

Lessons Learned from a Mature Behavioral Program

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ABSTRACT

Behavioral programs offered by many utilities across the country aim to increase engagement in the way people use energy. Many empirical studies on behavioral programs, such as home energy reports, show that customers reduce their energy usage when provided with more personalized information on how much energy they consume compared to their neighbors. Most literature for such programs is based on only a few years of evaluation that focus on a few components of the program's impact. To determine what happens to a behavioral program as it matures, we analyzed one of the longest-running home energy report programs in the country. Our analysis assessed approximately 80,000 households randomly selected into the treatment (home energy report recipient) and control (non-home energy report recipient) groups by combining daily consumption analysis with rebate and survey analysis that leveraged the program's experimental design to assess the different areas of program impact.

Our findings showed that energy savings persist up to the seventh year of the program even for households whose home energy reports were discontinued after only two years. We also observed that the program influenced electric and natural gas consumption differently. Compared to electric, gas savings across the years are more stable and the savings decay rate is relatively slower. In addition, the program encouraged participation in the utility's energy efficiency rebate programs, especially for gas. This study also highlights how the program influenced purchases of efficient CFL and LED bulbs over time, and overall customer satisfaction.

Introduction

In 2008, Puget Sound Energy (PSE) began implementing its first behavioral program which has now become one of the nation's longest running home energy reports (HER) programs. The HER program was designed to motivate customers to reduce energy consumption through behavioral changes and participation in other energy efficiency programs offered by the utility. Applying social norms theory, the HER program delivers comparative reports that provide information on how much energy customers consume compared to similar neighbors. The reports also provide personalized tips on ways to save energy.

The HER program is structured as a randomized, controlled trial (RCT) to facilitate precise and unbiased estimates of average per household savings that are small on a percentage basis. The program randomly assigned customers to the treatment and control groups. The customers in the treatment group receive the reports on a monthly or quarterly basis and have an option to opt out of the program. To date, the rate of opt-out among customers is low.

PSE started sending comparative reports in October 2008 to a legacy group composed of customers with high consumption. In 2010, PSE stopped sending the report to one-fourth of the treatment group. The reports were terminated to create a second treatment group, called suspended group, that

allowed the testing of persistence in savings after the cessation of reports. The remaining households in the treatment group continued to receive the comparative reports either monthly or quarterly.

In 2014, PSE expanded the HER program by adding households that fell into one of three groups (households with high usage relative to the size of their home (high relative user); electric only households; and non-urban households) to determine whether these groups showed a difference in program savings and/or customer satisfaction. Table 1 provides the different characteristics of the target groups while Table 2 presents the size of the treatment and control groups and the start dates.

Table 1. Characteristics of the HER target groups

Single family residential home			
Home does not utilize a solar PV system			
Address must be available with parcel data from the county assessor			
Has a bill history			
Home must have automatic daily meter reads			
Home must have 100 similar sized homes (neighbors) nearby			
Legacy (High users)	Relative high user	Non-urban	Electric only
Dual fuel (home uses both natural gas and electricity, which are both provided to the service address by Puget Sound Energy)			Single fuel home (electric only)
Uses more than 80 MBtu of energy per year	Energy consumption is high relative to size	Must be in one of the selected 'non-urban' zip code population (outside PSE's major metropolitan core)	Home uses electric for space and water heating

Table 2. Size and launch date of the HER target groups

Target group	Launch date	No. of treatment customers	No. of control customers
Legacy	October 2008	39,757	44,124
Relative high user	March 2014	31,500	10,500
Non-urban	March 2014	42,000	14,000
Electric only	March 2014	31,500	10,500

For this paper, we looked at the impact of the program and gathered all the lessons learned as we followed the PSE HER program for the last six years. The key questions we addressed include the following:

- What happens to program savings over time and do savings curves vary by fuel?
- Do savings persist when treatment ends?
- Do savings vary by frequency of receiving the reports and consumption quartile?
- Do savings vary across target groups?
- Is the program successful in increasing the uptake of rebate programs?

- Is the program successful in increasing overall satisfaction of the customers?

Methodology

We recently completed the seventh-year impact evaluation of PSE’s behavioral program initiative (DNV GL 2016). We used daily interval electric and gas consumption data from 2007 to 2015 to compare consumption of the control and treatment groups. We estimated program impacts using difference-in-differences. This approach compares the average change in consumption from pre- to post-period between the treatment and control groups. The change in consumption among the treatment homes captures all changes between the two periods including those related to receiving the reports while the control group captures all changes except for those related to the report. The random selection of the treatment and control groups ensures that, on average, the control group will appropriately reflect the non-report related changes experienced by both groups. The removal of the non-report changes from change in consumption among the treatment group produces an estimate of the program’s effect on consumption.

The estimate of HER impact is produced with the following equation.

$$\Delta C_i = \alpha + \beta T_i + \varepsilon_i$$

where:

ΔC_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 impact estimate
ε	=	error term

To establish savings persistence, we calculated program impact from 2009 to 2015 and examined the impact on electric and gas consumption across the years and estimated the impact of discontinuing the treatment separately in the legacy group. To test the theory that the home energy reports would have different impacts based on the selected customer characteristics, we also compared savings across the different target groups.

We also examined the program’s effectiveness in increasing the uptake of PSE’s energy efficiency rebate programs by comparing rebate participation of the treatment and control groups. We used PSE’s historical program tracking data to assess the program impact on downstream rebate programs and conducted a survey of both treatment and control customers to examine the potential impact on upstream lighting rebate programs. Lastly, we provide survey results on how the program influences overall customer satisfaction.

Results

What happens to program savings over time and do savings curves vary by fuel?

Legacy customers who received reports from the beginning through the seventh year continued to generate electric and gas savings at or above levels established in the first two years of the program. Figure 1 shows the electric and gas savings from the legacy group receiving the reports for seven years. We observed a ramp up in electric savings during the first year of the program which gradually increased at a decreasing rate up to the fifth year. From Year 5 and onwards, the program maintained the highest level of savings of approximately 3%. During this phase, customers appeared to maintain electric conservation levels as the trend in electric savings appeared to flatten.

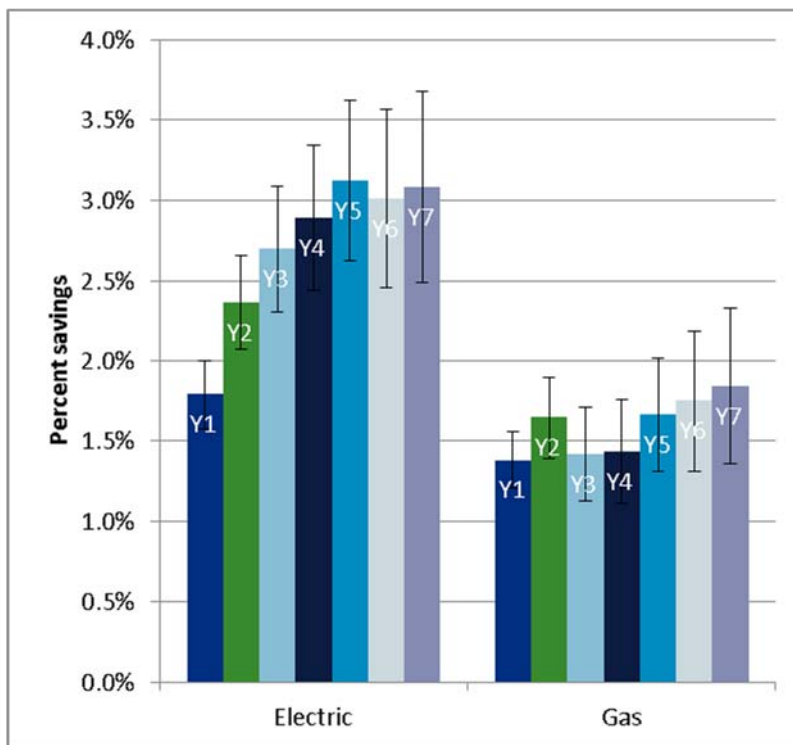


Figure 1. Percent electric and gas savings for the legacy group from 2009 to 2015. Source: DNV GL 2016.

Similarly, gas savings continue over time and appear relatively flatter year over year compared to electric savings. Gas savings increased slightly during the second year and after the fourth-year where savings maintained an average of 1.5% throughout the years. Contrary to the trends in electric savings, there is no apparent ramping up in gas savings during the first few years of treatment. The first-year savings in gas comprise more than three-fourths of the savings from Year 2 and onwards. The results suggest that conservation actions taken by the customers during the first year are most likely the primary drivers of the gas savings over the years.

The program consistently produced higher percent electric savings than gas savings. Research has not been able to definitively identify the varied sources of HER program end-use savings, but it is hypothesized that the greater number of electric end-uses and the more discretionary aspect of many electric end-uses (lighting, electronics) makes electric savings more feasible. Research also indicates that small savings are spread across a wide range of end-uses. The RCT design allows for a highly precise estimate of the small overall savings estimate, but getting definitive estimates of the varied sources of savings within those overall savings has not been possible.

Do savings persist when treatment ends?

The HER program exhibited two kinds of persistence. Legacy group customers receiving the reports through the seventh-year continued to generate savings and the customer who stopped getting the reports in 2010 also continued to produce savings. Figure 2 illustrates the electric and gas savings for the continued and suspended Legacy treatment groups.

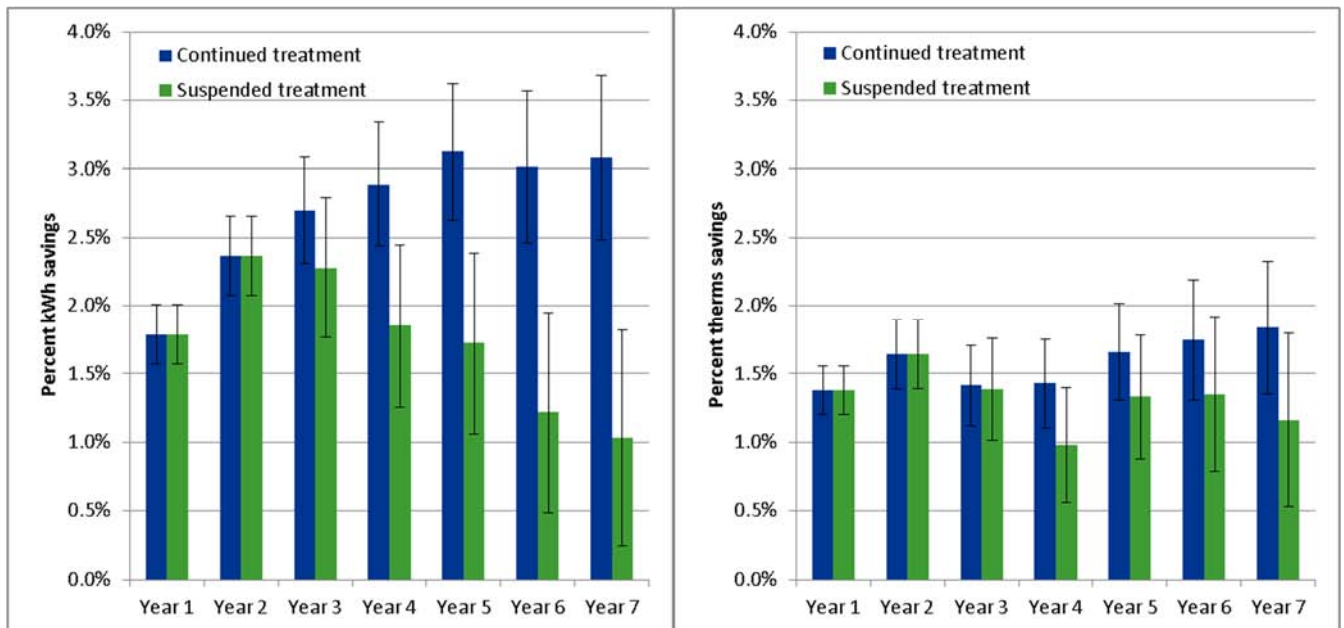


Figure 2. Percent savings from continued and suspended treatment groups. Source: DNV GL 2016.

The first year impact of discontinuing the reports resulted in a 16% decrease in electric savings from Year 2 to Year 3, relative to the group still receiving reports. Electric savings declined over the years with the termination of the reports but savings continued to be statistically significantly different from zero. In fact, customers who are in their fifth year of not receiving the reports still produced electric savings that are at least a third of the first-year savings.

While electric savings continued to drop after discontinuation of treatment, natural gas savings of the suspended treatment group are still over half of the savings from customers receiving the reports. The average decay in electric savings and natural gas savings are approximately 16% and 7% per year for five years after discontinuation of the reports. The lower decay in natural gas savings may suggest that conservation actions taken by the customers may have long lasting effect such as installing more efficient

equipment. DNV GL's report (DNV GL 2012) points toward purchases of energy efficient water heating equipment and lowering water heating set points as areas with evidence of savings actions for gas.

Do savings vary by frequency of receiving the reports and consumption level?

Figure 3 provides electric and gas savings for the monthly and quarterly recipients. The electric and gas savings results generally conform to the expectation that monthly recipients generate more savings than quarterly recipients. For electric, the annual differences in savings are small and may suggest that the additional reports are unnecessary in reducing electric consumption.

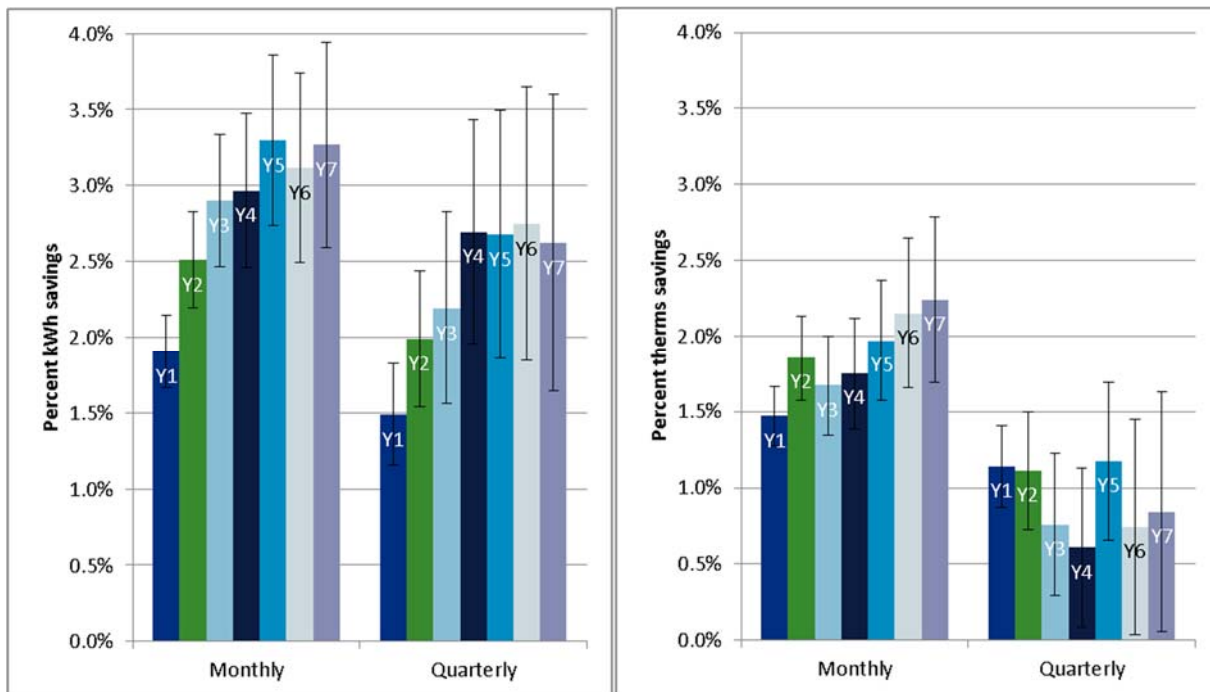


Figure 1. Percent savings from monthly and quarterly report recipients.

The frequency of treatment appears to play a more important role in reducing gas consumption. The results show statistically significant reduction in gas savings starting Year 3 for monthly recipients compared to quarterly recipients. This result could indicate that, in contrast to electric savings, the monthly reports are more important for maintaining a higher level of gas savings.

This study and similar studies have found a positive correlation between household consumption and savings even on a percentage basis. Customers in the top pre-period, consumption quartile or the largest users saved the highest savings at rates of 3.1% and 2.3% for electric and gas respectively. Figure 4 shows the savings in energy consumption from the different consumption quartiles in Year 7.¹

¹ The unexpected bottom quartile result is likely explained by a random imbalance between treatment and control groups. The bottom two electric quartile results are not statistically significantly different.

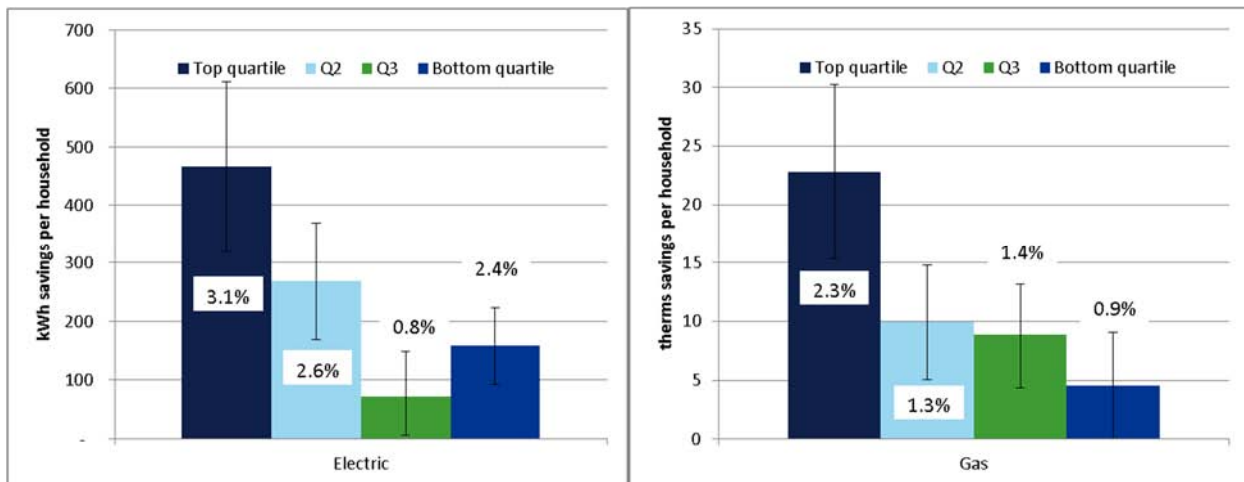


Figure 4. Average annual savings by consumption quartile. Note: The graph above shows the savings with upper and lower bounds at the 90% confidence intervals. Source: DNV GL 2016.

Do savings vary across target groups?

Figure 5 provides a comparison of electric and gas savings across the different groups targeted by the program. For this comparison, Year 1 covers the first 12 months of receiving the reports while Year 2 covers the second year. Comparing across years 1 and 2, the legacy group produced the highest electric and gas savings compared to the newer groups targeted by the program. This is consistent with a downward trend in savings for new behavioral implementations that is not fully understood but could be explained by site selection bias.² Among the newer groups, customers with high energy consumption relative to its size produced the highest savings while households outside urban areas produced the lowest. These findings indicate the importance of targeting in determining the expected level of savings and cost-effectiveness of the program.

² Site Selection Bias in Program Evaluation. Hunt Allcott. February 13, 2015

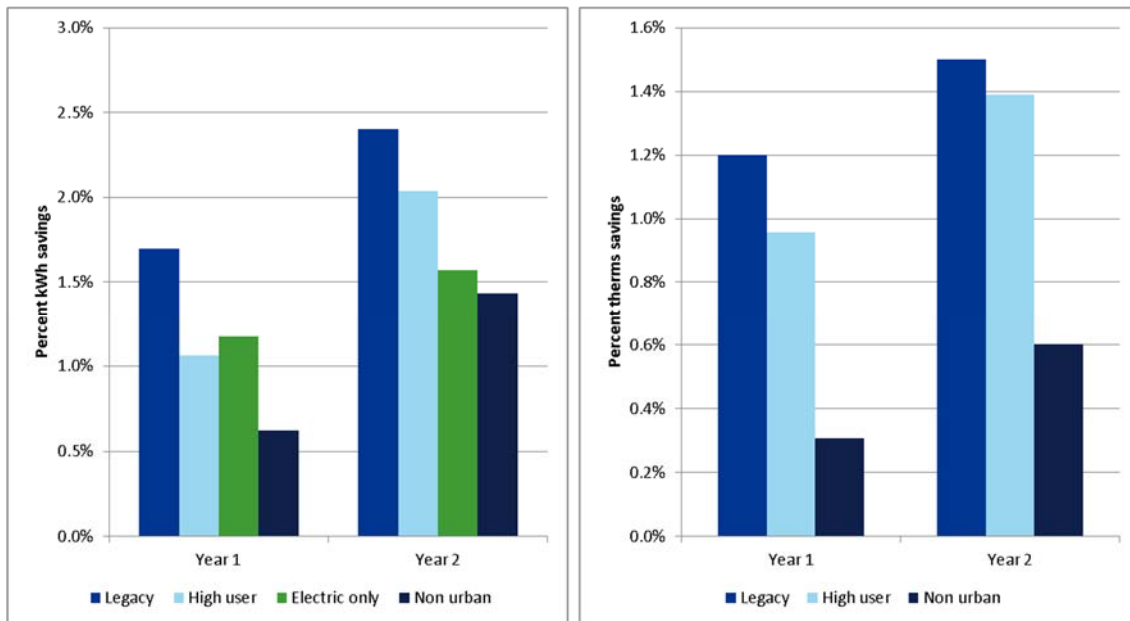


Figure 5. Electric and gas savings for year 1 and 2 by target groups. Source: DNV GL 2016.

Newer experiments tend to offer solid but lower savings levels because PSE targeted their largest customers in the initial pilot program. For PSE and other utilities looking to expand the program to the general population or other target groups, using the performance of the groups added to the pilot program in planning for cost-effectiveness may over- or underestimate the benefits from the program.

Is the program successful in increasing the uptake of rebate programs?

One possible effect of the HER program is to increase the customer's participation in energy efficiency rebate programs. These savings are causally linked to both the HER program and the rebate program and need to be identified so that they are not counted by both programs. Figure 6 presents the estimate of HER savings due to rebate program participation. The share of savings from rebate programs generally increases over time. The proportion of savings from electric rebate programs tends to be relatively small and not statistically significant until Year 7. The proportion of gas savings from the uptake of rebate programs has been relatively higher and statistically significant since Year 1. These findings suggest that the report is effective in increasing customer participation of gas rebate programs, but may not be as effective in encouraging the uptake of electric rebate programs.

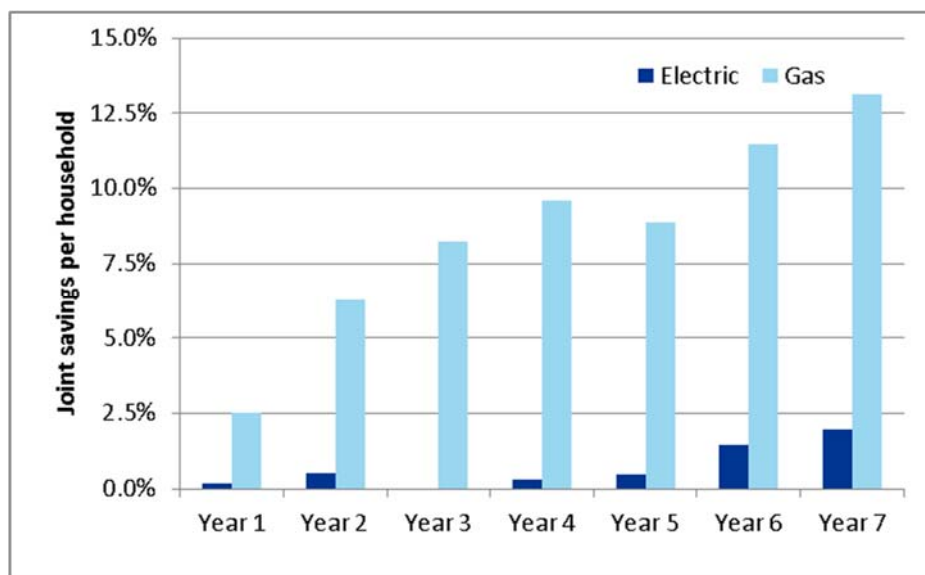


Figure 6. Proportion of HER savings from rebate programs for the legacy group. Source: DNV GL 2016.

We also assessed the impact of the program in purchasing more efficient bulbs offered through PSE’s upstream lighting program. Figure 7 presents a comparison of the purchases of CFL and LED program bulbs between the legacy treatment and control groups based on participant surveys conducted from Year 3 to Year 7. The average number of CFLs purchased by the treatment and control groups decreased through the years while the number of LED bulbs purchased increased. The treatment group purchased slightly more CFL program bulbs than the control group from Year 3 to Year 5 suggesting that the HER program has a very limited impact on purchasing efficient bulbs through PSE’s upstream lighting program. In Year 6 and Year 7, there was no evidence of an increase in treatment group CFL uptake relative to the control group. In year 7, there was evidence of an increased uptake of LED bulbs due to the HER program. These trends reflect the changing structure of the upstream lighting programs as utilities rebate more LED bulbs and fewer CFLs.

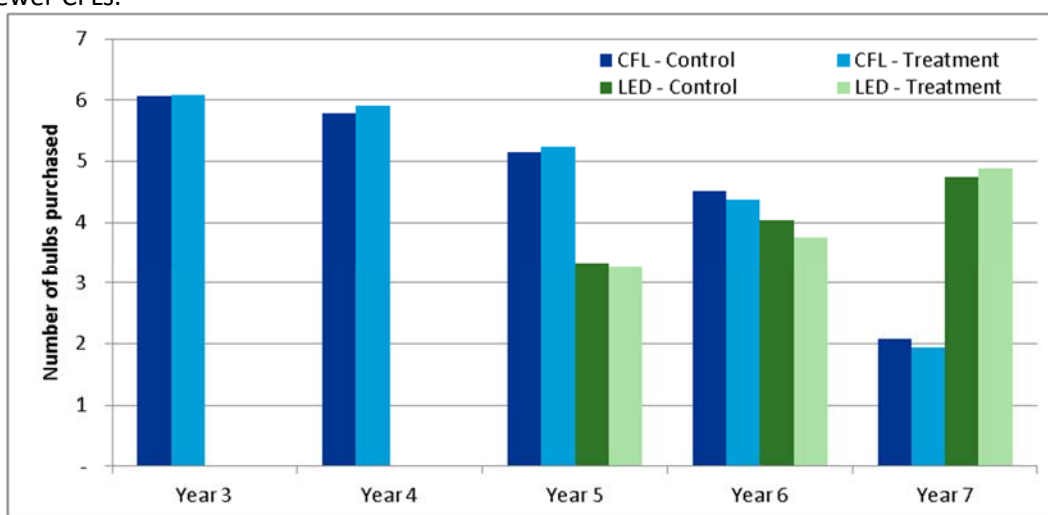


Figure 7. No. of CFL and LED program bulbs purchased by legacy group.

Figure 8 shows a comparison of CFL and LED program bulbs uptake for the first two years for the relative high users, electric only and non-urban target groups. Similar to findings from the legacy group, the number of CFLs purchased declined through the years and the impact of HER in increasing the uptake of CFL program bulbs is somewhat limited. For LED purchases, the impact of the program is more pronounced with the treatment groups purchasing more bulbs than the control group. In Year 2, the results suggests that customers purchase approximately one LED bulb due to the HER program.

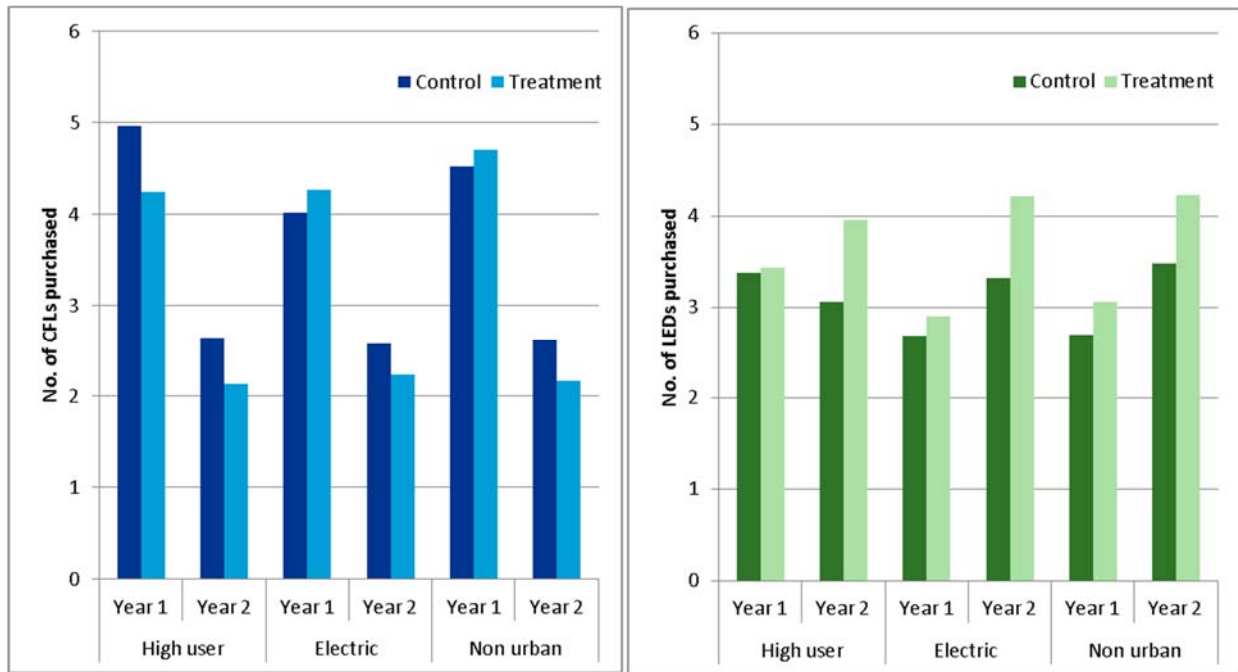


Figure 8. No. of CFL and LED program bulbs purchased by high user, electric only and non-urban groups.

Is the program successful in increasing overall satisfaction of the customers?

We asked a sample of respondents to rate their overall experience with PSE on a ten-point scale where 1 is Unacceptable and 10 is Outstanding. Nearly half of the respondents, across all groups, rated themselves as highly satisfied with a rating of 8, 9, or 10 (Figure 9). There was no statistically significant treatment effect across any of the different groups. These results are notable since some implementers of the HER programs tend to market the programs as a path to improved/maintain customer relations. However, there is limited evidence of an increase in the level of stated overall satisfaction among customers due to the presence of the HER programs.

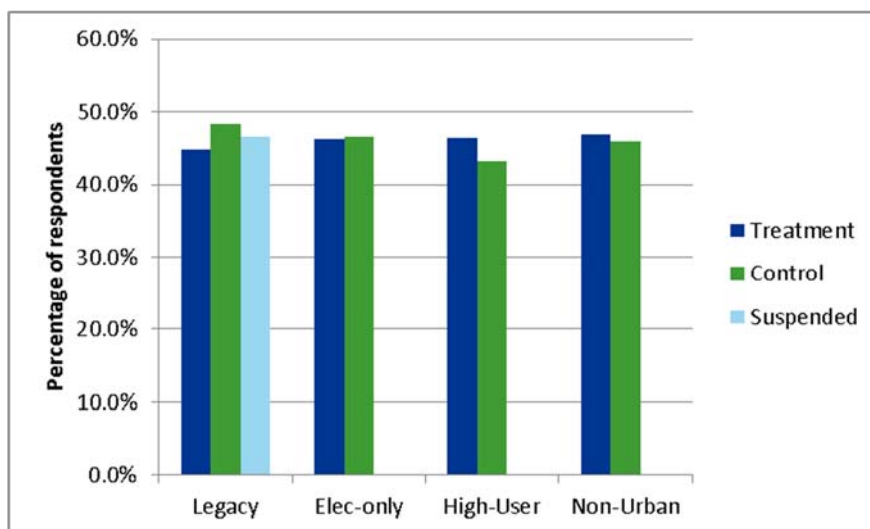


Figure 9. Respondents with overall satisfaction ratings of 8, 9, or 10. Source: DNV GL 2015.

Conclusions

Program savings persist up to the seventh year even for those who received the reports only for two years. The program produced higher electric savings than gas savings but the decay rate in gas savings after discontinuation of the treatment is much slower than the decay rate in electric savings. These findings imply that the energy conservation actions taken by the customers not only have a measure life of more than one year but have a much longer measure life for gas conservation actions than electric.

Targeting plays an important role in the program design as savings vary depending on the characteristics of the sample groups. Customers with high energy consumption tend to produce the highest energy savings in terms of magnitude and as a proportion of baseline consumption. This is one of the reasons why many utilities offering the HER program have targeted higher consumption customers in their pilot programs. Utilities that are looking to expand their program should use the results from their pilot programs with caution as they may have the tendency to overestimate or underestimate program benefits.

Lastly, the HER program has a secondary objective of promoting utility's rebate programs and increasing overall customer satisfaction. However, the impact on increasing overall customer satisfaction and promotion of rebate programs particularly for electric rebate programs is somewhat limited. Improvements in the way rebate programs are promoted in the reports could help increase rebate uptakes through the HER program.

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