PUGET SOUND ENERGY

2014
Web-Enabled Thermostat Impact Evaluation

Contents:

This document contains both the final Home Energy Reports Program Impact Evaluation and the Puget Sound Energy Evaluation Report Response (ERR). PSE program managers prepare an ERR upon completion of an evaluation of their program. The ERR addresses and documents pertinent adjustments in program metrics or processes subsequent to the evaluation.

DNV·GL

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Memo No: WET - 1
From: DNV GL - Energy
Date: 08/7/2015
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Subject:
Impact Evaluation of PSE Web-Enabled Thermostat Program

1 PROGRAM OVERVIEW AND OBJECTIVES

This memorandum presents the results of the 2014 Impact Evaluation of PSE's Web-Enabled Thermostat (WET) program. The WET program was offered to PSE's combined electric and gas service territory in the fall of 2013. The web-enabled thermostat optimizes customers' space heating systems by leveraging internet-based technology to allow customers to control home heating systems remotely. The thermostat is also accompanied by ongoing controls delivered through the interactive application on the homeowner's mobile phone and web portal. The program required all web-enabled thermostats to be programmed upon installation to initiate the thermostat.

The program is structured as a randomized controlled trial experimental design to facilitate estimating precise and unbiased estimates of average per household savings. The program participants consist of approximately 2,000 opt-in homeowners who were screened through a phone conversation and in-home inspection. Every other customer who qualified in PSE screening was given the thermostat and the rest of the qualified customers were not given a thermostat. Approximately 1,000 customers were given a thermostat and 1,000 customers were assigned as control group.

This study focused on estimating energy savings due to the PSE WET program in 2014. The specific objectives are as follows:

1. Measure the reduction in natural gas consumption between the control group and the treatment group
2. Quantify the savings from WET-related increased uptake of other PSE energy efficiency programs which may be present in the measured consumption reduction due to an increase in the number of participants and/or extent of participation in PSE rebate programs
3. Provide a final estimate of 2014 program savings which are adjusted for double counted savings resulting from participation in other PSE rebate programs

The remaining sections of this memorandum are organized as follows: Section 2 provides a summary of program savings. Section 3 describes the research design and data collection activities. Section 4 presents the methodology used in the impact evaluation while Section 5 presents the results of this study. Conclusions are offered in Section 6.

2 SAVINGS

The Randomized Control Trial experimental design establishes the savings estimates of this evaluation as robust and fundamentally un-biased. This evaluation showed that installing a web-enabled thermostat caused around 17 therms or 1.6% reduction in consumption per household with installed thermostat and no evidence of reducing electric consumption. Overall, the pilot program saved a total of 12,822 therms during its first year.

3 RESEARCH DESIGN AND DATA COLLECTION ACTIVITIES

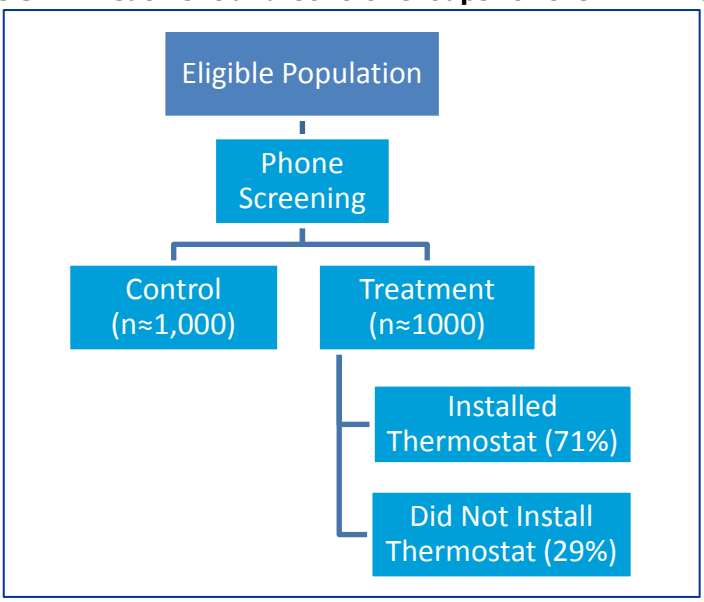
3.1 Experimental Design

The target population for the WET program was single family residential homes throughout PSE's combined electric and gas service territory. The eligibility criteria required for all program participants in the treatment and control group were as follows:

- Must be a PSE natural gas customer
- Uses natural gas as primary heating
- Must not have an electric back-up system or heat pump
- Must not have been unoccupied, sold, or had new tenants in the year previous to the program

PSE screened homeowners from the pool of eligible customers using a phone interview to determine homeowners who are interested in opting into the program. PSE selected approximately 2,000 opt-in customers and randomly assigned half of the opt-in customers to the treatment group and the rest of opt-in customers to the control group. Figure 3-1 presents a high-level overview of the treatment and control group allocation process for the WET program.

Figure 3-1: Treatment and Control Groups for the WET Program



The treatment and control allocation was based on a systematic random sampling with an interval of two. This sampling procedure assigns every other qualified customer who opted into the program to the treatment group and the rest of the customers were assigned as control. Households in the treatment group were given the thermostat while households in the control group were not given the thermostat.

Despite being allocated into the thermostat group, approximately 29 percent of the customers in the treatment group were unable to install the thermostat due to technical issues.

Households that were assigned to the treatment group but did not get the thermostats remain in the treatment group to maintain the experimental design and allow for an unbiased estimate of the program effects. Removing these households would undermine the similarity between the treatment and control groups that is established by the program's experimental design. This evaluation will assess average savings across all customers in the treatment group but will also provide savings estimates scaled to the treatment group that actually received the treatment.

3.2 Data Sources

This study used information collected from consumption data, weather data and program tracking data from August 2012 to November 2014. DNV GL reviewed all datasets for accuracy and completeness. Data sources are described below:

Program Participants

PSE provided a list of program participant premise numbers and their corresponding treatment assignments. This data served as the roster of participants for the WET program.

Monthly Billing Data

PSE provided monthly billing data from January 2012 to December 2014 for program participants. The monthly billing data contained the following information: premise number, customer account numbers, monthly consumption data, billing cycle and site address. This dataset is the primary data used in consumption analysis. The analysis periods used in the evaluation are August 2012 to July 2013 (pre-program period) and December 2013 to November 2014 (post-program period). The evaluators did not include the billing periods in which thermostat installation took place. Specifically, billing periods from August 2013 to November 2013 were assigned as the blackout period. The weather normalization process is designed to put the pre- and post-program periods on the same typical weather basis as well as make each period comparable to typical calendar year in PSE territory.

Downstream Program Tracking Data

The tracking data included information on PSE customers' participation in other PSE rebate programs in 2014. The tracking data include participant information, customer account numbers, program name, energy efficiency measures, installation dates and claimed savings. This dataset is used in calculating joint downstream savings for the WET program.

Weather Data

PSE provided hourly weather data from January 2005 to December 2014 for nine weather stations and a weather station lookup file that contains a list of zip codes covered by each station. DNV GL used PSE weather data to calculate annual heating and cooling degree days for each premise during the analysis period. For estimating normalized consumption, DNV GL used a ten-year average cooling and heating degree days for each PSE weather station. The TMY and normal datasets that are available from the National Renewable Energy Laboratory (NREL) or the National Oceanic and Atmospheric Administration

(NOAA) use longer data series that can get out of date. When ten years of local data are available, then constructing a typical weather data set of degree days is the best approach[1].

3.3 Data Disposition

The monthly billing data is the primary data used in the impact evaluation of the WET program. DNV GL examined the consumption data for completeness and potential data issues such as duplicates, extreme values, missing observations and other inconsistencies.

Data preparation steps included:

1. Removal of duplicate consumption reads. Duplicates are the same billing cycles with the same consumption values for the same customer and premise.
2. Exclusion of households with negative consumption reads
3. Examine for extreme consumption values (greater than 10,000 kWh per month or 1,000 therms per month)
4. Exclusion of households with less than ten billing periods during the pre-treatment or post-treatment period
5. Exclusion of households with zero electric reads in five or more billing periods
6. Exclusion of consumption readings from billing cycles with short (less than 10 billing days) or long billing interval (more than 65 billing days)
7. Removal of customers that moved out during the analysis period.

Error! Reference source not found.-1 summarizes the original program population, counts of households removed from the analysis, and the final sample DNV GL used in the billing analysis for the WET program. Overall, the data issues identified are minimal and should not bias the results of this evaluation.

Table 2-1: WET Program Data Disposition

Data Disposition	Counts
Initial Counts	
Control	1065
Treatment	1167
Technical turndowns	333
Exclusion criteria	
Participants assigned to both treatment and control	17
Not enough billing periods in pre or post	437
Participants with negative consumption reads	3
Participants with zero electric reads in five or more billing periods	3
Participants with inactive accounts	143
Final	1,762
Control	838
Treatment	924
Technical turndowns	279

Note: Some sites may have multiple issues

[1] Specifically, using the average degree days over the time period, as opposed to averaging the temperatures first, is the best way to capture the natural variability in the weather data while producing a "typical" weather scenario with which to normalize.

The list of program participants included 17 customers (0.8%) assigned to both treatment and control groups. The evaluators were unable to verify the correct treatment assignments of these customers and excluded them from the analysis to avoid potential contamination of the treatment and control groups.

Around 20% of the participants were excluded because these customers have less than 10 billing periods in the pre- or post-periods. This criterion also removed customers without any billing data or customers that potentially moved out during the analysis period. The exclusion of these customers is necessary to ensure that heating, cooling and shoulder months in the pre- and post-periods are well-represented in the analysis.

Unlike household attrition due to move-outs, households where the thermostat could not be installed (the "intent to treat" households) remain in the treatment group for the analysis. Removing these households would undermine the similarity between the treatment and control groups that is established by the experimental design. Around 29% of households in the treatment group did not get the web-enabled thermostat. Keeping these households in the analysis despite not receiving the treatment allows for testing the "intent to treat" and is necessary to get an unbiased estimate of the effect of the program. Testing "Intent to treat" is the term given to including the whole treatment group because, with the technical turn-downs, the full treatment group only experience an intent to treat. Because of the nature of the RCT, it is expected that the control group would have, on average, the same number of technical turn-downs if installations were done by the same people, to the same level quality, etc. This is a side finding from this analysis that may have implications for expanding the program.

This evaluation will assess average savings across all customers in the treatment group but will also provide savings estimates scaled to the treatment group that actually received the treatment (installed households). When we calculate the savings per installed household we assumed the technical turn downs did not show savings. If they did, that would lower the estimate of savings for the installed households.

3.4 Experimental Design Validation

DNV GL applied statistical tests to the final sample used in the analysis to ensure that the site exclusion criteria applied did not affect the experimental design of the program. The evaluators conducted a t-test to evaluate the randomness of the WET sample by comparing electric and gas consumption of the treatment and control group for each month in the pre-program period; the results are presented in Table 3-2.

Table 3-2: Test of Differences in Consumption in the pre-program period between Treatment and Control Groups

Fuel	Monthly	Treatment		Control		Control - Treatment			
		Count	Mean	Count	Mean	Difference	t-value	df	Pr > |t|
Electric	Aug-12	923	846	837	834	(11.74)	(0.50)	1,758	0.614
	Sep-12	865	750	788	756	5.60	0.28	1,651	0.778
	Oct-12	924	748	838	755	6.22	0.35	1,760	0.728
	Nov-12	924	871	838	882	10.50	0.50	1,760	0.615
	Dec-12	924	971	838	983	12.04	0.51	1,760	0.612
	Jan-13	924	1,021	838	1,047	25.89	1.00	1,760	0.319
	Feb-13	864	901	782	925	24.02	1.04	1,644	0.300
	Mar-13	857	806	771	838	32.14	1.37	1,626	0.170

	Apr-13	923	884	838	921	37.02	1.54	1,759	0.125
	May-13	924	744	838	740	(3.23)	(0.17)	1,760	0.868
	Jun-13	865	736	788	736	0.07	0.00	1,651	0.997
	Jul-13	924	796	838	792	(4.18)	(0.19)	1,760	0.846
Gas	Aug-12	923	24	837	25	0.94	0.88	1,758	0.379
	Sep-12	865	26	788	26	0.21	0.23	1,651	0.821
	Oct-12	924	50	838	51	0.98	0.83	1,760	0.406
	Nov-12	924	100	837	102	1.53	0.95	1,759	0.342
	Dec-12	924	142	838	144	1.96	1.03	1,760	0.304
	Jan-13	924	181	838	182	1.15	0.48	1,760	0.629
	Feb-13	864	156	784	156	0.07	0.03	1,646	0.975
	Mar-13	857	127	769	126	(0.44)	(0.19)	1,624	0.850
	Apr-13	924	112	838	113	1.10	0.52	1,760	0.600
	May-13	924	60	838	59	(0.53)	(0.37)	1,760	0.713
	Jun-13	865	39	788	39	0.28	0.29	1,651	0.769
	Jul-13	924	24	838	25	0.82	1.04	1,760	0.300

Overall, consumption difference between the treatment and control group in the pre-program period is not statistically significant at the 90% confidence level. These results indicate that pre-period consumption is balanced between the treatment and control groups and site exclusion criteria applied to the WET program participants maintains the experimental design of the program and should not bias the savings estimates from this study.

4 METHODOLOGY

This section discusses the methodology used in consumption analysis and joint savings analysis. The consumption analysis estimates the measured savings or the average difference in consumption between WET treatment and control groups while the joint savings analysis calculates savings potentially shared by the WET program and other PSE rebate programs. Results from joint savings are used to adjust the initial average difference to calculate credited program savings per households. Specifically, joint savings from WET and other rebate programs are subtracted from the measured savings derived from consumption analysis.

4.1 Consumption Analysis

The consumption analysis used monthly billing data to estimate the reduction in energy consumption resulting from the program[2]. This consumption reduction is the full measure of savings caused by installation of web-enabled thermostat and is referred to here as measured savings. The evaluators estimated savings using a two-stage billing analysis approach where the first stage involves a site-level modeling and the second stage applies a difference-in-differences method to measure program savings.

Stage 1: Site-level Modeling

[2] DNV GL also conducted consumption analysis using PSE daily consumption data for WET participants. The results based on monthly data and daily data are comparable. The evaluators found the savings estimates based on monthly billing data were slightly higher than the daily data due to the following reasons: 1) Monthly consumption data is more complete and allowed the evaluators to include more households in the analysis; 2) The use of monthly data allowed the evaluators to improve the treatment of black-out; and 3) The monthly data is the most accurate measure of full consumption of the households because these are tied to dollars.

DNV GL conducted site level modeling to estimate normalized annual consumption (NAC) for each customer in the sample, using the optimal cooling and/or heating degree day base. This process involved estimating consumption across a range of heating and cooling degree bases temperature. Cooling degree-day bases covered 64°F to 84°F while heating degree day bases covered 50°F to 70°F.

The full model specification is presented below:

$$\boldsymbol{E_{im} = \mu_i + \beta_H H_{im}(\tau_H) + \beta_C C_{im}(\tau_C) + \varepsilon_{im}}$$

where:

E_{im}	=	Average energy consumption during period m for customer i;
μ_i	=	Baseload usage estimate for customer i;
$H_{im}(\tau_H)$	=	Average heating degree-days (HDD) at the heating base temperature τ_H during period m, based on daily temperature, for customer i's meter reading;
$C_{im}(\tau_C)$	=	Average cooling degree-days (CDD) at the cooling base temperature τ_C during period m, based on daily temperature, for customer i's meter reading;
β_H	=	Heating coefficient, determined by the regression;
β_C	=	Cooling coefficient, determined by the regression;
τ_H	=	Heating degree-day base temperatures, determined by choice of the optimal regression;
τ_C	=	Cooling degree-day base temperatures, determined by choice of the optimal regression; and
ε_{im}	=	Regression residual.

Energy consumption was estimated using the following models: 'heating and cooling model', 'cooling only model', 'heating only model' and 'baseload only model'. For each model estimated, we chose the best cooling and heating degree day base for each site based on the individual R-squared and used an F-test to determine which model specification was superior. We then examined the distributions of cooling and heating base temperatures from the 'best' model to determine if the optimal degree day base temperature was on the border. If so, we re-estimated the models using the median base temperatures.

The optimal degree day base temperature reflects the outdoor temperature at which each site needs heating and/or cooling. Instead of imposing a fixed degree-day base on all sites, the site-specific degree day base takes into consideration the unique characteristics of each site due to differences in level of envelope insulation, infiltration, thermostat set point schedule and others.

Once optimal degree day bases are identified for each site and period, normalized annual consumption are calculated for the pre and post periods using the equation below:

$$\boldsymbol{NAC_i = (365.25 \times \hat{\mu}_i) + \hat{\beta}_H H_0 + \hat{\beta}_C C_0}$$

where:

NAC_i	=	Normalized annual consumption for customer *i*;
H_0	=	Annual TMY heating degree-days calculated at the optimal heating base temperature $\hat{\tau}_H$ for customer i;
C_0	=	Annual TMY cooling degree-days calculated at the optimal cooling base temperature $\hat{\tau}_C$ for customer i;
$\hat{\mu}_i, \hat{\beta}_H, \hat{\beta}_C$	=	Baseload and heating parameter estimates from the site-level models.

Stage 2: Difference-in-difference

The difference-in-differences approach is a simple, robust approach to measuring program-related savings in a randomized experimental design framework. The approach compares normalized annual consumption between the pre- and post-report periods for both the treatment and the control groups. The treatment group pre-post difference captures all changes between the two periods including those related to the WET program. The control group captures all changes with the exception of those related to the WET program. The random selection of the treatment and control groups ensures that, on average, the control group will appropriately reflect the non-program related changes experienced by treatment and control group alike between the pre and post periods. Removing the non-program differences, as represented by the control group difference, from the treatment difference produces an estimate of WET program's isolated effect on consumption.

Using the estimated normalized annual consumption in the pre- and post-treatment periods in Stage 1, a difference-in-differences method is applied to estimate program savings. The difference-in-differences savings estimate is produced using the following equation:

$$\boldsymbol{\Delta NAC_i = \alpha + \beta T_i + \varepsilon_i}$$

where:

ΔNAC_i	=	Pre-post difference in annual consumption for household i;
α	=	Intercept
T	=	Treatment indicator (value of 1 if treatment and 0 otherwise)
β	=	Treatment effect or savings estimate
ε	=	error term

The $\hat{\beta}$ coefficient gives the estimate of per household measured savings for the WET program.

4.2 Joint Savings Analysis

DNV GL conducted a joint savings analysis for downstream programs to assess the impact of the WET program on the uptake of other PSE programs and to avoid double counting of savings. Energy efficiency purchases that occur directly through a Puget Sound Energy rebate programs are tracked in PSE data systems. DNV GL analyzed PSE rebate program tracking data to identify possible increased uptake of other PSE energy efficiency programs by the treatment and control groups. The PSE rebate programs included purchases of energy efficient measures such as home appliances, space heating and weatherization. The rebated measures are all tracked at the household level so it is possible to directly calculate the number of measures installed and savings claimed by households in the treatment and control groups. The experimental design framework makes it possible to accurately measure any increased activity in programs by the treatment group. The goal of the joint savings[3] analysis is to quantify savings that are included in the measured WET program savings but have already been credited to other PSE energy efficiency programs. These joint savings are deducted from the WET measured savings to avoid double counting.

For this analysis, DNV GL compiled all rebated installations since program inception for both treatment and control groups. Savings were assigned on a daily basis starting with the installation date and carrying forward to the measure life. Savings are apportioned across the days of the year based on measure-level load shapes. This places the savings at the time of year when the measure is used most. It all means that savings occur during the year approximately when they would be captured in the difference-in-differences calculations.

For joint savings calculation, the total accumulated rebate savings of the control are removed from the total accumulated savings of the treatment group since program inception. The difference is the effect of WET on rebate program activity. These are savings that would not occur if the WET Program was not operating. If the WET program produces joint savings, it indicates that some aspect of the WET program promotes participation in other programs. The most common approach to addressing these potentially double counted savings is to deduct them from the experimental design program, in this case the WET program. While jointly caused, these savings are already being claimed by the rebate programs that facilitate the participation. As a result, the most practical solution is to remove joint savings from the overall measured consumption reduction caused by the WET Program.

The following equation shows how joint savings estimates are used in this evaluation:

$$\text{Credited savings per household} = \hat{\beta} - \text{Joint savings per household}$$

The $\hat{\beta}$ coefficient is estimated from Stage 2 in consumption analysis and represents the measured savings per household for the WET program. Credited savings per households are program savings with joint savings removed.

[3] Sometimes referred to as uplift in other evaluations.

5 RESULTS

Results of the impact evaluation for the first 12 months of the program (December 2013 to November 2014) are provided in this section. PSE may use these results to support savings claims for the 2014 WET Program.

5.1 Consumption Analysis

Results from Stage 1: Site-level Modeling
The normalized annual consumption allows comparison of energy consumption in the pre- and post-period under a normal weather year. Figure**Error! Reference source not found.** 4-1 and

Figure 5-2 show a comparison of actual and weather-normalized electric and gas consumption, respectively. Results show that actual electric and gas consumption are slightly lower than estimated normalized consumption. The slight difference in consumption implies that weather in the pre- and post-period is relatively milder than a typical year.

Figure 5-1: Average Actual and Normalized Annual Electric Consumption

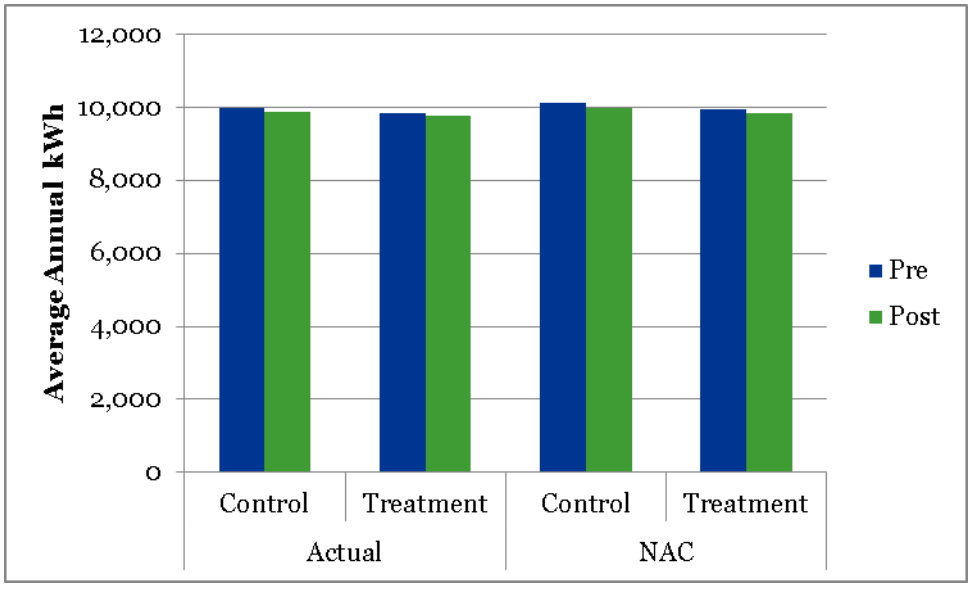
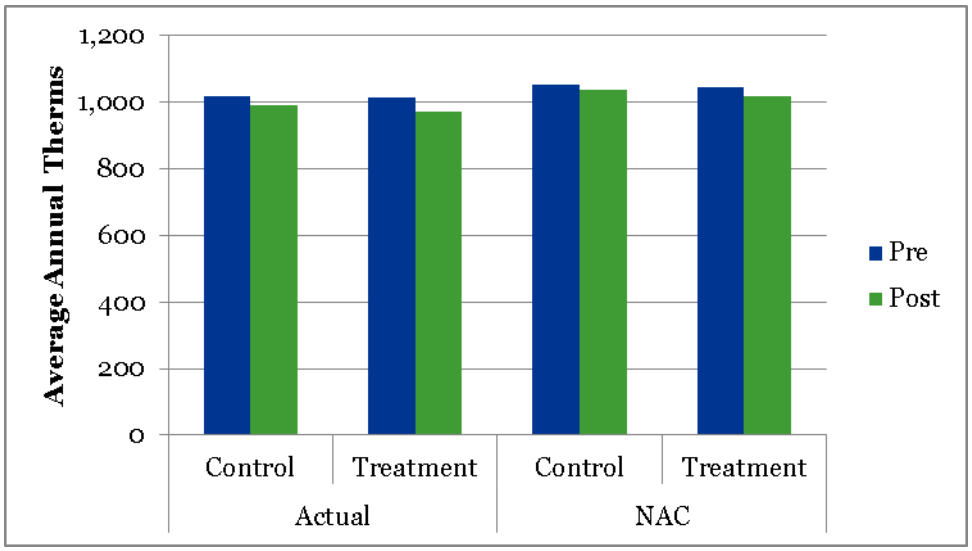


Figure 5-2: Average Actual and Normalized Annual Gas Consumption



The estimates of savings are based on a comparison of normalized annual consumption between pre- and post-program periods and between treatment and control groups. The difference-in-differences approach that is used for this analysis can be thought of in two ways that are mathematically identical:

1. The post-period difference between control group consumption and treatment group (thermostat effect + random differences between the groups) minus the same difference in the pre-period (random differences between the groups).
2. The pre-minus-post difference in treatment group consumption (thermostat effect + non-program-related change over time) minus the pre-minus-post difference in control group consumption (non-program-related change over time).

Results from Stage 2: Difference-in-Differences

Figure 5-3 provides a close-up plot of the normalized gas consumption results including pointers to explain the calculation using the difference-in-differences method. Using the normalized annual gas consumption from site-level modeling (Stage 1), the difference in consumption between the pre and post period is calculated for the treatment and control groups. The change in treatment group's consumption captures both program- and non-program-related change over time while the change in consumption in the control group reflects only non-program-related change over time. The difference between the change in treatment group consumption and the change in the control group consumption provides the estimate of program savings.

Figure 5-3: Close-Up Plot of Gas Savings Calculation using Difference-in-differences Method

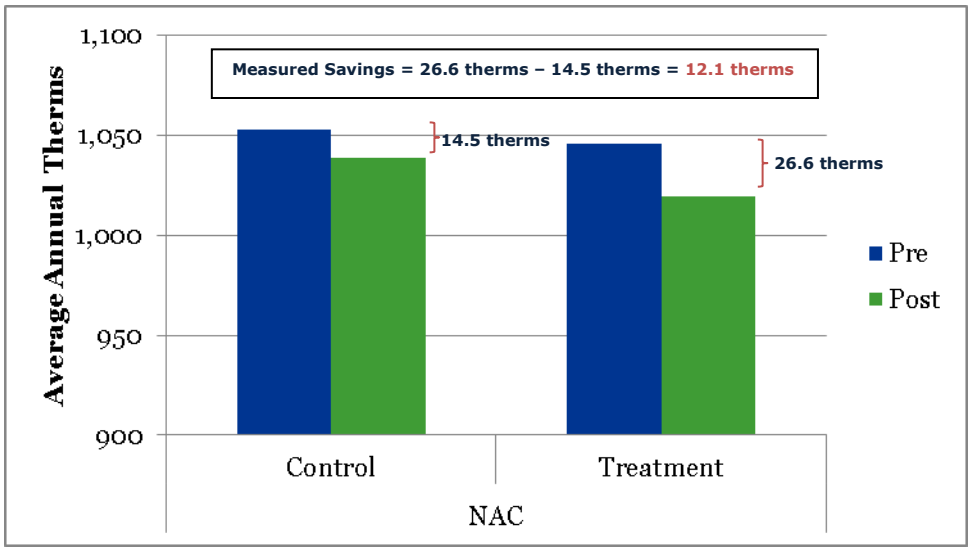


Table 5-1 presents the measured electric and gas savings per household for the WET program along with the upper and lower savings bounds at 90% confidence interval. Overall, results show that the program did not generate statistically significant electric savings but generated significant gas savings at the 90% confidence level. These savings estimates are based on all treatment households regardless of whether they receive the thermostat or not.

Table 5-1: WET Program Normalized Savings Per Treatment Household

Fuel	Savings	+/-	Lower Limit 90% CI	Upper Limit 90% CI
Electric (kWh)	(15.9)	168.27	(184.2)	152.4
Gas (Therms)	12.1*	8.80	3.3	20.9

*Statistically significant at 90% confidence level

DNV GL also calculated per household savings for the treatment households that actually installed the web-enabled thermostat. Table 5-2 presents savings per installed thermostat and savings with respect to baseline consumption.

Table 5-2: 2014 WET Program Normalized Savings Per Installed Thermostat as Percent of Consumption

Normalized savings	Electric (kWh)			Gas (therms)		
	Consumption	Savings	Percent	Consumption	Savings	Percent
Per installed thermostat	10,001.3	(22.4)	-0.2%	1,038.7	17.0*	1.6%

Note: Consumption is based on control group's consumption in the post period
*Statistically significant at 90% confidence level

Approximately, 71% of the treatment group installed the web-enabled thermostat while 29% of the treatment group was turned down due to technical issues. To reflect per household savings of those who actually installed the web-enabled thermostat, DNV GL scaled the full treatment group average per

household savings estimates by dividing savings from all treatment households (savings reported in Table 5-1) by the proportion of households who actually received the treatment (0.71). For example, gas savings per installed thermostat is calculated as 12.1 / 0.71 = 17.0 therms.

5.2 JOINT SAVINGS ANALYSIS

Table 5-3 summarizes other rebate program activity of WET participants. Results show that WET participants also participated in other energy efficiency programs such as Home Appliances, HomePrint, Residential Lighting, Residential Showerheads, SF Existing Space Heat and SF Existing Weatherization programs. CFLs and showerheads were awarded to all treatment and control households, which explains why more than 90% of the households in the treatment and control groups appear to have participated in Residential Lighting and Residential Showerhead programs. The relatively smaller rate of participation in Home Appliances and HomePrint program by the treatment group is likely due to random variation. Otherwise, participation percentages are relatively small and the differences between treatment and control groups participation are even smaller. On a percentage basis, none of the differences are statistically significant.

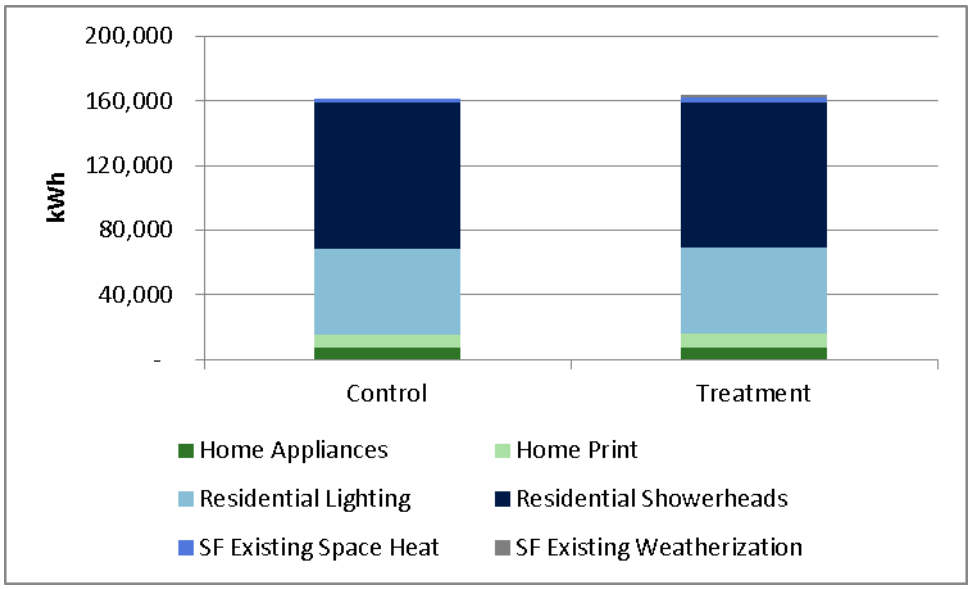
Table 5-3: Program Participation by Treatment and Control Groups

Fuel	Program	% Participation		
		Control	Treatment	Difference (T-C)
Electric (kWh)	Home Appliances	5.6%	3.7%	-1.9%
	Home Print	2.9%	1.9%	-0.9%
	Residential Lighting	96.3%	96.0%	-0.3%
	Residential Showerheads	93.7%	94.3%	0.6%
	SF Existing Space Heat	0.1%	0.4%	0.3%
	SF Existing Weatherization	0.0%	0.1%	0.1%
Gas (Therms)	Home Appliances	3.3%	1.7%	-1.6%
	Residential Showerheads	93.7%	94.3%	0.6%
	SF Existing Space Heat	1.1%	1.1%	0.0%
	SF Existing Weatherization	1.3%	1.4%	0.1%

Note: Space Heating and weatherization can generate savings for gas or electric depending on the source of heat. Home appliances that claimed gas savings include clothes washers with gas water heater and/or gas dryer.

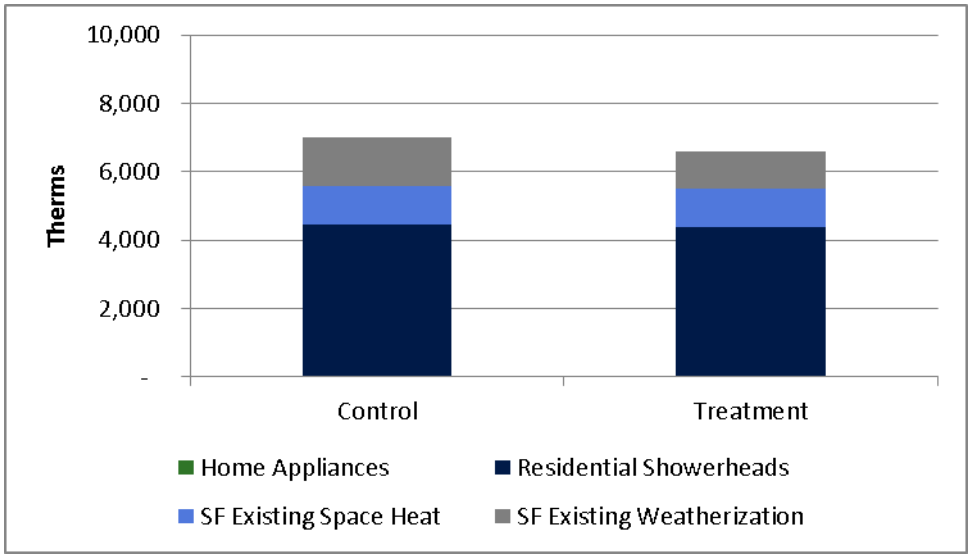
Figure 5-4 and Figure 5-5 show electric and gas savings from other energy efficiency programs for the treatment and control groups. Overall, savings from Residential Showerheads and Lighting programs comprised around 85% of the total electric savings. Similar to electric savings, a big portion of gas savings are from Residential Showerhead programs. These measures were tracked for this program because they were provided to all interested participants as a benefit of taking part in the pilot.

Figure 5-4: Total Electric Savings of WET Participants from Other Rebate Programs



Note: Control group savings were scaled for comparison with the treatment

Figure 5-5: Total Gas Savings of WET Participants from Rebate Programs



Note: Control group savings were scaled for comparison with the treatment

Only measures installed after program inception are included in the joint savings analysis. Savings from the rebated measures are apportioned across the days of the year starting from the date of installation and are weighted using measure-level load shapes. Rebate savings per household are calculated for the treatment and control groups. The difference between the two rebate savings are savings shared by the WET program and other rebate programs. Table 5-4 presents rebate savings per household and joint savings per household for electric and gas.

Table 5-4: Annual Joint Rebate Savings per Household for Electric and Gas

Fuel	Rebate Savings per Household		Joint Rebate Savings per Household			
	Control	Treatment	Savings	+/-	Lower Bound 90% CI	Upper Bound 90% CI
Electric (kWh)	138.35	137.40	-0.95	4.94	-5.89	3.99
Gas (Therms)	5.00	5.28	0.28	0.92	-0.64	1.20

Note: The joint savings reported in this table are for all treatment households. To get joint savings for households that actually installed the thermostat, joint rebate savings per household is divided by the proportion of treatment households that received the thermostat (0.71). For example, gas joint savings per installed thermostat are calculated as 0.28 therms / 0.71 or 0.39 therms.

The negative electric joint savings means that, during the analysis period, treatment household participated less than the control group. The decrease in participation by the treatment group is likely due to random variation. Also, none of the joint savings were statistically significant at the 90% confidence level. The small and non-statistically significant joint savings indicates that the WET program did not encourage participation of other PSE rebate programs.

In the case where joint savings are negative, no joint savings deductions will be made to measured electric savings. For gas, despite joint savings being small and non-significant, program savings would generally be removed from the WET program's measured gas savings to provide the most conservative savings estimates that are free of potentially double counted savings.

5.3 2014 Total Program Savings

Table 5-5 provides the credited savings per installed thermostat and total credited savings for the 2014 WET program. The credited savings are calculated by subtracting joint savings per household from the measured savings per household. The credited savings estimates per household are multiplied by the number of active households that installed web-enabled thermostat (n=771)[4] to estimate total credited savings for the program. Overall, the WET program generated 12,822 therms savings in 2014.

Table 5-5: Program Savings for 2014 WET Program

Fuel	Per Installed Thermostat Savings			Total Credited Savings	90% Confidence Interval	
	Measured Savings	Joint Savings	Credited Savings		Lower Limit	Upper Limit
Electric (kWh)	-22.39	-	-22.39	(17,264)	(200,175)	165,648
Gas (Therms)	17.02*	0.39	16.63	12,822*	3,200	22,444

* statistically significant at 90% confidence level

[4] The active household count equals initial treatment group accounts minus accounts that were no longer active at the end of the evaluation period.

6 CONCLUSIONS

Thermostats, in general, have a long history of providing mixed savings results. Thermostat savings occur due to lowering the thermostat set point whether the house is unoccupied (setback or avoided waste) or occupied (conservation). Thermostat savings potential is a function of 1) the additional setback behavior available in the participating households, and 2) the effectiveness of the thermostat in motivating lowered set points when the space is occupied. The pilot web-enabled thermostat facilitated customers practicing more aggressive setback behavior and downwardly adjusting the set point level they maintained when at home.

The experimental design used for this evaluation explicitly measures the effect of the thermostat installation relative to existing behaviors and technologies without the pilot intervention. The control group represents typical behavior for the recruited population with respect to set point levels and existing setback behavior.

Evaluation Report Response

Program: Web Enabled Thermostats

Program Manager: Dane Tomalin

Study Report Name: Impact Evaluation of PSE Web-Enabled Thermostat Program

Report Date: August 2015

Evaluation Analyst: Jim Perich-Anderson

Date ERR Provided to Program Manager: 8/7/2015

Date of Program Manager Response: 8/21/15

Please describe in detail, action plans to address the evaluation study's key findings and recommendations.

Overview: The Web Enabled Thermostat pilot evaluation shows savings for gas fuels in households that had a Honeywell Web Enabled Thermostat installed.

Action Plan: Based on the results of the Web Enabled thermostat pilot outlined in this evaluation, Program Management will adopt the savings and is in the process of implementing a new program. As a result of the evaluation, PSE will develop a rebate on eligible Web Enabled Thermostats. The device, customer and connectivity will be validated for eligibility, through PSEs partnership with our existing rebate processor and device manufacturers. The result will be a fully installed, pre-programmed system that will engage customers with a user interface that is easy to understand and control, helping reduce their energy usage while maintaining their comfort.

Date of Program Action: Web Enabled Thermostat program manager has approved of the findings in the WET Evaluation and require no corrections or additional actions.