (3.0, 5.4)	0.6%

*Indicates statistically significant at 90% confidence level. Values in parentheses show upper and lower bounds at 90% confidence level.

Table 4-5 presents baseline electric and gas consumption and the average savings per household as a percent of consumption for the unmatched households. For each fuel, we select the legacy current group's percentage savings per household and multiply these by the unmatched group's baseline consumption to generate the credited savings per household for the group.

Table 4-5. Summary of credited savings for the unmatched group

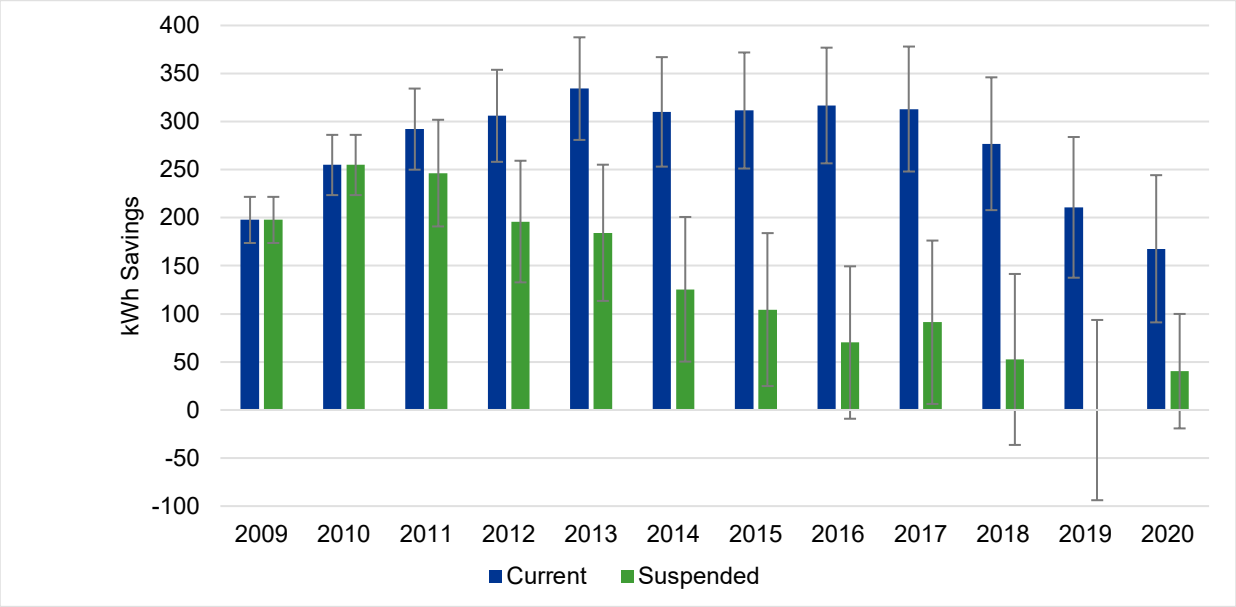
	Electric (kWh)			Gas (therms)		
	Consumption	Savings	Percent	Consumption	Savings	Percent
Legacy unmatched	9,612	157.0 (80.1, 233.9)	1.6%	858	10.2 (5.4, 15.1)	1.2%

To put the 2020 findings in context, we provide measured electric and gas savings over time. Figure 4-1 provides measured electric savings and Figure 4-2 measured gas savings for the legacy program from 2009 to 2020. The current legacy group has continually registered electricity savings since the start of the HER program. While the savings for this group have persisted over the entire period, their upward trend has stalled since 2013 (the fifth year of the program) and decreased since 2017. The electric savings of the suspended group have generally been in decline since the group stopped receiving

HERs in 2011, generating insignificant savings in 2020. Since 2015, the electric savings among the suspended households remained on the edge of statistical significance before dipping below zero in 2019 and back above zero in 2020.

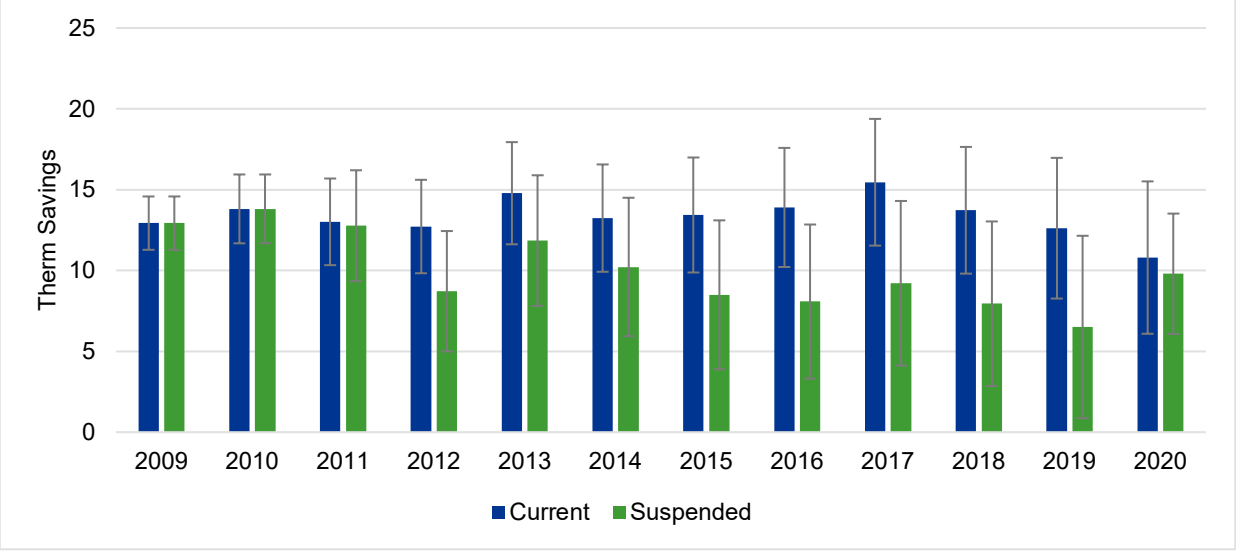
Gas savings also persist both for the current and suspended legacy groups. Gas savings do not have a marked trend and are not statistically different over the years. While legacy suspended gas savings have decreased since PSE discontinued HER messaging, 2020 measured savings of the suspended group are about the same as the legacy current households' gas savings.

Figure 4-1. Measured HER electric savings per household for legacy, 2009-2020



Note: The graph above shows the savings with upper and lower bounds at the 90% confidence level.

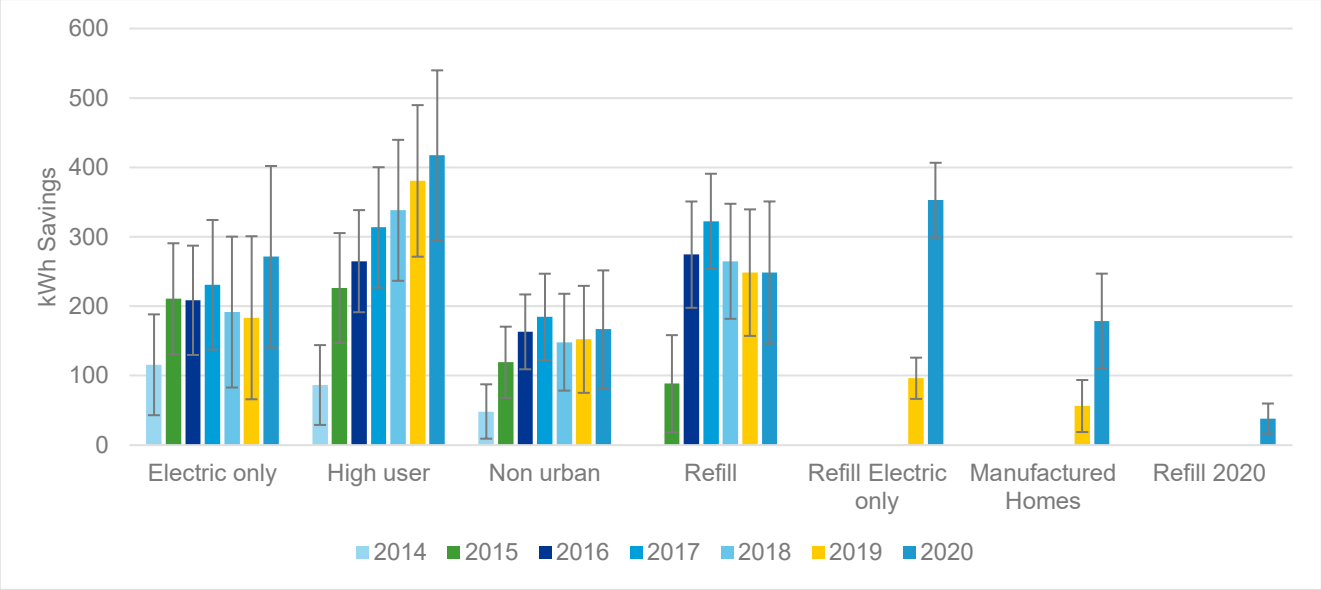
Figure 4-2. Measured HER gas savings per household for legacy, 2009-2020



Note: The graph above shows the savings with upper and lower bounds at the 90% confidence level.

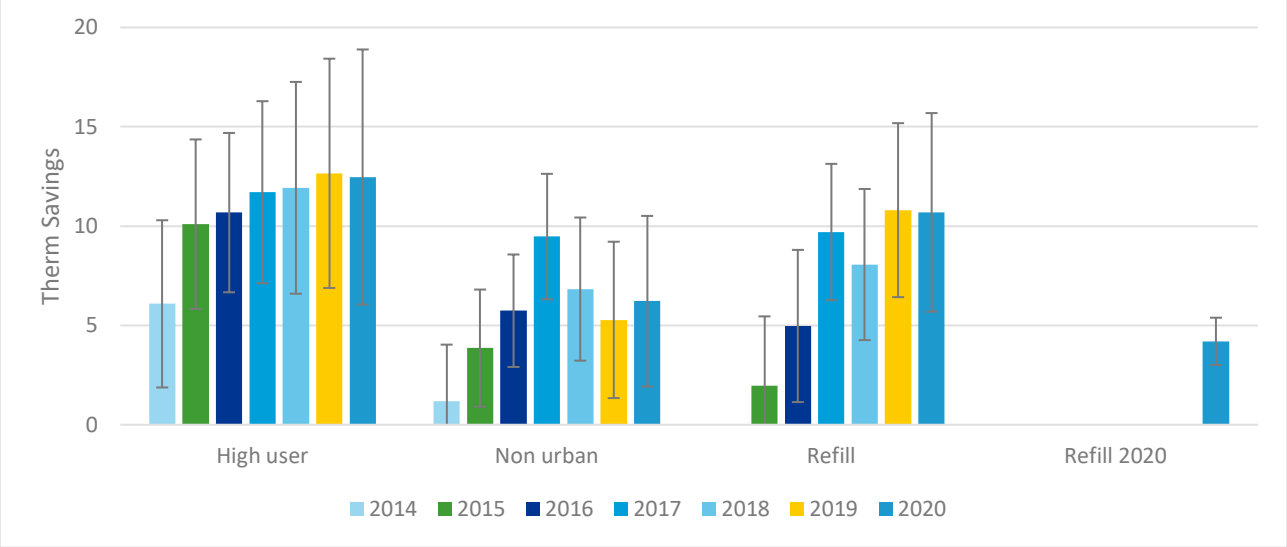
We provide expansion group electricity measured savings over time in Figure 4-3 and gas measured savings over time in Figure 4-4. The savings for 2014 reflect partial year HER messaging as the program began in March 2014 for high users, electric-only and non-urban households, all of which were in their sixth full-year of the program in 2020. The refill group is in its fifth full year since the program for this group began in May 2015. The refill 2020 group began in January 2020, so its results represent one full year. Measured electric and gas savings generally indicate an increasing trend for all expansion groups over time (except the first refill group) with the high-user group saving more electricity and gas in 2020 than in 2019. The increasing trend in savings for both electricity and gas follow patterns exhibited by other HER programs in their early years.

Figure 4-3. Measured electric per household expansion groups from 2014 to 2020



Note: The graph above shows the savings with upper and lower bounds at the 90% confidence level.

Figure 4-4. Measured gas savings per household expansion groups from 2014 to 2020



Note: The graph above shows the savings with upper and lower bounds at the 90% confidence level.

5 PROCESS EVALUATION RESULTS

This section summarizes the findings for the Home Energy Reports process evaluation and includes results from the program staff interview and online surveys.

5.1 Overview

The main objectives of this HER process evaluation are as follows:

1. Understand how energy-related customer behavior has changed during the COVID-19 pandemic and whether any changes are expected to persist after the pandemic
2. Understand how energy-using behaviors and technologies are different between customers who receive HERs and those who do not
3. Quantify the level of awareness and satisfaction among recipients of HERs
4. Determine whether low-income recipients find HERs useful and their level of engagement with the reports.

We present results related to these research objectives in the sections that follow. We also give a summary of recent and planned program changes in Section 5.2.1

5.2 Process Evaluation Results

Below we present key results from the process evaluation, including recent and planned program changes, participant awareness and satisfaction, and mechanisms for program changes.

5.2.1 Recent and Planned Program Changes

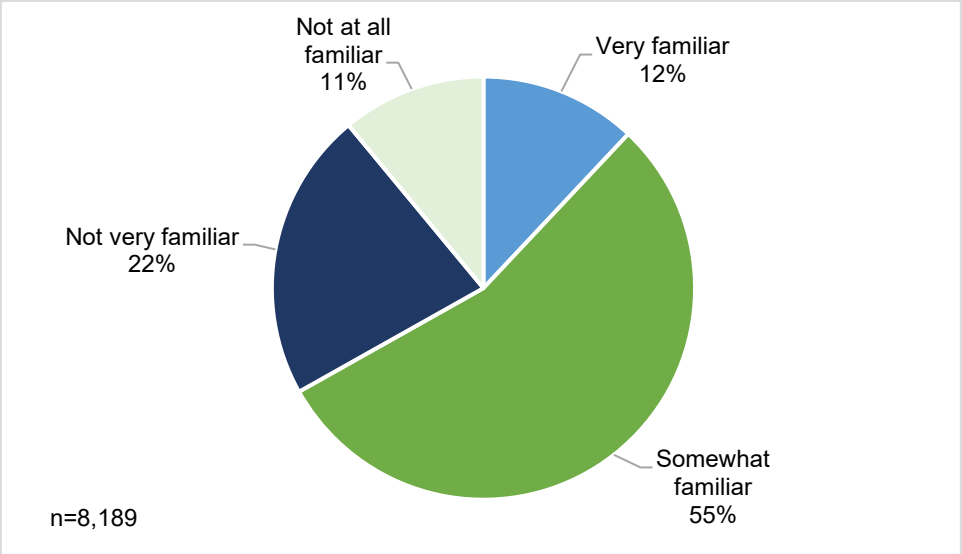
DNV spoke with the PSE home energy reports program manager about recent and planned program changes in June of 2021. In January 2020, PSE added a new group of Home Energy Report recipients, which included 90,000 treatment dual-fuel households and 30,000 control households. In September 2021, PSE added 85,000 recipients, which were gas-only households. Evaluators asked whether PSE offers HERs in languages other than English, such as Spanish. While PSE currently does not have concrete plans to offer Spanish language HERs, they are considering the addition of energy saving tips in Spanish on their website.

Changes for 2022 and beyond include the possible addition of households in multifamily buildings, a cohort comprised of households that recently moved, and a cohort for low to moderate income customers. PSE is also considering partnership opportunities moving forward where feasible.

5.2.2 Awareness

DNV assessed awareness of PSE's conservation programs and home energy reports through an online survey. We evaluated HER recipient awareness by first asking respondents how familiar they are with PSE's energy efficiency or conservation programs that are designed to help identify ways to use less energy or lower their bill. Figure 5-1 shows that over half (55%) of the 8,535 respondents reported being 'somewhat familiar' with energy efficiency or conservation programs, with only a relatively small percent (11%) of respondents being 'very familiar'.

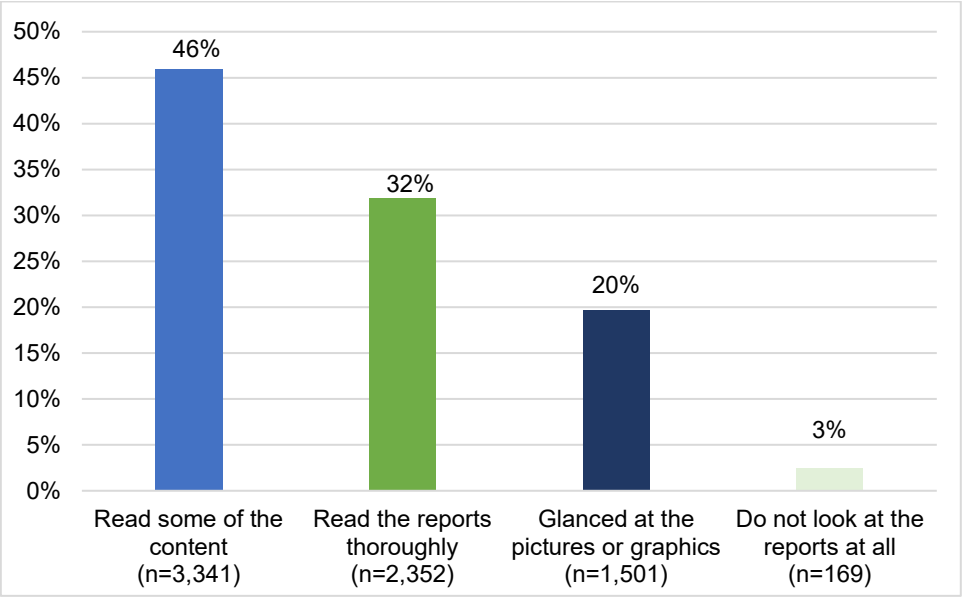
Figure 5-1. Familiarity with PSE's Energy Efficiency and Conservation Programs: Recipients



Program participants were then asked if they remembered receiving a HER from PSE in the past three months. A large majority (91%) of respondents stated they did remember receiving the HER, with the remainder reporting they either did not (5%) or were not sure (4%).[2]

Next, all respondents who said they did remember receiving the HER (n=7,363) were asked, in general, what they have done with them. As depicted in Figure 5-2, most of the participants either read some of the content (46%) or read the reports thoroughly (32%). Only 3% of the respondents said they did not look at them at all. This suggests that a vast majority of respondents have at least a moderate level of engagement with the HER reports they receive.

Figure 5-2. Level of Attention Given to Home Energy Reports

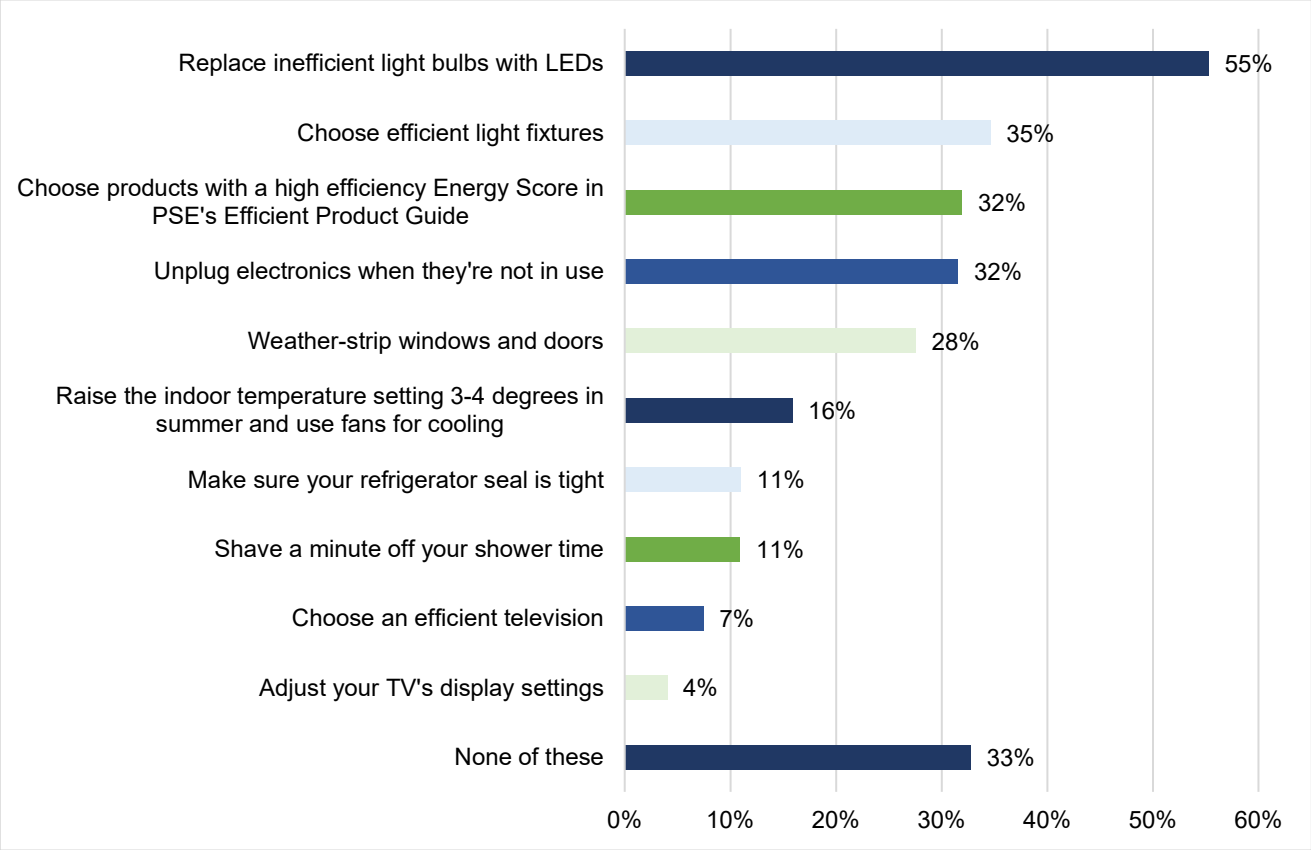


[2] There were 8,130 responses to this question.

Participants who remembered receiving the HER were then presented with a list of advertisements and messages and asked which they recalled seeing in the HER. Figure 5-3 shows over half (55%) of the participants who responded to this question recalled seeing the suggestion to replace inefficient light bulbs with LEDs. Roughly a third of the respondents remembered seeing the suggestion to choose efficient light fixtures (35%), choose products with high efficiency scores (32%), or unplug electronics when they're not in use (32%). One-third of the respondents (33%) reported they did not recall any of the messages presented to them.

Survey respondents were also presented with two messages that were not actually shown to participants on the HER. Twelve percent of respondents incorrectly recalled seeing the message to "use your microwave or grill to cook supper on hot days rather than your oven" and 5% incorrectly recalled seeing the message to "precool/preheat your home overnight and leave your AC/heating system off during the day."

Figure 5-3. Recall Specific Home Energy Report Messages



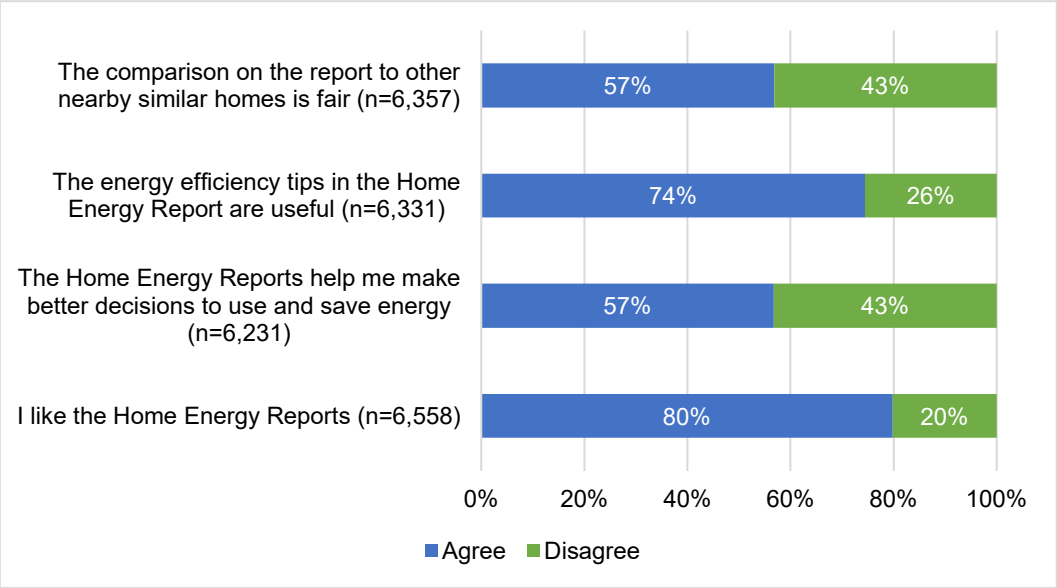
* Number of respondents = 6,955. Respondents were instructed to select all the messages they recalled, so the totals exceed 100%.

5.2.3 Satisfaction

Participant satisfaction was first evaluated by asking respondents if receiving the report made them more or less satisfied with PSE. Almost three-quarters (70%) of the survey respondents stated that their opinion of PSE did not change. Twenty-two percent reported that they were more satisfied with PSE after receiving the HER, with the remaining respondents (8%) being less satisfied.

Program participants were also asked to think about the home energy reports and then decide if they agree or disagree with the various statements presented in Figure 5-4. A large majority of respondents agreed that they liked the home energy reports (80%) and the energy efficiency tips within the report were useful (74%). Fewer respondents, though still a majority, agreed that the comparisons to similar homes were fair (57%) or that the reports helped them make better energy-related decisions (57%).

Figure 5-4. Program Experience and Satisfaction



5.2.4 Mechanisms for Savings

In addition to asking HER recipients about their awareness and satisfaction with the reports, we compared their self-reported energy usage behaviors to the control group of survey respondents who do not receive HERs. Table 5-1 contains self-reported percentages of HER recipients and non-recipients who use certain energy-consuming technologies. The technologies included in the survey were intended to represent new technologies and those that consume or large amounts of electricity.

Only one of these technologies shows a significant difference between groups: non-recipients are around 3% more likely than recipients to have window air conditioners (see Table 5-1). This could represent a small amount of the energy differential, given the high energy intensity of window air conditioners. However, for most of these technologies, we see no significant difference.

Table 5-1.: Comparison of recipient and non-recipient energy using technologies.

Which of the following technologies do you currently use?	Non-recipients (n=4,756)	Recipients (n=8,220)
Home hub or smart hub (like Amazon Alexa or Google Home)	32.2%	32.9%
Smart LED light bulbs, can be controlled by a phone app	22.2%	24.6%
Smart appliances, appliances that can be controlled by a phone app	13.3%	13.9%
Smart thermostat, (internet connected like Nest or Ecobee)	23.7%	23.4%
Central forced air, heat pump	47.8%	49.8%
Ductless heat pump or mini-split system	4.9%	6.4%
Air purifier	22.0%	21.2%
Window air conditioning unit	**25.6%**	22.9%
Solar photovoltaic panels	2.8%	2.4%
Battery storage (like Enphase or Powerwall)	0.5%	0.8%
Plug-in electric vehicle	7.0%	7.4%
None of these	16.3%	16.5%

* Bold text indicates a statistically significant difference between low income and not low income at 90% confidence level.

Table 5-2, similarly, shows very little significant difference between HER recipients and non-recipients. Recipients are significantly more likely to replace air filters on their space heating systems, and non-recipients are more likely to turn down heat at night. Overall, there is no trend to help explain whether or which energy-saving actions lead to overall HER savings.

Table 5-2. Comparison of recipient and non-recipient energy saving actions

Which of the following energy saving actions do you take in your home?	Non-recipients (n=4,744)	Recipients (n=8,248)
Keep water heater at a lower temperature	41.8%	40.8%
Clean/replace air filters on space heating system	63.1%	**65.2%**
Professionally maintenance performed on heat/cooling system	44.4%	45.6%
Turn down heat at night	**83.3%**	81.8%
Turn down heat when your home is unoccupied	79.6%	78.3%
Set cooling setpoint to higher temperature during the day	32.2%	31.9%
Set cooling setpoint to higher temperature when home is unoccupied	36.6%	35.4%
None of these	3.5%	3.2%

* Bold text indicates a statistically significant difference between low income and not low income at 90% confidence level.

We also asked more detailed questions about other specific home heating and cooling behaviors around smart thermostat settings. Again, we found minimal, if any, reported difference in temperature settings (cooling temperatures were significantly higher but heating temperatures were similar). We also found that the two groups had similar thermostat types and that HER recipients were slightly, but significantly more likely to prioritize comfortable temperatures. However, HER recipients were significantly more likely to program their smart thermostats and to override their heating settings.

Overall, these results suggest that the differences between HER recipients and non-recipients that lead to HER-associated savings are very small. It is possible that very small differences (not detectable at a statistically significant level) across

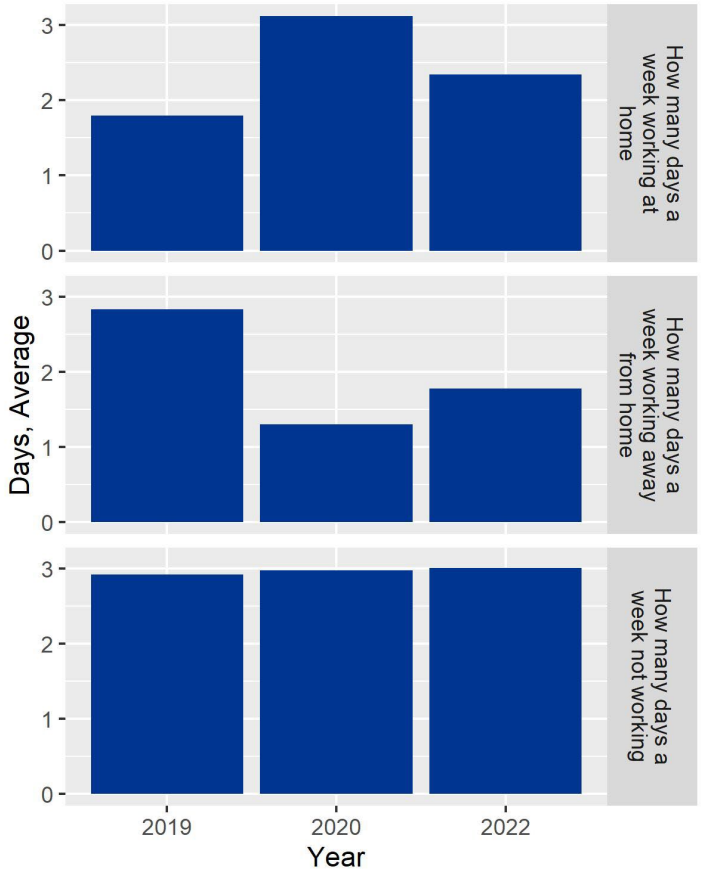
many different technologies and behaviors lead to these savings. However, even with the large sample sizes in these survey results, we are unable to conclusively identify those differences.

5.3 Other Online Survey Results

5.3.1 COVID Effects

As we designed the survey for this process evaluation, we hypothesized that the dramatic behavioral changes that accompanied the COVID-19 pandemic could affect the level of savings associated with home energy reports. While the final calculated savings amounts were not dramatically different in 2020 (i.e., during the COVID-19 pandemic) compared to 2019, survey respondents indicated that they spent much more time at home during 2020, and that they expect to spend more time at home in 2022. Figure 4-1 shows that average days worked away from home decreased during the pandemic, while average days worked from home increased. On average, survey respondents expected that their post-pandemic behavior will be in-between pre-pandemic and pandemic work life—they will continue to work from home more and away from home less compared to 2019.

Figure 5-5. Self-reported days working away from home, at home, and not working by year (2022 is 'expected').

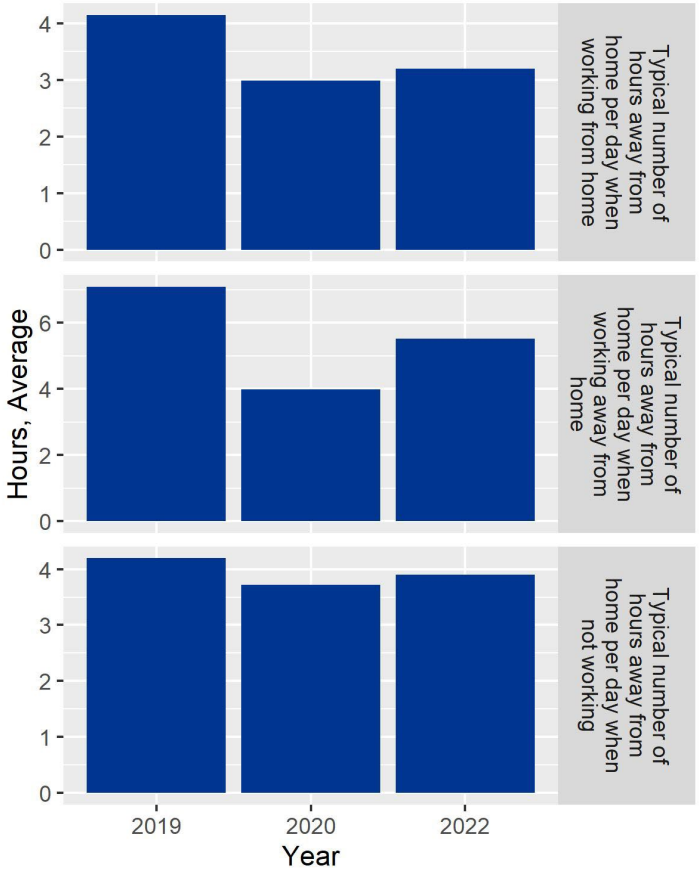


In addition to asking about days spent working at and away from home, we also asked survey recipients how many hours they were usually or expected to be away from home on these different day types. Figure 5-6 demonstrates that during the pandemic, respondents reported spending fewer hours away from home on all types of days, and they expect that this

increase in time at home will continue in 2022. Combining the trends in days worked from home and hours away from home, average reported weekly total hours at home went from 131 in 2019 to 143 in 2020, and respondents expected to spend about 139 hours at home in 2022.

While around a 6-9% increase in hours-at-home, the changes associated with the pandemic and post-pandemic world could influence which energy savings mechanisms are more and less important. For example, technologies and behaviors that save energy by reducing use when customers are away from their homes may be somewhat less important if customers are at home more. In contrast, technologies and behaviors that reduce energy use while customers are at home, especially while running work-from-home electronics, may be more important or present increased savings opportunities.

Figure 5-6. Self-reported hours away from home on days worked away from home, at home, and non-workdays.



5.3.2 Equity

One key goal of the customer survey we designed was to determine how low-income customers experienced HERs differently than non-low-income customers. We found that many low-income customers (defined here as having a self-reported income of less than $50,000) had different levels of awareness, satisfaction, and perceived usefulness of HERs, when compared to non-low-income customers.

We first explored customer awareness of PSE's energy efficiency programs overall (both HER recipients and non-recipients responded to this question). Specifically, we asked "How familiar are you with PSE's energy efficiency or conservation programs that are designed to help you identify ways to use less energy and lower your bill?" The results in Table 5-3

indicate that about 5% more low-income respondents were not at all familiar with programs and that about 3% more low-income respondents were very familiar with programs. This indicates that there is a segment of low-income customers who could see big benefits from outreach, but also a segment who are already very familiar with these programs.

Table 5-3. Familiarity with PSE's Energy Efficiency Programs: Low Income and Non-Low Income Customers

How familiar are you with PSE's energy efficiency or conservation programs that are designed to help you identify ways to use less energy and lower your bill?	Low Income (%) (n=1,153)	Non-low income (%) (n=4,471)
Not at all familiar	**16%**	11%
Not very familiar	18%	**23%**
Somewhat familiar	51%	**55%**
Very familiar	**14%**	11%

* Bold text indicates a statistically significant difference between low income and not low income at 90% confidence level.

We then asked HER recipients about their level of engagement with the reports: "Thinking of all the reports you have received, in general, what have you done with them?" Table 5-4 shows that low-income recipients are more likely to engage with the reports, with over 40% reading the reports thoroughly, as compared to only about 32% of other recipients.

Table 5-4. Level of Engagement with HERs: Low Income and Non-Low Income Customers

Thinking of all the reports you have received, in general, what have you done with them?	Low income (n=1,034)	Non-low Income (n=4,077)
Do not look at reports	5%	3%
Glanced at the pictures or graphics	15%	**20%**
Read some of the content	43%	**45%**
Read the reports thoroughly	**40%**	32%

* Bold text indicates a statistically significant difference between low income and not low income at 90% confidence level.

The last type of question where we saw differences in low-income responses were those that asked about report usefulness. Specifically, these questions asked if recipients found the home energy reports useful for making better decisions for using and saving energy and if the tips in the reports were helpful. Table 5-5 demonstrates that low-income recipients are about 5% more likely to find HERs useful as a decision-making aid and about 4% more likely to find the energy efficiency tips useful (when compared to medium and high-income recipients).

Table 5-5. Comparison of recipients' reported usefulness of HERs: Low Income and Non-Low Income Customers

Percentage who agree with these statements	Low Income	Non-low Income
The home energy reports help me make better decisions to use and save energy.	**64% (n=849)**	59% (n=3,520)
The energy efficiency tips in the Home Energy Report are useful.	**80% (n=868)**	76% (n=3,560)

* Bold text indicates a statistically significant difference between low income and not low income at 90% confidence level.

In other metrics of HER satisfaction or usefulness, low-income recipients tended to find HERs similarly useful compared to other recipients. All recipients had similar likelihood of remembering receiving HERs.

Overall, these results indicate that HERs are an effective mechanism of reaching out to PSE's low-income customers, reducing their energy burden, and promoting equity in energy savings.

6 FINDINGS AND RECOMMENDATIONS

6.1 Findings

Below are key findings from the impact evaluation:

- Total PSE HER 2020 electric savings are 46.6 million kWh and gas savings are 994,445 therms.
- After averaging more than 300 kWh savings per household for six years, the legacy current group has been generating fewer and fewer electric savings since 2018. Its measured gas savings has also been declining for the past four years.
- The suspended legacy group's electric savings continue to be statistically insignificant while its gas savings is nearly equal to the current legacy group's. This suggests that electric savings have not persisted without messaging from HERs while gas savings continue to maintain some level of persistence. Continued gas savings may be due to the installation of more efficient equipment, which persist after HERs are discontinued, while electric savings may be more dependent on behavioral changes, such as turning off lights and unplugging discretionary loads, which may be more short-lived.
- All previous expansion groups continue to save electricity and gas, with the high-user group generating an increase in electric savings from the previous year and generating nearly the same amount of gas savings as the previous year.
- The two new expansion waves from 2019, the electric only refill and the manufactured homes, show an increase in electric savings in 2020, following similar trajectories as the original expansion trio.
- Evaluators uncovered some extreme values in the consumption data, particularly within gas consumption data. These may be caused by errors at the meter level.

Key findings from the process evaluation are as follows:

- Ninety-one percent of HER recipients are aware they receive the report, and 66% are aware of PSE's energy efficiency programs. More than three-quarters of recipients (78%) reported reading at least some of the report. However, fewer than half of recipients remembered seeing any message other than the recommendation to replace light bulbs with LEDs (55% recalled messaging about replacing light bulbs). Additionally, one-third of respondents do not recall any of the messages from HERs.
- Eighty percent of recipients liked the reports and 92% reported that, after receiving the reports, their opinion of PSE was either unchanged or more favorable.
- Home energy reports appear to be an effective method to promote equity in energy savings. Of low-income report recipients, 40% report reading the reports thoroughly, as compared to 32% of non-low-income customers. Low-income recipients are also more likely to find the reports useful to help save energy; eighty percent of low-income

recipients report that the energy efficiency tips in the reports are useful compared to 76% of non-low-income recipients.

- PSE customers expect that, on average, they will continue to stay home for about 6% more hours (about 8 hours more per week) in 2022.

- Results show minimal difference in the energy savings behaviors and technologies examined in the survey. It is possible that differences too small to show statistical significance, over many behaviors and technologies, yield the meaningful savings found in the impact evaluation.

6.2 Recommendations

- PSE should consider further investigating the source of and reasons for extreme values that appear in the daily consumption data. This could ultimately produce more accurate consumption data and reduce the need to remove extreme values from the analysis.

- Because PSE customers expect that they will continue to spend more time at home after the pandemic, technologies and behaviors that save energy by reducing use when customers are away from their homes may be somewhat less important. In contrast, technologies and behaviors that reduce energy use while customers are at home, especially while running work-from-home electronics, may be more important or present increased savings opportunities.

- HERs are both an effective way to save energy and are broadly popular. Simple messages are remembered best. If PSE's goals adjust to focus on decarbonization instead of energy efficiency, a similar report recommending simple actions to achieve decarbonization is likely to be effective and popular. However, it is important to note that electrification will increase load and, if unaddressed in the impact evaluation methodology, subsequent evaluations would report lower energy savings. Therefore, if PSE choses to message electrification measures, it should simultaneously develop an energy savings methodology in coordination with evaluators and the stakeholder groups to ensure it does not unfairly affect its energy savings estimates.

7 APPENDICES

7.1 Appendix A: Online Survey Sample Design

For this program both electric (kWh) and gas (therm) savings were claimed. In order to understand both electric and gas savings, the total kBtu was calculated combining the electric and gas annual consumptions into a single common unit of measure for the sample design.

For the Home Energy Report, the sampling methodology employs a stratified ratio estimation technique. This stratified ratio estimation approach will study a subset of units, i.e., sample, drawn from the full population. The sample design approach first places participants into groups of interest (HER wave and treatment status – control or participant) and then place them into strata by size, measured in terms of kBtu annual consumption. For each wave and treatment status combination, 40% of customers were sampled.

The first step in the sample design process was to sampling frame of measures for each group of interest. Table 7-1 presents the Home Energy Report population summary statistics by wave and treatment status.

Table 7-1. Home Energy Report Population Summary

HER Wave	Treatment Status	Accounts	Annual kBtu Consumption	Mean kBtu Consumption
Expansion - Electric Only	Control	5,605	4,858,094,714	866,743
Expansion - Electric Only	Recipient	16,875	13,868,520,558	821,838
Expansion - High User	Control	4,989	325,697,249,271	65,283,073
Expansion - High User	Recipient	14,840	947,967,407,867	63,879,205
Expansion - Manufactured Homes	Control	8,477	2,660,559,064	313,856
Expansion - Manufactured Homes	Recipient	34,017	10,810,844,400	317,807
Expansion - Non Urban	Control	7,547	470,032,175,359	62,280,665
Expansion - Non Urban	Recipient	22,436	1,326,209,626,091	59,110,787
Expansion - Refill	Control	6,469	444,199,478,960	68,665,865
Expansion - Refill	Recipient	15,277	1,037,043,380,378	67,882,659
Expansion - Refill 2020	Control	29,870	1,643,620,715,760	55,025,802
Expansion - Refill 2020	Recipient	89,516	5,050,525,551,948	56,420,367
Expansion - Refill Electric Only	Control	22,207	59,577,063,154	2,682,806
Expansion - Refill Electric Only	Recipient	57,637	153,662,263,326	2,666,035
Legacy - Current	Control	20,862	1,294,149,720,972	62,033,828
Legacy - Current	Recipient	11,080	675,861,277,066	60,998,310
Legacy - Suspended	Recipient	5,503	337,771,645,285	61,379,547

Once sampling frames were defined, we stratified the population on the annual kBtu consumption. Next, sample sizes were calculated and finally we randomly chose sample points from the population in each stratum. The sample design for each

cohort is presented in Table 7-2 through Table 7-10. The tables show the number of customers, the maximum kBtu annual consumption, the total kBtu consumption for all customers, the number of sample points, and the inclusion probability for each stratum for HER treatment and control customers.

Table 7-2. Expansion – Electric Only Stratification

Treatment Status	Stratum	Maximum	Accounts	Annual kBtu Consumption	Sample	Inclusion Probability
Control	1	32,830	2,083	41,094,941	432	21%
Control	2	46,610	1,112	44,088,016	432	39%
Control	3	60,022	924	48,950,113	431	47%
Control	4	78,954	780	53,349,679	431	55%
Control	5	297,626	605	60,636,868	431	71%
Control	6	213,652,925	81	4,327,393,506	81	100%
Recipient	1	32,875	6,340	123,759,421	1,299	20%
Recipient	2	46,621	3,572	142,056,932	1,299	36%
Recipient	3	60,056	2,793	147,721,696	1,299	47%
Recipient	4	79,019	2,245	153,812,000	1,299	58%
Recipient	5	975,767	1,599	166,177,031	1,298	81%
Recipient	6	168,551,707	250	12,496,577,604	250	100%

Table 7-3. High User Stratification

Treatment Status	Stratum	Maximum	Accounts	Annual kBtu Consumption	Sample	Inclusion Probability
Control	1	48,388,432	1,599	52,073,381,009	392	25%
Control	2	62,527,052	1,058	58,583,961,086	391	37%
Control	3	76,449,724	853	59,014,468,170	391	46%
Control	4	98,034,564	758	64,975,362,176	391	52%
Control	5	194,061,608	563	69,503,438,707	391	69%
Control	6	1,166,915,041	38	11,946,388,131	38	100%
Recipient	1	48,398,430	4,917	153,889,384,203	1,163	24%
Recipient	2	62,555,046	3,092	171,219,529,750	1,162	38%
Recipient	3	76,436,727	2,626	181,238,670,603	1,162	44%
Recipient	4	98,026,566	2,123	182,101,787,269	1,162	55%
Recipient	5	196,666,985	1,592	195,631,770,829	1,162	73%
Recipient	6	1,067,222,873	121	34,773,884,055	121	100%

Table 7-4. Manufactured Homes Stratification

Treatment Status	Stratum	Maximum	Accounts	Annual kBtu Consumption	Sample	Inclusion Probability
Control	1	34,850	2,935	60,542,063	667	23%
Control	2	46,003	1,760	71,103,825	667	38%
Control	3	56,632	1,438	73,538,691	667	46%
Control	4	71,778	1,277	80,742,746	666	52%
Control	5	402,695	977	87,780,368	666	68%
Control	6	102,365,529	57	2,285,777,569	57	100%
Recipient	1	34,849	12,299	256,541,197	2,671	22%
Recipient	2	46,017	6,993	283,424,753	2,670	38%
Recipient	3	56,635	5,826	297,623,117	2,670	46%
Recipient	4	71,799	4,850	307,068,719	2,670	55%
Recipient	5	342,076	3,664	329,720,685	2,670	73%
Recipient	6	589,503,075	254	9,280,029,543	254	100%

Table 7-5. Non-Urban Stratification

Treatment Status	Stratum	Maximum	Accounts	Annual kBtu Consumption	Sample	Inclusion Probability
Control	1	46,856,799	2,404	75,787,444,175	594	25%
Control	2	59,641,742	1,525	81,259,025,450	594	39%
Control	3	72,124,758	1,322	86,537,287,644	593	45%
Control	4	89,382,632	1,142	91,109,925,522	593	52%
Control	5	185,857,569	925	102,265,874,813	593	64%
Control	6	2,097,754,517	50	19,704,145,583	50	100%
Recipient	1	46,854,799	7,396	166,849,590,379	1,762	24%
Recipient	2	59,641,742	4,672	249,043,171,453	1,762	38%
Recipient	3	72,124,758	3,902	256,011,985,508	1,761	45%
Recipient	4	89,488,607	3,298	262,583,714,490	1,761	53%
Recipient	5	186,955,307	2,484	274,524,616,932	1,761	71%
Recipient	6	2,216,730,075	158	53,963,802,568	158	100%

Table 7-6. Refill Stratification

Treatment Status	Stratum	Maximum	Accounts	Annual kBtu Consumption	Sample	Inclusion Probability
Control	1	53,989,094	2,011	73,212,412,066	513	26%
Control	2	67,165,944	1,299	78,819,201,707	513	39%
Control	3	80,114,848	1,158	84,900,168,009	513	44%
Control	4	98,844,371	992	87,577,969,861	513	52%
Control	5	207,366,428	800	97,492,580,703	512	64%
Control	6	1,037,947,871	24	7,793,824,831	23	96%
Recipient	1	53,985,094	4,885	179,545,665,124	1,211	25%
Recipient	2	67,169,943	3,177	192,388,955,048	1,211	38%
Recipient	3	80,130,844	2,680	196,304,102,104	1,210	45%
Recipient	4	98,886,361	2,290	202,354,005,831	1,210	53%
Recipient	5	208,634,125	1,742	211,397,669,879	1,210	69%
Recipient	6	1,251,760,758	55	19,841,798,876	55	100%

Table 7-7. Refill 2020 Stratification

Treatment Status	Stratum	Maximum	Accounts	Annual kBtu Consumption	Sample	Inclusion Probability
Control	1	43,899,506	10,094	218,563,303,286	2,347	23%
Control	2	56,880,402	6,084	307,313,603,491	2,347	39%
Control	3	69,199,457	5,160	323,585,206,648	2,346	45%
Control	4	86,447,334	4,266	327,895,900,146	2,346	55%
Control	5	171,425,020	3,386	360,039,107,083	2,346	69%
Control	6	2,688,179,372	207	57,302,028,041	207	100%
Recipient	1	43,899,506	30,724	854,353,578,737	7,047	23%
Recipient	2	56,880,402	18,288	921,997,630,888	7,047	39%
Recipient	3	69,205,456	15,185	952,625,285,229	7,047	46%
Recipient	4	86,457,332	12,995	997,056,404,453	7,047	54%
Recipient	5	172,348,799	9,827	1,043,448,947,085	7,046	72%
Recipient	6	2,099,931,996	546	141,693,214,226	546	100%

Table 7-8. Refill Electric Only Stratification

Treatment Status	Stratum	Maximum	Accounts	Annual kBtu Consumption	Sample	Inclusion Probability
Control	1	54,110	6,361	241,399,004	1,613	25%
Control	2	63,797	4,631	273,090,239	1,612	35%
Control	3	74,968	4,086	282,125,717	1,612	39%
Control	4	92,788	3,544	293,229,920	1,612	45%
Control	5	3,787,095	2,676	353,642,851	1,612	60%
Control	6	677,330,079	804	55,562,344,425	804	100%
Recipient	1	54,113	17,485	311,170,300	4,181	24%
Recipient	2	63,796	11,878	699,263,030	4,181	35%
Recipient	3	74,973	10,449	721,162,937	4,181	40%
Recipient	4	92,795	9,052	747,224,703	4,181	46%
Recipient	5	3,723,110	6,358	836,105,924	4,180	66%
Recipient	6	821,378,644	2,095	145,212,874,826	2,095	100%

Table 7-9. Legacy Current Stratification

Treatment Status	Stratum	Maximum	Accounts	Annual kBtu Consumption	Sample	Inclusion Probability
Control	1	49,134,254	6,261	223,652,894,876	1,666	27%
Control	2	60,505,536	4,347	238,705,959,637	1,666	38%
Control	3	71,768,843	3,801	250,683,145,406	1,666	44%
Control	4	87,303,130	3,284	258,648,476,236	1,666	51%
Control	5	190,278,513	2,618	276,677,405,292	1,665	64%
Control	6	2,223,562,442	14	7,086,566,906	14	100%
Recipient	1	49,134,254	3,432	122,893,754,897	886	26%
Recipient	2	60,505,536	2,359	129,353,712,072	886	38%
Recipient	3	71,762,845	1,978	130,510,560,519	885	45%
Recipient	4	87,319,126	1,706	134,175,425,407	885	52%
Recipient	5	183,680,090	1,323	138,861,939,063	885	67%
Recipient	6	260,101,821	5	1,136,166,391	5	100%

Table 7-10. Legacy Suspended Stratification

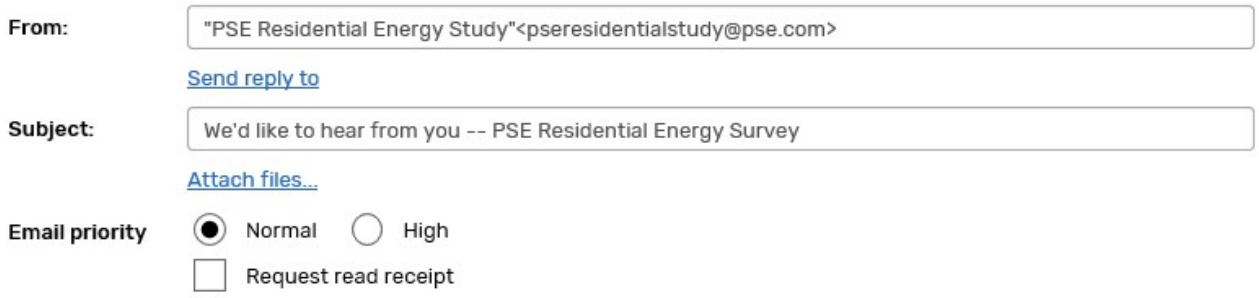
Treatment Status	Stratum	Maximum	Accounts	Annual kBtu Consumption	Sample	Inclusion Probability
Recipient	1	48,642,372	1,674	58,978,781,708	440	26%
Recipient	2	59,881,685	1,157	63,121,462,364	440	38%
Recipient	3	71,856,822	1,002	65,478,262,954	440	44%
Recipient	4	87,625,053	862	67,668,989,245	439	51%
Recipient	5	176,695,760	672	71,134,469,797	439	65%
Recipient	6	1,658,345,561	3	2,165,928,219	3	100%

7.2 Appendix B: Data Collection Instrument

DNV

2021 PSE's Home Energy Report Part & Non-Part Online Survey

SURVEY NOTIFICATION LETTER AND SURVEY INVITE



Dear PSE Customer,

Puget Sound Energy is committed to providing its customers with safe, reliable, and reasonably priced energy service. As part of this effort, we are conducting a Residential Energy Survey with DNV Energy (www.dnv.com), a company specializing in energy research, to learn more about lighting and energy usage in homes. This information will be used to help us make improvements to existing energy efficiency programs. The survey should only take ten minutes, and your responses are completely anonymous.

We value your help. Your participation is very important as only a limited number of customers were selected to take this survey.

Please complete the survey online. To get started, click here: **[ST]** This survey can be completed on a on mobile device, tablet, or a desktop computer**.**

Your answers will be held in the strictest of confidence. The information you provide will be combined with information from other households that complete the survey. Individual household responses will not be published. The results are reported in summaries such as group averages, percentages, and other general statistics.

Reward for you Participation: Don't delay. Submit your survey by August 31st and you will be entered into a drawing for a $300 Amazon gift card. If you wait until after the 31st you will be entered into a drawing for $200 Amazon card. The survey concludes on September 17th, 2021. For more information on the contest rules please visit: https://www.pse.com/pages/pse-events/rules.

If you have any questions about the survey, please contact the PSE Energy Efficiency Evaluations Group at EESEvaluations@PSE.com Thank you for participating in PSE's survey. We appreciate your input!

Kasey Curtis
Sr. Market Analyst
Strategic Planning, Evaluation and Research

PSE PUGET SOUND ENERGY

Puget Sound Energy
355 110th Ave NE
Bellevue, WA 98004

If you no longer wish to receive this survey or related emails, you may unsubscribe by clicking on this link: **[REMOVE]**

SURVEY

Lighting

1. Do you have an active account with PSE at this {address}?

    a1. Yes
    a2. No [END]

2. LED light bulbs are the most efficient light bulbs available on the market and come in many shapes and sizes. In this section we would like to learn about your household's purchase of LEDs light bulbs Have you heard of LED lights?

    a1. Yes
    a2. No [Skip to SECTION ON COVID]
    a3. Don't know [Skip to SECTION ON COVID]

3. In year 2021 or 2020 did anyone in your household purchase and install any of the following lights: LED screw-based bulbs, hard-wired fixtures, patio-style LED string lights, or linear LED tubes? Select all that apply.

    a1. LED screw-based bulbs
    a2. LED hard-wired fixtures
    a3. LED patio-style string lights
    a4. LED linear tubes
    a5. None of these

4. [Show if Q3= a1] Approximately how many LED screw-based light bulbs your household purchased in the following years? If you purchased any multi-packs, enter the total number of bulbs included in all packages. For example, two multi-packs with three bulbs each would count as six. Your best estimate is fine.

a1. Total purchases in 2021:
a2. Total purchases in 2020:

5. [Show if Q3= a2] Please indicate the number of LED fixtures your household purchased in the following years:

a1. Total purchases in 2021:
a2. Total purchases in 2020:

6. [Show if Q3= a3] Please indicate the number of LED patio-style LED string lights your household purchased in the following years:

a1. Total purchases in 2021:
a2. Total purchases in 2020:

7. [Show if Q3= a4] Please indicate the number of LED linear tubes lights your household purchased in the following years:

a1. Total purchases in 2021:
a2. Total purchases in 2020:

Household Response to the COVID Pandemic

8. In the next set of questions, we ask about home occupancy during a typical day where you worked outside of your home, worked at home, or did not work. We would like to learn about how your hours at home changed in the last

few years, including effects of the pandemic. The information collected is used for estimating household energy use. Below, please tell us about your typical weekly work schedule and time spent away from home in 2019.

	Days	Hours
	0 days, 1 day, 2 days, …7 days	1-4 hours 5-8 hours 9-12 hours 13-16 hours More than 16 hours Don't know
Q9. In the next set of questions, we ask about home occupancy during a typical day where you worked outside of your home, worked at home, or did not work. We would like to learn about how your hours at home changed in the last few years, including effects of the pandemic. The information collected is used for estimating household energy use. Below, please tell us about your typical weekly work schedule and time spent away from home in 2019. Please submit a response for all each category.		
In 2019, worked at home	DAYS	HOURS
In 2019, worked AWAY from home	DAYS	HOURS
In 2019, non-workdays	DAYS	HOURS
Q10 Below, please tell us about your typical weekly work schedule and time spent away from home in 2020. Please submit a response for all each category.		
In 2020, worked at home	DAYS	HOURS
In 2020, worked AWAY from home	DAYS	HOURS
In 2020, non-workdays	DAYS	HOURS
Q11. Below, please tell us about your expected weekly work schedule and time spent away from home in 2022. Please submit a response for all each category.		
In 2020, worked at home	DAYS	HOURS
In 2020, worked AWAY from home	DAYS	HOURS
In 2020, non-workdays	DAYS	HOURS

Q12. Did your household purchase and install any of the following in 2020: Select all that apply.

a1. Major household appliance, e.g., fridge, washer
a2. Heating, cooling, dehumidifier, or air purifier
a3. Water heating system
a4. Electronics, e.g., computer/monitor
a5. Insulate your home walls, floor, attic or ceiling
a6. None of these [exclusive]

[Show if appliance selected in Q12] Q13. Which of the following appliances did you purchase and install? Select all that apply.	**If the appliance is rated ENERGY STAR check this box**
a1. Freezer	[check box]
a2. Refrigerator	[check box]
a3. Clothes dryer- electric	[check box]
a4. Clothes dryer - gas	[check box]

a5. Clothes washer	[check box]
a6. Dishwasher	[check box]
[Show if heating/cooling selected in Q12] Q14. Which air heating, cooling or air comfort equipment did you purchase and install? Select all that apply.	**If the appliance is rated ENERGY STAR check this box**
a1. Air purifier	[check box]
a2. Air source heat pump	[check box]
a3. Boiler	[check box]
a4. Central air conditioner	[check box]
a5. Dehumidifier	[check box]
a6. Ductless heat pump	[check box]
a7. Electric furnace	[check box]
a8. Gas-powered furnace	[check box]
a9. Geothermal heat pump	[check box]
a10. Room/portable air conditioner	[check box]
a11. Uncertain of the technology (heater)	[check box]
a12. Uncertain of the technology (air conditioner)	[check box]
[Show if water heating selected in Q12] Q15. What kind of water heater did you purchase and install? Select all that apply.	**If the appliance is rated ENERGY STAR check this box**
a1. Electric water heater	[check box]
a2. Heat pump (also electric) water heater	[check box]
a3. Tankless water heater, electric	[check box]
a4. Tankless water heater, natural gas	[check box]
a5. Natural gas or propane water heater	[check box]
a6. Unsure of the technology (water heater)	[check box]
[Show if electronic selected in Q12] Q16. What electronics did you purchase? Select all that apply.	**If the appliance is rated ENERGY STAR check this box**
a1. Computer	[check box]
a2. Monitor	[check box]
a3. Television	[check box]
a4. Gaming devices	[check box]

Energy Saving Technologies and Behaviors

Q17. Which of the following technologies do you currently use?

a1. Home hub or smart hub (like Amazon Alexa or Google Home)
a2. Smart LED light bulbs, can be controlled by a phone app
a3. Smart appliances, appliances that can be controlled by a phone app
a4. Smart thermostat, (internet connected like Nest or Ecobee)
a5. Central forced air, heat pump
a6. Ductless heat pump or mini-split system
a7. Air purifier
a8. Window air conditioning unit
a9. Solar photovoltaic panels
a10. Battery storage (like Enphase or Powerwall)
a11. Plug-in electric vehicle
a12. None of these [exclusive]

Q18. [Show if selected in Q17] In which year did you install these technologies?

List options: 1. 2021 2. 2020 3. 2019 4. 2018-2015 5. Before 2015 6. Don't recall

a1. Home hub or smart hub (home automation system for devices like Alexa or Google Home)
a2. Smart LED light bulbs, can be controlled by a phone app
a3. Smart appliances, can be controlled by a phone app
a4. Smart thermostat, (internet connected like Nest or Ecobee)
a5. Central forced air, heat pump
a6. Ductless heat pump or mini split
a7. Air purifier
a8. Window air conditioning unit
a9. Solar photovoltaic panels
a10. Battery storage/backup e.g., Enphase or Powerwall
a11. Plug-in electric vehicle

Q19. Please describe any additional energy technologies you have in your home. (Optional)

Q20. Which energy saving actions do you take in your home?

a1. Keep water heater at a lower temperature
a2. Clean/replace air filters on space heating system
a3. Professionally maintenance performed on heat/cooling system
a4. Turn down heat at night
a5. Turn down heat when your home is unoccupied
a6. Set cooling setpoint to higher temperature during the day
a7. Set cooling setpoint to higher temperature when home is unoccupied
a8. None of these [exclusive]
a9. Other, specify:

Q21. In your search for a new large appliance such as a clothes dryer, home heating furnace, water heater, or central air conditioner, all else being equal, would you:

a1. Purchase a high efficiency appliance that costs a lot more?
a2. Purchase a high efficiency appliance that costs a little more?
a3. Purchase a standard efficiency appliance that costs a little less?
a4. Purchase a standard efficiency appliance that costs a lot less?
a5. Efficiency is not factored into my purchase decision?
a6. I do not make purchase decisions

Thermostat Use for Heating and Cooling

Q22. What type of thermostat does your household use?

a1. Non-programmable/manual thermostat [Go to Q26]
a2. Programmable thermostat that can be set to different temperatures for different times [Go to Q26]
a3. Smart thermostat, e.g., Nest, Lyric, Sensi or Ecobee [Go to Q23]
a4. No thermostat [Go to SECTION BILL PAY]

Q23. A smart thermostat can learn energy consumption habits of users through automation. Please select the response choice that best describes the settings/programming of your new smart thermostat:

a1. I use factory default settings
a2. Contractor/installer programmed the settings
a3. I have provided some setting preferences and minimal programming of my thermostat
a4. I programmed my thermostat settings per my schedule and comfort needs
a5. Let the smart thermostat programming/algorithm learn my household's habits and set an automatic schedule
a6. My smart thermostat is not working/turned on
a7. Don't know
a8. Other, please specify:

Q24 Do you use a mobile app to access your smart thermostat?

a1. Yes
a2. No

Q25. Which of the following smart thermostat device or mobile app features do you use? Select all that apply.

a1. Remotely lock thermostat use
a2. Remotely adjust home temperature
a3. Pre-cool or pre-heat the home to an exact specified time (e.g., use the "Early On" feature)

a4. Use an "Auto Away" feature, where the set point will automatically revert to the set-back temperature if the sensor senses no activity
a5. Use the "Cool to Dry" feature which runs the air conditioner to reduce humidity
a6. Use the smart thermostat to schedule the HVAC system fan
a7. None of these [exclusive]
a8. Other, specify:

Q26. If your main heating system is controlled by a thermostat, what is the average thermostat temperature usually set for during the heating season?

a1. Below 55
a2. 56-60
a3. 61-65
a4. 66-70
a5. 71-75
a6. Above 75
a7. Off
a8. Don't know
a9. Not applicable/no thermostat
a10. Other, please specify:

Q27. How often do you override the thermostat temperature setpoint during the heating season?

a1. Most days
a2. A few days per week
a3. A few days per month
a4. Almost never
a5. Never
a6. I don’t control the thermostat
a7. I don’t have a thermostat
a8. Don’t know

Q28. Did you change the daytime heating temperature inside your home in December 2020 compared to December 2019? Please select the option below that best describes your actions.

a1. Yes, kept my home warmer
a2. Yes, kept my home cooler
a3. No changes
a4. Do not recall/Not applicable

Q29. Next, we would like to ask a few questions about cooling your home. Do you use central air conditioning to cool your home?

a1. Yes
a2. No [skip to Q33]

Q30. If your main cooling system is controlled by a thermostat, what is the average thermostat temperature usually set for during the cooling season?

a1. Below 70
a2. 70-71
a3. 72-73
a4. 74-75
a5. 76-77
a6. 78-79
a7. 80-81
a8. Above 82 degrees
a9. Off
a10. Don't know
a11. Other, please specify:

Q31. How often do you override the thermostat temperature setpoint during the cooling season?

a1. Most days
a2. A few days per week
a3. A few days per month
a4. Almost never

a5. Never
a6. I don't control the thermostat
a7. Don't know

Q32. Did you change the daytime cooling temperature inside your home in July 2020 compared to July 2019? Please select the option below that best describes your actions.

a1. Yes, kept my home warmer - used less cooling
a2. Yes, kept my home cooler - used more cooling
a3. No changes
a4. Do not recall/Not applicable

Q33. When you adjust your home heating and cooling, do you:

a1. Prioritize saving energy despite being uncomfortable
a2. Prioritize saving energy to the extent that you are somewhat uncomfortable
a3. Consider saving energy, but ensure that you are often comfortable
a4. Ensure that you are always comfortable regardless of the energy use
a5. I do not make decisions about home heating and cooling

Bill Pay

Q34. During 2020, did you ever have to choose between paying your electric and gas bill or paying another bill?

a1. Yes [continue to Q35]
a2. No
a3. Prefer not to say
a4. Don't know

Q35. In 2020, how many months did you have to choose between paying your electric and gas bill and paying another bill?

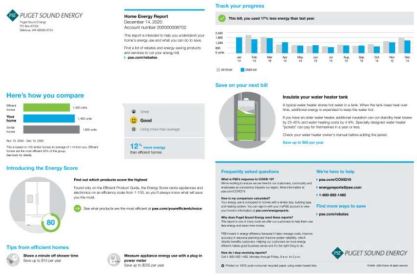
a1. Months

Home Energy Reports

Q36. How familiar are you with PSE's energy efficiency or conservation programs that are designed to help you identify ways to use less energy and lower your bill?

a1. Not at all familiar
a2. Not very familiar
a3. Somewhat familiar
a4. Very familiar

Q37. In the past three months, do you remember receiving a Home Energy Report from PSE about your in-home energy use?



a1. Yes
a2. No [Go to Q44- About Your Home]
a3. Don't know [Go to Q44- About Your Home]

Q38. Thinking of all the reports you have received, in general, what have you done with them?

a1. Read the reports thoroughly
a2. Read some of the content
a3. Glanced at the pictures or graphics
a1. Do not look at the reports at all [Go to Q40]

Q39. Do you recall seeing any of the following advertisements or messages in your Home Energy Report? Not all messages were shown to all Home Energy Report recipients. Check all that apply.

a1. Choose products with a high efficiency Energy Score in PSE's Efficient Product Guide
a2. Shave a minute off your shower time
a3. Choose efficient light fixtures
a4. Make sure your refrigerator seal is tight
a5. Use your microwave or grill to cook supper on hot days rather than your oven
a6. Raise the indoor temperature setting 3-4 degrees in summer and use fans for cooling
a7. Unplug electronics when they're not in use
a8. Choose an efficient television
a9. Adjust your TV's display settings
a10. Replace inefficient light bulbs with LEDs
a11. Precool/preheat your home overnight and leave your AC/heating system off during the day
a12. Weather-strip windows and doors
a13. None of these [exclusive]

Q40. Thinking about the Home Energy Reports you've received; how much do you agree or disagree with each of the following statements?

a1. I like the Home Energy Reports	[Agree/Disagree]
a2. The Home Energy Reports help me make better decisions to use and save energy	[Agree/Disagree
a3. The energy efficiency tips in the Home Energy Report are useful	[Agree/Disagree
a4. The comparison on the report to other nearby similar homes is fair	[Agree/Disagree

Q41. Has receiving the report made you more or less satisfied with PSE or has your opinion not changed?

a1. More satisfied
a2. Less satisfied
a3. Opinion unchanged

Q42. What aspect of the Home Energy Reports do you like the most? [Skip if Q38=a4]

[record]

Q43. What aspect of the Home Energy Reports should be improved? [Skip if Q38=a4]

[record]

About Your Home & Household

Q44. Do you own or rent?

a1. Own
a2. Rent
a3. Do not own or rent
a4. Prefer not to say

Q45. Which of the following building types best describes your home?

a1. Single-family detached home (home not attached to another home)
a2. Townhouse, duplex, or row house (shares exterior walls with neighboring unit, but not roof or floor)
a3. Apartment in multi-unit structure of 2–4 units
a4. Apartment in multi-unit structure of 5 or more units
a5. Manufactured or mobile home
a6. Other

Q46. Approximately how many square feet of living space is there in your home, including bathrooms, foyers and hallways? Exclude garages, unfinished basements or unheated porches.

a1. Less than 1,200 square feet
a2. 1,200 to less than 1,800 square feet
a3. 1,800 to less than 2.400 square feet
a4. 2,400 to less than 3,000 square feet
a5. 3,000 square feet or more
a6. Don't know

Q47. Did you complete a remodel or addition to your home between 2019 and 2020?

a1. Remodel
a2. Addition
a3. Both remodel and addition
a4. None of these

Q48. [If yes to Q47] How many square feet did you add?

a1. SQFT:

Q49. Approximately what year was this property built?

a1. Before the 1970s
a2. 1970s
a3. 1980s
a4. 1990s
a5. 2000-2009
a6. 2010-2015
a7. 2016 -2021
a8. Don't know

Q50. For each of the following age groups, how many people, including yourself, live in this home year-round? Please select one response for each age category.

Age category

a1. 5 and under
a2. 6–18
a3. 19–34
a4. 35–54
a5. 55–64
a6. 65 and over

Q51. How many people lived in your household, on average, in 2019 and in 2020? If you did not live in this home during these years, please skip this question.

a1. 2019
a2. 2020

Q52. What is the highest degree or level of school you have completed? If you're currently enrolled in school, please indicate the highest degree you have received.

a1. Elementary (grades 1-8)
a2. Some high school (grades 9-12)
a3. High school graduate
a4. Some college/trade/vocational school
a5. College graduate
a6. Postgraduate degree

a7. Prefer not to say
a8. Other (please specify)

Q53. What is the primary household language?

a1. English
a2. Spanish
a3. Chinese (including Mandarin and Cantonese)
a4. Tagalog
a5. Russian
a6. Vietnamese
a7. Korean
a8. Prefer not to say
a9. Other (please specify)

Q54. This information is collected for internal purposes only and remains confidential. Please check the range that best describes your household's 2020 total annual income.

a1. Less than $10,000
a2. $10,000 – $19,999
a3. $20,000 – $24,999
a4. $25,000 – $49,999
a5. $50,000 – $74,999
a6. $75,000 – $99,999
a7. $100,000 – $149,999
a8. $150,000 – $174,999
a9. $175,000 – $199,999
a10. $200,000 – $249,999
a11. $250,000 or more
a12. Prefer not to say

Q55. This concludes our survey. As a thank you for your participation your response will be entered into a drawing for a $300 Amazon e-gift card. If selected as the winning respondent, you will be notified by email. Would you like to be included in the incentive drawing?

a1. Yes, include my response in the drawing
a2. No, exclude my response in the drawing

7.3 Appendix C: Impact Evaluation Methods

7.3.1 Fixed Effects Model

We estimated monthly savings using a fixed-effects (FE) regression model that is standard for evaluating behavioral programs like HER. The FE model estimates program savings by comparing consumption of the treatment group to the control group before and after program implementation. The change that occurs in the treatment group is adjusted to reflect any change that occurred in the control group, to isolate changes attributable to the program.

The fixed effects equation is:

$$E_{it} = \mu_i + \lambda_t + \beta_t P_{it} + \varepsilon_{it}$$

Where:

E_{it} = Average daily energy consumption for account i during month t

P_{it} = Binary variable: one for households in the treatment group in the post period month *t*, zero otherwise

λ_t = Monthly effects

μ_i = Account level fixed effect

ε_{it} = Regression residual

This model produces estimates of average monthly savings using the following equation:

$$\bar{S}_t = \hat{\beta}_t$$

Where:

$\bar{S}_t$ = Average treatment related consumption reduction during month t

$\hat{\beta}_t$ = Estimated parameter measuring the treatment group difference in the post period month *t*

The model also includes site-specific and month/year fixed effects. The site-specific effects control for mean differences between the treatment and control groups that do not change over time. Baseline energy use is captured by estimates of λ_t in post-treatment period months. The month/year fixed effects control for change over time that is common to both treatment and control groups. The monthly post-program dummy variables pick up the average monthly effects of the treatment. During post-treatment months, the energy use of control households is estimated by $\widehat{\lambda_t}$ while those of the treatment households is estimated by $\widehat{\lambda_t}$+$\hat{\beta}_t$; the latter is a negative term that indicates reduction due to HER. This model is consistent with best practices as delineated in State and Local Energy Efficiency Action Network's (SEE Action) Evaluation, Measurement, and Verification (EM&V) of Residential Behavior-Based Energy Efficiency Programs: Issues and Recommendations.[3]

[3] https://www.energy.gov/sites/default/files/2021-08/emv_behaviorbased_eeprograms.pdf

7.4 Appendix D: Demographics of Online Survey Respondents

Table 7-11. Own or Rent Home

Own/Rent	Percent
Own	95%
Rent	5%
Do not own or rent	0%
Total	**100%**

n=12,593

Table 7-12. Home Building Type

Building Type	Percent
Single-family detached home (home not attached to another home)	86%
Townhouse, duplex, or row house (shares exterior walls with neighboring unit, but not roof or floor)	3%
Apartment in multi-unit structure of 2-4 units	0%
Apartment in multi-unit structure of 5 or more units	0%
Manufactured or mobile home	10%
Other	1%
Total	**100%**

n=12,779

Table 7-13. Living Space Square Footage

Living Space	Percent
Less than 1,200 square feet	8%
1,200 to less than 1,800 square feet	27%
1,800 to less than 2.400 square feet	28%
2,400 to less than 3,000 square feet	19%
3,000 square feet or more	18%
Total	**100%**

n=12,491

Table 7-14. Year Home Built

Year Built	Percent
Before the 1970s	21%
1970s	17%
1980s	18%
1990s	17%
2000-2009	17%
2010-2015	6%
2016 -2021	4%
Total	**100%**

n=12,553

Table 7-15. Highest Education Level

Education Level	Percent
Elementary (grades 1-8)	0%
Some high school (grades 9-12)	1%
High school graduate	6%
Some college/trade/vocational school	25%
College graduate	40%
Postgraduate degree	27%
Other (please specify)	1%
Total	**100%**

n=11,957

Table 7-16. Primary Household Language

Primary Language	Percent
Chinese (including Mandarin and Cantonese)	1%
English	96%
Korean	0%
Russian	0%
Spanish	1%
Tagalog	0%
Vietnamese	0%
Other (please specify)	2%
Total	**100%**

n=12,288

Table 7-17: 2020 Total Income Level

Income Range	Percent
Less than $10,000	1%
$10,000 - $19,999	2%
$20,000 - $24,999	2%
$25,000 - $49,999	10%
$50,000 - $74,999	14%
$75,000 - $99,999	17%
$100,000 - $149,999	22%
$150,000 - $174,999	8%
$175,000 - $199,999	6%
$200,000 - $249,999	6%
$250,000 or more	11%
Total	**100%**

n=8,979

About DNV

DNV is a global quality assurance and risk management company Driven by our purpose of safeguarding life, property and the environment, we enable our customers to advance the safety and sustainability of their business We provide classification, technical assurance, software and independent expert advisory services to the maritime, oil & gas, power and renewables industries We also provide certification, supply chain and data management services to customers across a wide range of industries Operating in more than 100 countries, our experts are dedicated to helping customers make the world safer, smarter and greener

PSE PUGET SOUND ENERGY

Evaluation Report Response

Program: Home Energy Reports

Program Manager: Chris Stapleton

Study Report Name: Evaluation of 2020 Home Energy Reports

Draft Report Date: December 23, 2021

Evaluation Analyst: Kasey Curtis, Jesse Durst, Michelle Wildie

Date Final Report provided to Program Manager: February 17, 2022

Date of Program Manager Response: February 18, 2022

Overview:

The Home Energy Reports (HER) program aims to reduce residential energy consumption by motivating no- to low-cost energy conservation actions. Participating households receive periodic reports which offer a mix of energy usage information, energy consumption benchmarking, and personalized advice for saving energy. The reports are designed to encourage energy conservation behavior for electric and gas customers.

The HER program evaluation was broken into two parts: an impact and a process evaluation. The impact evaluation covered the 2020 program year, while the process evaluation covered 2020-2021 biennium. A full impact evaluation of the 2021 program year is expected in Q2 2022.

The 2020 HER program impact evaluation was structured as a randomized controlled trial (RCT) where the eligible population was randomly assigned to treatment and control groups. The RCT design results in precise and unbiased estimates of savings per household since the only systematic difference between randomly assigned treatment and control households is treatment.

The 2020-21 process evaluation was designed to provide information on how the HER program creates savings and how it might increase those savings. This year's evaluation included two components: an interview of PSE HER program staff and a large-scale online survey of HER recipients and non-recipients to understand their behaviors and attitudes. The program staff interview was designed to understand challenges and opportunities from the perspective of a PSE program manager. The online survey was sent to a large sample of HER recipients and non-recipients from different survey waves to better understand customer behaviors that affect energy use, their attitudes toward the home energy reports, and how these might vary between different types of customers.

Key Findings

Key findings from the impact evaluation are as follows:

- Total PSE HER 2020 electric savings are 46.6 million kWh and gas savings are 994,445 therms.
- After averaging more than 300 kWh savings per household for six years, the legacy current group has been generating fewer and fewer electric savings since 2018. Its measured gas savings has also been declining for the past four years.
- The suspended legacy group's electric savings continue to be statistically insignificant while its gas savings is nearly equal to the current legacy group's. This suggests that electric savings have not persisted without messaging from HERs while gas savings continue to maintain some level of persistence. Continued gas savings may be due to the installation of more efficient equipment, which persist after HERs are discontinued, while electric savings may be more dependent on behavioral changes, such as turning off lights and unplugging discretionary loads, which may be more short-lived.
- All previous expansion groups continue to save electricity and gas, with the high-user group generating an increase in electric savings from the previous year and generating nearly the same amount of gas savings as the previous year.
- The two new expansion waves from 2019, the electric only refill and the manufactured homes, show an increase in electric savings in 2020, following similar trajectories as the original expansion trio.
- Evaluators uncovered some extreme values in the consumption data, particularly within gas consumption data. These may be caused by errors at the meter level.

Key findings from the process evaluation include the following:

- Ninety-one percent of HER recipients are aware they receive the report, and 66% are aware of PSE's energy efficiency programs. More than three-quarters of recipients (78%) reported reading at least some of the report. However, fewer than half of recipients remembered seeing any message other than the recommendation to replace light bulbs with LEDs (55% recalled messaging about replacing light bulbs). Additionally, one-third of respondents do not recall any of the messages from HERs.
- Eighty percent of recipients liked the reports and 92% reported that, after receiving the reports, their opinion of PSE was either unchanged or more favorable.
- Home energy reports appear to be an effective method to promote equity in energy savings. Of low-income report recipients, 40% report reading the reports thoroughly, as compared to 32% of non-low-income customers. Low-income recipients are also more likely to find the reports useful to help save energy; eighty percent of low-income recipients report that the energy efficiency tips in the reports are useful compared to 76% of non-low-income recipients.
- PSE customers expect that, on average, they will continue to stay home for about 6% more hours (about 8 hours more per week) in 2022.
- Results show minimal difference in the energy savings behaviors and technologies examined in the survey. It is possible that differences too small to show statistical

significance, over many behaviors and technologies, yield the meaningful savings found in the impact evaluation.

Evaluation Recommendations and Program Responses

Program recommendations are found in the Executive Summary (Section 1), as well as the Findings and Recommendations (Section 6). The report's overall conclusions and recommendations based on the impact and process related findings and program staff responses to those recommendations, are presented below.

- PSE should consider further investigating the source of and reasons for extreme values that appear in the daily consumption data. This could ultimately produce more accurate consumption data and reduce the need to remove extreme values from the analysis.

  Program Response: PSE will review and investigate this recommendation. As stated in the findings of the evaluation extreme values "may be caused by errors at the meter level." PSE will request if the evaluator can provide specific examples at the account level to research whether there is a theme that can be identified that may be causing this issue.

- Because PSE customers expect that they will continue to spend more time at home after the pandemic, technologies and behaviors that save energy by reducing use when customers are away from their homes may be somewhat less important. In contrast, technologies and behaviors that reduce energy use while customers are at home, especially while running work-from-home electronics, may be more important or present increased savings opportunities.

  Program Response: In 2022, PSE will continue to actively promote the online energy saving tools available to customers within their online accounts as a marketing module within the Home Energy Report. This should help customers perform the online assessment to gain better understanding about their home's energy usage and provide tips about how customers can be more energy efficient. Many of the tips apply whether the home is occupied, or not, but PSE does offer saving tips about spotlighting work areas, using electronic equipment (computers, monitors, etc.) efficiently.

- HERs are both an effective way to save energy and are broadly popular. Simple messages are remembered best. If PSE's goals adjust to focus on decarbonization instead of energy efficiency, a similar report recommending simple actions to achieve decarbonization is likely to be effective and popular. However, it is important to note that electrification will increase load and, if unaddressed in the impact evaluation methodology, subsequent evaluations would report lower energy savings. Therefore, if PSE chooses to message electrification measures, it should simultaneously develop an energy savings methodology in coordination with evaluators and the stakeholder groups to ensure it does not unfairly affect its energy savings estimates.

  Program Response: There is not a current plan to shift Home Energy Report messaging from an energy efficiency to a decarbonization focus. If that changes in the future, PSE will work with internal stakeholders and with evaluators to ensure the savings methodology is developed with potential changes in energy load in mind.