

Memo to:

Jim Perich-Anderson EES Evaluation (PSE)

From: DNV GL - Energy**Date:** 05-08-2020**Copied to:**

Jon Taffel

Geoff Barker

Ken Agnew

Prep. By: Lullit Getachew

Steven Chang

Chelsea Liddell

Subject: 2019 Home Energy Report Final Evaluation Results – Electric and Gas Savings

1 INTRODUCTION

This memo provides a summary of Puget Sound Energy's (PSE's) Home Energy Report (HER) legacy and expansion program savings for 2019. The 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 in 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. By program year 2019, about 17,600 (40%) 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 2019, about 38% of the original expansion 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 63% of the treatment households remain in the program in 2019.
- 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).

1.1 Evaluation Objectives

The main goal of this impact evaluation is to estimate HER legacy and expansion program savings for 2019. Specifically, the main objectives are as follows:

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
 - A HER-related increase in the number of purchased LED bulbs and fixtures supported by PSE upstream lighting programs
3. Provide an estimate of 2019 HER credited savings for legacy and expansion programs adjusted for joint savings resulting from participation in PSE rebate and upstream lighting programs in previous HER years.
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.¹ 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, and manufactured home groups for the HER expansion program. To quantify joint savings, DNV GL used the PSE program tracking data for downstream programs and a web-based participant survey for upstream lighting.²

1.2 Findings – Measured Savings and Rebate Savings

DNV GL's primary goal for this evaluation is to develop the 2019 PSE HER program credited savings. The estimated credited savings have three components. The first is the HER program's measured savings that reflects the program's impact on average household consumption. It is the average reduction in energy consumption of HER treated households. The second and third components are the rebate downstream and upstream retail lighting joint savings. To avoid double counting, DNV GL calculates credited savings by removing the downstream rebate and upstream joint savings from the HER measured savings.

¹ DNV GL used daily consumption data obtained from Opower (the program administrator) to do the 2019 analysis.

² Results to quantify upstream savings are based on a 2018 online survey of PSE-sponsored LED lighting purchases.

The downstream rebate joint savings are calculated from PSE tracking data while the upstream joint savings are estimated based on a survey. Like program year 2018, the 2019 upstream savings estimates are based on the 2018 online survey of PSE HER customers.

The credited savings DNV GL 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 3,268 unmatched households that have remained at the same premise since the start of the program. We estimated the unmatched group’s 2019 HER savings by applying the percentage savings of the legacy current group to the baseline consumption of the unmatched group.

Table 1-1 and Table 1-2 provide the group-level and overall electric and gas savings estimates, respectively. The overall electric savings were estimated at 90/20 precision and the gas savings were estimated at 90/25 precision. Legacy suspended customers showed no electric savings in 2019. All but one of the remaining HER groups had statistically significant electric savings. Overall, PSE HER electric customers saved 24,144 MWh in 2019.

Table 1-1 Total credited electric savings for 2019 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	210.78	7.55	203.23	11,718	2,381,417	1,519,851	3,242,983
Legacy - Suspended	-0.12	1.74	-1.86	5,885	0	0	0
Legacy - Unmatched [^]			187.28	3,268	612,018	371,739	852,298
Expansion - Electric only	183.45	68.87	114.58	17,867	2,047,164	-188,653	4,282,980
Expansion - High relative user	380.53	26.24	354.29	16,093	5,701,546	3,782,953	7,620,140
Expansion – Non-urban	152.32	43.81	108.51	24,234	2,629,708	627,647	4,631,769
Expansion - Refill	248.42	14.08	234.34	16,506	3,867,953	2,354,389	5,381,516
Expansion - Refill Electric only	96.26	11.22	85.04	62,549	5,318,973	3,156,078	7,481,869
Expansion - Manufactured Homes	56.34	12.97	43.37	36,558	1,585,438	53,342	3,117,534
ALL			124.02	194,678	24,144,218	19,368,816	28,919,620

*For the purpose of aggregation, the negative value will be zeroed out.

[^]Note that we calculated the unmatched per household savings by multiplying the legacy current per household savings as a percentage of consumption (2.2%) by the average household consumption of the unmatched group (8,697 kWh).

All PSE groups generated statistically significant gas savings (Table 1-2). Overall, PSE HER customers saved 679,044 therms in 2019.

Table 1-2 Total credited gas savings for 2019 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	12.62	1.66	10.95	11,718	128,355	75,869	180,841
Legacy - Suspended	6.51	0.00	6.51	5,885	38,283	5,080	71,485
Legacy - Unmatched [^]			11.99	3,268	39,172	24,534	53,810
Expansion - High relative user	12.66	1.27	11.39	16,093	183,296	86,319	280,272
Expansion – Non-urban	5.28	0.20	5.08	24,234	123,096	24,071	222,122
Expansion - Refill	10.80	0.69	10.11	16,506	166,843	92,653	241,032
ALL			8.74	77,704	679,044	509,380	848,708

[^]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 1-3. The legacy current treatment group produced credited electric and gas savings of 203.2 kWh or 2.2% and 11 therms or 1.4%, respectively. These savings were statistically significant. The suspended group had a statistically significant average reduction of 6.5 therms (0.8% savings per household) and no statistically significant kWh change. The absence of measured electric savings in 2019 suggests that the persistence of electric savings may be at an end nine years after HER messaging was discontinued. Gas savings, on the other hand, persist suggesting that the program has a lasting effect on gas conservation. Gas savings from the program may be due to installation of more efficient hardware, while electric savings may depend more on behavioral changes, such turning off lights and unplugging discretionary load. Efficient gas hardware remains after the program, while discretionary behaviors may attenuate.

Table 1-3 Summary of credited savings per household for PSE HER Legacy, 2019

Treatment Groups	Consumption	HER measured savings	Joint Savings	Credited savings	Percent credited savings
Electric (kWh)					
Current	9,438	210.8* (137.6,284.0)	7.6* (0.5, 14.6)	203.2* (129.7, 276.8)	2.2%
Suspended		-0.1 (-93.9,93.6)	1.7 (-7.3, 10.8)	0.0	0.0%
Gas (therms)					
Current	784	12.6* (8.3,17.0)	1.7* (0.6, 2.7)	11.0* (6.5, 15.4)	1.4%
Suspended		6.5* (0.9,12.1)	0.0 (0.0, 0.0)	6.5* (0.9, 12.1)	0.8%

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

Each expansion group, except the electric only, generated statistically significant credited electric and gas savings (Table 1-4). Among the expansion groups, the high user group generated the largest credited electric and gas savings. We note that the refill electric only and manufactured homes groups have only been in the field since May 2019, and the savings per household measured for these groups

reflect activity from a partial year only. These groups appear to have large baseline usage and the relatively high partial first-year savings per households may reflect this. 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. The 2015 and 2018 upstream lighting surveys indicated substantial upstream joint savings of 9.5 and 13.7 kWh for this wave, which are cumulative for the 5-year effective useful life of the rebated bulbs. If upstream residential rebates still in existence are limited both in scope (types of bulbs rebated) and volume, incremental upstream joint savings should be considered zero; prior year upstream savings that remain will continue to be deducted until the remaining useful life of rebated bulbs expire. A thorough review of rebate offerings for lighting is needed to verify that incremental upstream joint savings no longer apply.

Table 1-4 Summary of credited savings per household for PSE HER Expansion, 2019

Treatment Groups	Consumption	HER measured savings	Joint Savings	Credited savings	Percent credited savings
Electric (kWh)					
Electric Only	13,889	183.5*	68.9*	114.6	0.8%
		(65.7,301.2)	(26.6, 111.2)	(-10.6, 239.7)	
High User	10,824	380.5*	26.2	354.3*	3.3%
		(271.4,489.7)	(-21.7, 74.2)	(235.1, 473.5)	
Non-urban	9,572	152.3*	43.8*	108.5*	1.1%
		(75.3,229.4)	(14.0, 73.6)	(25.9, 191.1)	
Refill	11,682	248.4*	14.1*	234.3*	2.0%
		(157.3,339.5)	(3.7, 24.5)	(142.6, 326.0)	
Refill Electric only	12,202	96.3*	11.2	85.0*	0.7%
		(66.5,126.0)	(-6.5, 28.9)	(50.5, 119.6)	
Manufactured Homes	8,191	56.3*	13.0	43.4*	0.5%
		(18.9,93.8)	(-5.8, 31.7)	(1.5, 85.3)	
Gas (therms)					
High User	747	12.7*	1.3	11.4*	1.5%
		(6.9,18.4)	(-0.5, 3.0)	(6.2, 16.6)	
Non-urban	674	5.3*	0.2	5.1*	0.8%
		(1.3,9.2)	(-0.9, 1.3)	(1.6, 8.6)	
Refill	792	10.8*	0.7	10.1*	1.3%
		(6.4,15.2)	(-0.3, 1.7)	(6.2, 14.0)	

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

Table 1-5 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.

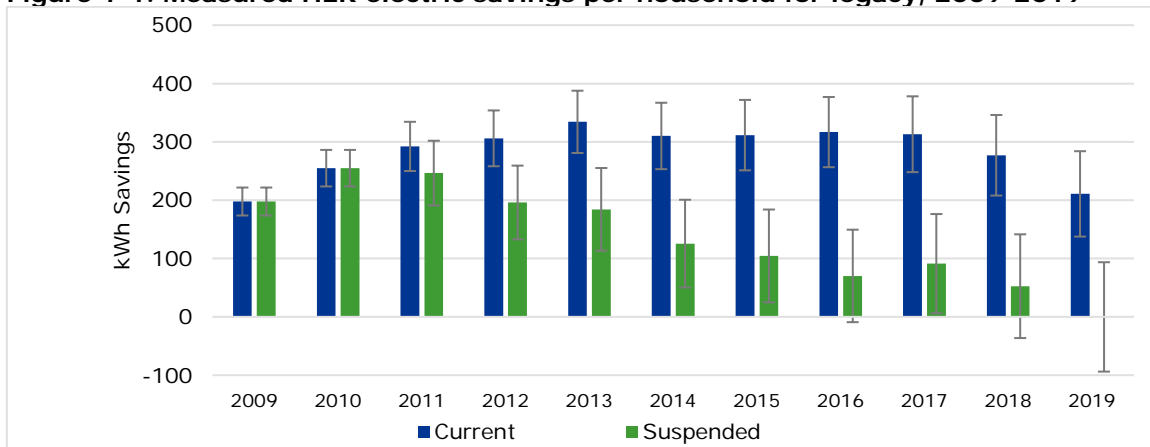
Table 1-5 Summary of credited savings for the unmatched group

	Electric (kWh)			Gas (therms)		
	Consumption	Savings	Percent	Consumption	Savings	Percent
Legacy unmatched	8,697	187.3	2.2%	858	12.0	1.4%
		(113.8, 260.8)			(7.5, 16.5)	

To put the 2019 findings in context, we provide measured electric and gas savings over time. Figure 1-1 provides measured electric savings and Figure 1-2 measured gas savings for the legacy program from 2009 to 2019. 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 no savings in 2019. Since 2015, the electric savings among the suspended households remained on the edge of statistical significance before dipping below zero in 2019.

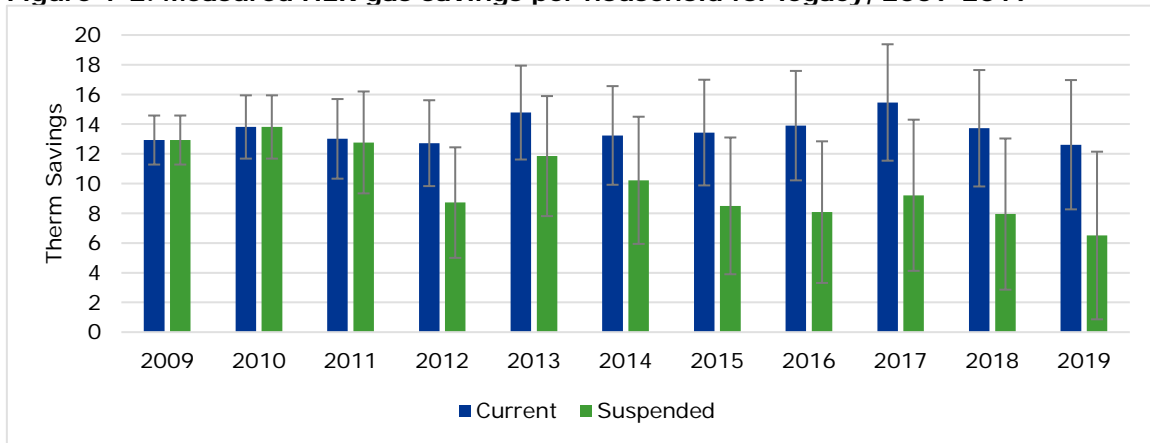
Gas savings also persist both for the current and suspended legacy groups. Gas savings do not have a marked trend and are not statistically different over the years. While legacy suspended gas savings have decreased since PSE discontinued HER messaging, 2019 measured savings of the suspended group are about 50% of those of the legacy current households' gas savings.

Figure 1-1. Measured HER electric savings per household for legacy, 2009-2019



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

Figure 1-2. Measured HER gas savings per household for legacy, 2009-2019

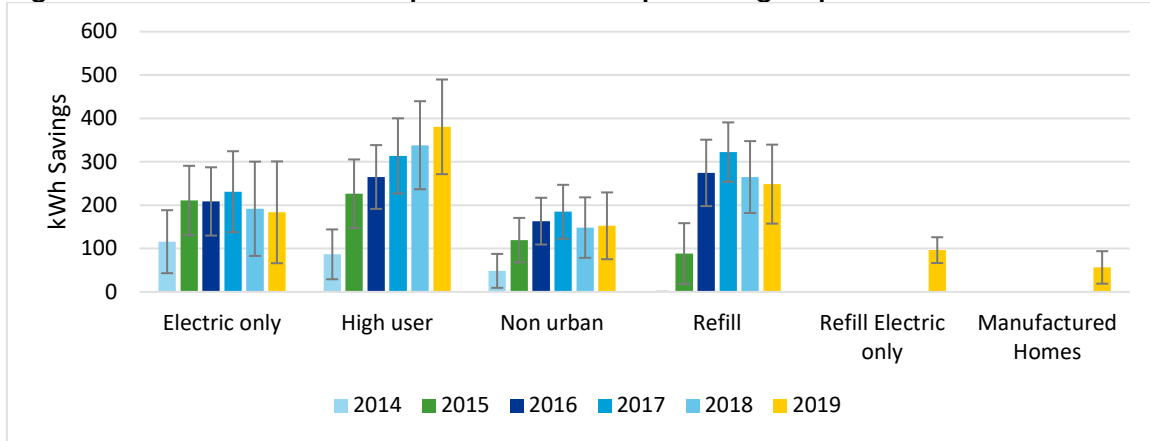


Note: The graph above shows the savings with upper and lower bounds at the 90% confidence level.

We provide expansion group electricity measured savings over time in Figure 1-3 and gas measured savings over time in Figure 1-4. 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 fifth full-year of the program in 2019. The refill group is in its fourth full year since the program for this group began in May 2015. The electric only refill and manufactured homes' savings reflect partial year

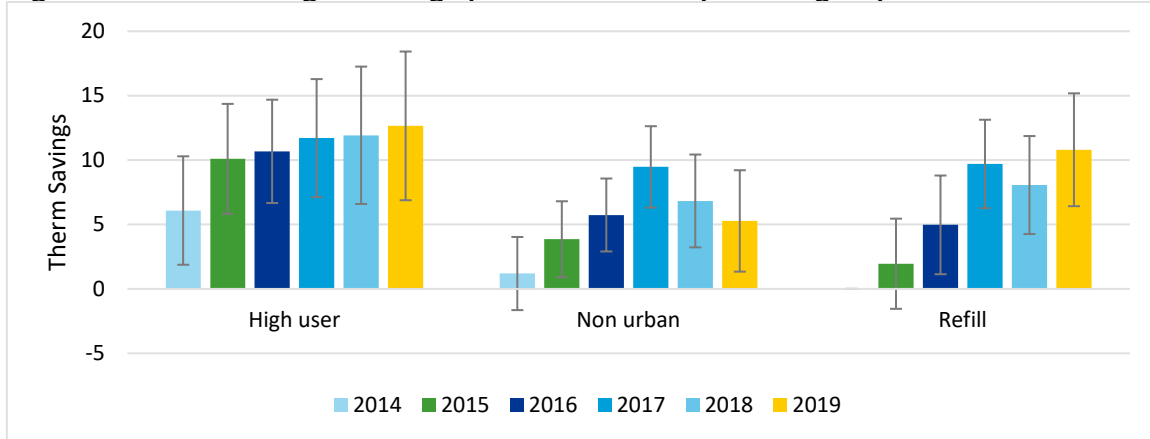
activity since both started in May 2019. Measured electric and gas savings generally indicate an increasing trend for all expansion groups over time with the high-user group saving more electricity and gas in 2019 than in 2018. The increasing trend in savings for both electricity and gas follow patterns exhibited by other HER programs in their early years.

Figure 1-3. Measured electric per household expansion groups from 2014 to 2019



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

Figure 1-4. Measured gas savings per household expansion groups from 2014 to 2019



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

2 CONCLUSIONS

We note the following general results:

- Measured electric savings are declining but still persist for the active legacy group.
- The legacy current group’s measured electric savings trend has decreased since the fifth year of the program while its measured gas savings have had no discernible trend and are not statistically significantly different from one another over time.
- The suspended legacy group’s electric and gas savings have been on a downward trend since households in the group stopped receiving HER, with no electric savings and gas savings at about 50% of the current group’s savings in 2019.

- All previous expansion groups continue to save electricity with the high-user group generating an increase from the previous year.
- All previous expansion groups continue to save gas, with the non-urban group saving slightly less than in 2019 than in the prior two years.
- The two new expansion waves, the electric only refill and the manufactured homes, show relatively high electric savings during the partial year in 2019 when they were active.
- Total PSE HER 2019 electric savings are 24.1 million kWh and gas savings are 679,044 therms.

3 RECOMMENDATIONS

- PSE should coordinate collaboration between DNV GL and its program implementer to clarify data handling and cleaning rules as well as methods used to generate savings estimates. Such collaboration will ultimately improve quality checks of evaluation results.
- We recommend a thorough review of retail lighting rebate offerings to determine if a survey needs to be delivered to estimate upstream joint savings.
- We recommend a survey that considers general energy efficiency related purchasing and use behavior among HER treatment and control customers to identify the mechanisms of HER savings.
- DNV GL also recommends a customer segmentation study to better understand which customer groups contribute to savings and to inform improved program design.
- Given the decline in per household savings observed in most waves, we recommend studying weather normalized HER savings to determine if per household savings are weather-dependent and if weather normalization can be used to improve forecasts of expected savings.
- A study that examines the persistence of HER savings in homes occupied by previous HER treatment customers, who have since moved out, would be useful to identify additional savings that the program may be generating.