

1606 Eversource Behavior Program Persistence Evaluation

REVISED DRAFT

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SUBMITTED TO:
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Executive Summary

NMR Group, Inc. (NMR) was contracted by Eversource to update findings from three prior evaluations of Eversource's Home Energy Reports (HERs) Pilot Program. This study is referred to as R1606.

Comment [GR1]: And the Board?

The HERs pilot program, implemented by OPower, began in January 2011. The pilot program randomly selects residential customers to whom it sends reports rating their energy use, comparing it to that of their neighbors, and suggesting ways for the households to save energy.

Since its inception, the pilot program has had various cohorts. At its start, it selected customers with high electricity consumption ("high use"), and in its second year added customers with average levels of electricity consumption ("average use"). Each year, the program adds new cohorts of households and removes some households from previous years; within these cohorts, the frequency with which households receive the reports varies, creating numerous "treatment groups."

Leveraging that program structure, the R1606 study involved four tasks:

- Using a billing analysis, the study **estimated electricity savings** for participants in five treatment groups, all of whom joined the program in either 2011 or 2012. Three of the treatment groups, referred to as discontinued groups, stopped receiving reports eight to fourteen months after receiving the first letter, and the two other groups continued to receive reports to the time of study.
- The billing analysis facilitated **estimating a degradation rate** which the study then benchmarked against existing literature.
- The billing analysis findings allowed the study to **assess the program's cost-effectiveness**, again by treatment group, by estimating a ratio of the dollars spent for every kWh saved.
- Reflecting on the findings from the three previous tasks, the study considered the differences across the treatment groups—in terms of total savings and effectiveness—to **recommend optimal program delivery scenarios**.

The findings indicate that on average, households continue to save energy years after the program stops sending them reports. This substantiates the claim that the measure lifetime is longer than the treatment period. The study provided defensible estimates of retained savings from behavioral programs that will allow for more accurate attribution of program savings, inform refinement of the program design, and consider the program's cost-effectiveness with lifetime numbers. The results indicated that program cycling (stopping and starting the program or delivering the program to different subgroups in turn) may offer a way to maximize savings, increase cost-effectiveness, and touch more customers all at the same time. The key takeaways can be summarized as follows:

- High-use discontinued groups exhibit statistically significant savings at least two but no more than three years post-treatment, with the variation in persistence largely an artifact of the sample size (i.e., statistical power) and length of treatment (eight months

versus one year). The average annual degradation was 16% spread across three years for all high-use discontinued groups (see Table 1).

- Ramp-up rates are the increase in savings associated with multiple years of treatment. High-use continued groups exhibited an average ramp-up rate of 2% (including the second year of treatment in which they had a three-month report hiatus; the average ramp-up was 8% without the hiatus). Annual ramp-up rates for the high-use continued groups declined over time with continual treatment.
- Average-use continued groups also exhibited ramp-up, with an average of 40% (compared to the high-use ramp-up rate of 2%), but with substantial variation from year to year. Despite this high ramp-up rate, because they achieve smaller percentage savings and kWh savings compared to high-use groups, it took the average-use group four full years of treatment to accumulate the same energy savings as one year of treatment among high-use groups.
- Taking persistence savings into account, the cost per kWh saved over five years was less than one cent for high-use discontinued groups. In contrast, taking ramp-up into account, the cost per kWh was about three cents for high-use continued groups over five years of treatment, and approximately 12 cents for average-use continued groups over four years of treatment.
- Cycling approaches provide an avenue to maximize savings at the lowest cost per kWh saved and touch a greater number of customers in the process. The cycles that perform the best involve treating successive groups for one year each and banking the persistence savings. Two-year treatment cycles are less cost-effective, and, for average-use households, do not maximize savings.
- Cycling is not the only alternative approach available to Eversource for program delivery, but it is the only approach examined in this study. Eversource could also work with the implementer to alter messaging and the types of customers targeted, among other options. Yet, this analysis makes clear that cycling serves as one viable alternative to the current design of continual monthly treatment to all enrolled customers.

Comment [GR2]: I'm sure it's explained later, but how does this get you to zero in year three?

Comment [GR3]: "Annual" ramp up rate? Not clear what this means: 2% higher savings in year 2? Yes, terms are explained later, but many just read the ES.

Comment [GR4]: I assume – and maybe I'm wrong – that there is some loss of savings from cycling vs. continuous treatment. Either way, please speak to this. Even if it is more cost-effective, we still may be leaving cost-effective savings on the table with cycling (or not).

Table 1: Post-treatment Savings for Discontinued Groups

| Group and sample size | Report frequency | Treatment Months | Year post retained savings | | | | Average yearly degradation | Implied lifetime multiplier ¹ |
|-------------------------------|---------------------|-----------------------|----------------------------|-----|-----|----|----------------------------|--|
| | | | 1 | 2 | 3 | 4 | | |
| Monthly (1,507) | Monthly 1/11-4/12 | 16 reports, 16 months | 82% | 77% | 0% | 0% | 12% | 2.08 |
| Quarterly (9,374) | Quarterly 1/11-4/12 | ~5 reports, 16 months | 68% | 56% | 28% | 0% | 28% | 2.79 |
| Persistence (3,796) | Monthly 1/11-8/11 | 8 reports, 8 months | 64% | 56% | 0% | 0% | 25% | 2.12 |
| Overall Discontinued (14,733) | varies | varies | 79% | 67% | 36% | 0% | 16% | 2.79 |

¹ Preliminary estimates.

Comment [GR5]: Was delivery: paper vs. online – the same for all groups?
Which of these are high use groups?

Based on these findings, the study makes the following two recommendations.

- **Recommendation 1:** This study assessed cost-effectiveness using a very simple approach—the cost per kWh saved. Deciding whether a cycling approach meets the more detailed utility cost test (or other benefit-cost ratio tests) would require a more thorough analysis to determine the full benefits and costs of cycling versus continued treatment.
- **Recommendation 2:** If the HERs program stops sending reports to high-use and average-use continued groups, examine the degradation rates of their savings to inform long-term program design.

Comment [GR6]: First year or lifetime?

Eversource and OPower expanded the program in 2014, adding 300,000 households and enrolling HES and HES-IE customers into the program. These program changes inform the third and fourth recommendations.

- **Recommendation 3:** Because savings vary by pre-program energy use, Eversource should examine the pre-program energy use of the 300,000 households in the current iteration of the Eversource HERs program for the distribution of pre-program energy use and analyze the most effective and fair way to target the program. For example, the program may want to consider cycling high-use households (who achieve higher percentage and kWh savings) but treating average-use households continuously (due to lower percentage and kWh savings). The use of cycling may allow such a design to achieve high cost effectiveness and touch more customers, while maximizing savings overall.

Comment [GR7]: Within a given budget.

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- **Recommendation 4:** Households that opt in to a program like HES or HES-IE may differ from the randomly selected population of high users and average users that were in the HERs pilot. Moreover, by already taking part in HES and HES-IE and then receiving HERs, the program runs the risk of double counting savings between HERs and HES/HES-IE. Therefore, Eversource should study the impact of enrolling HES and HES-IE households into HERs on program attribution and double counting of savings.
- **Recommendation 5:** When the current implanter contract ends, Eversource should consider adopting a revised program design that includes a cycling approach, particularly for the high-use customers in the sample, who achieve similar or higher savings from treatment and retention savings compared to continual treatment, even with ramp-up taking into account.

Comment [GR8]: Good point.

Comment [GR9]: "implementer"?

Comment [GR10]: This can't be currently pursued? When does contract end? Please find out.

1

Section 1 Introduction

This report updates findings from three prior evaluations of the Home Energy Reports (HERs) Pilot Program implemented for Eversource by OPower, a subsidiary of Oracle.^{1,2} The study addressed only the households that first received reports in the pilot programs that started in January 2011 and July 2012. Some of these households continued to receive reports through 2016, as explained more fully below. NMR Group, Inc. (NMR) conducted the analyses described in the current report. Because the program and evaluation histories are essential to understanding the current study outcome and objectives, the report briefly summarizes these histories and then reports results of the current study, referred to as R1606.

1.1 PROGRAM AND EVALUATION HISTORY

The HERs Pilot Program (“the program”) relies on an experimental design known as the randomized control trial (RCT). Working with Eversource billing data, the implementer OPower identified residential customers that met a predetermined set of criteria (focused on adequate billing history and the amount of electricity used) to form a sample frame. Then they sampled households from among these customers and randomly assigned them to either a treatment or control group. The treatment group received reports that rated their energy use, compared it to a comparable group of households (called “neighbors” in the report), and suggested ways for households to save energy. The control group did not receive reports of any kind.

The program issued its first reports to Eversource customers in January 2011. The first effort, the Year 1 Pilot, included high-use households only. In the Year 2 Pilot, starting in July 2012, Eversource added average-use households to the pilot study even as it dropped some of the original high-use households. Eversource expanded the program further in 2014, sending reports to an additional 200,000 households, placing another 100,000 on an email version of the program, and enrolling an additional 30,000 Home Energy Solutions (HES) and Home Energy Solutions-Income Eligible (HES-IE) households in the program (for a total of 330,000 households).³ Table 2 summarizes the known starts and stops for various treatment groups. This study addresses only the Year 1 and Year 2 Pilot households listed in the first three

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>
 NMR Group, Inc. 2016. *R32 Evaluation of Persistence in the Eversource Customer Behavior Program (R32)*. Available at http://www.energizect.com/sites/default/files/R32%20-%20Persistence%20of%20Eversource%20HER%20Pgm_Final%20Report%2C%203.30.16.pdf
² Oracle purchased OPower in May 2016 (<https://opower.com/oracle/>). This report will continue to refer to the implementer as OPower.
³ Connecticut Electric and Gas Utilities. 2014. *2014 Annual Update of the 2013-2015 Electric and Natural Gas Conservation and Load Management Plan*.

rows of the table, as it seeks to measure all program-induced savings, including the retained, persistent savings that occur after households stop receiving reports.

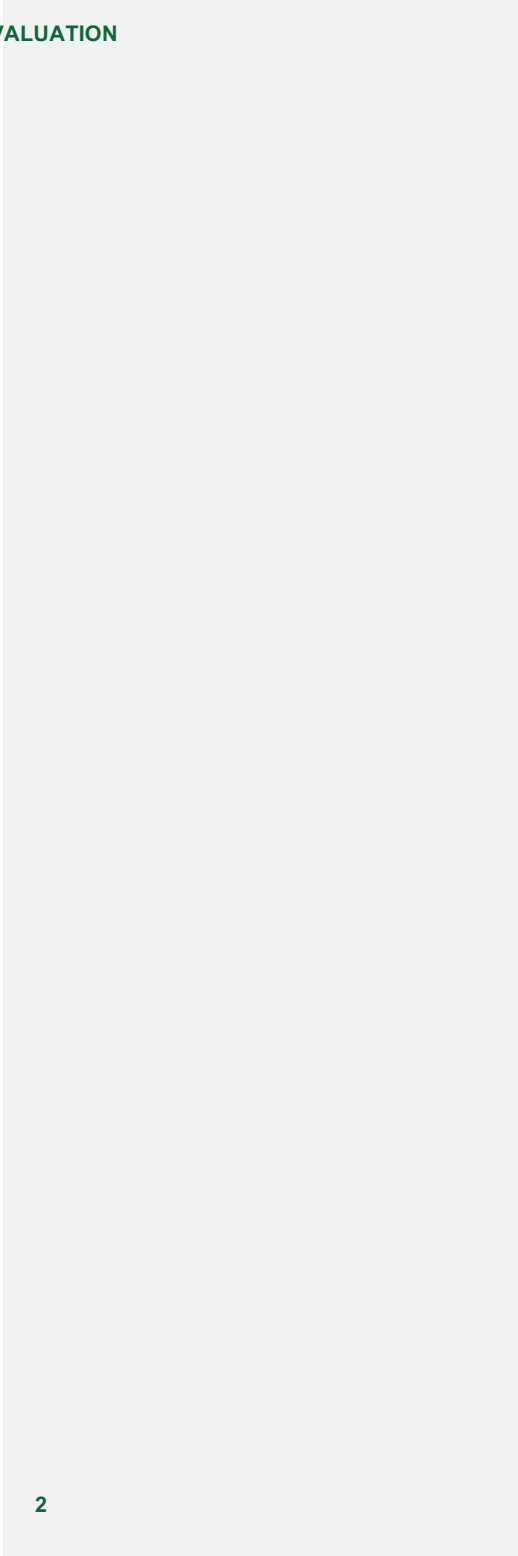


Table 2: HERs Program Treatment Timeline

| Treatment Group | Jan. 2011 (Year 1) | March 2012 | Jul. 2012 (Year 2) | PY 2014 | Current Status | Included in Current Study |
|---|--------------------|----------------|--------------------|------------------|----------------|---------------------------|
| High-use Discontinued Households | Treatment Begins | Treatment Ends | -- | -- | -- | Yes |
| High-use Extension Households | Treatment Begins | Treatment Ends | Treatment Resumes | Still Active | Still Active | Yes |
| Average-use New Households | -- | -- | Treatment Begins | | Still Active | Yes |
| Additional randomly selected households | -- | -- | -- | Treatment Begins | Still Active | No |
| HES and HES-IE participants | -- | -- | -- | Treatment Begins | Still Active | No |

Comment [GR11]: Consider adding column for report type (paper vs. email).

The Connecticut Energy Efficiency Board (EEB) has conducted three prior studies of the Eversource HERs Pilot Program. Table 3 summarizes the studies completed to date, including the findings most relevant to the current investigation (R1606). These prior evaluations of the pilot program showed that the program clearly induces electricity savings during the treatment period. However, those savings vary a great deal based on how much electricity a household used prior to receiving reports; for example, average-use households reduced electricity usage by 1.1%, while high-use households reduced it by 2.2% during the first year of treatment. Evaluations also documented strong savings retention (24% annual retention relative to treatment period savings) and persistence (saving an average of 1% for up to three years) for the high-use households that stopped receiving reports late in September 2011 or in March 2012. When taken together, the treatment period savings and persistence savings cost Eversource less than one cent for each kWh saved in high-use households that stopped receiving reports by March 2012. This is compared to a cost of approximately three cents per kWh saved for all high-use households during the treatment period and 13 cents per kWh for average-use households during the treatment period.

Comment [GR12]: Also, note somewhere UI's behavioral efforts and whether there have been any evaluations of those efforts.

1.2 STUDY OUTCOME AND OBJECTIVES⁴

The key outcome of this study was an *estimate of the annual amount of participant savings that persist for all households that have stopped receiving reports since the start of the program*. The study pursued the following objectives to deliver this outcome:

Comment [GR13]: Define upfront the usage thresholds for average and high use customers, the percent of total residential customers each represents, and the percentage of residential sales that each represents.

Also, besides usage, are there other characteristics of high use customers that make them different, e.g., high penetration of electric heat and/or DHW, CAC, etc.? While this may have been addressed in earlier reports, it's worth providing some discussion of this; even as a footnote.

1. Estimate the program-induced full treatment period and persistent savings for all high-use discontinued households from Year 1 treatment groups.
2. Estimate the program-induced full treatment period for all high-use households from Year 1 that continued to receive reports in Year 2.
3. Estimate the program-induced full treatment period for all average-use households from Year 2.
4. Compare the treatment savings and, if applicable, annual retention rates, savings persistence, and total program-induced savings (treatment period plus any persistence savings) for the three groups (Year 1 high-use discontinued, Year 1 high-use continued, Year 2 average-use new) to determine the effectiveness of length of treatment and pre-program use on retention.
5. Estimate the annualized savings per expenditure for each group and compare across groups.
6. Explore four program delivery scenarios to identify the most optimal timing and duration of report delivery

⁴ The initial project scope for this study called for assessing the retention and persistence of savings for continued high-use and average-use households that received reports in the Year 2 Pilot Program. However, Eversource confirmed in October 2016 that these households still receive reports, precluding the fulfillment of this objective. It also means that the study is unable to assess alternative program delivery scenarios for average users, as all average uses in the Year 2 pilot still receive reports.

Table 3: Evaluation Studies Completed to Date¹

| Final Evaluation Report Delivered | Study 1: Completed March 2013 | Study 2: Completed July 2014 | Study 3: Completed March 2016 |
|-----------------------------------|--|--|---|
| Period Covered | January 2011 to April 2012 | January 2011 to July 2013 | January 2011 to November 2014 |
| Treatment Group | High-use Households (monthly, quarterly recipients; some monthly received for only 8 months) | High-use Extension Households Average-use households | High-use Extension Households Average-use households |
| Discontinued Group | None | High-use Households | High-use households |
| Control Group | Implementer selected, high use | Implementer selected, high use & average use | Implementer selected, high use & average use |
| Topics Addressed | Program treatment savings by frequency & duration of treatment Program impact on participation in other programs Customer engagement and satisfaction Self-reported energy-efficient behavior | Program treatment savings by frequency pre-program electricity use; post-treatment savings for high-use discontinued households Cost-effectiveness (expenditures to savings) for all groups Customer engagement and satisfaction Self-reported energy-efficient behavior | Post-treatment savings for high-use discontinued households Cost-effectiveness (expenditures to savings) for all high-use groups Alternative program delivery models Program impact on participation in other programs and deeper measure uptake |

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| Final Evaluation Report Delivered | Study 1: Completed March 2013 | Study 2: Completed July 2014 | Study 3: Completed March 2016 |
|--|--|--|--|
| Findings Most Relevant for Current Study | Treatment households saved about 2% over control group | High-use Extension households saw slight increase in savings with repeated delivery (2.2% to 2.3%) Average use households saw energy savings of 1.2% Savings persisted for high-use discontinued households Cost-effectiveness for high-use households was about 3 cents / kWh during treatment period; 2 cents / kWh if taking post-treatment savings into account Cost-effectiveness for average-use households was about 13 cents / kWh during treatment period | Savings persisted for high-use discontinued households to just under three years post treatment Cost-effectiveness for high-use households remained about 3 cents / kWh during treatment period; less than one cent / kWh if taking all post-treatment savings into account |

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>

NMR Group, Inc. 2016. *R32 Evaluation of Persistence in the Eversource Customer Behavior Program (R32)*. Available at http://www.energizect.com/sites/default/files/R32%20-%20Persistence%20of%20Eversource%20HER%20Pgm_Final%20Report%2C%203.30.16.pdf

1.3 KEY DEFINITIONS

There are many definitions around the concept of measure lifetimes associated with energy savings. To add to the confusion, *persistence*, *lifetime*, and *measure life* are all used casually to mean similar concepts even if they technically have distinct meanings. Most of the definitions assume adoption of an efficiency measure rather than a behavior. Two critical concepts include the following:⁵

- **Effective Useful Life (EUL):** Typically refers to the *median* lifetime for savings from measures, and is typically multiplied by first-year savings to yield lifetime savings resulting from the investment in the measure.
- **Technical degradation factor (TDF):** Represents how much the savings from a measure decrease over time due to mechanical (e.g., furnace does not operate as efficiently over time; duct insulation comes loose) or behavior degradation (e.g., being less diligent about washing full loads of laundry). There are very few data on TDF in the literature, so usually the concept is folded into measure lifetime, assuming full savings for each year of that EUL.

For behavioral measures, the TDF is an important component. One does not expect 100% savings each year due to behavioral variation for any number of reasons. Realistically, when examining behavior persistence, studies measure the TDF until savings no longer differ statistically from a control group.

Considering this, **for the purposes of this study**, the following definitions apply:

- **Measure life:** Number of years the treatment households exhibit statistically significant savings compared to the control group.
- **Technical degradation factor (TDF):** The pattern of the percentage of savings achieved in (successive) years.
- **Effective Useful Life (EUL):** Combination of measure life and TDF—in years—to be applied to the savings in the benefit/cost equations, measured as the *mean* as opposed to the *median* due to the lack of information on the latter.

Other key concepts include the following:

- **Savings ramp-up:** For behavior programs, any increase in the percentage of savings associated with multiple years of treatment.
- **Behavior savings persistence:** For behavior programs, this refers to the savings treatment households achieve after they stop receiving reports. The study also refers to this concept as “persistence of savings.” This measure provides the numbers that factor into the TDF.

⁵ Skumatz, Khawaja, and Colby, “Lessons Learned and Next Steps in Energy Efficiency Measurement and Attribution: Energy Savings, Net to Gross, Non-Energy Benefits, and Persistence of Energy Efficiency Behavior”, CIEE, 11/2009; and Skumatz, “Behavioral Measure Lifetimes, Persistence, Retention, and EULs”, 2/5/16.

- **Retention rate:** Ratio of annual post-treatment savings achieved relative to treatment savings; **technical retention rate** is the average of this ratio for years with statistically significant savings.
- **Savings degradation rate:** The percentage by which savings decline annually. This differs from the TDF in that the savings degradation rate is the *change* in the TDF.
- **Persistence factor:** Retention rate multiplied by the measure life; serves as a critical input to estimating total lifetime savings. This can be used as another term for the Behavior EUL.

The literature on behavioral programs sometimes uses these terms interchangeably or may introduce new terms to capture the same concepts, as the nomenclature has not been codified. Likewise, the current study sometimes used *savings persistence* as an umbrella term encompassing all of these concepts.

Another potential point of confusion in this study stems from the many different treatment and sub-treatment groups included in the HERs Pilot Program between January 2011 and July 2013. The critical groups included in this study are as follows:⁶

- **High-use Discontinued group (n=16,000):** Started receiving reports in January 2011 and stopped receiving reports no later than March 2012; all had higher than average pre-program energy use
 - **Discontinued Monthly group (n=2,000):** Received monthly reports through March 2012, for an average of 16 reports
 - **Discontinued Quarterly group (n=10,000):** Received reports every three months through March 2012, for an average of five reports
 - **Discontinued Persistence group (n=4,000):** Received an average of eight monthly reports through August 2011 and then discontinued treatment
 - The Persistence Group was so named by OPower and Eversource. The study design sought to determine Year 1 program savings for this sub-treatment group that received reports for eight months versus those that received reports for a full year.
- **High-use Continued Monthly (Extension) group (n=8,000):** Received reports starting in January 2011 and continued to receive them through at least July 2016, with a hiatus from April to June 2012. As of July 2016, they had received an average of 64 reports.
- **Average-use Continued Monthly (Expansion) group (n=10,000):** Received reports starting in July 2012 and continued to receive them through at least July 2016. As of July 2016, they had received an average of 48 reports.

Finally, the three previous studies and the current study of households included in the Year 1 and Year 2 HERs Pilot Program coincide with calendar or program years. This reflects a mixture of program design and when they received their first and (if applicable) last reports as well as the timing of the evaluations. **To provide consistency with prior reporting, the**

⁶ The sample sizes presented here represent those at the start of the pilot program. The sample has experienced attrition due some of the accounts having service disconnected since they first received reports.

Comment [GR14]: Again, speak to type of report received.

current analysis presents results over time by study, noting which study yielded the results. However, annualized results (i.e., those that coincide with a 12-month period) are needed to assess program cost-effectiveness (because budgets are annual) and to assess optimal delivery modes (for ease of comparison across groups). **Therefore, this report also summarizes annualized savings and uses those annualized savings to assess cost effectiveness and optimal program delivery.**

1.4 METHODOLOGY

As in prior investigations of the HERs Pilot Program, the study used billing analysis to examine treatment period savings for all high-use and average-use study groups and the persistence of savings for all high-use discontinued groups (that is, Year 1 households that stopped receiving reports sometime between September 2011 and March 2012). The study used data obtained from three different sources: 1) Eversource, 2) OPower, and 3) the National Climate Data Center (NCDC) website, as outlined in [Appendix A](#).⁷ The data span from January 1, 2010, through July 2016.⁸

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 or caused by the influence of 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:

$$\text{Estimated Average Electricity Savings} = \beta_0(\text{Avg. Post-Treatment Electricity Use}) + \beta_1(\text{Dichotomous Treatment}) + \beta_2(\text{Avg. Pre-Treatment Electricity Use}) + \beta_3(\text{Dichotomous Electric Heat}) + \beta_4(\text{Heating Degree Days}) + \beta_5(\text{Cooling Degree Days})^9$$

The study calculated annual retention and degradation rates; this analysis was based on the persistence of savings post-treatment for all high-use discontinued households and the multi-year treatment savings for high-use continued and average-use continued households. Table 4 shows the various study groups, type of savings, and periods of analysis.

Using program budgets and estimated savings, the study also calculated the ratio of program expenditures to savings for the treatment period for all groups as well as the post-treatment period and combined treatment and post-treatment period for the high-use discontinued groups. Given that Eversource expanded the program in 2013 and was unable to provide the portion of the budget devoted solely to the continued treatment of continued high-use extension and average-use expansion households in 2013 through 2016, the study assumes that the budget remained the same from 2012 through 2016 for these two groups.

⁷ Accessed at

<http://www7.ncdc.noaa.gov/CDO/cdoselect.cmd?datasetabbv=GSOD&countryabbv=&georegionabbv=>

⁸ January 2010 allows for the inclusion of at least one full year of pre-program data for all households.

⁹ 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.

Drawing on the study results on treatment and persistence savings, degradation rates, and cost-effectiveness, the analysis then explored alternative program designs for each of the study groups. The explorations included examining continual treatment over four years as well as *crop rotation* approaches in which households cycle between treatment and post-treatment. As explained more in [Optimal Program Delivery Scenarios](#), this analysis examined varying cycle lengths and degradation rates, including drawing on the broader literature as well as the results of the HERs pilot study.

Table 4: Study Groups and Periods of Savings in Current Analysis¹

| | Treatment Groups | | | | | | Control Groups | |
|---------------------------------------|-------------------------|-------------------------|--------------------------------|-------------------------|------------------------|--------------------------|-----------------------|--------------------------|
| | Discontinued | | | Continued | | | High-use ³ | Average-Use ² |
| | Monthly | Quarterly | Persistence | All | High-use | Average-Use ² | | |
| Sample Size ⁴ | 1,507 | 9,374 | 3,796 | 14,733 | 7,211 | 8,985 | 22,584 | 9,963 |
| Pre-program Use (kWh) ⁴ | 1,611 | 1,601 | 1,595 | 1,576 | 1,606 ⁵ | 713 | 1,577 ⁵ | 707 |
| Study 1: Jan. 2011 to Mar. 2012 | Treatment | Treatment | Partial Treatment ⁷ | Treatment | Treatment | N/A ⁸ | Control | N/A ⁸ |
| Study 2: Apr. 2012 to Jul. 2013 | Persistence | Persistence | Persistence | Persistence | Treatment ⁹ | Treatment | Control | Control |
| Study 3: Aug. 2013 to Nov. 2014 | Persistence | Persistence | Persistence | Persistence | Treatment | Treatment | Control | Control |
| Current Study: Dec. 2014 to Jul. 2016 | Persistence | Persistence | Persistence | Persistence | Treatment | Treatment | Control | Control |
| Annualized Savings ¹⁰ | Treatment & Persistence | Treatment & Persistence | Treatment & Persistence | Treatment & Persistence | Treatment | Treatment | Control | Control |

¹ Prior studies include: 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>

NMR Group, Inc. 2016. *R32 Evaluation of Persistence in the Eversource Customer Behavior Program (R32)*. Available at http://www.energizect.com/sites/default/files/R32%20-%20Persistence%20of%20Eversource%20HER%20Pgm_Final%20Report%2C%203.30.16.pdf

² Average use for Eversource customers was about 700 kWh per month in 2012; it has more recently been closer to 800 kWh per month.

³ Encompasses all control group households from the Year 1 Pilot. The analysis keeps the same control group for comparison to high-use continued (extension) households as they were statistically similar in their pre-program use.

⁴ Sample size of households included in the current analysis, which is smaller than at the program start due to attribution related largely to disconnected accounts.

⁵ 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.

⁶ The high-use continued group and the high-use control group used less energy prior to the program than the discontinued group; the difference was not statistically significant but could be sufficient to limit generalizing results from the discontinued group to the continued group.

⁷ Received reports through September 2011.

⁸ Average-use households were not added until July 2012.

⁹ This group had a report hiatus between April and July of 2012; otherwise they have received constant treatment since January 2011.

¹⁰ In addition to showing savings as they align with evaluation study periods, the report annualizes the results to show savings one year post-treatment, two years post-treatment, etc.

2

Section 2 Study Results

The study presents four sets of interrelated results:

- Electricity savings for all five treatment groups, including three high-use discontinued groups, the high-use discontinued group as a whole, one high-use continued group (extension), and one average-use continued group (expansion)
- Benchmarking of the current results against other studies of similar programs
- Cost-effectiveness, measured simply as the ratio of cost per kWh saved
- Exploration of optimal program delivery scenarios for high-use and average-use groups according to various schedules of cycling households on and off reports and into and out of the program

2.1 ELECTRICITY SAVINGS

Table 5 summarizes energy savings for all treatment groups across the four EEB HERs pilot program studies, including the current one.¹⁰ The table includes the average daily savings in kWh, the average percentage of savings, with shading denoting that the group was under treatment during the specified period. The most important findings on energy savings include the following:

- The program induces statistically significant savings during the treatment period and for two to three years post-treatment, depending on the savings rate and the sample size of households included in the group.¹¹
- Compared to their respective starting years, households that used more energy (high-use households) saved a greater percentage of energy than households with average pre-program energy use.
- Average daily savings in kWh remained somewhat stable over time for high-use and average-use households that continued to receive reports for multiple years; percentage savings tended to increase over time for continued households.
- Among high-use discontinued households, those that received reports for a full year (high-use discontinued monthly and quarterly groups) saved more than those households that received them for only eight months (high-use discontinued persistence).
- Among high-use discontinued households, those that received reports monthly saved more energy than households that received them on a quarterly basis.
- High-use discontinued monthly households saved 45% more kWh per day than high-use continued monthly households and more than the other two high-use discontinued groups. They also had the highest pre-program use.

Comment [GR15]: Did they have the highest % savings?

¹⁰ The sample sizes presented in Table 5 also apply to Figure 1 through Figure 3.

¹¹ That is, high-use discontinued persistence households exhibited fewer savings and stopped exhibiting statistically significant savings after two years; high-use discontinued monthly households exhibited high levels of savings, but a small sample size (1,507) limited the statistical power needed to achieve statistical significance.

Figure 1 graphs the daily kWh savings and statistically significant percentage savings by study period for each group. The solidly filled bars represent treatment periods for each continued and discontinued group, while the hashed bars represent post-treatment periods for each discontinued group.

Table 5: Energy Savings in kWh by Treatment Group Across Studies

| | Sample Size ² | Pre-program Energy Use | Study 1: January 2011- March 2012 | Study 2: April 2012- July2013 | Study 3: August 2013- November 2014 | Current: December 2014- July2016 |
|---|--------------------------|------------------------|-----------------------------------|-------------------------------|-------------------------------------|----------------------------------|
| High-use Discontinued Monthly | 1,507 | 1,611 | 1.75* (3.62%) | 1.49* (3.70%) | 0.71 (1.66%) | 0.96 (1.96%) |
| High-use Discontinued Quarterly | 9,374 | 1,601 | 0.86* (1.79%) | 0.83* (2.06%) | 0.61* (1.27%) | 0.35 (0.70%) |
| High-use Discontinued Persistence | 3,796 | 1,595 | 0.76* (1.57%) | 0.75* (1.86%) | 0.09 (0.23%) | 0.08 (0.16%) |
| High-use Discontinued Group Overall | 14,733 | 1,576 | 0.91* (1.88%) | 0.88* (1.82%) | 0.48* (0.99%) | 0.57 (1.20%) |
| High-use Continued Monthly (Extension) | 7,211 | 1,606 | 1.20* (2.46%) | 1.19* (2.31%) ³ | 1.22* (2.51%) | 1.21* (2.54%) |
| Average-use Continued Monthly (Expansion) | 8,985 | 713 | N/A | 0.26* (1.17%) | 0.28* (1.26%) | 0.36* (1.64%) |

* Statistical significant at the 0.1 level.

¹ Prior studies include: 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>

NMR Group, Inc. 2016. *R32 Evaluation of Persistence in the Eversource Customer Behavior Program (R32)*. Available at http://www.energizect.com/sites/default/files/R32%20-%20Persistence%20of%20Eversource%20HER%20Pgm_Final%20Report%2C%203.30.16.pdf

² Sample size of households included in the current analysis, which is smaller than at the program start due to attribution related largely to disconnected accounts.

³ Table 20 in Appendix A includes the actual sample sizes included in each study's analysis.

³ Includes a hiatus in receiving reports from April 2012 to July 2012, likely explaining the slightly lower savings compared to other years.

Comment [GR16]: Daily?

Comment [GR17]: Monthly

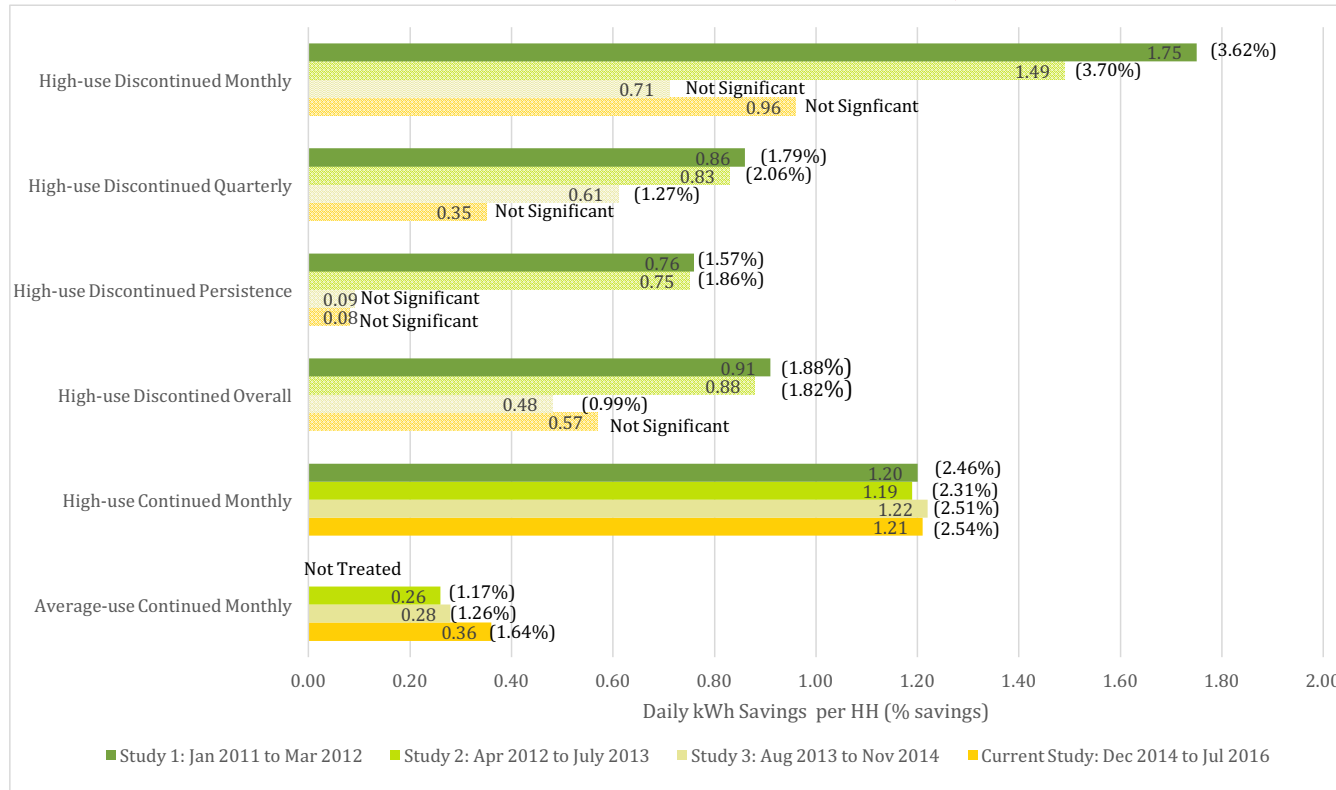
Comment [GR18]: Daily kWh savings, yes?

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Figure 1: Daily kWh Savings per Household by Treatment Group

(Based on Billing Analysis, sample sizes reported in Table 5)



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Note: All percentages shown represent statistically significant savings at the 0.1 level.

Figure 2 presents the annual savings per household for all treatment groups. As with Figure 1, the solid bars for each year represent treatment periods, while the hash bars for each year represent post-treatment periods. Graphing the annual savings emphasized three key results:

- Savings degraded once households stopped receiving reports.
- In contrast, households that kept receiving reports experienced a small ramping up on savings with repeated treatment until about the third year, then savings seemed to stabilize or decline slightly. The dip in savings for the high-use continued monthly group in the second year of treatment likely reflects a hiatus in the delivery of reports between April 2012 and July 2012.
- The savings for the high-use discontinued monthly group and the average-use continued monthly group differed from the other three groups. In fact, the total program-induced savings for the high-use discontinued monthly group for one year of treatment and two years post-treatment (2,195 kWh) was nearly the same as the program-induced savings achieved by the high-use continued monthly group over five years of treatment (2,214 kWh).

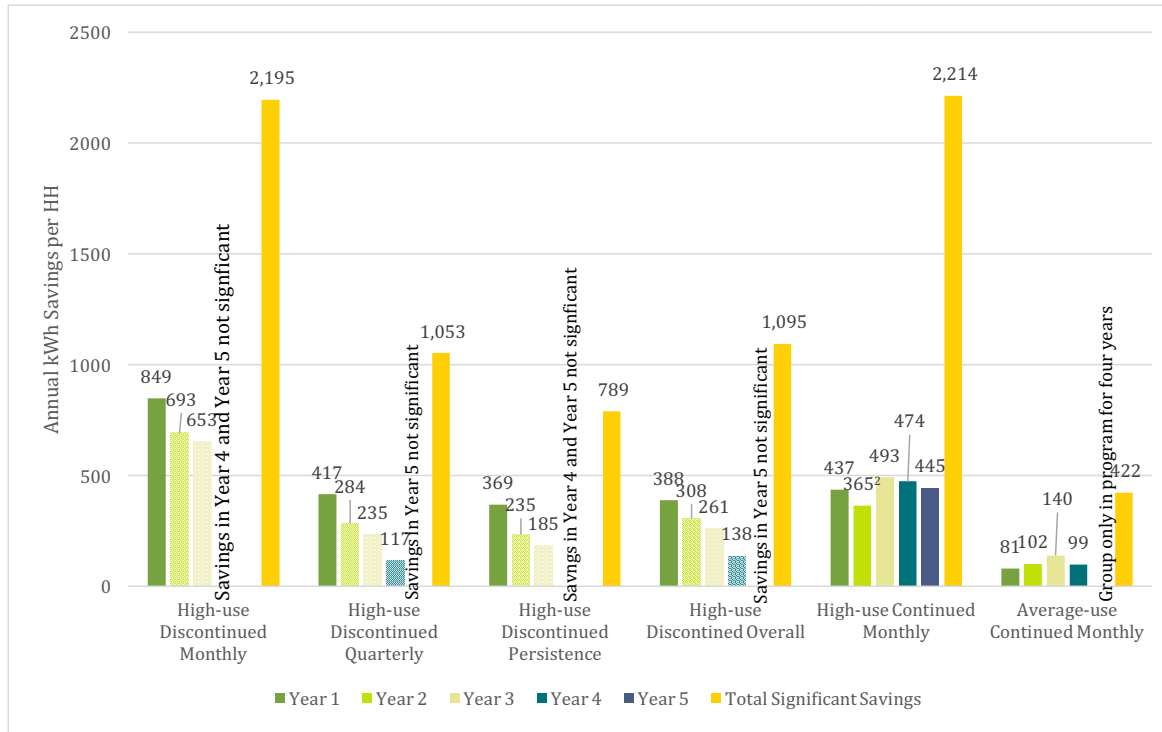
Figure 3 shows the retention of savings relative to the first year of treatment for each of the treatment groups, again with the solid bars and hash bars for each year representing treatment and post-treatment periods. Several trends emerged:

- The two continued treatment groups generally achieved greater savings than the first year of treatment over time, again suggesting a ramp-up in savings with continued treatment that may level over time.
- The high-use quarterly and persistence discontinued groups retained about two-thirds of savings the year following treatment (68% and 64%, respectively) and about one-half of the savings two years post-treatment (56% and 50%, respectively).
- In the third year post-treatment, the high-use discontinued persistence group ceased achieving statistically significant savings, while the high-use discontinued quarterly group saw savings retention of about one-fourth (28%).
- The high-use discontinued monthly group again diverged, retaining greater post-treatment savings than the other high-use discontinued groups, 82% one year post-treatment and 77% two years post-treatment. They stopped achieving statistically significant savings three years post-treatment, although the small sample size (n=1,507) may partly explain this result.¹²

¹² In a typical degradation analysis, a median or mean savings value would be estimated to determine effective useful life of the measure. These measures of central tendency are problematic for the current behavioral billing analysis because all savings values are predicted based on model inputs. The models fit the energy use of individual households, but these households do not always display consistent savings (e.g., they may be seasonal in nature, a household may save one month and not another, etc.). Due to the lack of individual recorded savings and the seasonal and inconsistent nature of savings for individual households month to month, there is no clear measurable midpoint where behavioral savings fail. Instead, they simply degrade over time, with some seasonal variation in that degradation.

Figure 2: Annualized Savings in kWh per Household, by Treatment Group¹

(Based on Billing Analysis, sample sizes reported in Table 5)



Comment [GR19]: I think some version of Figure 1 and/or 2 should go into the ES.

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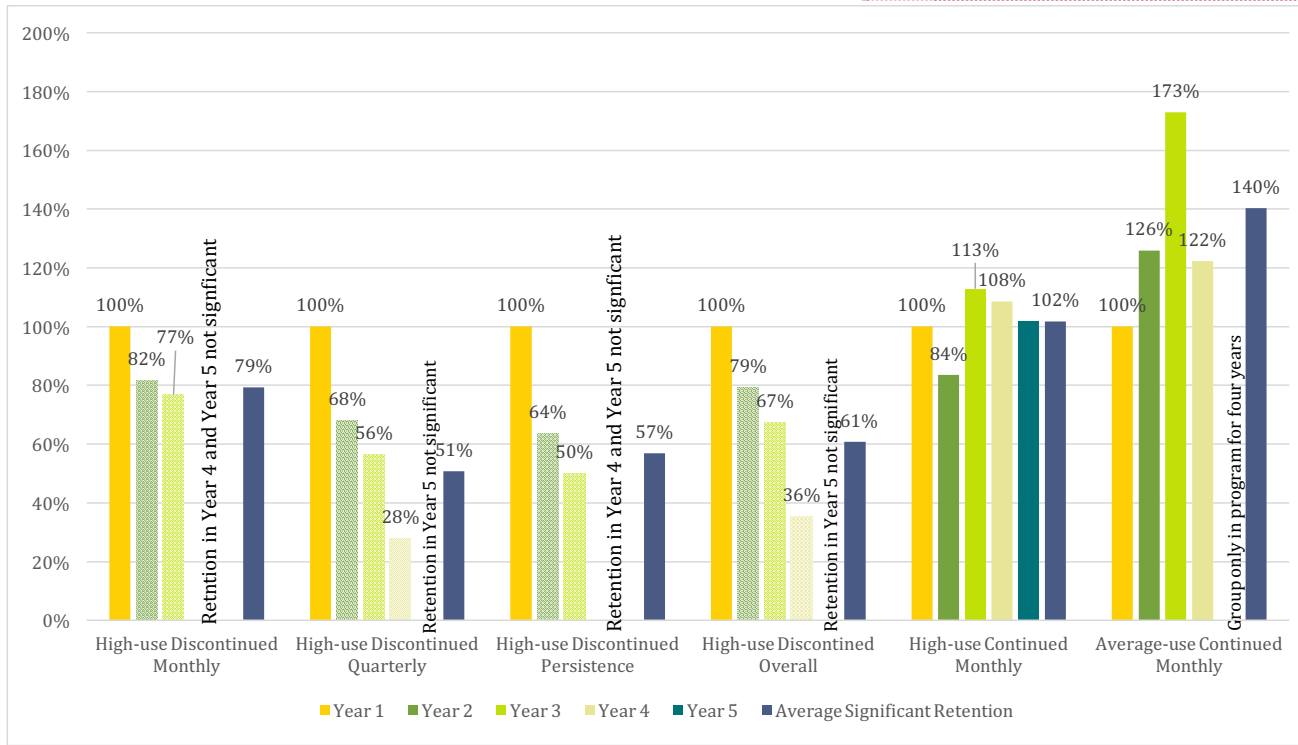
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¹ Year 1 represents the respective group's first year in the program; Year 2 to Year 5 represent post-treatment periods for all discontinued households and treatment periods for all high-use continued monthly households. Average-use continued monthly households started receiving reports a year later than all other households, so the study only shows four years of savings for this group.

² A report hiatus from April 2012 to July 2012 likely explains the decrease in savings in the second year of treatment for this group.

Figure 3: Percentage of Annual Savings Retained Relative to Treatment/First Year by Treatment Group¹

(Based on Billing Analysis, sample sizes reported in Table 5)



Comment [GR20]: Should something be said above re: the ramp up rate for the monthly average use group? Very steep.

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¹ Year 1 represents the respective group's first year in the program; Year 2 to Year 5 represent post-treatment periods for all discontinued households and treatment periods for all high-use continued monthly households. Average-use continued monthly households started receiving reports a year later than all other households, so the study only shows four years of savings for this group.

Table 6 presents the annual and average savings degradation rates and length of statistically significant persistence savings for each of the high-use discontinued treatment groups. The average annual degradation for all discontinued households was 16% over three years, but this varied from 12% over two years for the high-use discontinued monthly group to 28% over three years for the high-use discontinued quarterly group.

Table 6: Savings Degradation Among High-use Discontinued Groups

| Group | One Year Post-Treatment | Two Years Post-Treatment | Three Years Post-Treatment | Average Degradation | Years Post-Treatment Savings |
|--------------------------------------|-------------------------|--------------------------|----------------------------|---------------------|------------------------------|
| High-use Discontinued Monthly | 18% | 5% | Not Significant | 12% | 2 |
| High-use Discontinued Quarterly | 32% | 12% | 28% | 28% | 3 |
| High-use Discontinued Persistence | 36% | 14% | Not Significant | 25% | 2 |
| High-use Discontinued Overall | 21% | 12% | 34% | 16% | 3 |

2.2 BENCHMARKING DEGRADATION RATES TO OTHER EXISTING STUDIES

In the R32 study, NMR found a degradation rate of 24% for Eversource's HERs program in Connecticut, and the updated results in the current study (R1606) find an average decay rate of 16% for high-use discontinued households. These rates fall within the range observed in other studies of OPower HERs programs. Alcott and Rogers studied OPower's three longest running program sites at the time of their study—two on the West Coast and one in the upper Midwest—in order to estimate savings persistence. They found that after two years of active treatment, the program effects decayed at about 10% to 20% every year post-treatment which is in keeping with earlier work by Harrigan and Gregory who find that 85-90% of savings were retained for up to three years.^{13,14} Khawaja and Stewart came to similar conclusions; their study compared the estimated annual savings degradation rates from multiple studies of OPower HERs programs, with decay rates ranging from 11% to 32%, with an average of 20% per post-treatment year, and a measure life of 3.9 years (Table 7).¹⁵ Skumatz reviewed the literature on behavioral persistence and concluded that short term retention of savings is usually high even after two years post-treatment further lending further credence to this study's findings.¹⁶

One of the studies Khawaja and Stewart included in their review was the 2014 Puget Sound Energy (PSE) evaluation of a 24-month HERs program. This program updated their evaluation in 2015. The 2015 PSE study found that households continued to save a significant amount of energy five years after treatment cessation. Using data from the 2015 PSE study, NMR calculated an average degradation rate of 8%.^{17,18} Eversource persistence groups, which received reports for an average of eight to 14 months, stopped saving significant amounts of energy 32 months post-treatment, indicating that longer exposure to treatment encourages more persistent savings.

Comment [GR21]: Though this retention rate seems higher than what one would achieve with the stated annual decay rates.

And maybe I'm confusing decay and degradation rates.

¹³ Alcott, H. and T. Rogers (2014). "The Short-Run and Long-Run Effects of Behavioral Interventions? Experimental Evidence from Energy Conservation." *American Economic Review*, 204(10): 3003–3037. <https://doi.org/10.1257/aer.104.10.3003>.

¹⁴ Harrigan and Gregory (1994). "Do Savings from Energy Education Persist?" ACEEE paper

¹⁵ See the full report at http://www.cadmusgroup.com/wp-content/uploads/2014/11/Cadmus_Home_Energy_Reports_Winter2014.pdf

¹⁶ Skumatz, L. "Persistence of Behavioral Programs: New Information and Implications for Program Optimization" *The Electricity Journal*, vol. 29, 2016.

¹⁷ PSE. *Home Energy Reports Program: 2015 Impact Evaluation- Final Report*. Prepared for Puget Sound Energy, October 10, 2016. Prepared by DNV GL.

¹⁸ The PSE 2015 report did not list or update the previous report's decay rate.

Table 7: Savings Decay among Discontinued Sub-Groups Across Multiple Studies (Rate of Active Treatment Savings to Post-Treatment Savings)

| Source | Program Administrator or Geographic Area | Number of Treatment months | Number of Post-Treatment Months | Annual Savings Decay |
|---------------------------|--|----------------------------|---------------------------------|----------------------|
| DNV GL (2014) | Puget Sound Energy | 24 | 36 | 11% |
| DNV GL* (2015) | Puget Sound Energy | 24 | 60 | 8% |
| 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 (2016) | Eversource | 8 to 14 | 32 | 24% |
| Integral Analytics (2012) | Sacramento Municipal Utility District | 27 | 12 | 32% |

*These values were calculated by NMR using data from multiple PSE evaluations.¹⁹

2.3 COST-EFFECTIVENESS: EXPENDITURES-TO-SAVINGS RATIO

Coming back to the current study (R1606) results, Table 8 presents annualized estimates of the HERs program costs, savings, and expenditures-to-savings ratio cumulatively from January 2011 to July 2016 for all high-use households and August 2012 to July 2016 for average-use households. The shaded cells denote the treatment period for each group. The results make clear that the most cost-effective approach among the HERs pilot treatment groups involves sending reports to a household for about a year, leveraging the expectation that after cessation, recipients will continue to reap savings for two or three more years. This result holds true not only for the outlying high-use discontinued monthly households but also for the high-use discontinued persistence households that received reports for only eight months.

- On average, the high-use discontinued households saved an average of 1,095 kWh at a cost of about one cent per kWh saved by the fourth year after treatment began. It is also the case that the high-use continued households who received reports for four years saved an average of 1,769 kWh, about 38% higher than the average high-use discontinued household over the same period. Yet, it cost nearly three cents per household to achieve these savings compared to one cent per household for the high-use discontinued households.
- Average-use continued households show very little savings over time. Over four years of treatment, they saved an average of 422 kWh, cumulatively—about what high-use households save annually during the treatment period. The cost per kWh saved for

Comment [GR22]: May need to clarify that these costs are per lifetime, not first year or annual, kWh.

¹⁹ <http://aceee.org/files/proceedings/2012/data/papers/0193-000051.pdf> and <file:///C:/Users/Chris/Downloads/2015%20Home%20Energy%20Reports%20with%20ERR.pdf>

average-use households is about 12 cents, indicating a lower level of cost-effectiveness.

These results suggest that a hybrid approach in terms of length and frequency of treatment may strike the strongest balance between maximizing savings and maximizing cost-effectiveness. The next section explores some of the possible hybrid approaches (additional approaches are broached in Appendix B).

Table 8: Annualized Expenditures-to-Savings Ratio by Treatment Group¹

| | Discontinued | | | | Continued | |
|--|-----------------|-----------------|-----------------|-----------------|-----------|--------------------------|
| | High Use | | | | High Use | Average Use |
| | Monthly | Quarterly | Persistence | All | Monthly | Monthly |
| Cost per HH Year 1 | \$7.55 | \$7.55 | \$7.55 | \$7.55 | \$7.55 | \$12.50 |
| Savings per HH Year 1 (kWh) | 849 | 417 | 369 | 388 | 437 | 81 |
| Expenditures to Savings Ratio Year 1 | \$0.009 | \$0.018 | \$0.020 | \$0.019 | \$0.017 | \$0.154 |
| Cumulative Cost per HH Year 2 | \$7.68 | \$7.68 | \$7.13 | \$7.54 | \$20.05 | \$25.01 |
| Cumulative Savings per HH Year 2 (kWh) | 1542 | 701 | 604 | 696 | 802 | 183 |
| Expenditures to Savings Ratio Year 2 | \$0.005 | \$0.011 | \$0.012 | \$0.011 | \$0.025 | \$0.137 |
| Cumulative Cost per HH Year 3 | \$7.68 | \$7.68 | \$7.13 | \$7.54 | \$32.55 | \$38.31 |
| Cumulative Savings per HH Year 3 (kWh) | 2,195 | 936 | 789 | 957 | 1,295 | 323 |
| Expenditures to Savings Ratio Year 3 | \$0.003 | \$0.008 | \$0.009 | \$0.008 | \$0.025 | \$0.119 |
| Cumulative Cost per HH Year 4 | | \$8.07 | | \$7.86 | \$45.72 | \$52.53 |
| Cumulative Savings per HH Year 4 (kWh) | Not significant | 1,053 | Not significant | 1,095 | 1,769 | 422 |
| Expenditures to Savings Ratio Year 4 | | \$0.008 | | \$0.007 | \$0.026 | \$0.124 |
| Cumulative Cost per HH Year 5 | | | | | \$59.67 | Not treated ² |
| Cumulative Savings per HH Year 5 (kWh) | Not significant | Not significant | Not significant | Not significant | 2,214 | |
| Expenditures to Savings Ratio Year 5 | | | | | \$0.027 | |

¹ Cost per household varies based on number of households in the billing analysis models. This changes largely due to program attrition resulting from disconnected accounts but also annual variations in the ability to match customer accounts across Eversource billing data and OPower treatment records.

² Average-use monthly group has been treated only four years (August 2012 to July 2016); all other groups first received reports in January and February 2011.

2.4 OPTIMAL PROGRAM DELIVERY SCENARIOS

The study considered various schedules to delivering the program, both for high-use and average-use homes. As shown in Table 9, this involved exploring energy savings and cost-effectiveness for various lengths of treatment and post-treatment relative to the savings and cost of continual treatment.²⁰ To the extent possible, the analysis relies on the actual achieved statistically significant savings and degradation rates, with Table 9 noting any deviations. In all cases, assumptions about multi-year or continual treatment relied on the average ramp-up rate (i.e., additional savings achieved from multiple years of treatment) achieved by high-use continued or average-use continued groups. This decision reflected the fact that the second year of treatment showed smaller (and for high-use customers, negative) ramp-up, but later years showed higher ramp-up rates. Note that [Appendix B](#) includes the same delivery options but uses the average degradation rate and the low and high rates as identified in the benchmarking effort.

The first section of Table 9 compiles the actual program delivery and the achieved savings and costs for each treatment group from the start of the pilot program in January 2011 through June 2016, with the information also presented separately in Figure 2, Figure 3, and Table 8 above. As with other tables in this report, shaded cells denote the treatment period for each group. The second section of Table 9 presents program delivery for a single year without considering persistence. It lists the first year's savings and cost per kWh saved. The remainder of the sections consider various alternative program delivery models that allow the length of treatment and post-treatment to vary, assessing them on the following program indicators:

- Estimated savings
- Cost per kWh saved
- Percent of cost per kWh saved relative to similar years of continual treatment
- Percent of kWh saved relative to similar years of continual treatment

Reviewing the total savings per delivery approach reveals that two or even three years of treatment can achieve a high percentage of savings at a substantially lower cost. The total savings for households that receive reports for one or two years plus post-treatment savings for one to three years fall between 50% to 90% of what such households would have achieved if they had received reports for the entire treatment and post-treatment periods. The cost per kWh saved ranges from 14% to 70%, bookmarked by the highest (high-use discontinued monthly group) and lowest (average-use continued monthly group) users in the pilot. More typical costs per kWh saved hover below 50% for a single year of treatment and in the 50% to 70% range for two years of treatment, again with variation by study group.

²⁰ The scenarios explored here explore only one type of variation: the frequency and duration of report delivery, including cycling which households receive reports. There are numerous other ways that the program could be implemented such as alternative messaging or no longer sending reports to households that consistently fail to demonstrate statistically significant savings, among other options. However, the study did not have the capability to explore these other options, as they would require developing experiments directly with the implementer. Such experiments could be considered in future evaluations.

Across all scenarios, the high-use discontinued persistence group (who received reports for only eight months) and the average-use continued group routinely exhibit the lowest benefit from cycling, a reflection of their lower savings and, for the discontinued group, their more rapid degradation rate.

Table 9: Comparison of Savings by Treatment Group under Different Program Delivery Scenarios
(Actual Annual Degradation Rate by Treatment Group)

| | High-use Discontinued | | | | Continued | |
|--|-----------------------|-----------------|--------------------------|-----------------|-----------|-------------|
| | Monthly ¹ | Quarterly | Persistence ¹ | Overall | High Use | Average Use |
| Actual Conditions through Five Years | | | | | | |
| Year 1 savings kWh per household (HH) | 849 | 417 | 369 | 388 | 437 | 81 |
| Year 2 savings (% of Yr1) | 82% | 68% | 64% | 79% | 84% | 126% |
| Year 3 savings (% of Yr1) | 77% | 56% | 50% | 67% | 113% | 173% |
| Year 4 savings (% of Yr1) | NS ² | 56% | NS ² | 50% | 108% | 122% |
| Year 5 savings (% of Yr1) | NS ² | NS ² | NS ² | NS ² | 102% | NA |
| Total Cumulative Savings | 2,195 | 1,053 | 789 | 1,095 | 2,214 | 422 |
| Cost/household for treatment | \$7.55 | \$7.55 | \$7.55 | \$7.55 | \$59.67 | \$52.53 |
| Single Year of Reports, No Persistence Considered | | | | | | |
| Achieved Savings | 849 | 417 | 369 | 388 | 437 | 81 |
| Cost / kWh Achieved | \$0.009 | \$0.018 | \$0.020 | \$0.019 | \$0.017 | \$0.154 |
| Single Year of Reports / One Year No Report | | | | | | |
| Achieved Savings | 1,542 | 701 | 604 | 696 | 784 | 145 |
| Cost / kWh Achieved | \$0.005 | \$0.011 | \$0.012 | \$0.011 | \$0.010 | \$0.086 |
| Percent of \$/kWh compared to similar years of continual treatment | 20% | 44% | 47% | 43% | 39% | 63% |
| Percent of kWh compared to similar years of continual treatment | 90% | 83% | 81% | 89% | 89% | 75% |
| Single Year of Reports / Three Years No Report | | | | | | |
| Achieved Savings | 2,195 | 1,053 | 789 | 1,095 | 1,233 | 229 |
| Cost / kWh Achieved | \$0.003 | \$0.008 | \$0.009 | \$0.007 | \$0.006 | \$0.055 |
| Percent of \$/kWh compared to similar years of continual treatment | 14% | 30% | 35% | 28% | 24% | 44% |
| Percent of kWh compared to similar years of continual treatment | 64% | 62% | 53% | 70% | 70% | 54% |

R1606 EVERSOURCE BEHAVIOR PROGRAM PERSISTENCE EVALUATION

| | High-use Discontinued | | | | Continued | |
|--|-----------------------|-----------|--------------------------|---------|-----------|-------------|
| | Monthly ¹ | Quarterly | Persistence ¹ | Overall | High Use | Average Use |
| Two Years of Reports / Two Years No Report | | | | | | |
| Achieved Savings | 3,058 | 1,360 | 1,164 | 1,351 | 1,522 | 282 |
| Cost / kWh Achieved | \$0.007 | \$0.015 | \$0.017 | \$0.015 | \$0.013 | \$0.089 |
| Percent of \$/kWh compared to similar years of continual treatment | 25% | 57% | 67% | 57% | 51% | 71% |
| Percent of kWh compared to similar years of continual treatment | 89% | 81% | 78% | 86% | 86% | 67% |
| Two Years of Reports / Three Years No Report | | | | | | |
| Achieved Savings | 3,058 | 1,477 | 1,164 | 1,489 | 1,677 | 311 |
| Cost / kWh Achieved | \$0.007 | \$0.014 | \$0.017 | \$0.013 | \$0.012 | \$0.080 |
| Percent of \$/kWh compared to similar years of continual treatment | 24% | 50% | 64% | 50% | 44% | 65% |
| Percent of kWh compared to similar years of continual treatment | 59% | 58% | 52% | 63% | 63% | 50% |

¹ Results reflect that this group exhibited statistically significant savings for only two-years post-treatment.

² Savings not statistically different from the control group.

The alternative delivery scenarios suggest that an approach that cycles households through the program—sometimes called a crop rotation—could have clear advantages over a model that sends reports to the same households year after year. Table 10 to Table 17 explore cycling for three groups of high-use (Table 10 to Table 13) and average-use (Table 14 to Table 17) households assuming the same schedules explored in Table 9 above, comparing the savings achieved and cost-effectiveness of cycling to what would be achieved by continual treatment of high-use or average-use households. The examples for a single year of treatment rely on actual degradation rates and ramp-up rates based on empirical evidence, while the examples for two years of treatment rely on average degradation and average ramp-up rates since the pilot never directly explored a two-year treatment scenario. While some of the scenarios include re-treating groups after their designated persistence period has passed to simplify the exercise, similar savings would be achieved by adding study groups rather than returning to one that was previously treated. Some of the highlights of the exploration include the following:

- The cycling approaches touch more households than continually treating the same households year after year.
- High-use households always achieve greater savings at lower costs per kWh saved from cycling, but average-use households exhibit mixed results from cycling.
- Cycles that rely on sending households a report for a single year yield greater savings at lower costs per kWh than those that rely on sending households a report for two years.
- Average-use households in particular do not benefit from two years of treatment, exhibiting lower savings than continuous treatment in such scenarios. This reflects the small annual savings achieved by average-use households coupled with the high ramp-up rate exhibited by these households.
- In the approaches when two high-use cycled groups receive reports in the same year (e.g., Table 10 and Table 14), the cost per household is greater than continual treatment but the cost per kWh saved remains lower. This is only sometimes true for the average-use cycled groups.

The preference for cycling at Eversource may depend on the costs relative to other programs, and the relative mix of high-use and average-use consumers in the treatment group. It is also the case that Connecticut law may require Eversource to pursue all cost-effective savings. However, the current analysis demonstrates that cycling may both be more cost-effective and maximize savings compared to continual treatment.

Comment [GR23]: Has anyone done this? If not, why not? Note this in the ES.

While OPower may have self-serving reasons not to support such an approach, has this alternative been discussed with them?

Comment [GR24]: For a given budget.

Comment [GR25]: These are important considerations and should be noted in the ES. Is the mix of high vs. average use consumers available?

Ideally, these per customer savings should be extrapolated to the population of eligible customers.

Is there a worksheet/workbook that NMR could provide Eversource and the Board Consultants that would allow them to do some "what if" scenarios?

Table 10: Cycling High-Use Households, Single Year with Reports, One Year No Reports¹

| | | Group A | Group B | Group C | Program Total ³ | Five Years Continual |
|--------|--------------------------------------|---------|---------|---------|----------------------------|----------------------|
| | <i>Assumed Treatment Group Size</i> | 1,000 | 1,000 | 1,000 | 3,000 | 1,000 |
| Year 1 | Treatment Savings (kWh) | 437 | 0 | 0 | 437 | 437 |
| | Persistence Savings (kWh) | 0 | 0 | 0 | 0 | 0 |
| | Total Savings (kWh) | 437 | 0 | 0 | 437 | 437 |
| | Annual Cost ² | \$12.50 | \$0.00 | \$0.00 | \$12.50 | \$12.50 |
| | Cost Effectiveness | \$0.029 | N/A | N/A | \$0.029 | \$0.029 |
| Year 2 | Treatment Savings (kWh) | 0 | 437 | 0 | 437 | 365 |
| | Persistence Savings (kWh) | 347 | 0 | 0 | 347 | 0 |
| | Accumulated Two-Year Savings (kWh) | 784 | 437 | 0 | 1,221 | 802 |
| | Annual Cost ² | \$0.00 | \$12.50 | \$0.00 | \$12.50 | \$12.50 |
| | Accumulated Two-Year Cost | \$12.50 | \$12.50 | \$0.00 | \$25.00 | \$25.00 |
| | Cost Effectiveness | \$0.016 | \$0.029 | N/A | \$0.020 | \$0.031 |
| Year 3 | Treatment Savings (kWh) | 437 | 0 | 437 | 874 | 493 |
| | Persistence Savings (kWh) | 0 | 347 | 0 | 347 | 0 |
| | Accumulated Three-Year Savings (kWh) | 1,221 | 784 | 437 | 2,442 | 1,295 |
| | Annual Cost ² | \$12.50 | \$0.00 | \$12.50 | \$25.00 | \$12.50 |
| | Accumulated Three-Year Costs | \$25.00 | \$12.50 | \$12.50 | \$50.00 | \$37.50 |
| | Cost Effectiveness | \$0.020 | \$0.016 | \$0.029 | \$0.020 | \$0.029 |
| Year 4 | Treatment Savings (kWh) | 0 | 437 | 0 | 437 | 474 |
| | Persistence Savings (kWh) | 347 | 0 | 347 | 694 | 0 |
| | Accumulated Four-Year Savings (kWh) | 1,568 | 1,221 | 784 | 3,573 | 1,769 |
| | Annual Cost ² | \$0.00 | \$12.50 | \$0.00 | \$12.50 | \$12.50 |
| | Accumulated Four-Year Costs | \$25.00 | \$25.00 | \$12.50 | \$62.50 | \$50.00 |
| | Cost Effectiveness | \$0.016 | \$0.020 | \$0.016 | \$0.017 | \$0.028 |

R1606 EVERSOURCE BEHAVIOR PROGRAM PERSISTENCE EVALUATION

| | | Group A | Group B | Group C | Program Total ³ | Five Years Continual |
|-------------------------------------|---|---------|---------|---------|----------------------------|----------------------|
| Year 5 | Treatment Savings (kWh) | 437 | 0 | 437 | 874 | 445 |
| | Persistence Savings (kWh) | 0 | 347 | 0 | 347 | 0 |
| | Accumulated Five-Year Savings (kWh) | 2,005 | 1,568 | 1,221 | 4,793 | 2,214 |
| | Annual Cost ² | \$12.50 | \$0.00 | \$12.50 | \$25.00 | \$12.50 |
| | Accumulated Five-Year Costs | \$37.50 | \$25.00 | \$25.00 | \$87.50 | \$62.50 |
| | Cost Effectiveness | \$0.019 | \$0.016 | \$0.020 | \$0.018 | \$0.028 |
| Program Total for Five Years | Accumulated Five-Year Savings (kWh) | | | | 4,793 | 2,214 |
| | Accumulated Five-Year Costs | | | | \$87.50 | \$62.50 |
| | Cost Effectiveness | | | | \$0.018 | \$0.028 |
| | Percent Greater Savings from Cycling | | | | 117% | |

¹ Used actual achieved savings, degradation rates, and ramp-up rates.

² Price per household held constant for ease of comparison; uncertainly about actual OPower charges per household over time.

³ Accumulated is the effect costs and savings.

Table 11: Cycling High-Use Households, Single Year with Reports, Three Years No Reports¹

| | | Group A | Group B | Group C | Program Total ² | Five Years Continual |
|---------------------|--------------------------------------|---------|---------|---------|----------------------------|----------------------|
| | <i>Assumed Treatment Group Size</i> | 1,000 | 1,000 | 1,000 | 3,000 | 1,000 |
| Year 1 | Treatment Savings (kWh) | 437 | 0 | 0 | 437 | 437 |
| | Persistence Savings (kWh) | 0 | 0 | 0 | 0 | 0 |
| | Total Savings (kWh) | 437 | 0 | 0 | 437 | 437 |
| | Annual Cost ² | \$12.50 | \$0.00 | \$0.00 | \$12.50 | \$12.50 |
| | Cost Effectiveness | \$0.029 | N/A | N/A | \$0.029 | \$0.029 |
| Year 2 | Treatment Savings (kWh) | 0 | 437 | 0 | 437 | 365 |
| | Persistence Savings (kWh) | 347 | 0 | 0 | 347 | 0 |
| | Accumulated Two-Year Savings (kWh) | 784 | 437 | 0 | 1,221 | 802 |
| | Annual Cost ² | \$0.00 | \$12.50 | \$0.00 | \$12.50 | \$12.50 |
| | Accumulated Two-Year Cost | \$12.50 | \$12.50 | \$0.00 | \$25.00 | \$25.00 |
| | Cost Effectiveness | \$0.016 | \$0.029 | N/A | \$0.020 | \$0.031 |
| Year 3 | Treatment Savings (kWh) | 0 | 0 | 437 | 437 | 493 |
| | Persistence Savings (kWh) | 294 | 347 | 0 | 641 | 0 |
| | Accumulated Three-Year Savings (kWh) | 1,078 | 784 | 437 | 2,299 | 1,295 |
| | Annual Cost ² | \$0.00 | \$0.00 | \$12.50 | \$12.50 | \$12.50 |
| | Accumulated Three-Year Costs | \$12.50 | \$12.50 | \$12.50 | \$37.50 | \$37.50 |
| | Cost Effectiveness | \$0.012 | \$0.016 | \$0.029 | \$0.016 | \$0.029 |
| Year 4 ⁴ | Treatment Savings (kWh) | 0 | 0 | 0 | 0 | 474 |
| | Persistence Savings (kWh) | 155 | 294 | 347 | 796 | 0 |
| | Accumulated Four-Year Savings (kWh) | 1,233 | 1,078 | 784 | 3,095 | 1,769 |
| | Annual Cost ² | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$12.50 |
| | Accumulated Four-Year Costs | \$12.50 | \$12.50 | \$12.50 | \$37.50 | \$50.00 |
| | Cost Effectiveness | \$0.010 | \$0.012 | \$0.016 | \$0.012 | \$0.028 |

R1606 EVERSOURCE BEHAVIOR PROGRAM PERSISTENCE EVALUATION

| | | Group A | Group B | Group C | Program Total ³ | Five Years Continual |
|-------------------------------------|---|---------|---------|---------|----------------------------|----------------------|
| Year 5 | Treatment Savings (kWh) | 437 | 0 | 0 | 437 | 445 |
| | Persistence Savings (kWh) | 0 | 155 | 294 | 449 | 0 |
| | Accumulated Five-Year Savings (kWh) | 1,670 | 1,233 | 1,078 | 3,981 | 2,214 |
| | Annual Cost ² | \$12.50 | \$0.00 | \$0.00 | \$12.50 | \$12.50 |
| | Accumulated Five-Year Costs | \$25.00 | \$12.50 | \$12.50 | \$50.00 | \$62.50 |
| | Cost Effectiveness | \$0.015 | \$0.010 | \$0.012 | \$0.013 | \$0.028 |
| Program Total for Five Years | Accumulated Five-Year Savings (kWh) | | | | 3,981 | 2,214 |
| | Accumulated Five-Year Costs | | | | \$50.00 | \$62.50 |
| | Cost Effectiveness | | | | \$0.013 | \$0.028 |
| | Percent Greater Savings from Cycling | | | | 80% | |

¹ Used actual achieved savings, degradation rates, and ramp-up rates.

² Price per household held constant for ease of comparison; uncertainly about actual OPower charges per household over time.

³ Accumulated is the effect costs and savings.

⁴ Note absence of treatment in Year 4 for all cycled groups. Expansion to a fourth group or shortening the cycle to two years off both provide viable options to not treating any households for a year.

Table 12: Cycling High-Use Households, Two Year with Reports, Two Years No Reports¹

| | | Group A | Group B | Group C | Program Total ² | Five Years Continual |
|--------|--------------------------------------|---------|---------|---------|----------------------------|----------------------|
| | <i>Assumed Treatment Group Size</i> | 1,000 | 1,000 | 1,000 | 3,000 | 1,000 |
| Year 1 | Treatment Savings (kWh) | 437 | 0 | 0 | 437 | 437 |
| | Persistence Savings (kWh) | 0 | 0 | 0 | 0 | 0 |
| | Total Savings (kWh) | 437 | 0 | 0 | 437 | 437 |
| | Annual Cost ² | \$12.50 | \$0.00 | \$0.00 | \$12.50 | \$12.50 |
| | Cost Effectiveness | \$0.029 | N/A | N/A | \$0.029 | \$0.029 |
| Year 2 | Treatment Savings (kWh) | 446 | 0 | 0 | 446 | 446 |
| | Persistence Savings (kWh) | 0 | 0 | 0 | 0 | 0 |
| | Accumulated Two-Year Savings (kWh) | 883 | 0 | 0 | 883 | 883 |
| | Annual Cost ² | \$12.50 | \$0.00 | \$0.00 | \$12.50 | \$12.50 |
| | Accumulated Two-Year Cost | \$25.00 | \$0.00 | \$0.00 | \$25.00 | \$25.00 |
| | Cost Effectiveness | \$0.028 | N/A | N/A | \$0.028 | \$0.028 |
| Year 3 | Treatment Savings (kWh) | 0 | 437 | 0 | 437 | 455 |
| | Persistence Savings (kWh) | 373 | 0 | 0 | 373 | 0 |
| | Accumulated Three-Year Savings (kWh) | 1,256 | 437 | 0 | 1,693 | 1,337 |
| | Annual Cost ² | \$0.00 | \$12.50 | \$0.00 | \$12.50 | \$12.50 |
| | Accumulated Three-Year Costs | \$25.00 | \$12.50 | \$0.00 | \$37.50 | \$37.50 |
| | Cost Effectiveness | \$0.020 | \$0.029 | N/A | \$0.022 | \$0.028 |
| Year 4 | Treatment Savings (kWh) | 0 | 446 | 0 | 446 | 464 |
| | Persistence Savings (kWh) | 312 | 0 | 0 | 312 | 0 |
| | Accumulated Four-Year Savings (kWh) | 1,567 | 883 | 0 | 2,450 | 1,801 |
| | Annual Cost ² | \$0.00 | \$12.50 | \$0.00 | \$12.50 | \$12.50 |
| | Accumulated Four-Year Costs | \$25.00 | \$25.00 | \$0.00 | \$50.00 | \$50.00 |
| | Cost Effectiveness | \$0.016 | \$0.028 | N/A | \$0.020 | \$0.028 |

R1606 EVERSOURCE BEHAVIOR PROGRAM PERSISTENCE EVALUATION

| | | Group A | Group B | Group C | Program Total ³ | Five Years Continual |
|-------------------------------------|---|---------|---------|---------|----------------------------|----------------------|
| Year 5 | Treatment Savings (kWh) | 437 | 0 | 437 | 874 | 473 |
| | Persistence Savings (kWh) | 0 | 373 | 0 | 373 | 0 |
| | Accumulated Five-Year Savings (kWh) | 2,004 | 1,256 | 437 | 3,697 | 2,274 |
| | Annual Cost ² | \$12.50 | \$0.00 | \$12.50 | \$25.00 | \$12.50 |
| | Accumulated Five-Year Costs | \$37.50 | \$25.00 | \$12.50 | \$75.00 | \$62.50 |
| | Cost Effectiveness | \$0.019 | \$0.020 | \$0.029 | \$0.020 | \$0.027 |
| Program Total for Five Years | Accumulated Five-Year Savings (kWh) | | | | 3,697 | 2,274 |
| | Accumulated Five-Year Costs | | | | \$75.00 | \$62.50 |
| | Cost Effectiveness | | | | \$0.020 | \$0.027 |
| | Percent Greater Savings from Cycling | | | | 63% | |

¹ Used actual achieved savings, degradation rates, and ramp-up rates.

² Price per household held constant for ease of comparison; uncertainly about actual OPower charges per household over time.

³ Accumulated is the effect costs and savings.

Table 13: Cycling High-Use Households, Two Years with Reports, Three Years No Reports¹

| | | Group A | Group B | Group C | Program Total ² | Five Years Continual |
|--------|--------------------------------------|---------|---------|---------|----------------------------|----------------------|
| | <i>Assumed Treatment Group Size</i> | 1,000 | 1,000 | 1,000 | 3,000 | 1,000 |
| Year 1 | Treatment Savings (kWh) | 437 | 0 | 0 | 437 | 437 |
| | Persistence Savings (kWh) | 0 | 0 | 0 | 0 | 0 |
| | Total Savings (kWh) | 437 | 0 | 0 | 437 | 437 |
| | Annual Cost ² | \$12.50 | \$0.00 | \$0.00 | \$12.50 | \$12.50 |
| | Cost Effectiveness | \$0.029 | N/A | N/A | \$0.029 | \$0.029 |
| Year 2 | Treatment Savings (kWh) | 446 | 0 | 0 | 446 | 446 |
| | Persistence Savings (kWh) | 0 | 0 | 0 | 0 | 0 |
| | Accumulated Two-Year Savings (kWh) | 883 | 0 | 0 | 883 | 883 |
| | Annual Cost ² | \$12.50 | \$0.00 | \$0.00 | \$12.50 | \$12.50 |
| | Accumulated Two-Year Cost | \$25.00 | \$0.00 | \$0.00 | \$25.00 | \$25.00 |
| | Cost Effectiveness | \$0.028 | N/A | N/A | \$0.028 | \$0.028 |
| Year 3 | Treatment Savings (kWh) | 0 | 437 | 0 | 437 | 455 |
| | Persistence Savings (kWh) | 373 | 0 | 0 | 373 | 0 |
| | Accumulated Three-Year Savings (kWh) | 1,256 | 437 | 0 | 1,693 | 1,337 |
| | Annual Cost ² | \$0.00 | \$12.50 | \$0.00 | \$12.50 | \$12.50 |
| | Accumulated Three-Year Costs | \$25.00 | \$12.50 | \$0.00 | \$37.50 | \$37.50 |
| | Cost Effectiveness | \$0.020 | \$0.029 | N/A | \$0.022 | \$0.028 |
| Year 4 | Treatment Savings (kWh) | 0 | 446 | 0 | 446 | 464 |
| | Persistence Savings (kWh) | 312 | 0 | 0 | 312 | 0 |
| | Accumulated Four-Year Savings (kWh) | 1,567 | 883 | 0 | 2,450 | 1,801 |
| | Annual Cost ² | \$0.00 | \$12.50 | \$0.00 | \$12.50 | \$12.50 |
| | Accumulated Four-Year Costs | \$25.00 | \$25.00 | \$0.00 | \$50.00 | \$50.00 |
| | Cost Effectiveness | \$0.016 | \$0.028 | N/A | \$0.020 | \$0.028 |

R1606 EVERSOURCE BEHAVIOR PROGRAM PERSISTENCE EVALUATION

| | | Group A | Group B | Group C | Program Total ³ | Five Years Continual |
|-------------------------------------|---|---------|---------|---------|----------------------------|----------------------|
| Year 5 | Treatment Savings (kWh) | 0 | 0 | 437 | 437 | 473 |
| | Persistence Savings (kWh) | 261 | 373 | 0 | 634 | 0 |
| | Accumulated Five-Year Savings (kWh) | 1,828 | 1,256 | 437 | 3,521 | 2,274 |
| | Annual Cost ² | \$0.00 | \$0.00 | \$12.50 | \$12.50 | \$12.50 |
| | Accumulated Five-Year Costs | \$25.00 | \$25.00 | \$12.50 | \$62.50 | \$62.50 |
| | Cost Effectiveness | \$0.014 | \$0.020 | \$0.029 | \$0.018 | \$0.027 |
| Program Total for Five Years | Accumulated Five-Year Savings (kWh) | | | | 3,521 | 2,274 |
| | Accumulated Five-Year Costs | | | | \$62.50 | \$62.50 |
| | Cost Effectiveness | | | | \$0.018 | \$0.027 |
| | Percent Greater Savings from Cycling | | | | 55% | |

¹ Used actual achieved savings, degradation rates, and ramp-up rates.

² Price per household held constant for ease of comparison; uncertainly about actual OPower charges per household over time.

³ Accumulated is the effect costs and savings.

Table 14: Cycling Average-Use Households, Single Year with Reports, One Year No Reports¹

| | | Group A | Group B | Group C | Program Total ³ | Five Years Continual |
|--------|--------------------------------------|---------|---------|---------|----------------------------|----------------------|
| | <i>Assumed Treatment Group Size</i> | 1,000 | 1,000 | 1,000 | 3,000 | 1,000 |
| Year 1 | Treatment Savings (kWh) | 81 | 0 | 0 | 81 | 81 |
| | Persistence Savings (kWh) | 0 | 0 | 0 | 0 | 0 |
| | Total Savings (kWh) | 81 | 0 | 0 | 81 | 81 |
| | Annual Cost ² | \$12.50 | \$0.00 | \$0.00 | \$12.50 | \$12.50 |
| | Cost Effectiveness | \$0.154 | N/A | N/A | \$0.154 | \$0.154 |
| Year 2 | Treatment Savings (kWh) | 0 | 81 | 0 | 81 | 102 |
| | Persistence Savings (kWh) | 64 | 0 | 0 | 64 | 0 |
| | Accumulated Two-Year Savings (kWh) | 145 | 81 | 0 | 226 | 183 |
| | Annual Cost ² | \$0.00 | \$12.50 | \$0.00 | \$12.50 | \$12.50 |
| | Accumulated Two-Year Cost | \$12.50 | \$12.50 | \$0.00 | \$25.00 | \$25.00 |
| | Cost Effectiveness | \$0.086 | \$0.154 | N/A | \$0.110 | \$0.137 |
| Year 3 | Treatment Savings (kWh) | 81 | 0 | 81 | 162 | 140 |
| | Persistence Savings (kWh) | 0 | 64 | 0 | 64 | 0 |
| | Accumulated Three-Year Savings (kWh) | 226 | 145 | 81 | 453 | 323 |
| | Annual Cost ² | \$12.50 | \$0.00 | \$12.50 | \$25.00 | \$12.50 |
| | Accumulated Three-Year Costs | \$25.00 | \$12.50 | \$12.50 | \$50.00 | \$37.50 |
| | Cost Effectiveness | \$0.110 | \$0.086 | \$0.154 | \$0.110 | \$0.116 |
| Year 4 | Treatment Savings (kWh) | 0 | 81 | 0 | 81 | 99 |
| | Persistence Savings (kWh) | 64 | 0 | 64 | 129 | 0 |
| | Accumulated Four-Year Savings (kWh) | 291 | 226 | 145 | 662 | 422 |
| | Annual Cost ² | \$0.00 | \$12.50 | \$0.00 | \$12.50 | \$12.50 |
| | Accumulated Four-Year Costs | \$25.00 | \$25.00 | \$12.50 | \$62.50 | \$50.00 |
| | Cost Effectiveness | \$0.086 | \$0.110 | \$0.086 | \$0.094 | \$0.118 |

R1606 EVERSOURCE BEHAVIOR PROGRAM PERSISTENCE EVALUATION

| | | Group A | Group B | Group C | Program Total ³ | Five Years Continual |
|-------------------------------------|---|---------|---------|---------|----------------------------|----------------------|
| Year 5 | Treatment Savings (kWh) | 81 | 0 | 81 | 162 | 113 |
| | Persistence Savings (kWh) | 0 | 64 | 0 | 64 | 0 |
| | Accumulated Five-Year Savings (kWh) | 372 | 291 | 226 | 888 | 535 |
| | Annual Cost ² | \$12.50 | \$0.00 | \$12.50 | \$25.00 | \$12.50 |
| | Accumulated Five-Year Costs | \$37.50 | \$25.00 | \$25.00 | \$87.50 | \$62.50 |
| | Cost Effectiveness | \$0.101 | \$0.086 | \$0.110 | \$0.098 | \$0.117 |
| Program Total for Five Years | Accumulated Five-Year Savings (kWh) | | | | 888 | 535 |
| | Accumulated Five-Year Costs | | | | \$87.50 | \$62.50 |
| | Cost Effectiveness | | | | \$0.098 | \$0.117 |
| | Percent Greater Savings from Cycling | | | | 66% | |

¹ Used actual achieved savings, degradation rates, and ramp-up rates.

² Price per household held constant for ease of comparison; uncertainly about actual OPower charges per household over time.

³ Accumulated is the effect costs and savings.

Table 15: Cycling Average-Use Households, Single Year with Reports, Three Years No Reports¹

| | | Group A | Group B | Group C | Program Total ² | Five Years Continual |
|---------------------|--------------------------------------|---------|---------|---------|----------------------------|----------------------|
| | <i>Assumed Treatment Group Size</i> | 1,000 | 1,000 | 1,000 | 3,000 | 1,000 |
| Year 1 | Treatment Savings (kWh) | 81 | 0 | 0 | 81 | 81 |
| | Persistence Savings (kWh) | 0 | 0 | 0 | 0 | 0 |
| | Total Savings (kWh) | 81 | 0 | 0 | 81 | 81 |
| | Annual Cost ² | \$12.50 | \$0.00 | \$0.00 | \$12.50 | \$12.50 |
| | Cost Effectiveness | \$0.154 | N/A | N/A | \$0.154 | \$0.154 |
| Year 2 | Treatment Savings (kWh) | 0 | 81 | 0 | 81 | 102 |
| | Persistence Savings (kWh) | 64 | 0 | 0 | 64 | 0 |
| | Accumulated Two-Year Savings (kWh) | 145 | 81 | 0 | 226 | 183 |
| | Annual Cost ² | \$0.00 | \$12.50 | \$0.00 | \$12.50 | \$12.50 |
| | Accumulated Two-Year Cost | \$12.50 | \$12.50 | \$0.00 | \$25.00 | \$25.00 |
| | Cost Effectiveness | \$0.086 | \$0.154 | N/A | \$0.110 | \$0.137 |
| Year 3 | Treatment Savings (kWh) | 0 | 0 | 81 | 81 | 140 |
| | Persistence Savings (kWh) | 54 | 64 | 0 | 119 | 0 |
| | Accumulated Three-Year Savings (kWh) | 200 | 145 | 81 | 426 | 323 |
| | Annual Cost ² | \$0.00 | \$0.00 | \$12.50 | \$12.50 | \$12.50 |
| | Accumulated Three-Year Costs | \$12.50 | \$12.50 | \$12.50 | \$37.50 | \$37.50 |
| | Cost Effectiveness | \$0.063 | \$0.086 | \$0.154 | \$0.088 | \$0.116 |
| Year 4 ⁴ | Treatment Savings (kWh) | 0 | 0 | 0 | 0 | 99 |
| | Persistence Savings (kWh) | 29 | 54 | 64 | 148 | 0 |
| | Accumulated Four-Year Savings (kWh) | 229 | 200 | 145 | 574 | 422 |
| | Annual Cost ² | \$0.00 | \$0.00 | \$0.00 | \$0.00 | \$12.50 |
| | Accumulated Four-Year Costs | \$12.50 | \$12.50 | \$12.50 | \$37.50 | \$50.00 |
| | Cost Effectiveness | \$0.055 | \$0.063 | \$0.086 | \$0.065 | \$0.118 |

R1606 EVERSOURCE BEHAVIOR PROGRAM PERSISTENCE EVALUATION

| | | Group A | Group B | Group C | Program Total ³ | Five Years Continual |
|-------------------------------------|---|---------|---------|---------|----------------------------|----------------------|
| Year 5 | Treatment Savings (kWh) | 81 | 0 | 0 | 81 | 113 |
| | Persistence Savings (kWh) | 0 | 29 | 54 | 83 | 0 |
| | Accumulated Five-Year Savings (kWh) | 310 | 229 | 200 | 738 | 535 |
| | Annual Cost ² | \$12.50 | \$0.00 | \$0.00 | \$12.50 | \$12.50 |
| | Accumulated Five-Year Costs | \$25.00 | \$12.50 | \$12.50 | \$50.00 | \$62.50 |
| | Cost Effectiveness | \$0.081 | \$0.055 | \$0.063 | \$0.068 | \$0.117 |
| Program Total for Five Years | Accumulated Five-Year Savings (kWh) | | | | 738 | 535 |
| | Accumulated Five-Year Costs | | | | \$50.00 | \$62.50 |
| | Cost Effectiveness | | | | \$0.068 | \$0.117 |
| | Percent Greater Savings from Cycling | | | | 38% | |

¹ Used actual achieved savings, degradation rates, and ramp-up rates.

² Price per household held constant for ease of comparison; uncertainly about actual OPower charges per household over time.

³ Accumulated is the effect costs and savings.

⁴ Note absence of treatment in Year 4 for all cycled groups. Expansion to a fourth group or shortening the cycle to two years off both provide viable options to not treating any households for a year.

Table 16: Cycling Average-Use Households, Two Year with Reports, Two Years No Reports¹

| | | Group A | Group B | Group C | Program Total ² | Five Years Continual |
|--------|--------------------------------------|---------|---------|---------|----------------------------|----------------------|
| | <i>Assumed Treatment Group Size</i> | 1,000 | 1,000 | 1,000 | 3,000 | 1,000 |
| Year 1 | Treatment Savings (kWh) | 81 | 0 | 0 | 81 | 437 |
| | Persistence Savings (kWh) | 0 | 0 | 0 | 0 | 0 |
| | Total Savings (kWh) | 81 | 0 | 0 | 81 | 437 |
| | Annual Cost ² | \$12.50 | \$0.00 | \$0.00 | \$12.50 | \$12.50 |
| | Cost Effectiveness | \$0.154 | N/A | N/A | \$0.154 | \$0.029 |
| Year 2 | Treatment Savings (kWh) | 113 | 0 | 0 | 113 | 446 |
| | Persistence Savings (kWh) | 0 | 0 | 0 | 0 | 0 |
| | Accumulated Two-Year Savings (kWh) | 194 | 0 | 0 | 194 | 883 |
| | Annual Cost ² | \$12.50 | \$0.00 | \$0.00 | \$12.50 | \$12.50 |
| | Accumulated Two-Year Cost | \$25.00 | \$0.00 | \$0.00 | \$25.00 | \$25.00 |
| | Cost Effectiveness | \$0.129 | N/A | N/A | \$0.129 | \$0.028 |
| Year 3 | Treatment Savings (kWh) | 0 | 81 | 0 | 81 | 455 |
| | Persistence Savings (kWh) | 95 | 0 | 0 | 95 | 0 |
| | Accumulated Three-Year Savings (kWh) | 289 | 81 | 0 | 370 | 1,337 |
| | Annual Cost ² | \$0.00 | \$12.50 | \$0.00 | \$12.50 | \$12.50 |
| | Accumulated Three-Year Costs | \$25.00 | \$12.50 | \$0.00 | \$37.50 | \$37.50 |
| | Cost Effectiveness | \$0.086 | \$0.154 | N/A | \$0.101 | \$0.028 |
| Year 4 | Treatment Savings (kWh) | 0 | 113 | 0 | 113 | 464 |
| | Persistence Savings (kWh) | 79 | 0 | 0 | 79 | 0 |
| | Accumulated Four-Year Savings (kWh) | 369 | 194 | 0 | 563 | 1,801 |
| | Annual Cost ² | \$0.00 | \$12.50 | \$0.00 | \$12.50 | \$12.50 |
| | Accumulated Four-Year Costs | \$25.00 | \$25.00 | \$0.00 | \$50.00 | \$50.00 |
| | Cost Effectiveness | \$0.068 | \$0.129 | N/A | \$0.089 | \$0.028 |

R1606 EVERSOURCE BEHAVIOR PROGRAM PERSISTENCE EVALUATION

| | | Group A | Group B | Group C | Program Total ³ | Five Years Continual |
|-------------------------------------|---|---------|---------|---------|----------------------------|----------------------|
| Year 5 | Treatment Savings (kWh) | 81 | 0 | 81 | 162 | 473 |
| | Persistence Savings (kWh) | 0 | 95 | 0 | 95 | 0 |
| | Accumulated Five-Year Savings (kWh) | 450 | 289 | 81 | 820 | 2,274 |
| | Annual Cost ² | \$12.50 | \$0.00 | \$12.50 | \$25.00 | \$12.50 |
| | Accumulated Five-Year Costs | \$37.50 | \$25.00 | \$12.50 | \$75.00 | \$62.50 |
| | Cost Effectiveness | \$0.083 | \$0.086 | \$0.154 | \$0.091 | \$0.027 |
| Program Total for Five Years | Accumulated Five-Year Savings (kWh) | | | | 820 | 887 |
| | Accumulated Five-Year Costs | | | | \$75.00 | \$62.50 |
| | Cost Effectiveness | | | | \$0.091 | \$0.070 |
| | Percent Greater Savings from Cycling | | | | -8% | |

¹ Used actual achieved savings, degradation rates, and ramp-up rates.

² Price per household held constant for ease of comparison; uncertainly about actual OPower charges per household over time.

³ Accumulated is the effect costs and savings.

Table 17: Cycling Average-Use Households, Two Years with Reports, Three Years No Reports¹

| | | Group A | Group B | Group C | Program Total ² | Five Years Continual |
|--------|--------------------------------------|---------|---------|---------|----------------------------|----------------------|
| | <i>Assumed Treatment Group Size</i> | 1,000 | 1,000 | 1,000 | 3,000 | 1,000 |
| Year 1 | Treatment Savings (kWh) | 81 | 0 | 0 | 81 | 81 |
| | Persistence Savings (kWh) | 0 | 0 | 0 | 0 | 0 |
| | Total Savings (kWh) | 81 | 0 | 0 | 81 | 81 |
| | Annual Cost ² | \$12.50 | \$0.00 | \$0.00 | \$12.50 | \$12.50 |
| | Cost Effectiveness | \$0.154 | N/A | N/A | \$0.154 | \$0.154 |
| Year 2 | Treatment Savings (kWh) | 113 | 0 | 0 | 113 | 113 |
| | Persistence Savings (kWh) | 0 | 0 | 0 | 0 | 0 |
| | Accumulated Two-Year Savings (kWh) | 194 | 0 | 0 | 194 | 194.4 |
| | Annual Cost ² | \$12.50 | \$0.00 | \$0.00 | \$12.50 | \$12.50 |
| | Accumulated Two-Year Cost | \$25.00 | \$0.00 | \$0.00 | \$25.00 | \$25.00 |
| | Cost Effectiveness | \$0.129 | N/A | N/A | \$0.129 | \$0.129 |
| Year 3 | Treatment Savings (kWh) | 0 | 81 | 0 | 81 | 159 |
| | Persistence Savings (kWh) | 95 | 0 | 0 | 95 | 0 |
| | Accumulated Three-Year Savings (kWh) | 289 | 81 | 0 | 370 | 353 |
| | Annual Cost ² | \$0.00 | \$12.50 | \$0.00 | \$12.50 | \$12.50 |
| | Accumulated Three-Year Costs | \$25.00 | \$12.50 | \$0.00 | \$37.50 | \$37.50 |
| | Cost Effectiveness | \$0.086 | \$0.154 | N/A | \$0.101 | \$0.106 |
| Year 4 | Treatment Savings (kWh) | 0 | 113 | 0 | 113 | 222 |
| | Persistence Savings (kWh) | 79 | 0 | 0 | 79 | 0 |
| | Accumulated Four-Year Savings (kWh) | 369 | 194 | 0 | 563 | 575 |
| | Annual Cost ² | \$0.00 | \$12.50 | \$0.00 | \$12.50 | \$12.50 |
| | Accumulated Four-Year Costs | \$25.00 | \$25.00 | \$0.00 | \$50.00 | \$50.00 |
| | Cost Effectiveness | \$0.068 | \$0.129 | N/A | \$0.089 | \$0.087 |

R1606 EVERSOURCE BEHAVIOR PROGRAM PERSISTENCE EVALUATION

| | | Group A | Group B | Group C | Program Total ³ | Five Years Continual |
|-------------------------------------|---|---------|---------|---------|----------------------------|----------------------|
| Year 5 | Treatment Savings (kWh) | 0 | 0 | 81 | 81 | 311 |
| | Persistence Savings (kWh) | 66 | 95 | 0 | 161 | 0 |
| | Accumulated Five-Year Savings (kWh) | 435 | 289 | 81 | 805 | 887 |
| | Annual Cost ² | \$0.00 | \$0.00 | \$12.50 | \$12.50 | \$12.50 |
| | Accumulated Five-Year Costs | \$25.00 | \$25.00 | \$12.50 | \$62.50 | \$62.50 |
| | Cost Effectiveness | \$0.057 | \$0.086 | \$0.154 | \$0.078 | \$0.070 |
| Program Total for Five Years | Accumulated Five-Year Savings (kWh) | | | | 805 | 887 |
| | Accumulated Five-Year Costs | | | | \$62.50 | \$62.50 |
| | Cost Effectiveness | | | | \$0.078 | \$0.070 |
| | Percent Greater Savings from Cycling | | | | -9% | |

¹ Used actual achieved savings, degradation rates, and ramp-up rates.

² Price per household held constant for ease of comparison; uncertainly about actual OPower charges per household over time.

³ Accumulated is the effect costs and savings.

3

Section 3 Conclusions and Recommendations

The analysis presented in this study of households in the Eversource HERs Pilot program indicates that the full measure lifetimes of receiving reports may be substantiated as multiple years due to substantial retention even after the program interventions are interrupted. The study provided defensible estimates of retained savings from behavioral programs that will allow for more accurate attribution of program savings, inform refinement of the program design, and consider the program's cost-effectiveness with lifetime numbers. The study also presented calculations based on empirical evidence gained through the billing analysis that indicate that program cycling (stopping and starting the program or delivering the program to different subgroups in turn) may offer a way to maximize savings and increase cost-effectiveness at the same time. It should be noted that cycling is not the only alternative approach available to Eversource for program delivery. They could work with the implementer to alter messaging and the types of customers targeted, among other options. Yet, this analysis makes clear that cycling serves as one viable alternative to the current design of continual monthly treatment to all enrolled customers. The key takeaways can be summarized as follows:

- High-use discontinued groups exhibit statistically significant savings at least two but no more than three years post-treatment, with the variation in persistence largely an artifact of the sample size (i.e., statistical power) and length of treatment (eight months versus one year). The average annual degradation was 16% spread across three years for all high-use discontinued groups.
- High-use continued groups exhibited an average ramp-up rate of 2% (including the second-year of treatment in which they had a three-month report hiatus; the average ramp-up was 8% without the hiatus). Ramp-up rates for the high-use continued groups declined over time.
- Average-use continued groups also exhibited ramp-up, with an average of 40%, but with substantial variation from year to year. Because they achieve smaller percentage savings and kWh savings compared to high-use groups, it took the average-use group four full years of treatment to accumulate the same savings as one year of treatment among high-use groups.
- Taking persistence savings and ramp-up into account, the cost per kWh saved over five years was less than one cent for high-use discontinued groups, about three cents for high-use continued groups, and approximately 12 cents for average-use continued groups.
- Cycling approaches provide an avenue to maximize savings at the lowest cost per kWh saved and touch a greater number of customers in the process. The cycles that perform the best involve treating successive groups for one year each, banking the persistence savings. Two-year treatment cycles are less cost-effective and, for average-use households, do not maximize savings.

Based on these findings, the study makes the following two recommendations.

- **Recommendation 1:** This study assessed cost-effectiveness using a very simple approach—the cost per kWh saved. Deciding whether a cycling approach meets the more detailed utility cost test (or other benefit-cost ratio tests) would require a more thorough analysis to determine the full benefits and costs of cycling versus continued treatment.
- **Recommendation 2:** If the HERs program stops sending reports to high-use and average-use continued groups, examine the degradation rates of their savings to inform long-term program design.

Eversource and OPower expanded the program in 2014, adding 300,000 households and enrolling HES and HES-IE customers into the program. These program changes inform the third and fourth recommendations.

- **Recommendation 3:** Because savings vary by pre-program energy use, Eversource should examine the pre-program energy use of the 300,000 households in the current iteration of the Eversource HERs program for the distribution of pre-program energy use and analyze the most effective and fair way to target the program. For example, the program may want to consider cycling high-use households (who achieve higher percentage and kWh savings) but treating average-use households continuously (due to lower percentage and kWh savings). The use of cycling may allow such a design to achieve high cost effectiveness and touch more customers, while maximizing savings overall.
- **Recommendation 4:** Households that opt in to a program like HES or HES-IE may differ from the randomly selected population of high users and average users that were in the HERs pilot. Moreover, by already taking part in HES and HES-IE and then receiving HERs, the program runs the risk of double counting savings between HERs and HES/HES-IE. Therefore, Eversource should study the impact of enrolling HES and HES-IE households into HERs on program attribution and double counting of savings.
- **Recommendation 5:** When the current implementer contract ends, Eversource should consider adopting a revised program design that includes a cycling approach, particularly for the high-use customers in the sample, who achieve similar or higher savings from treatment and retention savings compared to continual treatment, even with ramp-up taking into account.

Comment [GR26]: Which is when? Have we missed that window or are we about to?

A

Appendix A Expanded Methods

This section provides more information on the data used in the study and the energy use characteristics of treatment and control households.

Eversource provided data on households that had service disconnected since they started receiving reports or who had opted out of the program (i.e., asked not to receive reports). Opt-out households have been retained in the analysis.

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 July 31, 2016. 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.

Weather data came from four regional stations in Connecticut, as agreed on during the initial evaluation in 2012 and retained in subsequent studies over time for the sake of comparability and consistency. **Figure 4** 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. 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 study 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 July 2016 and included the heating and cooling degree days as a control for the impact model.

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Table 18: Billing Analysis Data Sources

| Eversource | OPOWER | NCDC |
|---|---|---|
| Flag for treatment households who opted out of program ^a | 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 |
| | 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 4: Weather Station Assignment

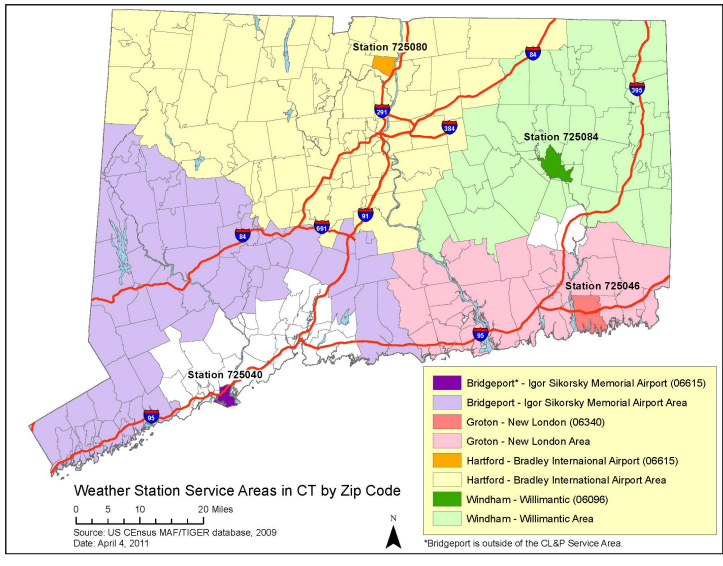


Table 19 summarizes the final sample sizes used in the billing analysis as well as the monthly pre-treatment electricity use for the households.

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Table 19: Total Pre-Program Electricity Usage for Households Included in Current Analysis¹

| | Sample Size | Average Monthly Use (kWh) |
|---|-------------|---------------------------|
| Average-use Expansion Treatment Group | 8,985 | 713 |
| Average-use Expansion Control Group | 9,963 | 707 |
| High-use Extension Treatment Group | 7,211 | 1,606 |
| High-use Extension Control Group | 22,584 | 1,577 |
| Discontinued Treatment Group | 14,733 | 1,576 |
| Discontinued Monthly | 1,507 | 1,611 |
| Discontinued Persistence | 3,796 | 1,595 |
| Discontinued Quarterly | 9,374 | 1,601 |
| Discontinued Control Group ³ | 22,584 | 1,577 |

¹ 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.

² Sample size of households included in the current analysis, which is smaller than at the program start due to attribution related largely to disconnected accounts.

³ 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.

Table 20 presents the results of savings explorations over the course of the pilot program, from January 2011 through June 2016.

Table 20: Energy Savings by Treatment Group Across Studies

| | Discontinued | | | | Continued | |
|--|--------------------|-----------|--------------------|---------------------|--------------|--------------|
| | Monthly | Quarterly | Persistence | All | High-use | Average-Use |
| Study 1: Submitted 2013 | | | | | | |
| Sample Size | 9,681 ² | 9,990 | 3,923 | 23,594 ² | N/A | N/A |
| Average Daily Treatment kWh Savings | 1.07* | 0.72* | 0.76* ³ | 0.85* | N/A | N/A |
| Average Daily Treatment % Savings | 2.17%* | 1.45%* | 1.57%* | 1.75%* | N/A | N/A |
| Study 2 Submitted 2014 | | | | | | |
| Sample Size | 1,670 | 9,856 | 3,979 | 15,505 | 8,047 | 10,217 |
| Average Daily Treatment kWh Savings | 1.75* | 0.76* | 0.76* | 0.91* | 1.19 | 0.26 |
| Average Daily Treatment % Savings | 3.62%* | 1.55%* | 1.57%* | 1.88%* | 2.31% | 1.17% |
| Average Daily Post-Treatment kWh Savings Apr. 2012 to Jul. 2013 | 1.49* | 0.83* | 0.75* | 0.88* | N/A | N/A |
| Average Daily Post-Treatment % Apr. 2012 to Jul. 2013 Savings | 3.70%* | 2.06%* | 1.86%* | 1.82%* | N/A | N/A |
| Study 3 Submitted 2016 | | | | | | |
| Sample Size | 1,670 | 9,641 | 3,896 | 15,207 | Not explored | Not explored |
| Average Daily Treatment kWh Savings | 1.75* | 0.86* | 0.76* | 0.91* | Not explored | Not explored |
| Average Daily Treatment % Savings | 3.62%* | 1.79%* | 1.57%* | 1.88%* | Not explored | Not explored |
| Average Daily Post-Treatment kWh Savings Apr. 2012 to Jul. 2013 | 1.49* | 0.83* | 0.75* | 0.88* | N/A | N/A |
| Average Daily Post-Treatment % Savings Apr. 2012 to Jul. 2013 % | 3.70%* | 2.06%* | 1.86%* | 1.82%* | N/A | N/A |
| Average Daily Post-Treatment kWh Savings Aug. 2013 to Nov. 2014 kWh | 0.71 | 0.61* | 0.09 | 0.48* | N/A | N/A |
| Average Daily Post-Treatment % Savings Aug. 2013 to Nov. 2014 % | 1.66% | 1.27%* | 0.23% | 0.99%* | N/A | N/A |

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| | Discontinued | | | | Continued | |
|--|--------------|-----------|-------------|--------|-----------|-------------|
| | Monthly | Quarterly | Persistence | All | High-use | Average-Use |
| Study 4: Current Study Submitted 2017 | | | | | | |
| Sample Size | 1,507 | 9,374 | 3,796 | 14,733 | 7,211 | 8,985 |
| Average Daily Treatment kWh Savings | 1.75* | 0.86* | 0.76* | 0.91* | 1.21* | 0.36* |
| Average Daily Treatment % Savings | 3.62%* | 1.79%* | 1.57%* | 1.88%* | 2.54% | 1.64% |
| Average Daily Post-Treatment kWh Savings Apr. 2012 to Jul. 2013 | 1.49* | 0.83* | 0.75* | 0.88* | N/A | N/A |
| Average Daily Post-Treatment % Savings Apr. 2012 to Jul. 2013 % | 3.70%* | 2.06%* | 1.86%* | 1.82%* | N/A | N/A |
| Average Daily Post-Treatment kWh Savings Aug. 2013 to Nov. 2014 kWh | 0.71 | 0.61* | 0.09 | 0.48* | N/A | N/A |
| Average Daily Post-Treatment % Savings Aug. 2013 to Nov. 2014 % | 1.66% | 1.27%* | 0.23% | 0.99%* | N/A | N/A |
| Average Daily Post-Treatment kWh Savings Dec. 2014 to July 2016 kWh | 0.96 | 0.35 | 0.08 | 0.57 | N/A | N/A |
| Average Daily Post-Treatment % Savings Dec. 2014 to July 2016 % | 1.96% | 0.70% | 0.16% | 1.20% | N/A | N/A |

* Statistical significant at the 0.1 level.

¹ Studies include: 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>

NMR Group, Inc. 2016. *R32 Evaluation of Persistence in the Eversource Customer Behavior Program (R32)*. Available at

http://www.energizect.com/sites/default/files/R32%20-%20Persistence%20of%20Eversource%20HER%20Pgm_Final%20Report%2C%203.30.16.pdf

² Includes high-use continued group

³ Treatment continued for eight months only; total savings for January 2011 through March 2012 was 0.52 daily kWh (1.06%) per household.

B

Appendix B Additional Comparisons of Savings by Treatment Group Under Various Scenarios

The tables below continue the exploration started in [Optimal Program Delivery Scenarios](#), particularly Table 9, but vary the assumed degradation rate. While Table 9 relied on annual degradation rates, Table 21 turns to the average degradation rates, Table 22 the low degradation rate identified in the literature, and Table 23 the high degradation rate identified in the literature.

Table 21: Comparison of Savings by Treatment Group Under Different Program Delivery Scenarios
(Average Annual Degradation Rate by Treatment Group)

| | High-use Discontinued | | | | Continued | |
|--|-----------------------|-----------------|--------------------------|-----------------|-----------|-------------|
| | Monthly ¹ | Quarterly | Persistence ¹ | Overall | High Use | Average Use |
| Actual Conditions through Five Years | | | | | | |
| Year 1 savings kWh per household (HH) | 849 | 417 | 369 | 388 | 437 | 81 |
| Year 2 savings (% of Yr1) | 82% | 68% | 64% | 79% | 84% | 126% |
| Year 3 savings (% of Yr1) | 77% | 56% | 50% | 67% | 113% | 173% |
| Year 4 savings (% of Yr1) | NS ² | 56% | NS ² | 50% | 108% | 122% |
| Year 5 savings (% of Yr1) | NS ² | NS ² | NS ² | NS ² | 102% | NA |
| Total Cumulative Savings | 2,195 | 1,053 | 789 | 1,095 | 2,214 | 422 |
| Cost/household for treatment | \$7.55 | \$7.55 | \$7.55 | \$7.55 | \$59.67 | \$52.53 |
| Single Year of Reports, No Persistence Considered | | | | | | |
| Achieved Savings | 849 | 417 | 369 | 388 | 437 | 81 |
| Cost / kWh Achieved | \$0.009 | \$0.018 | \$0.020 | \$0.019 | \$0.017 | \$0.154 |

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| | High-use Discontinued | | | | Continued | |
|--|-----------------------|-----------|--------------------------|---------|-----------|-------------|
| | Monthly ¹ | Quarterly | Persistence ¹ | Overall | High Use | Average Use |
| Single Year of Reports / One Year No Report | | | | | | |
| Achieved Savings | 1,600 | 734 | 646 | 713 | 802 | 149 |
| Cost / kWh Achieved | \$0.005 | \$0.011 | \$0.012 | \$0.011 | \$0.010 | \$0.086 |
| Percent of \$/kWh compared to similar years of continual treatment | 20% | 44% | 47% | 43% | 39% | 63% |
| Percent of kWh compared to similar years of continual treatment | 93% | 87% | 87% | 91% | 91% | 76% |
| Single Year of Reports / Three Years No Report | | | | | | |
| Achieved Savings | 2,351 | 1,368 | 923 | 1,362 | 1,533 | 284 |
| Cost / kWh Achieved | \$0.003 | \$0.008 | \$0.009 | \$0.007 | \$0.006 | \$0.055 |
| Percent of \$/kWh compared to similar years of continual treatment | 14% | 30% | 35% | 28% | 24% | 44% |
| Percent of kWh compared to similar years of continual treatment | 68% | 81% | 62% | 87% | 87% | 67% |
| Two Years of Reports / Two Years No Report | | | | | | |
| Achieved Savings | 3,214 | 1,475 | 1,298 | 1,431 | 1,612 | 299 |
| Cost / kWh Achieved | \$0.007 | \$0.015 | \$0.017 | \$0.015 | \$0.013 | \$0.089 |
| Percent of \$/kWh compared to similar years of continual treatment | 25% | 57% | 67% | 57% | 51% | 71% |
| Percent of kWh compared to similar years of continual treatment | 94% | 87% | 87% | 91% | 91% | 71% |
| Two Years of Reports / Three Years No Report | | | | | | |
| Achieved Savings | 3,214 | 1,792 | 1,298 | 1,756 | 1,977 | 367 |
| Cost / kWh Achieved | \$0.007 | \$0.014 | \$0.017 | \$0.013 | \$0.012 | \$0.080 |
| Percent of \$/kWh compared to similar years of continual treatment | 24% | 50% | 64% | 50% | 44% | 65% |
| Percent of kWh compared to similar years of continual treatment | 62% | 71% | 58% | 75% | 75% | 59% |

¹ Results reflect that this group exhibited statistically significant savings for only two-years post-treatment.

² Savings not statistically different from the control group.

Table 22: Comparison of Savings by Treatment Group Under Different Program Delivery Scenarios
(Literature Low Degradation Rate)

| | High-use Discontinued | | | | Continued | |
|--|-----------------------|-----------------|--------------------------|-----------------|-----------|-------------|
| | Monthly ¹ | Quarterly | Persistence ¹ | Overall | High Use | Average Use |
| Actual Conditions through Five Years | | | | | | |
| Year 1 savings kWh per household (HH) | 849 | 417 | 369 | 388 | 437 | 81 |
| Year 2 savings (% of Yr1) | 82% | 68% | 64% | 79% | 84% | 126% |
| Year 3 savings (% of Yr1) | 77% | 56% | 50% | 67% | 113% | 173% |
| Year 4 savings (% of Yr1) | NS ² | 56% | NS ² | 50% | 108% | 122% |
| Year 5 savings (% of Yr1) | NS ² | NS ² | NS ² | NS ² | 102% | NA |
| Total Cumulative Savings | 2,195 | 1,053 | 789 | 1,095 | 2,214 | 422 |
| Cost/household for treatment | \$7.55 | \$7.55 | \$7.55 | \$7.55 | \$59.67 | \$52.53 |
| Single Year of Reports, No Persistence Considered | | | | | | |
| Achieved Savings | 849 | 417 | 369 | 388 | 437 | 81 |
| Cost / kWh Achieved | \$0.009 | \$0.018 | \$0.020 | \$0.019 | \$0.017 | \$0.154 |
| Single Year of Reports / One Year No Report | | | | | | |
| Achieved Savings | 1,605 | 788 | 697 | 733 | 826 | 153 |
| Cost / kWh Achieved | \$0.005 | \$0.011 | \$0.012 | \$0.011 | \$0.010 | \$0.086 |
| Percent of \$/kWh compared to similar years of continual treatment | 20% | 44% | 47% | 43% | 39% | 63% |
| Percent of kWh compared to similar years of continual treatment | 94% | 94% | 94% | 94% | 94% | 79% |
| Single Year of Reports / Three Years No Report | | | | | | |
| Achieved Savings | 2,360 | 1,530 | 1,026 | 1,424 | 1,604 | 297 |
| Cost / kWh Achieved | \$0.003 | \$0.008 | \$0.009 | \$0.007 | \$0.006 | \$0.055 |
| Percent of \$/kWh compared to similar years of continual treatment | 14% | 30% | 35% | 28% | 24% | 44% |
| Percent of kWh compared to similar years of continual treatment | 69% | 91% | 69% | 91% | 91% | 70% |

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| | High-use Discontinued | | | | Continued | |
|--|-----------------------|-----------|--------------------------|---------|-----------|-------------|
| | Monthly ¹ | Quarterly | Persistence ¹ | Overall | High Use | Average Use |
| Two Years of Reports / Two Years No Report | | | | | | |
| Achieved Savings | 3,223 | 1,583 | 1,401 | 1,473 | 1,659 | 307 |
| Cost / kWh Achieved | \$0.007 | \$0.015 | \$0.017 | \$0.015 | \$0.013 | \$0.089 |
| Percent of \$/kWh compared to similar years of continual treatment | 25% | 57% | 67% | 57% | 51% | 71% |
| Percent of kWh compared to similar years of continual treatment | 94% | 94% | 94% | 94% | 94% | 73% |
| Two Years of Reports / Three Years No Report | | | | | | |
| Achieved Savings | 3,223 | 1,954 | 1,401 | 1,818 | 2,048 | 380 |
| Cost / kWh Achieved | \$0.007 | \$0.014 | \$0.017 | \$0.013 | \$0.012 | \$0.080 |
| Percent of \$/kWh compared to similar years of continual treatment | 24% | 50% | 64% | 50% | 44% | 65% |
| Percent of kWh compared to similar years of continual treatment | 63% | 77% | 63% | 77% | 77% | 62% |

¹ Results reflect that this group exhibited statistically significant savings for only two-years post-treatment.

² Savings not statistically different from the control group.

Table 23: Comparison of Savings by Treatment Group Under Different Program Delivery Scenarios
(Literature High Degradation Rate)

| | High-use Discontinued | | | | Continued | |
|---|-----------------------|-----------------|--------------------------|-----------------|-----------|-------------|
| | Monthly ¹ | Quarterly | Persistence ¹ | Overall | High Use | Average Use |
| Actual Conditions through Five Years | | | | | | |
| Year 1 savings kWh per household (HH) | 849 | 417 | 369 | 388 | 437 | 81 |
| Year 2 savings (% of Yr1) | 82% | 68% | 64% | 79% | 84% | 126% |
| Year 3 savings (% of Yr1) | 77% | 56% | 50% | 67% | 113% | 173% |
| Year 4 savings (% of Yr1) | NS ² | 56% | NS ² | 50% | 108% | 122% |
| Year 5 savings (% of Yr1) | NS ² | NS ² | NS ² | NS ² | 102% | NA |

R1606 EVERSOURCE BEHAVIOR PROGRAM PERSISTENCE EVALUATION

| | High-use Discontinued | | | | Continued | |
|--|-----------------------|-----------|--------------------------|---------|-----------|-------------|
| | Monthly ¹ | Quarterly | Persistence ¹ | Overall | High Use | Average Use |
| Total Cumulative Savings | 2,195 | 1,053 | 789 | 1,095 | 2,214 | 422 |
| Cost/household for treatment | \$7.55 | \$7.55 | \$7.55 | \$7.55 | \$59.67 | \$52.53 |
| Single Year of Reports, No Persistence Considered | | | | | | |
| Achieved Savings | 849 | 417 | 369 | 388 | 437 | 81 |
| Cost / kWh Achieved | \$0.009 | \$0.018 | \$0.020 | \$0.019 | \$0.017 | \$0.154 |
| Single Year of Reports / One Year No Report | | | | | | |
| Achieved Savings | 1,520 | 746 | 661 | 695 | 782 | 145 |
| Cost / kWh Achieved | \$0.005 | \$0.011 | \$0.012 | \$0.011 | \$0.010 | \$0.086 |
| Percent of \$/kWh compared to similar years of continual treatment | 20% | 44% | 47% | 43% | 39% | 63% |
| Percent of kWh compared to similar years of continual treatment | 89% | 89% | 89% | 89% | 89% | 74% |
| Single Year of Reports / Three Years No Report | | | | | | |
| Achieved Savings | 2,190 | 1,405 | 952 | 1,308 | 1,473 | 273 |
| Cost / kWh Achieved | \$0.003 | \$0.008 | \$0.009 | \$0.007 | \$0.006 | \$0.055 |
| Percent of \$/kWh compared to similar years of continual treatment | 14% | 30% | 35% | 28% | 24% | 44% |
| Percent of kWh compared to similar years of continual treatment | 64% | 83% | 64% | 83% | 83% | 65% |
| Two Years of Reports / Two Years No Report | | | | | | |
| Achieved Savings | 3,053 | 1,500 | 1,327 | 1,395 | 1,571 | 291 |
| Cost / kWh Achieved | \$0.007 | \$0.015 | \$0.017 | \$0.015 | \$0.013 | \$0.089 |
| Percent of \$/kWh compared to similar years of continual treatment | 25% | 57% | 67% | 57% | 51% | 71% |
| Percent of kWh compared to similar years of continual treatment | 89% | 89% | 89% | 89% | 89% | 69% |
| Two Years of Reports / Three Years No Report | | | | | | |
| Achieved Savings | 3,053 | 1,829 | 1,327 | 1,702 | 1,917 | 355 |
| Cost / kWh Achieved | \$0.007 | \$0.014 | \$0.017 | \$0.013 | \$0.012 | \$0.080 |

R1606 EVERSOURCE BEHAVIOR PROGRAM PERSISTENCE EVALUATION

| | High-use Discontinued | | | | Continued | |
|--|-----------------------|-----------|--------------------------|---------|-----------|-------------|
| | Monthly ¹ | Quarterly | Persistence ¹ | Overall | High Use | Average Use |
| Percent of \$/kWh compared to similar years of continual treatment | 24% | 50% | 64% | 50% | 44% | 65% |
| Percent of kWh compared to similar years of continual treatment | 59% | 72% | 59% | 72% | 72% | 58% |

¹ Results reflect that this group exhibited statistically significant savings for only two-years post-treatment.

² Savings not statistically different from the control group.