

EEB Residential Consultant Comments and Mark-Ups (1/4/16)

Evaluation of Persistence in the Eversource Customer Behavior Program (R32)

DRAFT

December 2015

SUBMITTED TO:  
Connecticut Energy Efficiency Board

Eversource

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# Executive Summary

**ES**

This report updates findings from two prior evaluations of the Home Energy Reports (HERs) Pilot Program, implemented for Eversource by OPower.[[1]](#footnote-2) NMR Group, Inc. (NMR) conducted the analyses described in the current report.

The objectives included the following:

* Update savings persistence for households[[2]](#footnote-3) that stopped receiving reports no later than April 2013
* Estimate the post-treatment measure life of savings
* Explore program cost-effectiveness[[3]](#footnote-4) and realization rates
* Examine the impact of HERs on participation in other CEEF programs and deeper measure adoption
* Assess whether Eversource is in danger of “double counting” savings in HERs and other CEEF programs

Note that data on retention rates for behavioral programs in the literature is somewhat sparse and so cannot easily be transferred from other studies. This study provides specific information for the Eversource program.

## Program Description

**The HERs Pilot program is a behavior-based program that sends households a report reporting their energy use, providing comparisons to other households, and suggesting ways to save energy. The pilot program uses an experimental design to provide reports to a sample of households, and not provide reports to a specially-selected “control group”, facilitating comparisons and impact measurements.** Eversource and program implementer OPower administered a behavior pilot program for the purposes of achieving residential electricity savings and providing value to their customers through the delivery of two-page (printed on front and back) reports. Relying on a randomized control design, these reports present a treatment group with feedback on their electricity use and compare that use to a group of similar households referred to as “neighbors,” which are defined as 100 occupied households similar in size and paying the same rate code as the participant home. They also provide lists of energy-saving tips that differ from month to month and year to year. The implementer then compares the energy savings of the treatment group to a control group that did not receive the HERs. The pilot program uses an “opt-out” design (prior research concluded that very few households actually do opt out), so the design does not suffer from the self-selection bias that often plagues other energy efficiency program evaluations.

**Definitions of the various study or “retention” groups addressed in the report are included in the following box.**

|  |
| --- |
| * **Discontinued group**: Starting receiving reports in January 2011 and stopped receiving reports by April 2012; all had higher than average pre-program energy use   + Discontinued Monthly group: Received monthly reports through April 2012   + Discontinued Quarterly group: Received reports every three months through April 2012   + Discontinued persistence group: Received reports through August 2011 * **High-use Extension group**: Received reports starting in January 2011 and continued to receive them through at least July 2013, with a hiatus in April to June 2012 * **Average-use Expansion group**: Received reports July 2012 through at least July 2013 |

## Study Methods

**The study used billing analysis to examine persistence of savings for the Discontinued group(s).** This study conducted a billing analysis to estimate savings for the period through November 2014, which makes a continuous set of savings estimates for the *Discontinued group* since they first began receiving reports in January 2011

**The study *did not / could not* examine the persistence of the High-use Extension or Average-use Expansion groups.** These two groups were still receiving reports when the work plan for this study was developed. An examination of their persistence will need to await discontinuation of reports to these households.

**The study provided information related to program cost effectiveness and realization rates.** Using program budgets and estimated savings, the study presents the ratio of program expenditures to savings and comments on the program realization rate.

**The study explored participation in other programs and deeper measure uptake.** The study presents statistical comparisons of rates of Home Energy Services (regular and income eligible) and rebate programs participation and deeper measure update for HERs treatment and control group households all three groups—discontinued, high-use extension, and average-use expansion.

## Findings

### Persistence of Savings

**The HERs program leads to savings during – and well after – the households receive reports.** Figure 1[[4]](#footnote-5) summarizes the estimated savings, and retained savings, for the various groups for treatment (actively receiving HER reports), and various lengths of post-treatment periods. The main findings are:

* **Over the entire analysis period:** The discontinued high use homes saved an average of 0.78 kWh per day over the 47 months of their analysis period from treatment through post-treatment (January 2011- November 2014). The savings for the subgroups varied, ranging from 0.54 kWh per day for the persistence group, 0.76 kWh per day for the Quarterly group, and 1.72 kWh for the monthly group.
* **Sub-Periods**: Examining individual periods shows that the Persistence and Monthly households stopped savings energy within 16 months post treatment, while the Quarterly group continued to achieve savings up to 32 months post treatment. The lower result for the monthly group is more a function of small sample size of discontinued household than to a lack of savings.[[5]](#footnote-6) Figure 1 shows substantial retention of savings in the years after the HER reports are stopped.

Figure 1: Discontinued Group Average Daily Savings Over Time1,2

1 All discontinued households were considered “high users” of electricity prior to receiving home energy reports.

2 The number of cases per subgroup are as follows: Monthly group (n=1,670), persistence group (n=3,979), quarterly group (n=9,856), control group (n=24,268).

Figure 2 recasts the savings from Figure 1 into annualized figures, and Figure 3 translates these retention results (from Figure 2) into percentage of treatment year savings retained annually for each study group. The figures show:

**Annualized retention rates for these behavioral savings are strong, declining less than 25% on average for each of the 3 years after discontinuation**.

* The discontinued group realized 426 kWh savings during the first year, and (retained) savings declined to 119 kWh by the third year. The monthly group saved the most energy during and post-treatment (but the small sample size undermines the statistical significance of the savings estimate).
* As expected, savings decline in each year post-treatment for all three groups. However, degradation rates were not linear within groups and also varied across groups. Average annual degradation was most severe for the Persistence group (34%), who received reports for only eight months—and their savings persisted for only two years. It was least severe for Quarterly households at 21% annually for their three years of savings persistence. Monthly households fell in between, with a 28% degradation across the two years they achieved statistically significant persistence savings.

Figure 2: Annualized Savings per Household, Discontinued Treatment Groups

Figure 3: Percentage of Annual Savings Retained Relative to Treatment by Discontinued Treatment Group\*

\* Statistically significant savings persist two years post treatment for the Persistence and Monthly treatment groups and three years for the Quarterly treatment group and all Discontinued households. As discussed in text, the analysis suggests that the Monthly savings would be significant if the sample size were larger.

### What the Retention Results Mean for Total Savings and Cost-Effectiveness

The retention of behavior savings from this program are quite strong. This has implications related to “revised” costs per kilowatt-hour savings that the program delivers for the pilot study groups – and for the program more widely.

The study used information on the treatment year savings and costs, and the retained savings ratios (a kind of “persistence” factor akin to measure-based measure lifetimes) to compute the total cost per kWh under the programs as they existed (considering the actual years they delivered and did not deliver report), and by extension, the savings under “hypothetical” conditions of starting / stopping HER reports. Table 1 provides a summary from more detailed tables included later in the report (which include much more explanation). This table summarizes both the total savings and the implied cost per kWh saved per household (the assessment of cost effectiveness) under alternative scenarios.[[6]](#footnote-7)

The figures in Table 1 imply that lower cost per kWh is achieved if the program delivery design leverages off the fact that the program has strong retention; “cycling” customers may be more cost-effective than continual delivery of HERs.

Table 1: Summary of Total Program Savings and Ratio of Expenditures to Savings, Three Treatment Groups

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | Quarterly Treatment Group | Persistence Treatment Group | Monthly Treatment Group |
| Actual – 1 year treatment, no persistence | kWh savings including retention | 391 | 346 | 796 |
| Amount spent / household | $11.87 | $11.97 | $8.34 |
| Cost per kWh | $0.030 | $0.035 | $0.010 |
| Actual – 1 year treatment, 1 year persistence | kWh savings including retention | 391 | 620 | 1,340 |
| Amount spent / household | $11.87 | $11.97 | $8.34 |
| Cost per kWh | $0.017 | $0.019 | $0.006 |
| Actual: 1 year treatment, 2 years persistence | kWh savings including retention | 391 | 733 | 1,694 |
| Amount spent / household | $11.87 | $11.97 | $8.34 |
| Cost per kWh | $0.013 | $0.016 | $0.005 |
| Actual: 1 year treatment, 3 years persistence | kWh savings including retention | 391 | n/a | n/a |
| Amount spent / household | $11.87 | n/a | n/a |
| Cost per kWh | $0.011 | n/a | n/a |
| Scenario / Projected: 4 years continual treatment | kWh savings including retention | 1565 | 1,383 | 3,185 |
| Amount spent / household | $47.49 | $47.89 | $33.37 |
| Cost per kWh | $0.030 | $0.035 | $0.010 |
| Scenario / Projected: 2 years treatment, 2 years persistence | kWh savings including retention | 783 | 692 | 1,593 |
| Amount spent / household | $23.75 | $23.94 | $16.69 |
| Cost per kWh | $0.018 | $0.022 | $0.007 |

**The study could not estimate retention rates for high-use extension households and average-use expansion households; given the number of customers in these groups, their persistence of savings be documented in future studies and credited to the program in assessing cost-effectiveness.** The PSD revisions for measure life/savings degradation cited should be applied solely to high-use households that received reports for about a year. Additional treatment savings and persistence savings remain unknown for these two groups at this time. Future studies should examine persistence/degradation for these groups as 18,000 Eversource customers fall into these two groups, so their full savings—treatment and persistence—should be documented and credited to the program. The utility should consider requesting cessation interruption of the HERs for (at least portions of) these groups.

**The study did not have access to savings as reported from OPower, which would be necessary to assess realization rates. Therefore, we have no option but to suggest Eversource maintain an assumed treatment period realization rate of 100%, as stated in the PSD.** The PSD for 2015 assumes a treatment period realization rate of 100%[[7]](#footnote-8) for Behavioral Change programs. Lacking access to the deemed savings provided by OPower, this analysis cannot confirm or reject the assumed realization rate of 100%, it is suggested that the Companies continue to assume a treatment period realization rate of 100%.[[8]](#footnote-9) This recommendation applies to *all* treatment households regardless of study group, treatment year, or pre-program usage. To refine this estimate, we would suggest the Utility request the needed information from OPower.

### Outside Program Participation and Deeper Measure Impact

**HERs treatment households take part in HES at higher rate (4.69%) than the control households (3.96%).** The analysis of uptake in the HES program demonstrated that treatment households participated in the program at a significantly higher rate than did the control households. No other program showed statistically greater participation among the treatment group compared to the control group.

**Insulation is the only deeper measure adopted at a greater rate by treatment households (8.93% versus 7.09% for control households), and only by High-Use Extension households.** Table 2 shows rates of deep measure adoption of all households in the HERs study group—discontinued, high-use extension, and average-use expansion. Looking at the percentage of deep measure adoption between the groups, only one measure was adopted a higher rate among treatment households—insulation for high-use extension households; otherwise, no extra adoption of “deeper” measures is induced by HERs.

Table 2: Deep Measure Adoption among HERs Study Group Households

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **Sample Size** | **Insula-tion** | **Fur-nace / Boiler** | **HVAC** | **Fridge/ Freezer** | **Water Heater Heat Pump** | **Win-dow** |
| Discon-  tinued | Treatment | 15,519 | 7.43% | 0.08% | 1.77% | 2.51% | 1.94% | 0.26% |
| Control | 24,268 | 7.09% | 0.08% | 2.01% | 2.37% | 1.91% | 0.21% |
| High-use | Treatment | 8,047 | 8.93%\* | 0.09% | 0.58% | 0.23% | 1.88% | 0.26% |
| Control | 24,268 | 7.09% | 0.08% | 2.01% | 2.37% | 1.91% | 0.21% |
| Average-use | Treatment | 10,217 | 7.14% | 0.14% | 1.94% | 2.26% | 1.87% | 0.32% |
| Control | 10,242 | 6.81% | 0.13% | 1.75% | 2.23% | 1.91% | 0.35% |

\* Indicates that the treatment group measure adoption rate is significantly different than the control group measure adoption rate (*X2*=30.62, p<0.001).

**There is little danger of double counting of savings across HERs and other programs due to small rates of adoption of deeper measures by HERs treatment households.** In order to assess the degree to which deeper measure adoption drives HERs program savings—and therefore may result in double counting of savings—the evaluators included controls for these measures in energy savings models. By including deeper measures in savings estimations, the study found that various measures were indeed associated with greater savings—as one would expect—but none of these measures reduced the estimated savings resulting directly from receipt of the HERs report.[[9]](#footnote-10) Given that measures did not “absorb” the Behavior Program savings, we can conclude that the HERs program savings are largely due to behavior change and not deeper measure adoption. The reported estimates of HERs savings also do not lead to significant double counting of savings in HERs compared to HES and rebate programs.

## Conclusions and Recommendation

The study draws the following conclusions and related recommendations.

**Persistence of Savings**: The HERs program induces energy savings for high-use households not only during the treatment period but for months and even years post-treatment.

**Recommendation 1:**  Eversource should consider revising the PSD to reflect the findings from this study. The specific values are summarized in Table 3. Note that this study does not provide estimated savings for High-use Extension or Average-Use Expansion Households as persistence savings have not been studied to date.

Table 3: Recommended Revisions to the Program Savings Document

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Discontinued Quarterly** | **Discontinued Persistence** | **Discontinued Monthly** |
| Treatment Savings in kWh1 | 391 | 346 | 796 |
| Persistent Factor2 | 1.79 | 1.12 | 1.13 |

1 Assumes a treatment period of about one-year. Longer treatment periods, such as those of the high-use extension households, may yield different annual savings.

2 To be multiplied by Treatment Savings and the two values summed to yield total lifetime savings per household.

**Recommendation 2: Until we have sufficient data to revise the estimate, Eversource should retain a realization rate of 100% for the treatment period.** The evaluators did not have access to updated estimates of energy savings as provided by OPower, so the study could not provide realization rates. However, it is our experience that most OPower estimates of savings *during the treatment period* tend to align with those estimated from third-party evaluations. Thus, the study recommends a treatment period realization rate of 100%. To calculate realization rates for post-treatment periods, Eversource will need to compare the savings estimates presented in this report with those provided by OPower.

**Cost-Effective Program Design:** Due to the sheer number of people in the treatment group, the HERs program yields a great deal of savings relative to the program expenditures. Factoring in the persistence of savings only increases program cost-effectiveness, suggesting that the most cost effective design may involve bursts of treatment activity followed by “down” periods when the program reaps persistence savings.

**Recommendation 3: Eversource should consider the most appropriate length of treatment given that savings persist for at least two years post treatment, yielding savings that rival continued treatment but at a lower cost to the program.** The analyses suggest that a single-year of monthly treatment followed by two years “off” would yield savings of 1,694 kWh per household at a cost of less than one cent per kWh. Program designs that call for continual treatment may yield greater savings but at greater cost per kWh in savings. An “on/off” treatment design may yield the most cost effective savings.

**Participation in other CEEF-funded programs and deeper measure adoption:** The study concludes that the HERs program induces participation in the HES program and greater uptake of insulation among high-use extension households. However, due to the relatively small number of treatment households taking part in other CEEF programs or adopting deeper measures, the analysis finds little danger of double-counting of savings across programs.

**Recommendation 4: Do not adjust the HERs program savings to avoid double counting with other CEEF programs.** Although a few HES-installed deeper measures do result in statistically significant savings in treatment households, their effect does not diminish the estimated savings from the HERs program. Therefore, Eversource should not make any adjustments to the savings calculations for HES or HERs in the Program Savings Document to correct for double counting.

# Introduction and Background

**1**

This report updates findings from two prior evaluations of the Home Energy Reports (HERs) Pilot Program, implemented for Eversource by OPower.[[10]](#footnote-11) NMR Group, Inc. (NMR) conducted the analyses described in the current report.

## Program Description

**Using an experimental design, some households**[[11]](#footnote-12) **receive a report describing their energy use relative to other households and suggesting ways to save energy.** Eversource and program implementer OPower administered a behavior pilot program for the purposes of achieving residential electricity savings and providing value to their customers through the delivery of HERs. Home Energy Reports provide feedback on household electricity use and compare that use to a group of similar households referred to as “neighbors.” The implementer uses a randomized control trial (RCT) approach, a true experimental design in which households eligible for the program are randomly assigned to either the treatment group that receives reports or the control group that does not. We urge readers to review our earlier reports, linked in prior footnotes, for a more detailed program description.

**The study design changed over time to include various sub-treatment groups based on pre-program energy use and how frequently and for how long they received HERs.** Table 4 summarizes the study designs for the Year 1 and Year 2 Pilot Program, provided as background information to understand program design and introduce the different study groups referred to in this report. The current analysis focuses on the long-term savings achieved by the discontinued treatment group, but it also explores the influence of HERs on other program participation and deeper measure adoption as well as cost effectiveness and realization rates for all households that were a part of the HERs program from January 2011 through July 2013. The most important point to keep in mind is that the pre-program energy use for participants differed over time in order to assess program impact on both high-use (1,600 kWh/month on average) and average-use (700/month kWh on average) customers.

Table 4: HERs Year 1 and Year 2 Program Designs and Study Groups

|  |  |  |
| --- | --- | --- |
| **Program Component** | **Year 1** | **Year 2** |
| Treatment Period | January 2011 to April 2012 | July 2012 to June 2013 |
| Study Group Size | 48,000 | 67,000 |
| Control Group Size | 24,000 | 34,500 |
| Active Treatment Group Size | 24,000 | 18,000a |
| Discontinued Treatment Group Sizeb | 0 | 16,000 |
| Pre-program usage type | High users only (1,600 kWh) | High-use (1,600 kWh) Extension (continued) (n=8,000)  Average-use (700 kWh) Expansion (new) n=10,000) |
| Quarterly Sub-treatment Group (received reports every three months for a year) | Yes | No |
| Persistence Sub-treatment Group (received monthly reports, but only for eight months rather than 12) | Yes | No |

a Includes 8,000 households from the Year 1 Pilot that continued receiving reports in the Year 2 Pilot

b Comprising all recipients from the Year 1 Pilot who did not receive reports in the Year 2 Pilot.

## Study Objectives

**The study objectives focus on how long savings persist after households stop receiving reports and the impact of HERs on participation in other Connecticut Energy Efficiency Fund (CEEF) programs and measure adoption.**

More specifically the objectives are as follows:

* Update savings persistence for households that stopped receiving reports no later than April 2013
* Estimate the post-treatment measure life of savings
* Examine the impact of HERs on participation in other CEEF programs and deeper measure adoption
* Assess whether Eversource is in danger of “double counting” savings in HERs and other CEEF programs
* Explore program cost-effectiveness[[12]](#footnote-13) and realization rates

## Methods

**The evaluators used three different methods to inform the study objectives:**

1. Billing analysis of discontinued households
2. Cross-tabulation and statistical testing for significant differences in other CEEF program participation and deeper measure adoption between the HERs treatment and control groups
3. Estimation of savings in the treatment group due to deeper measure adoption and program-induced savings

Table 5 summarizes the different study groups included in all three evaluations of the HERS program.

Table 5: HERs Evaluation Activities Over Time and by Study Group

|  |  |  |  |
| --- | --- | --- | --- |
| **Evaluation Activity1** | **High-use Discontinued2** | **2 High-use Extension3** | **Average-use Expansion4** |
| Study 1 Billing Analysis | Yes | Yes | No |
| Study 1 Persistence Analysis | 8-month treatment group only | No | No |
| Study 1 Assessment of other CEEF Program Participation | Yes | Yes | No |
| Study 2 Billing Analysis | No | Yes | Yes |
| Study 2 Persistence Analysis | Yes | No | No |
| Study 3 Persistence Analysis | Yes | No | No |
| Study 3 Assessment of other CEEF Program Participation | Yes | Yes | Yes |
| Study 3 Assessment of Deeper Measure Uptake | Yes | Yes | Yes |

1 Study 1: NMR and Tetra Tech, 2013 as cited above; Study 2: NMR and Tetra Tech, 2014 as cited above; Study 3: Current Study.

2 Discontinued households received reports from approximately January 2011 through either September 2011 or April 2012. All were considered “high users” prior to receiving reports.

3 Extension households received reports from approximately January 2011 through June 2013. All were considered “high users” prior to receiving reports.

4 Extension households received reports from approximately July 2012 to June 2013. All were considered “average users” prior to receiving reports.

### Billing Analysis

**The study relied on billing analyses to estimate post-treatment electricity savings and the persistence of these savings.** The billing analysis relied on data obtained from three different sources: 1) Eversource, 2) OPower, and 3) the National Climate Data Center (NCDC) website, as outlined in [Appendix A](#AppA).[[13]](#footnote-14) The data span from January 1, 2010 (one year pre-program) through November 30, 2014 (one month prior to the original data request).

**The study subjected customer electricity bills to a billing analysis to determine if savings persisted and for how long.** The billing analysis relied on a statistical technique known as ordinary least squares (OLS) robust regression. This technique ensures that the method does not over-estimate or underestimate treatment effects reflecting any imbalances in pre-program use between treatment and control groups and also to outliers. Inputs to the model included billing data, whether a household was in the treatment or control group, and weather data. The estimating equation is as follows:

Estimated Average Electricity Savings=β0(Avg. Post-Treatment Electricity Use)+ β1(Dichotomous Treatment)+ β2 (Avg. Pre-Treatment Electricity Use)+ β3 (Dichotomous Electric Heat)+ β4 (Heating Degree Days)+ β5 (Cooling Degree Days)[[14]](#footnote-15)

**The analysis explored persistence by various sub-treatment groups that had stopped receiving reports no later than April 2013 and for various time periods**, as follows:

* Study Groups
  + Monthly Discontinued: received reports every month from January 2011 through March 2012 (n=1, 670)
  + Quarterly Discontinued: received reports every three months from January 2011 through March 2012 (n=9,856)
  + Persistence: as named during the Year 1 Pilot; received reports every month from January 2011 through August 2011 (n=3.979)
  + Discontinued control group who never received reports (n=24,268)
* Time Period
  + January 2011 to March 2012: Year 1 Pilot treatment period
  + April 2012 to July 2013: approximately one to 14 months post-treatment (coincides with Year 2 Pilot program)
  + August 2013 to November 2014: 15 to 32 months post-treatment

### Other Program Participation and Deeper Measure Uptake

**The study also explored the impact of deep measure adoption on savings by comparison HERS treatment and control group participation in other CEEF programs**. This analysis involved matching accounts numbers for CEEF program participants[[15]](#footnote-16) from January 2010 through December 2014 to households in the HERs treatment and control group, including those who took part in both Year 1 and Year 1 of the pilot program (see Table 6). Statistical cross-tabulations and Chi-square tests assessed whether behavioral treatment and control households participated in CEEF programs at significantly different rates.

**The study also explored the impact of the HERs program on deeper measure update**. In order to define what deeper measures were impacting Behavior Program savings, the study ran a savings regression model with controls for whether the household had installed a deeper measure (e.g., insulation, HVAC equipment, and appliances). The analysis included separate models for discontinued, a high-use extension, and an average-use expansion households.

# Key Findings

**2**

The study results point to three critical findings:

* Most discontinued treatment households saved energy at least 32 months after receiving their last report
* The program induced greater participation in HES
* Deeper measure adoption among treatment group households does not lead to double counting of savings for reasons described below.

This section expands on each of these findings and related issues of savings decay, cost effectiveness, and realization rates.

## Persistence of Savings Two Years After Treatment Cessation

**The HERs program design induces statistically significant savings during the treatment period and beyond.** The study finds that the discontinued treatment group achieved statistically significant savings of 1.6% over the control group from the beginning of the program (January 2011) through November 2014 (nearly three years after report cessation, Table 6). However, it is worth noting that the same analysis conducted through July 2013 showed the overall savings to be 2%, so savings do seem to be slipping over time.[[16]](#footnote-17) An analysis by different time periods further suggests a degradation of savings over time. While discontinued households achieved savings of 1.9% during the treatment period and 1.8% for the 16 months immediately following treatment, they achieved savings of 1.0% in the next 16 months post-treatment—statistically lower than the other two periods.

Table 6: Discontinued Household Program Savings through November 2014

(Savings relative to the control group’s energy use)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Entire Period (Jan. 2011 – Nov. 2014)** | **Jan. 2011 – Mar. 2012 (Treatment)** | **Apr. 2012 – Jul. 2013 (Post)** | **Aug. 2013 – Nov. 2014 (Post)2** |
| Average Daily kWh saving1 | 0.78 | 0.91 | 0.88 | 0.48 |
| Average Percent Savings | 1.59% | 1.88% | 1.82% | 0.99% |
| Sample Size | 35,096 | 35,000 | 35,000 | 35,000 |
| Explained Variance | 75% | 82% | 66% | 62% |

1 All results are statistically significant at 90% confidence, p < 0.001

2 While the model demonstrates that the discontinued group continued to save statistically more energy than the control group during this period, it is also the case that the savings were statistically lower than those from the two previous time periods. A Wald test (*X2* = 14.46, p<.001) concludes that the savings estimates in all three time periods differ significantly.

**The study also examines persistence of savings by the duration and frequency at which households received HERs**. While evaluations in other areas have documented that HERs-type program savings persist after treatment, the evaluation team for the current study is not aware of any other studies that have examined persistence by how long and how often households received reports. The two prior studies of the Eversource HERs program found that the persistence group—those households who received HERs for eight months only—saved a significant amount of electricity from September 2011 through March 2012 but their savings stopped achieving statistical significance five months after they stopped receiving reports.[[17]](#footnote-18) The prior studies also suggested that savings amounts differed between the quarterly and monthly report recipients, with monthly housing savings more per household.

**The analysis of savings by time period found mixed results for the persistence of savings based on how long and how often households received reports, but different sample sizes muddy the results.** The analysis suggests that all three sub-treatment groups continued to achieve savings in the April 2012 through July 2013 time period (Table 7). However, only the quarterly group exhibited statistically significant savings over the control group (1.3%) in the August 2013 to November 2014 period. The findings, though, are somewhat perplexing because the monthly treatment group achieved savings of 1.7% but the results were not statistically significant. Because Eversource and OPower continued to send reports to most monthly report households in the Year 2 Pilot (these are the Extension households described in Table 6), the discontinued treatment group contains only 1,670 monthly report households. This small sample size lacks the statistical power to yield significant results. Yet, the fact that the quarterly group had smaller savings that nevertheless achieved significance due to a larger sample size strongly suggests that the monthly group most likely saved energy in the August 2013 to November 2014 period as well. In contrast, the persistence group’s savings decrease to only 0.23%, pointing to an earlier end of the program effect for households that received report for only eight months. A Wald test for the monthly discontinued households (*X2* = 9.92, p<.01) and the persistence discontinued households (*X2* = 14.78, p<.001) concludes that the savings estimates in all three time periods differ significantly. The quarterly discontinued group shows significant savings in all time periods, but a Wald test does not allow us to conclude that we detect a significant amount of change in savings from one evaluation period to the next.

Table 7: Estimated Average Savings among the Discontinued Sub-Groups during Evaluation Periods1

(Savings relative to the control group’s energy use)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Discontinued Treatment  Sample Size** | **Jan. 2011 – Nov. 2014 (Treatment & Post Treatment)** | **Jan. 2011 – Mar. 2012 (Treatment)** | **Apr. 2012 – Jul. 2013 (Post-Treatment)** | **Aug. 2013 – Nov. 2014  (Post-Treatment)** |
| Discontinued Monthly Treatment Effect | 1,670 | 1.72\*  (3.56%) | 1.75\*  (3.62%) | 1.49\*  (3.70%) | 0.71  (1.66%) |
| Discontinued Persistence Treatment Effect | 3,979 | 0.54\*  (1.11%) | 0.76\*  (1.57%) | 0.75\*  (1.86%) | 0.09  (0.23%) |
| Discontinued Quarterly Treatment Effect | 9,856 | 0.76\*  (1.56%) | 0.86\*  (1.79%) | 0.83\*  (2.06%) | 0.61\*  (1.27%) |
| Sample Size Overall2 | 15.505 | 35,000 | 35,000 | 35,000 | 35,000 |
| Explained Variance | n/a | 75% | 82% | 69% | 62% |

1 Daily savings in kWh and percentages. Recall that all discontinued households were “high users” of electricity prior to receiving reports.

2 The remaining19,495 households in the overall sample size are the discontinued control group households.

\* Statistically significant at 90% confidence.

**Analysis of savings by month allows the study to pinpoint when households in different treatment groups stop savings energy.** To delve into more detail about the duration of persistent savings for each of the discontinued treatment groups, the study examined monthly persistence from April 2012 through November 2014.[[18]](#footnote-19) Figure 4 graphs the trend lines in savings for each of the discontinued treatment groups, with the dotted lines showing when the savings generally cease being statistically significant for each group. As the earlier analyses suggested, the graph confirms that households that received reports for a full year—whether monthly or quarterly—appear to exhibit greater savings and persistence of these savings when compared to the group that received reports for only eight months. For the monthly treatment group, these savings remain significant for about two years after receipt of the last report, while those for the quarterly group remain significant for nearly three years after receipt of the last report. Again, the variation in the number of cases likely explains why the quarterly group exhibits significant results longer than the monthly group. Thus, this study concludes that a full year of treatment—and not eight months—is sufficient to produce long-term persistence in savings for at least two years; the results are *indicative* of those savings persisting for nearly three years post-treatment, although the lack of statistical power means we cannot definitively conclude this is the case.

It is also the case that all of the trend lines show some seasonal and monthly variation and point to gradually diminishing savings over time. In other words, savings do not drop off precipitously at a given length of time after the program; instead, they seem to be slowly fading over time, likely because consumers return to their old habits as the energy-saving tips and neighbor comparison fade from their memories.

Figure 4: Persistent Savings by Month after Treatment Cessation

**Savings persist, but they decline each year after the household stops receiving reports.** Figure 5 shows the per household annualized savings in kWh for each of the treatment groups, coinciding with the treatment period and then 12 months, 12 to 24 months, and 25 to 32 months post-treatment. The figure demonstrates that households that received monthly reports for a year saved the most energy during and post-treatment, but the small sample size of 1,670 lacks the power to yield a statistically significant result. The figure also makes clear that savings for all three groups decline each year post-treatment.

Figure 5: Annualized Savings per Household, Discontinued Treatment Groups

**Savings persist, but they decline at about an average rate of 24% each year overall relative to treatment period savings.** (Figure 6). Degradation rates were not linear within groups and also varied across groups. Average annual degradation was most severe for the persistence group (34%), who received reports for only eight months—and their savings persisted for only two years. It was least severe for quarterly households at 21% annually for their three years of savings persistence. Monthly households fell in between, with a 28% degradation across the two years they achieved statistically significant persistence of savings.

Figure 6: Percentage of Annual Savings Retained Relative to Treatment by Discontinued Treatment Group\*

\* Statistically significant savings persist two years post treatment for the Persistence and Monthly treatment groups and three years for the Quarterly treatment group and all Discontinued households. As discussed in text, the analysis suggests that the Monthly savings would be significant if the sample size were larger.

**The savings decay of 24% in the Eversource HERs is in line with those reported for similar programs.** The overall Discontinued Group savings decayed an average of 24% per year for 32 months post treatment. This falls within the range of decay rates compiled by Khawaja and Stewart in their review of a number of OPower programs’ long-run savings (Table 8).[[19]](#footnote-20) Khawaja and Stewart were able to review five studies reporting persistent savings more than a year after behavioral treatment cessation and found a range of first year savings decay from 11% to 32%.

Table 8: Savings Decay among the High-Use Discontinued Sub Groups

(Ratio of Active Treatment Savings to Post-treatment Persistence Savings)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Original Author** | **Area** | **Number of treatment months** | **Number of Post Treatment Months** | **Annual Savings Decay** |
| DNV GL (2014) | Puget Sound Energy | 24 | 36 | 11% |
| Allcott and Rogers (2014) | West Coast | 25 to 28 | 34 | 15% |
| Allcott and Rogers (2014) | West Coast | 24 | 29 | 18% |
| Allcott and Rogers (2014) | Upper Midwest | 24 to 25 | 26 | 21% |
| **NMR Group (2015)** | **Eversource** | **8 to 14** | **32** | **24%** |
| Integral Analytics (2012) | SMUD | 27 | 12 | 32% |

**The overall HERs program ratio of program expenditures ratio is about one cent per kWh save when only using Year 1 costs and persistence savings.** By using the Year 1 Pilot program budget to estimate the ratio of program expenditures to program savings across the treatment and post-treatment period. Table 9. shows that the ratio of expenditures to savings was relatively low for all three discontinued groups during the treatment period, ranging from one cent per kWh saved for the Monthly Group and three cents for the Quarterly and Persistence Groups. Adding in statistically significant persistence savings only adds to the already high cost effectiveness of the program. The Persistence Group had the largest cost per savings at two cents; the Monthly Group expenditure to savings ratio was one-half a cent; while the largest group, the Quarterly Group, ratio was one cent per kWh saved. The ratio of expenditure to savings is not directly correlated to the number of reports issued, the monthly group received the largest number of reports and had the smallest ratio, and the persistence group received more reports than did the quarterly group but had a higher ratio than did the quarterly group. In short it is not number of reports driving the expenditure ratio but the magnitude of savings generated by the group that is driving the low expenditure to savings ratios.

Table 9: Dollar Expenditure per kWh Savings for the Discontinued Group

(Calculations include the treatment and post-treatment period)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Savings Period | **Discontinued Quarterly Group** | **Discontinued Persistence Group** | **Discontinued Monthly Group** | **Total Discontinued Group** |
| Treatment | $0.03 | $0.03 | $0.01 | $0.03 |
| Treatment and one year post-treatment | $0.02 | $0.02 | $0.01 | $0.02 |
| Treatment and two years post-treatment | $0.01 | $0.02 | $0.005 | $0.01 |
| Treatment and three  years post-treatment | $0.01 | -- | -- | $0.01 |
| Program Expenditure | $117,026 | $47,638 | $13,932 | $178,596 |
| Sample Size | 9,856 | 3,979 | 1,670 | 15,505 |

**Because of savings persistence, Discontinued Group households exhibit a higher ratio of expenditures to savings (one cent) than High-use Extension (two cents) and Average-use Expansion households (five cents) as measured through November 2014.** Through July 2013, the cost effectiveness of the High-use Extension Group rivaled that of the three Discontinued groups (three cents per kWh), but, by November 2014, its ratio of expenditures to savings more closely resembled the Discontinued Persistence Group (two cents per kWh) than the more successful Discontinued Quarterly or Monthly Groups (one cent and one-half cent per kWh, respectively). Additionally, because their savings rate is lower than high-use households, the Average-use Expansion achieved a ratio of expenditure to savings of 13 cents per kWh through July 2013 (one year of treatment), while this improved to five cents through November 2014. Importantly, the Extension and Expansion households were still receiving reports during planning for the current study. While they have requested the information, at the time of writing the evaluators were not aware of how long their treatment continued or the total budget spent on each group during the full treatment period. Therefore, the ratio of expenditures to savings through November 2014 *overstates* the cost-effectiveness of the program because additional money was spent during that time. Future evaluations will need to assess the persistence of savings for these two groups, which would provide a fuller understanding of the lifetime cost-effectiveness for the Extension and Expansion households.

Table 10: Dollar Expenditure per kWh Savings for the Extension and Expansion Groups

|  |  |  |
| --- | --- | --- |
| Savings Period | **High Use Extension Group** | **Average Use Expansion Group** |
| Treatment through July 2013 | $0.03 | $0.13 |
| Treatment/post-treatment through November 2014 | $0.02 | $0.05 |
| Program Expenditure | $201,131 | $128,319 |
| Sample Size | 3,979 | 9,856 |

1 The Treatment period only savings come from the *Evaluation of the Year 2 CL&P Pilot Customer Behavior Program (R2)*. Available at <http://www.energizect.com/government-municipalities/evaluation-year-2-clp-pilot-customer-behavior-pgm-r2-final-report-8-8-14>

2 The date when these households stopped receiving reports is unknown at this time. If available before this report is finalized, the study will revise these estimates. The treatment / post treatment period for the average-use group includes July 2012 through November 2014 and for the high-use group is January 2011 through November 2014.

The three tables on the following pages summarize treatment and post-treatment savings for the three discontinued groups, **including presenting “persistence factors” that should be used in place of a measure life to estimate lifetime savings, with calculations described in the tables below.** The tables also summarize the assessment of cost effectiveness—measure as expenditures per kWh saved per household—for different hypothetical program scenarios. The study relies on these hypothetical scenarios because of the uncertainties cited above regarding how long the High-use Extension and Average-use Expansion households received reports and the total budget expended on treatment for these two groups.

**The Quarterly Treatment Group exhibited statistically significant savings for three years after treatment, yielding a total lifetime savings of 1,093 per household at a little over one cent per kWh saved (Table 11).** This total savings comprises both treatment savings and three years of persistence savings, at an average annual retention of savings of 0.6, or 1.79 (the persistence factor) across the three years. If the program had continued to send reports to these households for four years *at the same cost and with the same savings achieved*, the total energy savings would have been 1,575 kWh at a cost of three cents per kWh saved.[[20]](#footnote-21)

Table 11: Summary of Total Program Savings and Ratio of Expenditures to Savings, Quarterly Treatment Group

(n=9,856)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Actual: One Year Treatment, no Persistence** | **Actual: One Year Treatment, One Year Persistence** | **Actual: One Year Treatment, Two Year Persistence** | **Actual: One Year Treatment, Three Year Persistence** | **Hypothetical: Four Years Continual Treatment** | **Hypothetical: Two Year Treatment, Two Year Persistence** |
| 1. Treatment Savings (kWh / HH) | 391 | 391 | 391 | 391 | 1,565 | 783 |
| 2. Years Post-Treatment with Statistically Significant Savings | 0 | 1 | 2 | 3 | 0 | 2 |
| 3. Technical Retention (Average by Years Persistent) | 0 | 0.77 | 0.71 | 0.60 | 0 | 0.71 |
| 4. Persistence factor (Row 2 x Row 3) | 0 | 0.77 | 1.41 | 1.79 | 0 | 1.41 |
| 5. Amount spent on group per HH\* | $11.87 | $11.87 | $11.97 | $11.87 | $47.49 | $23.75 |
| 6. Total Saved in kWh / HH (Row 1 + [Row 1 x Row 4]) | 391 | 693 | 944 | 1,093 | 1,565 | 1,335 |
| 7. Expenditures per kWh Saved (Row 5 / Row 6) | $0.030 | $0.017 | $0.013 | $0.011 | $0.030 | $0.018 |
| \* Based on Year 1 program spending proportionately allocated to each discontinued group (and adjusting for amount spent in Year 1 of the program on the continued group); multiplied by assumed years of treatment in alternative scenarios. | | | | | | |

Although the Persistent Treatment Group received reports for only eight months, **Table** **12** converts their savings to a full year for ease of comparison across groups. **Because this group achieved statistically significant savings only two years post-treatment, the lifetime savings sums to 733 kWh per household at a cost of about 1.6 cents per kWh saved, representing the most spent** among **discontinued households relative to achieved savings. The persistence factor for this group is 1.12.**

Table 12: Summary of Total Program Savings and Ratio of Expenditures to Savings, Persistent Treatment Group

(n=3,979)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Actual: One Year Treatment, no Persistence** | **Actual: One Year Treatment, One Year Persistence** | **Actual: One Year Treatment, Two Year Persistence** | **Hypothetical: Four Years Continual Treatment** | **Hypothetical: Two Year Treatment, Two Year Persistence** |
| 1. Treatment Savings (kWh / HH) | 346 | 346 | 346 | 1,383 | 692 |
| 2. Years Post-Treatment with Statistically Significant Savings | 0 | 1 | 2 | 0 | 2 |
| 3. Technical Retention (Average by Years Persistent) | 0 | 0.79 | 0.56 | 0 | 0.56 |
| 4. Persistence factor (Row 2 x Row 3) | 0 | 0.79 | 1.12 | 0 | 1.12 |
| 5. Amount spent on group per HH\* | $11.97 | $11.97 | $11.97 | $47.89 | $23.94 |
| 6. Total Saved in kWh / HH (Row 1 + [Row 1 x Row 4]) | 346 | 620 | 733 | 1,383 | 1,079 |
| 7. Expenditures per kWh Saved (Row 5 / Row 6) | $0.035 | $0.019 | $0.016 | $0.035 | $0.022 |
| \* Based on Year 1 program spending proportionately allocated to each discontinued group (and adjusting for amount spent in Year 1 of the program on the continued group); multiplied by assumed years of treatment in alternative scenarios. | | | | | |

**Even with just two years of statistically significant post-treatment savings, the Monthly treatment group exhibited the greatest amount of savings per household (1,694 kWh) at the lowest cost per kWh (about one-half of a cent). The persistence factor for this group is 1.13.** The regular, monthly reminder of the HERs led the discontinued Monthly treatment households to achieve the highest savings during treatment (Table 3). While their savings degraded at faster rate than the quarterly group (0.56 in two years versus 0.71 in two years, respectively), this degradation rate still could not undo the greater savings experienced by this group during treatment. As mentioned earlier in this report, the fact that the Quarterly treatment group (n=9,856) achieved statistically significant savings three years post treatment with smaller savings than the Monthly group (n=1,670) strongly suggests that the monthly group would also have shown savings persistence with a larger sample size, which would only serve to increase its overall savings and cost effectiveness.

Table 13: Summary of Total Program Savings and Ratio of Expenditures to Savings, Monthly Treatment Group

(n=1,670)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Actual: One Year Treatment, no Persistence** | **Actual: One Year Treatment, One Year Persistence** | **Actual: One Year Treatment, Two Year Persistence** | **Hypothetical: Four Years Continual Treatment** | **Hypothetical: Two Year Treatment, Two Year Persistence** |
| 1. Treatment Savings (kWh / HH) | 796 | 796 | 796 | 3,185 | 1,593 |
| 2. Years Post-Treatment with Statistically Significant Savings | 0 | 1 | 2 | 0 | 2 |
| 3. Technical Retention (Average by Years Persistent) | 0 | 0.68 | 0.56 | 0 | 0.56 |
| 4. Persistence factor (Row 2 x Row 3) | 0 | 0.68 | 1.13 | 0 | 1.13 |
| 5. Amount spent on group per HH\* | $8.34 | $8.34 | $8.34 | $33.37 | $16.69 |
| 6. Total Saved in kWh / HH (Row 1 + [Row 1 x Row 4]) | 796 | 1,340 | 1,694 | 3,185 | 2,491 |
| 7. Expenditures per kWh Saved (Row 5 / Row 6) | $0.010 | $0.006 | $0.005 | $0.010 | $0.007 |
| \* Based on Year 1 program spending proportionately allocated to each discontinued group (and adjusting for amount spent in Year 1 of the program on the continued group); multiplied by assumed years of treatment in alternative scenarios. | | | | | |

**The study did not have access to savings as reported from OPower, which would be necessary to assess realization rates. Therefore, the Eversource should maintain an assumed treatment period realization rate of 100%, as stated in the PSD.** The PSD for 2015 assumes a treatment period realization rate of 100%[[21]](#footnote-22) for Behavioral Change programs. Lacking access to the deemed savings provided by OPower, this analysis cannot confirm or reject the assumed realization rate of 100%, it is suggested that the Companies continue to assume a treatment period realization rate of 100%.[[22]](#footnote-23) This recommendation applies to *all* treatment households regardless of study group, treatment year, or pre-program usage.

## Rates of Outside Program Participation among Behavioral Program Participant and Non-participant Households

**The HERs program induces participation in the HES program.** While the persistence savings analysis focused only on discontinued households, the study included all treatment households from Year 1 and Year 2 Pilot programs in the analysis of the HERs program impact on participation in other CEEF programs. The results of the analysis of participation in other CEEF programs suggests that HERs treatment households inducing greater participation in the HES and between January 1, 2011, and December 31, 2014 (*X2*=21.2 and p-value <0.001) (Table 16). The evidence for other programs is not statistically significant (and sometimes points to greater control group participation).

Table 14: Participation in other CEEF Programs

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Program** | **Sample Size** | **HES-IE** | **HES** | **Resi Rebate** | **Res HVAC** | **Lighting Catalog** | **Lighting Coupon** |
| # Treatment Group | 32,974 | 294 | 1,558 | 280 | 390 | 15 | 278 |
| # Control Groups | 33,037 | 290 | 1,320 | 305 | 429 | 16 | 256 |
| % of all Treatment | 32,974 | 0.88% | 4.69%\* | 0.84% | 1.17% | 0.05% | 0.84% |
| % of all Control | 33,037 | 0.88% | 3.96% | 0.91% | 1.29% | 0.05% | 0.77% |
| Difference | n/a | 0.00% | 0.73% | -0.07% | -0.12% | 0.00% | 0.07% |

\* Indicates that the treatment group measure adoption rate is significantly different than the control group measure adoption rate (*X2*=21.2 and p-value < 0.001).

While confirming greater HES participation among HERs households, this straightforward analysis does not allow us to conclude that these households were acting on specific tips from the HERs when choosing to take part in these other CEEF programs. Nor do we know if these households adopted deeper measures due to their HES participation—a topic to which we turn next.

## Deeper Measure Adoption Impact on Program Savings

**High-use Extension households adopted insulation at a higher rate than the control group.** To examine deeper measure adoption among HERs treatment households, the evaluation team linked measure adoption data in the HES, HES-IE, and rebate program tracking database (2010 to 2014) to HERs treatment and control group households. Looking at deep measure adoption by treatment group (discontinued, high-usage [Extension], and average-usage [Expansion]), HERs High-use Extension households adopted insulation at a greater rate than the control group (Table 15). The HERs households in all other groups failed to adopt any other measures at a greater rate than the control group.

Table 15: Deep Measure Adoption among Behavior Program Households

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **n** | **Insula-tion** | **Furnace / Boiler** | **HVAC** | **Fridge / Freezer** | **Water Heater Heat Pump** | **Window** |
| Discontinued all high-use | Treatment | 15,519 | 7.59% | 0.08% | 1.77% | 2.51% | 1.94% | 0.26% |
| Control | 24,268 | 7.29% | 0.08% | 2.01% | 2.37% | 1.91% | 0.21% |
| High-use Extension | Treatment | 8,047 | 7.26%\* | 0.09% | 0.58% | 0.23% | 1.88% | 0.26% |
| Control | 24,268 | 7.29% | 0.08% | 2.01% | 2.37% | 1.91% | 0.21% |
| Average-use Expansion | Treatment | 10,217 | 7.14% | 0.14% | 1.94% | 2.26% | 1.87% | 0.32% |
| Control | 10,242 | 6.81% | 0.13% | 1.75% | 2.23% | 1.91% | 0.35% |

\* Indicates that the treatment group measure adoption rate is significantly different than the control group measure adoption rate (*X2*=30.62, p<0.001).

**The study examines the possible double counting of savings between HERs and other programs.** Because the HERs program includes energy-saving tips that encourage households to take part in HES and buy products that may have incentives applied to them, the question arises as to whether the HERs savings are being double counted in other programs—notably, HES, HES-IE, and rebate programs. In other words, are the HERs savings simply reflecting measures adopted in other programs? To explore this, the study included a series of regression models with flags for whether the treatment and control households had adopted deeper measures (the same named in Table 17 above). We ran separate models for discontinued households, high-use extension households, and average-use expansion households due to their different pre-program energy use and length of time they received reports. If the measures were in fact responsible for a portion of the HERs savings, then the model should capture it. Statistically, the coefficient for the impact of receiving HERs should decrease.

**The models suggests little danger of double counting of savings in HERs due to deeper measure adoption.** As one would expect, the regression models confirm that households in both the treatment and control groups that adopted deeper measures saved energy. However, the coefficient for HERs program-induced savings—the element of the model that tells us how much energy the average HERs treatment household saved—decreased no more than a hundredth of a percent when the deeper measure variable was included in the models (Table 18 to Table 20). In short, deeper measure adoption impacts savings, but not on a scale that would lead to any double counting between other programs. Why would this be the case? The number of HERs households adopting deeper measures is too small to matter in the average. Those households with insulation, for example, save more than other households, but another household ignore the HERs and does nothing. It all averages out in the end.

Table 16 to Table 18 present the results of these models for the discontinued, high-use, and average-use households.

Table 16: Estimated Discontinued Group Program Savings   
with Deeper Measures

(Savings relative to the control group’s energy use)

|  |  |  |
| --- | --- | --- |
|  | **Discontinued High-Use Households** | **Discontinued Households with Deeper Measures included in Model** |
| Average Daily kWh saving1 | 0.777 | 0.773 |
| Average Percent Savings | 1.59% | 1.58% |
| Sample Size | 35,000 | 35,000 |
| Explained Variance | 75% | 75% |

1 All results are statistically significant at 90% confidence

Table 17: Estimated High Usage Household Program Savings   
with Deeper Measures

(Savings relative to the control group’s energy use)

|  |  |  |
| --- | --- | --- |
|  | **High Usage Extension Households** | **High Usage Households with Deeper Measures included in Model** |
| Average Daily kWh saving1 | 1.13 | 1.12 |
| Average Percent Savings | 2.37% | 2.34% |
| Sample Size | 31,000 | 31,000 |
| Explained Variance | 72% | 72% |

1 All results are statistically significant at 90% confidence

Table 18: Estimated Average Usage Household Program Savings   
with Deeper Measures

(Savings relative to the control group’s energy use)

|  |  |  |
| --- | --- | --- |
|  | **Average Usage Expansion Households** | **Average Usage Households with Deeper Measures included in Model** |
| Average Daily kWh saving1 | 0.294 | 0.291 |
| Average Percent Savings | 1.33% | 1.31% |
| Sample Size | 20,000 | 20,000 |
| Explained Variance | 45% | 45% |

1 All results are statistically significant at 90% confidence

# Conclusions and Recommendations

**3**

This study was designed to determine whether the HERs program was continuing to induce persistent savings and, if not, when the savings stopped. These analyses allowed the study to also comment on realization rates, measure life, and cost effectiveness. The study additionally explored whether deeper measure adoption was responsible for a portion of the HERs savings, thereby leading to double counting of savings across programs. The analyses in this report suggest the following conclusions.

The study draws the following conclusions and related recommendations.

**Persistence of Savings**: The HERs program induces energy savings for high-use households not only during the treatment period but for months and even years post-treatment.

**Recommendation 1:**  Eversource should consider revising the PSD to reflect the findings from this study. The specific values are summarized in Table 3. Note that this study does not provide estimated savings for High-use Extension or Average-Use Expansion Households as persistence savings have not been studied to date.

Table 19: Recommended Revisions to the Program Savings Document

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Discontinued Quarterly** | **Discontinued Persistence** | **Discontinued Monthly** |
| Treatment Savings in kWh1 | 391 | 346 | 796 |
| Persistent Factor2 | 1.79 | 1.12 | 1.13 |

1 Assumes a treatment period of about one-year. Longer treatment periods, such as those of the high-use extension households, may yield different annual savings.

2 To be multiplied by Treatment Savings and the two values summed to yield total lifetime savings per household.

**Recommendation 2: Retain a treatment period realization rate of 100% for the treatment period.** The evaluators did not have access to updated estimates of energy savings as provided by OPower, so the study could not provide realization rates. However, it is our experience that most OPower estimates of savings *during the treatment period* tend to align with those estimated from third-party evaluations. Thus, the study recommends a treatment period realization rate of 100%. To calculate realization rates for post-treatment periods, Eversource will need to compare the savings estimates presented in this report with those provided by OPower.

**Cost-Effective Program Design:** Due to the sheer number of people in the treatment group, the HERs program yields a great deal of savings relative to the program expenditures. Factoring in the persistence of savings only increases program cost-effectiveness, suggesting that the most cost effective design may involve bursts of treatment activity followed by “down” periods when the program reaps persistence savings.

**Recommendation 3: Eversource should consider the most appropriate length of treatment given that savings persist for at least two years post treatment, yielding savings that rival continued treatment but at a lower cost to the program.** The analyses suggest that a single-year of monthly treatment followed by two years “off” would yield savings of 1,694 kWh per household at a cost of less than one cent per kWh. Program designs that call for continual treatment may yield greater savings but at greater cost per kWh in savings. An “on/off” treatment design may yield the most cost effective savings.

**Participation in other CEEF-funded programs and deeper measure adoption:** The study concludes that the HERs program induces participation in the HES program and greater uptake of insulation among high-use extension households. However, due to the relatively small number of treatment households taking part in other CEEF programs or adopting deeper measures, the analysis finds little danger of double-counting of savings across programs.

**Recommendation 4: Do not adjust the HERs program savings to avoid double counting with other CEEF programs.** Although a few HES-installed deeper measures do result in statistically significant savings in treatment households, their effect does not diminish the estimated savings from the HERs program. Therefore, Eversource should not make any adjustments to the savings calculations for HES or HERs in the Program Savings Document to correct for double counting.

1. Expanded Methods

**A**

The evaluation team cleaned the data to exclude incomplete data, add weather data, and evaluate the usage patterns compared to average Eversource households.

Eversource provided flags for households who had contacted Eversource to opt out of the program. Eversource also included rate codes, so the evaluators could determine all-electric rate-paying households and flags for whether service had been disconnected.

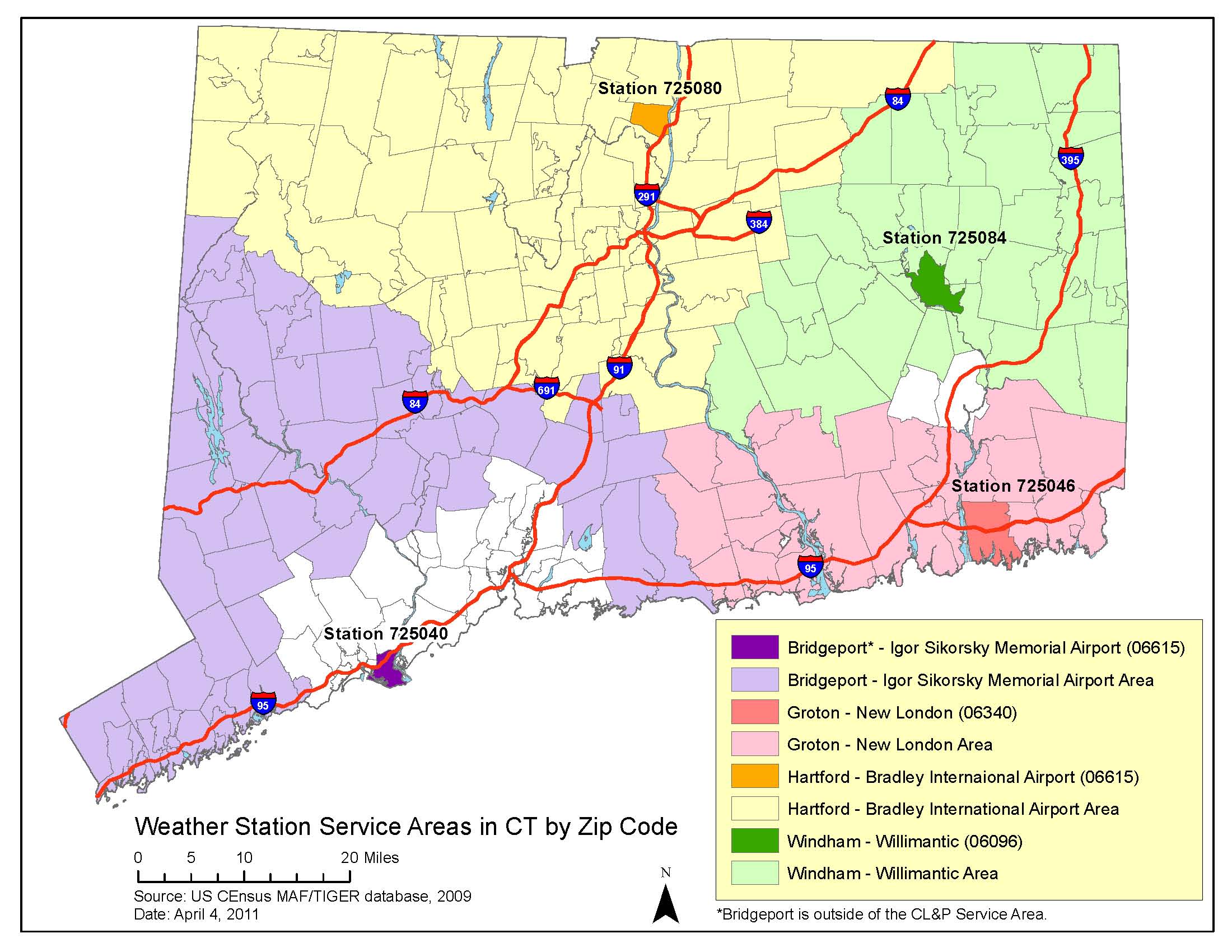
OPower provided the billing data used in this analysis, making certain to include electricity account numbers for matching to other data files (e.g., data from prior evaluations study years) and providing the data in formats requested by the evaluators. These data included monthly electricity use per service account for both the HERs treatment group and control group as well as the meter read dates from January 1, 2010, through November 30, 2014. OPower also sent data on treatment group, control group, and sub-treatment group assignments (i.e., average use, quarterly, monthly, and persistence samples). Data sent by OPower also showed the date that they mailed the first report to each treatment household. As with the billing data, OPower also provided the supporting data in the formats requested.

Weather data came from four regional stations in Connecticut, as agreed on during the initial evaluation. We have retained these same stations in each subsequent evaluation for the sake of comparability and consistency. This appendix includes a map that links zip codes to the nearest of the four weather stations. The areas in white are served by municipal utilities and the United Illuminating Company. Also, the Igor Sikorsky Memorial Airport is outside of the Eversource service territory, but it is the closest weather station to many of the Eversource towns located in the southwest corner of the state. For each region, the evaluation team calculated average monthly temperature, total monthly heating degree days, and total monthly cooling degree days from daily data available from the NCDC website for December 2009 through November 2014 and included the heating and cooling degree days as a control for the impact model.

Table 20: Billing Analysis Data Sources

|  |  |  |
| --- | --- | --- |
| **Eversource** | **OPOWER** | **NCDC** |
| Flag for treatment households who opted out of programa | Monthly billing data in kWh, presented as total usage and daily average usage | Average daily temperature for four major weather stations in Connecticut |
| Flag for service disconnection | Meter read date | Heating Degree Days (HDD), calculated from the average daily temperature data |
| Rate codes to identify all-electric rate customers | Date of first report | Cooling Degree Days (CDD), calculated from the average daily temperature data |
|  | Assignment to treatment and control as well as any sub-treatment group |  |

Figure 7: Weather Station Assignment



Opt-out households have been retained in the analysis. The final database included household characteristics, monthly billing data, and monthly regional weather data. Table 23 summarizes the final sample sizes used in the analysis as well as the monthly pre-treatment electricity use for the households.

Table 21: Total Pre-Program Electricity Usage for Households Included in Analysis

|  |  |  |
| --- | --- | --- |
|  | **Households** | **Average Monthly Use (kWh)** |
| Average-use Expansion Treatment Group | 10,217 | 708 |
| Average-use Expansion Control Group | 10,242 | 709 |
| High-use Extension Treatment Group | 8,047 | 1,650 |
| High-use Extension Control Group | 24,268 | 1,654 |
| Discontinued Treatment Group | 15,519 | 1,663 |
| Discontinued Monthly | 1,670 | 1,669 |
| Discontinued Persistence | 3,979 | 1,660 |
| Discontinued Quarterly | 9,856 | 1,664 |
| Discontinued Control Groupb | 24,268 | 1,654 |

a These data reflect the period from January 2010 through December 2010 for the high-use Extension and Discontinued groups and August 2011 through July 2012 for the average-use Expansion groups.

b Encompasses all control group households from the Year 1 Pilot including the high-use Extension control group. The high-use Extension control group households have never received a report and should be statistically similar to the other control group households from the Year 1 Pilot.

Turning first to the persistence group (i.e., those who stopped receiving monthly reports in August 2011), the Year 1 and Year 2 Pilot Program evaluations found that savings for this group diminished over time. The current evaluation shows that this group is no longer generating significant savings as of August 2013.

1. Expanded Monthly Results

**B**

The analysis involved running monthly regressions for the persistence group by sub-group to determine how long savings persist as well as if and when the savings stop.

The evaluators approach the savings for the individual month results with prudence, as any single month carries a great deal of statistical “noise.” Using multiple months of data in a model has the benefit of reducing such noise because the results take more data into account, which serves to smooth what could be random monthly variations. Using a single month of data does not permit this smoothing and is the likely reason we see a good deal of variation in savings from month to month.

Table 24 reports that the persistence sub-group failed to achieve any significant savings after August 2013 and, looking back to the Year 2 Pilot Program evaluation, the sub-group had not achieved consistent significant savings as of January 2013. The monthly treatment sub-groups continues to have significant program-induced savings through March 2013, and the quarterly sub-group is still achieving significant program-induced savings.

Table 22: Estimated Average Electricity Savings among the Discontinued Group by Subgroup by Month during Two Years after Report Cessation

|  | **Discontinued Monthly Treatment Effect-Daily kWh** | **Discontinued Persistence Treatment Effect-Daily kWh** | **Discontinued Quarterly Treatment Effect-Daily kWh** | **Sample Size** | **Explained Variance** |
| --- | --- | --- | --- | --- | --- |
| August 2013 | 1.20 | 0.15\* | 0.87 | 31,224 | 73 |
| 2.13% | 0.26% | 1.59% |  |  |
| September 2013 | 1.25 | -0.07\* | 0.77 | 31,256 | 70 |
| 2.59% | -0.14% | 1.58% |  |  |
| October 2013 | 1.17 | -0.09\* | 0.43 | 31,271 | 59 |
| 3.12% | -0.24% | 1.15% |  |  |
| November 2013 | 1.09 | 0.13\* | 0.72 | 28,204 | 53 |
| 2.61% | 0.32% | 1.72% |  |  |
| December 2013 | 2.35 | 0.14\* | 0.96 | 31,165 | 63 |
| 4.36% | 0.26% | 1.78% |  |  |
| January 2014 | 2.11 | 0.13\* | 0.94 | 31,508 | 69 |
| 3.34% | 0.21% | 1.48% |  |  |
| February 2014 | 1.50 | 0.22\* | 1.01 | 28,741 | 71 |
| 2.39% | 0.35% | 1.60% |  |  |
| March 2014 | -0.22\* | 0.06\* | 1.05 | 31,504 | 62 |
| -0.38% | 0.10% | 1.80% |  |  |
| April 2014 | 1.33 | -0.33\* | 0.82 | 30,128 | 48 |
| 2.85% | -0.70% | 1.76% |  |  |
| May 2014 | 0.53\* | -0.41\* | 0.45 | 29,988 | 43 |
| 1.43% | -1.09% | 1.21% |  |  |
| June 2014 | 1.24\* | 0.00\* | 0.44 | 31,542 | 56 |
| 3.10% | -0.01% | 1.10% |  |  |
| July 2014 | 0.06\* | 0.09\* | 0.49 | 31,530 | 61 |
| 0.11% | 0.17% | 0.93% |  |  |
| August 2014 | 0.41\* | 0.01\* | 0.51 | 31,655 | 62 |
| 0.81% | 0.01% | 1.01% |  |  |
| September 2014 | 0.99\* | 0.02\* | 0.52 | 31,697 | 65 |
| 2.10% | 0.05% | 1.09% |  |  |
| October 2014 | 0.68\* | 0.12\* | 0.26 | 31,717 | 53 |
| 1.86% | 0.33% | 0.72% |  |  |
| November 2014 | -0.42\* | 0.09\* | 0.42 | 30,095 | 41 |
| -1.06% | 0.22% | 1.05% |  |  |

\*Indicates effect is not statistically significant.

1. NMR Group, Inc. and Tetra Tech. 2013. *Evaluation of the Year 1 CL&P Pilot Customer Behavior Program*. <http://www.energizect.com/government-municipalities/final-clp-behavioral-year-1-program-report-030613>  
   NMR Group, Inc. and Tetra Tech. 2014. *Evaluation of the Year 2 CL&P Pilot Customer Behavior Program (R2)*. Available at <http://www.energizect.com/government-municipalities/evaluation-year-2-clp-pilot-customer-behavior-pgm-r2-final-report-8-8-14> [↑](#footnote-ref-2)
2. The report refers to “households” rather than “participants” for two reasons: 1) strictly speaking, in an experiment design, members of both the treatment and the control groups are “participants”; and 2) it avoids confusion when speaking about participants in other programs (especially HES and HES-IE) addressed in the process evaluation. [↑](#footnote-ref-3)
3. Determined solely as the ratio of program expenditures to savings; the analysis does not perform a full cost effectiveness assessment. [↑](#footnote-ref-4)
4. Figure 1 compare the savings achieved by the discontinued households in three different periods, coinciding with each of the three HERs program studies: January 2011 to March 2012, April 2012 to July 2013, and August 2013 to November 14 (see [Section 2.1](#_Persistence_of_Savings) of the main body for additional discussion and statistics). The figure present the results for the overall Discontinued Group and each of the sub-groups. [↑](#footnote-ref-5)
5. The smaller sample size undermines estimates of statistical significance. There were only 1,670 households were in this group, yet their savings up to 32 months post treatment are 21% higher than those of the quarterly group. The main body of this report addresses this topic in more detail in the main report. Statistical tests also confirm that savings differ within each group across time periods. [↑](#footnote-ref-6)
6. The analysis focuses on the hypothetical or projected scenarios rather than drawing on the experiences of High-use Extension and Average-use Expansion households due to lack of information on total program budgets and full treatment period for these households. [↑](#footnote-ref-7)
7. Appendix 3, page 290: Realization Rates. [↑](#footnote-ref-8)
8. In comparison, the Massachusetts Behavior Program assumes a realization rate of 105% and a measure life of one year. Source: 2011 Massachusetts Technical Reference Manual, Residential Energy Efficiency Measures. [↑](#footnote-ref-9)
9. Statistically, the inclusion of these measures does not change the coefficient for HERs-induced savings enough (less than a hundredth of a percent), likely because so few HERs treatment households actually install deeper measures relative to the population size. Therefore, the claimed HERs savings do not include any measureable double-counting from HES. [↑](#footnote-ref-10)
10. NMR Group, Inc. and Tetra Tech. 2013. *Evaluation of the Year 1 CL&P Pilot Customer Behavior Program*. <http://www.energizect.com/government-municipalities/final-clp-behavioral-year-1-program-report-030613>  
    NMR Group, Inc. and Tetra Tech. 2014. *Evaluation of the Year 2 CL&P Pilot Customer Behavior Program (R2)*. Available at <http://www.energizect.com/government-municipalities/evaluation-year-2-clp-pilot-customer-behavior-pgm-r2-final-report-8-8-14> [↑](#footnote-ref-11)
11. The report refers to “households” rather than “participants” for two reasons: 1) strictly speaking, in an experiment design, members of both the treatment and the control groups are “participants”; and 2) it avoids confusion when speaking about participants in other programs (especially HES and HES-IE) addressed in the process evaluation. [↑](#footnote-ref-12)
12. Determined solely as the ratio of program expenditures to savings; the analysis does not perform a full cost effectiveness assessment. [↑](#footnote-ref-13)
13. Accessed at

    <http://www7.ncdc.noaa.gov/CDO/cdoselect.cmd?datasetabbv=GSOD&countryabbv=&georegionabbv>= [↑](#footnote-ref-14)
14. All results have also been multiplied by negative one (-1.0) for ease of interpretation; this step converts a measure of decreased use—a negative number—to a measure of savings—a positive number. [↑](#footnote-ref-15)
15. These included Home Energy Solutions, Home Energy Solutions Income Eligible, and various rebate programs. [↑](#footnote-ref-16)
16. NMR and Tetra Tech, 2014, as cited above. [↑](#footnote-ref-17)
17. Full Year 1 persistence group savings can be found in *Evaluation of Year1 of the CL&P Pilot Customer Behavior Program*” cited previously. [↑](#footnote-ref-18)
18. [Appendix B](#AppB) provides more detail on this monthly persistence analysis. [↑](#footnote-ref-19)
19. See the full report at http://www.cadmusgroup.com/wp-content/uploads/2014/11/Cadmus\_Home\_Energy\_Reports\_Winter2014.pdf [↑](#footnote-ref-20)
20. The experiences of the High-use Expansion group from the Year 2 Pilot Program draw this assumption into question: their savings increased in their second year of treatment. However, despite their similar pre-program usage, the first year treatment savings of the expansion group differed statistically from the discontinued group, so the experiences of the two groups cannot be generalized across them. [↑](#footnote-ref-21)
21. Appendix 3, page 290: Realization Rates. [↑](#footnote-ref-22)
22. In comparison, the Massachusetts Behavior Program assumes a realization rate of 105% and a measure life of one year. Source: 2011 Massachusetts Technical Reference Manual, Residential Energy Efficiency Measures. [↑](#footnote-ref-23)