1606 Eversource Behavior Program Persistence Evaluation

FINAL

October 15, 2017

SUBMITTED TO:
Energy Efficiency Board Evaluation Adminstrator Consultants

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Abstract

This project (R1606) estimates energy savings and the persistence of savings from Eversource Energy's Home Energy Reports (HERs) program. The study provides results for four years following cession of reports, and accumulates the results from previous studies to provide a complete accounting program savings. In addition, this project calculates the cost effectiveness of the program and suggests optimal program delivery scenarios. This report updates the results of three previous studies estimating energy savings, and tracks changes in savings in successive years for households that stopped receiving energy reports. The program induced statistically significant savings during the treatment period and for two to three years post-treatment. First-year savings after energy report discontinuation for the high-use customer groups are consistent with those found in the literature (1.6-3.6%, depending on cohort). The measured savings from all discontinued groups decreased over time. This study finds the average decrease in kWh savings over time is about 12-26% per year, averaged across the three years after treatment. Savings do not continue for a fourth year for any group. The implied "measure lifetime" estimated for this behavioral program is approximately three years (2.7 years – 3.3 years, depending on the assumptions made). The study finds that cycling report delivery across households offers a cost effective alternative program delivery model that yields comparable or better savings than continual report delivery. The table presented on the next page summarizes the accumulated results from the four studies of the HERs Pilot Program.

Summary of Accumulated Findings Across Four Studies

		High-Use Households					Average-Use Households	High-Use Households	Average-Use Households
		Monthly Discontinued n=1,507	Qtly Discontinued n=9,374	Persistence discontinued n=3,796	Discontinued overall n=14,733	Monthly Continued Extension n=7,211	Monthly contined expansion n=8,966	High-use control n=8,779	Average-use control n=9,963
	Participation Dates	1/11-4/12	1/11-4/12	1/11-8/11	Varied	1/11-12/16	7/12-12/16	N/A	N/A
	Report Frequency	Monthly	Quarterly	Monthly	Varied	Monthly	Monthly	N/A	N/A
Monthly kWh usage	pre-program	1,611	1,601	1,595	1,576	1,606	712	1,599	721
	4 yr pre-end	N/A	N/A	N/A	N/A	1,407		1,432	
	3 yr pre-END	N/A	N/A	N/A	N/A	1,462	720	1,479	689
	2 yr pre-END	N/A	N/A	N/A	N/A	1,519	678	1,555	691
	1 YR pre-end H	1,478	1,488	1,489	1,481	1,434	671	1,517	730
	TREATMENT	1,482	1,489	1,490	1,485	1,487	675		691
	1 yr post	1,427	1,505	1,506	1,493	N/A	N/A	1,517	N/A
	2 yrs post	1,519	1,545	1,546	1,540	N/A	N/A	1,555	N/A
	3 yrs post	1,441	1,479	1,481	1,475	N/A	N/A	1,479	N/A
	4 yrs post (not a full 12 months)	1,334	1,357	1,353	1,352	N/A	N/A	1,432	N/A
Avg. Daily kWh savings	4 yr pre-end	N/A	N/A	N/A	N/A	438	N/A		
	3 yr pre-END	N/A	N/A	N/A	N/A	434	95		
	2 yr pre-END	N/A	N/A	N/A	N/A	445	102		
	1 YR pre-end H	639	314	277	332	442	131		
	TREATMENT	639	314	277	332	442	131		
	1 yr post	544	303	274	321	N/A	N/A		
	2 yrs post	-	223	-	175	N/A	N/A		
	3 yrs post	-	-	-	-	N/A	N/A		
	4 yrs post (not a full 12 months)	-	-	-	-	N/A	N/A		
Degradation Rate	1 yr post	18%	32%	36%	21%				
	2 yrs post	5%	12%	14%	12%				
	3 yrs post	No Savings	28%	No Savings	34%				
Smoothed Degradation	Avg. yearly rate	12%	24%	25%	21%				
Estimated	Based on Stat. Sig. Findings	2.00	2.50	2.10	2.70				
Implied Lifetime Multiplier	Calculated based on decay and attrition	2.28	3.80	2.70	3.30				

ES Executive Summary

The objective of this project (R1606) was to estimate the remaining energy savings from the Eversource Home Energy Reports (HERs) program four years after the program stopped delivering his project (please refer to the Abstract for a full accounting of the accumulated findings of the current study and the prior three studies). It also explored cost effectiveness and optimal program delivery. The report added these results to the series of three previous reports to examine the persistence and derive a measure lifetime for this behavioral program.[1]

PROGRAM AND COHORT OVERVIEW

The Home Energy Reports (HERs) pilot program randomly selects residential customers to be sent paper reports rating their energy use. The reports, implemented by OPower, compare the energy use of receiving customers to that of neighbors (similar households) and suggest ways for the households to save energy.

Since its inception, the pilot program has had various cohorts. At its start in January 2011 the program randomly selected customers with high electricity consumption ("high-use"), and in its second year added randomly selected customers with average levels of electricity consumption ("average-use"). The cohorts of households that received reports are called *treatment groups*.

Three of the treatment groups stopped receiving reports eight to fourteen months after receiving the first letter, while two continued to receive reports through 2016. Households who stopped receiving reports are referred to as discontinued groups (all discontinued groups are high-use customers), while the other two groups are called continued households. One continued group is high-use, while the other is average-use. The program also created comparable control groups composed of household that did not receive reports. The control groups provide baseline electricity use estimates.

The study estimates electricity savings using billing analysis. The billing analysis compares energy use of treatment groups with control groups. The report examines savings during the treatment period and after households stop receiving energy reports. The study explores cost effectiveness and optimal program delivery methods. Using the results of the billing analysis and program budgets, the study calculates the expenditures per kWh saved and explores ways to maximize savings and cost effectiveness and reach additional customers.

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[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

ELECTRICITY SAVINGS

On average, high-use discontinued households continued to save significant energy for either two or three years after the program stopped sending them reports (see Figure 1). The variation in persistence among discontinued groups is largely an artifact of the sample size (i.e., statistical power) and length of treatment (eight months versus one year).

High-use continued and average-use continued households saved electricity the entire time they received reports. High-use continued households showed savings for the five years they received reports, while average-use savings showed savings for the four years they received reports. The percentage of savings and overall savings are lower for average-use households.

SAVINGS RAMP-UP AND DEGRADATION

High-use continued groups exhibited an average ramp-up rate of 2%. Ramp-up rates reflect the increase in savings associated with multiple years of treatment. A ramp-up rate of 2% means that over the five years they received reports, high-use continued groups saw their savings increase that much each year compared to the baseline control group. Most of the ramp-up occurred in the first three years of treatment, then leveled off. (See Figure 4 in main body of the report.)

The average ramp-up rate for average-use continued groups was 40%, but it varied year to year. Because they achieved smaller percentage and kWh savings than high-use groups, it took the average-use group four full years of treatment to accumulate the same energy savings as the high-use groups did in one year of treatment.

High-use discontinued households saw their savings decline an average of 21% per year, over three years. Degradation rates (also referred to as decay rates in the literature) measure the degree to which savings diminish post-treatment, relatively to the baseline control group. Degradation rates varied among the high-use discontinued treatment groups. Households that received reports quarterly had a 24% degradation rate, while those who received them monthly for a full year had a 12% degradation rate (see Table 1).

The estimated measure life of program savings is estimated to be between 2.7 and 3.3 years. This is considerably longer than the treatment period for discontinued groups, which ranged from 8 to 14 months. After about three years, the energy use of the discontinued high-use groups returned to levels that were statistically similar to the control group. Put another way, the discontinued high-use groups may still have used less electricity but the difference was not enough to be captured by common statistical tests (see Table 2).

PROGRAM COST-EFFECTIVENESS AND OPTIMAL DELIVERY SCENARIOS

The cost per kWh saved is far lower for discontinued high-use households than for either continued high-use or continued average-use households. The program spends less than one cent for each kWh saved by discontinued high-use households, including both

their active treatment and post-treatment persistence savings. In contrast, the program spends about three cents for each kWh saved by continued high-use households and 12 cents for each kWh saved by continued average-use households.

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 simultaneously.

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. The critical findings are as follows:

- **Cycling cohorts can maximize savings, provide greater cost effectiveness, and touch a greater number of customers.** The cycles that perform the best involve treating successive groups for one year each and banking multiple years of the persistence savings. As long as the design involves rotating reports among different groups of households, this approach has the potential to achieve greater savings than treating one group of households for the same length of time.
- **Average-use households exhibit mixed results from cycling.** This largely reflects the high 40% ramp-up rate, which exceeds the post-treatment savings rates.

EVERSOURCE AND IMPLEMENTER CONCERNS

The implementer and Eversource voiced concerns about the cycling approach, as summarized below, with evaluation team responses:

- **Cycling may lead to avoided cost in implementation but increases analytic costs.** Such costs must be taken into consideration in a more thorough cost-effectiveness analysis. However, the extra evaluation costs would not be expected to be high, and the savings from cycling should cover the costs. The evaluation budget accounts for about 1.35% of Connecticut's Conservation and Load Management budget. The program savings from cycling are substantially higher than this percentage. This latest program evaluation update cost less than 1% of the program's costs, and falls far below the 115% cost savings that could be gained by a one-year on/three-year off cycle.
- **Cycling could lead to a disjointed customer experience that may engender negative associations.** The Year 2 evaluation results showed no evidence of negative associations with the HERs program among customers who experienced a four-month hiatus.[2]
- **Touching more customers would require reaching out to lower users who save less, leading to a decrease in overall cost-effectiveness.** Although expanding the program to low-use customers does not make programmatic sense, the current

[2] 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

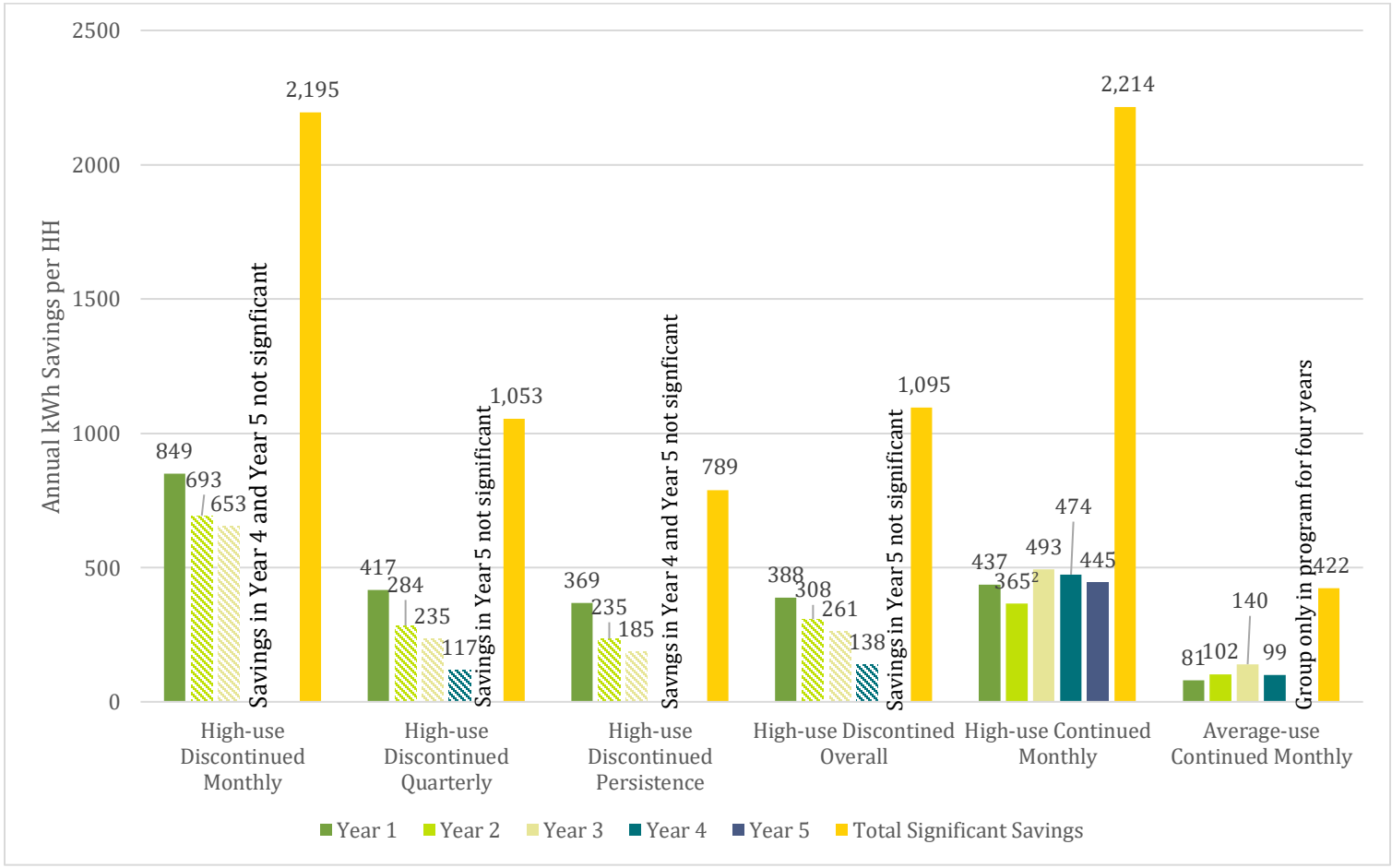
program sends reports to over 300,000 households, offering ample opportunity for an experimental cycling schedule.

- **Eversource would lose the ability to market other energy efficiency programs through HERs tips and messaging.** Previous evaluations have shown that the HERs provide a small boost in customer engagement in Home Energy Solutions and adoption of insulation, but Eversource's highly successful marketing campaigns reach customers regardless of their inclusion or exclusion from the HERs program.[3]

[3] HES participation among the treatment and control groups were significantly different, with treatment HES participation of 4.7% and control HES participation of 4.0%. The active behavioral high-use treatment group adopted insulation at a statistically higher rate when compared to the control group—7.9% vs. 7.1%. 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. 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

Figure 1: Annualized Savings in kWh per Household, by Treatment Group[1]

(Based on Billing Analysis, sample sizes reported in Table 6)



[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.

Table 1: Post-treatment Savings Degradation for High-use Discontinued Groups

Group and sample size	Report frequency	Treatment Months	Year post retained savings				Average yearly degradation
			1	2	3	4	
Monthly (1,507)	Monthly 1/11-4/12	16 reports, 16 months	82%	77%	0%	0%	12%
Quarterly (9,374)	Quarterly 1/11-4/12	~5 reports, 16 months	68%	56%	28%	0%	24%
Persistence (3,796)	Monthly 1/11-8/11	8 reports, 8 months	64%	56%	0%	0%	25%
Overall Discontinued (14,733)	varies	varies	79%	67%	36%	0%	21%

Table 2: Post-treatment Persistence for High-use Discontinued Groups

Group and sample size	Report frequency	Treatment Months	EUL based on modeled statistically significant savings[1]	Implied lifetime multiplier[2]
Monthly (1,507)	Monthly 1/11-4/12	16 reports, 16 months	2	2.28
Quarterly (9,374)	Quarterly 1/11-4/12	~5 reports, 16 months	2.5	3.8
Persistence (3,796)	Monthly 1/11-8/11	8 reports, 8 months	2.1	2.7
Overall Discontinued (14,733)	varies	varies	2.7	3.3

[1] Model significance based on 90/10 confidence and error levels.

[2] Implied Lifetime Multiplier=first year savings/[(Annual degradation rate-Annual participant attrition)-(Annual degradation rate * Annual participant attrition)]

CONCLUSIONS AND RECOMMENDATIONS

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

- **Recommendation 1: Consider conducting deeper investigation into cycling's cost effectiveness.** This study assessed cost-effectiveness using a very simple approach—the lifetime 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: The HERs program should cease sending reports to a random selection high-use and average-use continued groups from the pilot study.** This will allow the program to examine the degradation rates of their savings after multiple years of treatment to inform long-term program design and provide estimates of associated program lifetime.

Eversource and OPower expanded the program in 2014, adding 300,000 households to the program. These program changes inform the third and fourth recommendation.

- **Recommendation 3: Experiment with cycling for new participants.** Because savings vary substantially by pre-program energy use, Eversource should examine whether a targeted cycling approach within the existing 300,000 HERs participants could benefit the utility and ratepayers. For example, the program could cycle high-use households (who achieve higher percentage and kWh savings) but treat average-use households continuously (due to lower percentage and kWh savings). This targeted cycling approach may allow such a design to achieve high cost effectiveness and maximize overall savings under a constant (or reduced) program budget.
- **Recommendation 4: Integrate cycling into a revised program design.** 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 taken into account). Based on earlier evaluation results, renegotiated programs should also require greater utility control over customer selection and, from an evaluation transparency standpoint, greater control over control groups and other evaluation elements.

The current analysis demonstrates that cycling may be more cost-effective and maximize savings compared to continual treatment, thus freeing up funding for other programs that can deliver additional savings**.** Ultimately, the decision of whether Eversource opts for cycling may depend on the costs relative to other programs and interpretations of the directives in Connecticut law to pursue all cost-effective savings.

1 Section 1 Introduction

This report updates findings from three prior evaluations of the Home Energy Reports (HERs) Pilot Program (the program) implemented for Eversource by OPower, a subsidiary of Oracle.[4,5] The study is the latest in a series of four that have examined the treatment and persistence savings of households included in the HERs pilot. It analyzes the latest results and incorporates those from previous studies, accumulating the results from previous studies to provide a complete picture of retention for the HERs pilot program. This study only includes the households that first received reports in the pilot programs that started in January 2011 and July 2012. Some cohorts continued to receive reports through 2016. Because the program and evaluation histories are essential to understanding the current study outcome and objectives, the history of the current study, referred to as R1606, and the previous report results are summarized below.

1.1 Program and Evaluation History

The HERs Pilot 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. They then sampled households from among these customers and randomly assigned them to either a treatment or control group. The treatment group received paper reports that rated their energy use, compared it to a similar 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).[6,7] Table 3 summarizes the known starts and stops for various treatment groups.

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[4] 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

[5] Oracle purchased OPower in May 2016 (https://opower.com/oracle/). This report will continue to refer to the implementer as OPower.

[6] Connecticut Electric and Gas Utilities. 2014. *2014 Annual Update of the 2013-2015 Electric and Natural Gas Conservation and Load Management Plan*.

[7] Eversource has explained that OPower randomly assigns the HES and HES-IE participants into treatment and control groups to avoid double-counting of savings among HES participants receiving HERs.

This study includes only the Year 1 and Year 2 Pilot households listed in the first three 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 3: HERs Paper Report Program Treatment Timeline

Treatment Group	Jan. 2011 (Year 1)	March 2012	Jul. 2012 (Year 2)	PY 2014	Status Late 2016	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

The Connecticut Energy Efficiency Board (EEB) conducted three prior studies of the Eversource HERs Pilot Program[8]. Table 4 summarizes the studies completed to date, including the findings most relevant to R1606. These prior evaluations 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 in late 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.

1.2 Study Outcome and Objectives[9]

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:

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 total program-induced savings (treatment period plus any persistence savings) for high-use discontinued households, high-use continued households, and average-use continued households to determine the effectiveness of length of treatment and pre-program use on retention.[10]

[8] The United Illuminating Company also started a HERs Pilot program in 2012. The UI Pilot sent paper HERs reports to 6,060 customers. The Pilot process evaluation performed after the first year of treatment can be found at https://www.energizect.com/sites/default/files/UI%20Behavior%20Report%20FINAL(1).pdf. According to the 2016 to 2018 Conservation and Load Management Plan, UI also launched a broader HERs program in 2015. However, neither this program nor the expanded Eversource program have undergone third-party evaluation.

[9] 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 fulfilment of this objective. It also means that the study is unable to assess alternative program delivery scenarios for average-users, as all average-users in the Year 2 pilot still receive reports.

[10] The definitions of "high-use" or "average-use" were used as a means of identification by OPower for customers in the study, and Eversource does not segment CT residential customers based on usage. As a rough benchmark, average consumption is around 8500 kWh/year, and the top quartile is roughly in the 11,000 - 12,000 kWh and above.

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.

Table 4: Evaluation Studies Completed to Date[1]

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

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

[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

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:[11]

- **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 is very little 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. The literature sometimes calls this the decay rate.
- **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 or ramp-up rate**: 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.

[11] 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 the 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:[12]

- **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 named by OPower and Eversource. The study design sought to determine Year 1 program savings for the 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

[12] The sample sizes presented here represent those at the start of the pilot program who only received paper reports through the program. The sample has experienced attribution due some of the accounts having service disconnected since they first received reports. More recent iterations of the program include households that receive reports electronically only, but the evaluation does not address the more recent program.

mixture of program design, when they received their first and (if applicable) last reports, and the timing of the evaluations. **To provide consistency with prior reporting, the 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.[13] The data span from January 1, 2010, through July 2016.[14]

The billing analysis relied on ordinary least squares (OLS) robust regression. This technique ensures that the method does not over-estimate or under-estimate treatment effects that reflect any imbalances in pre-program electricity 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:

> Estimated Average Electricity Savings=β_0(Avg. Post-Treatment Electricity Use)+ β_1(Dichotomous Treatment)+ β_2 (Avg. Pre-Treatment Electricity Use)+ β_3 (Dichotomous Electric Heat)+ β_4 (Heating Degree Days)+ β_5 (Cooling Degree Days)[15]

The study estimated and developed the following:

- **Annual Retention and Degradation Rates.** 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 5 shows the various study groups, type of savings, and periods of analysis.
- **Cost effectiveness.** 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 for the post-treatment period and combined treatment and post-treatment period for the high-use discontinued groups. Given that Eversource

[13] Accessed at http://www7.ncdc.noaa.gov/CDO/cdoselect.cmd?datasetabbv=GSOD&countryabbv=&georegionabbv=
[14] January 2010 allows for the inclusion of at least one full year of pre-program data for all households.
[15] 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.

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.

- **Alternative Program Design.** 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 and *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. This included drawing on the broader literature and the results of the HERs pilot study.

Table 5: Study Groups and Periods of Savings in Current Analysis[1]

	Treatment Groups						Control Groups	
	Discontinued				Continued			
	Monthly	Quarterly	Persistence	All	High-use	Average-Use[2]	High-use[3]	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 because 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 report presents four sets of interrelated results: 1) **Electricity savings** for all five treatment groups, including the 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); 2) **Benchmarking of the degradation rates** against other studies of similar programs; 3) **Cost-effectiveness**, which is measured simply as the ratio of cost per kWh saved; and 4) **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

2.1.1 Key Findings

The program induced statistically significant savings during the treatment period, and for discontinued households, for two to three years post-treatment. However, savings varied across treatment groups.[16] Table 6 summarizes the daily electricity savings in kWh. Key findings drawn from the table are as follows:

- High-use households saved a greater percentage of energy than average-use households.
- High-use discontinued monthly households had the highest energy savings of all groups. These households saved 45% more kWh per day than high-use continued monthly households and more than the other two high-use discontinued groups.[17].
- Among high-use discontinued households, those that received reports for a full year (monthly and quarterly groups) saved more than those households that received them for only eight months (persistence).

Percentage savings tended to increase over time for continued households, while savings degraded post-treatment for all discontinued households. Figure 2 presents the average daily savings in kWh per household for each treatment group. Some of the key findings suggested by the figure include the following:

- Average daily savings in kWh declined for all discontinued high-use groups during the two-to-three year period post-treatment when they still achieved statistically significant savings, with the discontinued persistence group (only eight months of reports) experiencing the most rapid decline.

[16] 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.
[17] They also had the highest pre-program use compared to all of the other study groups. Note that the greater pre-program use and savings could be due to noise in the data given the small sample size of the high-use discontinued monthly group

- Daily savings in kWh remained somewhat stable over time for high-use households that continued to receive reports for multiple years, but increased each year for average-use continued households.
- 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 total program-induced savings—comprising one year of treatment and two years post-treatment—was nearly the same as the program-induced savings achieved by the high-use continued monthly group over five years of treatment (2,195 kWh vs. 2,214 kWh, respectively). Table 7 and Figure 3 annualize the savings for each group over time, with the following key findings:

- Both the high-use continued and average-use continued treatment households experienced their highest savings in the third year of treatment; savings diminished in the fourth and fifth year of treatment.
- High-use continued households reached a high annual savings of 493 kWh per year, while average-use continued households saved a high of 140 kWh per year.

High-use discontinued households saw 61% of their treatment savings persist three years after treatment. Figure 4 presents the percentage of annual savings retained by each group relative to their treatment or first year savings. Additional key results include the following:

- The high-use discontinued monthly group retained 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.
- 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).
- At an average of 40%, the ramp up rate for average-use continued households was particularly steep. Yet, it took four years of continual treatment with a 40% average ramp up rate for average-use households to achieve similar savings to one year of treatment for high-use groups.
- Savings for high-use continued households ramped up at an average of 2% when including a report hiatus period in the second year of treatment. Excluding the hiatus period, the ramp-up rate was 8% for these households.

The average degradation rate was 21% relative to the savings achieved the prior year. The measure life of savings is about three years. Table 7 summarizes the degradation rates and measure life estimates among high-use discontinued groups relative to the prior year's savings.

- Average annual degradation varied from 12% over two years for the high-use discontinued monthly group to 24% over three years for the high-use discontinued quarterly group.
- The calculated overall EUL is 2.7 years. A less statistically rigorous alternative methodology, the Implied Lifetime Multiplier (ILM), suggests an average ILM of 3.3 years. This approach considers annual degradation and attrition rates.

2.1.2 Tables and Graphs

Table 6 summarizes energy savings for all treatment groups across the four EEB HERs pilot program studies, including the current one. Table 7 presents the annualized percentage savings for the groups. In each table, shading denotes that the group was under treatment during the specified period. The sample sizes in Table 6 and Table 7 also apply to Figure 2 through Figure 4.

Figure 2 graphs the daily kWh savings and statistically significant percentage savings by study period for each group. The solid bars represent treatment periods for each continued and discontinued group, while the hashed bars represent post-treatment periods for each discontinued group.

Figure 3 presents the annual savings per household for all treatment groups. The solid bars for each year represent treatment periods, while the hash bars for each year represent post-treatment periods.

Figure 4 shows the retention of savings relative to the first year of treatment for each of the treatment groups, with the solid bars and hash bars for each year representing treatment and post-treatment periods.

Table 8 presents the annual and average savings degradation rates and length of statistically significant persistence savings for each of the high-use discontinued treatment groups.

Table 6: Daily Energy Savings in kWh and Percent by Treatment Group Across Studies

	Sample Size[2]	Pre-program Energy Use (monthly)	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. Table 16 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.

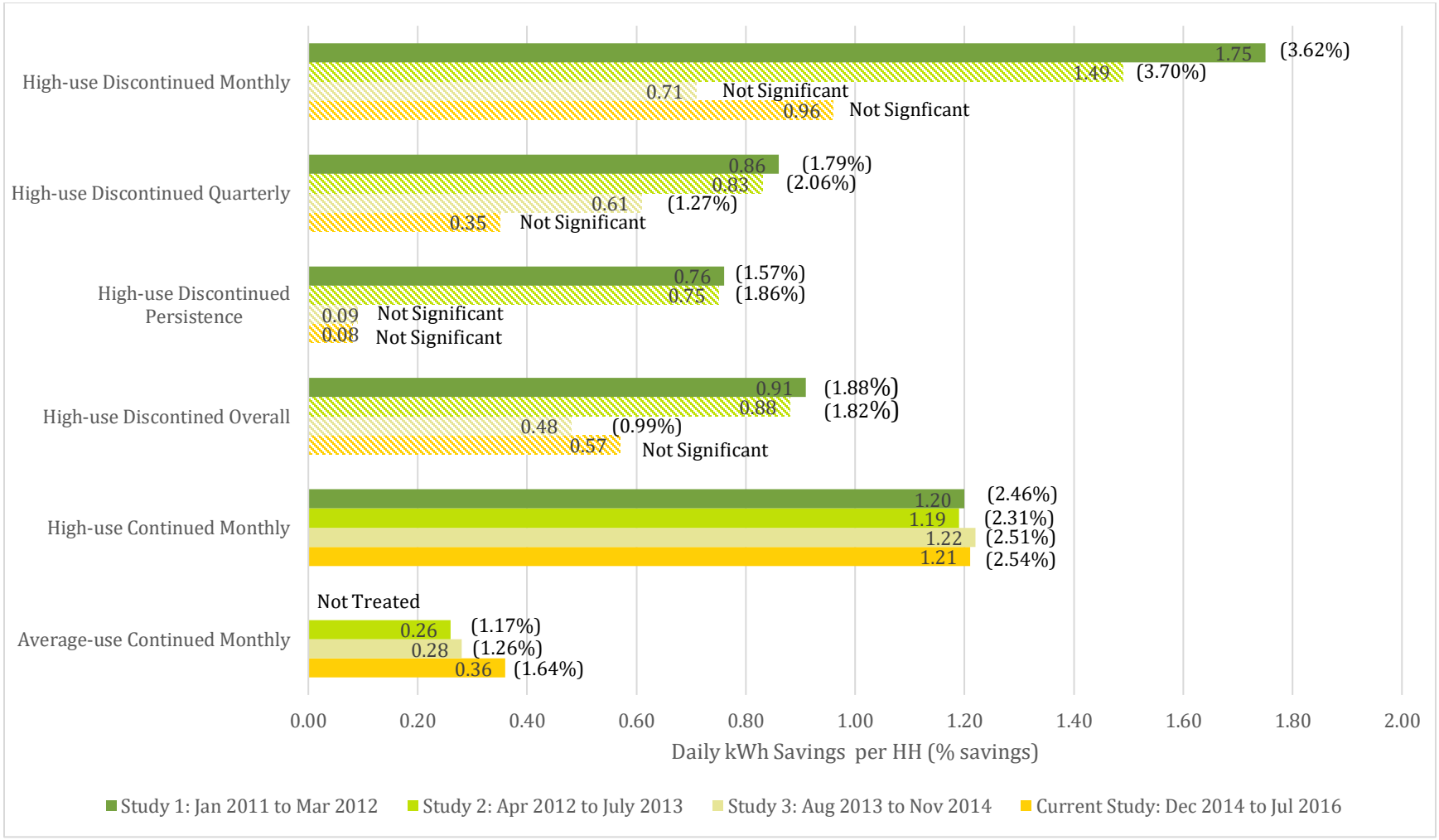
Table 7: Annualized Daily Percent Savings by Treatment Group

	Sample Size[1]	First Year	Second Year	Third Year	Fourth Year	Fifth Year
High-use Discontinued Monthly	1,507	3.6%*	3.8%*	3.5%*	3.2%	2.6%
High-use Discontinued Quarterly	9,374	1.8%*	1.5%*	1.3%*	0.7%*	0.5%
High-use Discontinued Persistence	3,796	1.6%*	1.3%*	1.0%*	0.3%	1.0%
High-use Discontinued Group Overall	14,733	1.9%*	1.7%*	1.4%*	0.8%*	0.8%
High-use Continued Monthly (Extension)	7,211	2.5%*	2.1%*	2.7%*	2.6%*	2.5%*
Average-use Continued Monthly (Expansion)	8,985	1.0%*	1.2%*	1.7%*	1.2%*	N/A

* Statistical significant at the 0.1 level.
[1] 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. Table 16 in Appendix A includes the actual sample sizes included in each study's analysis.

Figure 2: Daily kWh Savings per Household by Treatment Group

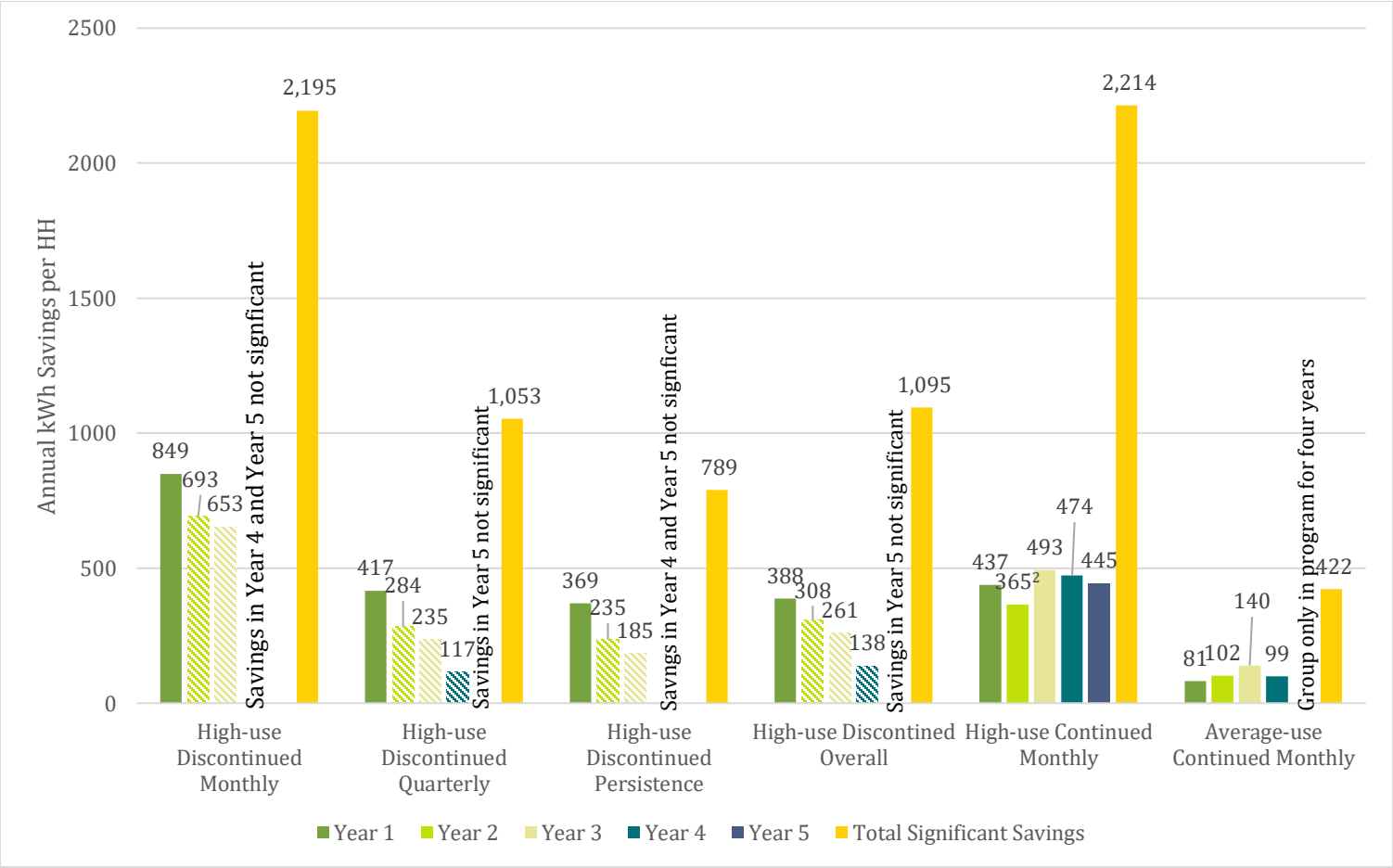
(Based on Billing Analysis, sample sizes reported in Table 6)



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

Figure 3: Annualized Savings in kWh per Household, by Treatment Group[1]

(Based on Billing Analysis, sample sizes reported in Table 6)

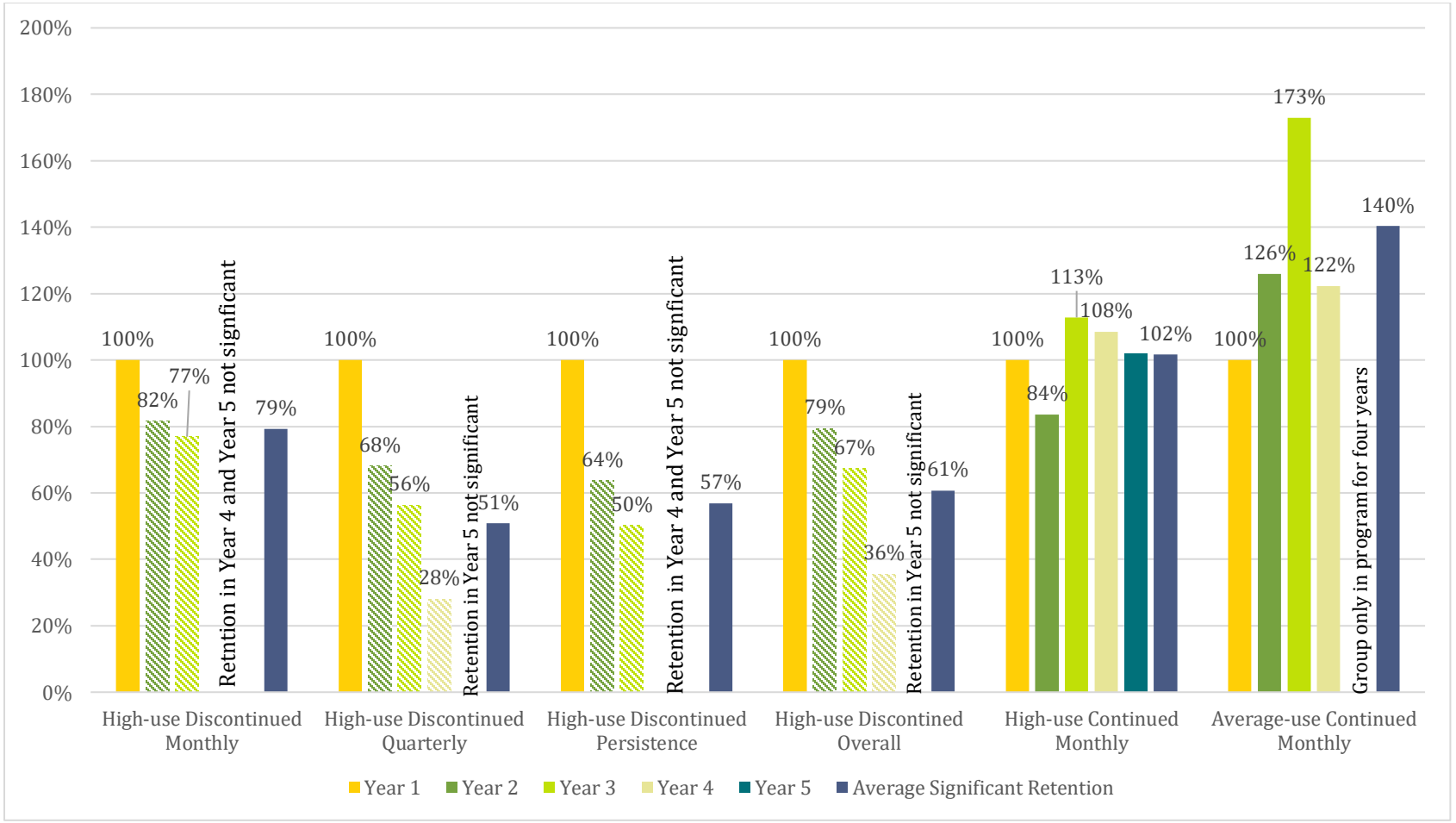


[1] Year 1 represents the respective group's first year in the program; Year 2 to Year 5 represent post-treatment periods for all discontinued households and treatment periods for all high-use continued monthly households. Average-use continued monthly households started receiving reports a year later 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 4: Percentage of Annual Savings Retained Relative to Treatment/First Year by Treatment Group[1]

(Based on Billing Analysis, sample sizes reported in Table 6)



[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 8: Savings Degradation Among High-use Discontinued Groups

Group	One Year Post-Treatment	Two Years Post-Treatment	Three Years Post-Treatment	Average Degradation	EUL based on modeled statistically significant savings[1]	Implied lifetime multiplier[2]
High-use Discontinued Monthly	18%	5%	Not Significant	12%	2	2.28
High-use Discontinued Quarterly	32%	12%	28%	24%	2.5	3.8
High-use Discontinued Persistence	36%	14%	Not Significant	25%	2.1	2.7
High-use Discontinued Overall	**21%**	**12%**	**32%**	**21%**	2.7	3.3

[1] Model significance based on 90/10 confidence and error levels.

[2] Implied Lifetime Multiplier=first year savings/[(Annual degradation rate-Annual participant attrition)-(Annual degradation rate * Annual participant attrition)]

2.2 BENCHMARKING RAMP-UP AND DEGRADATION RATES

2.2.1 Key Findings

The observed degradation rate of 21% for high-use discontinued households fell within the range observed in other studies of HERs programs. The report compared the results of the current study with that of prior research in Connecticut and elsewhere. The R32 Eversource Behavior Persistence study completed in 2016 found a degradation rate of 24% (the current study updates R32).[18] 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—to estimate savings persistence. They found that after two years of active treatment, the program effects degraded at about 10% to 20% every year post-treatment.[19] Khawaja and Stewart came to similar conclusions; their study compared the estimated annual savings degradation rates from multiple studies of OPower HERs programs. They had degradation rates ranging from 11% to 32%, with an average of 20% per post-treatment year, and a measure life of 3.9 years (Table 9).[20] Skumatz reviewed the literature on behavioral persistence and concluded that short term retention of savings is usually high, even after two years post-treatment, lending further credence to this study's findings.[21] Using data from a 2015 evaluation of the Puget Sound Energy (PSE) HERs program, this study estimated an average degradation rate of 8% over the five years that discontinued households from that program continued to show significant post-treatment savings.[22,23]

Ramp-up effects for continual treatment exist, but wane over time. Similar to the results of the current study, Allcott and Rogers found that continual treatment includes a ramp-up of savings. However, the effect waned after two to four years and often lead to declining savings after that point.[24]

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[18] 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

[19] Allcott, 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.

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

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

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

[23] The PSE 2015 report did not list or update the previous report's degradation rate.

[24] Allcott and Rogers (2014) Ibid.

2.2.2 Tables and Graphs

Table 9 compares the degradation rates of other studies with those of the current study.

Table 9: Savings Degradation among Discontinued 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 Degradation
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.[25]

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

2.3 COST-EFFECTIVENESS: EXPENDITURES-TO-SAVINGS RATIO

2.3.1 Key Findings

The HERs pilot program achieved the most cost-effective savings by sending reports to high-use households for about a year and then reaping the savings that persisted for two to three years post-treatment. Using the annualized estimates of the HERs program costs and savings, the study calculated the expenditures-to-savings ratio for each study group (Table 9).[26] Other critical findings regarding the expenditures-to-savings ratio include the following.

- High-use discontinued households saved an average of 1,095 kWh at a lifetime cost of about one cent per kWh over four years (one treatment, three post-treatment).
- High-use continued households who received reports for four years saved an average of 1,769 kWh at a cost of three cents per kWh. This made their savings 38% higher than the average high-use discontinued household, but the cost of continual treatment was also 200% higher.
- Average-use continued households saved an average of 422 kWh over four years of treatment at a cost per kWh of 12 cents.

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[26] The report recognizes that this ratio does not capture the full range of factors Eversource considers in more complete cost-effectiveness tests

2.3.2 Tables and Figures

Table 10 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

Table 10: Annualized Expenditures-to-Savings Ratio by Treatment Group[1]

	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	$.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	Not significant	$8.07	Not significant	$7.86	$45.72	$52.53
Cumulative Savings per HH Year 4 (kWh)		1,053		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	Not significant	Not significant	Not significant	Not significant	$59.67	Not treated[2]
Cumulative Savings per HH Year 5 (kWh)					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

2.4.1 Varying Length of Treatment

2.4.1.1 Key Findings

The analysis explored energy savings and cost-effectiveness for various lengths of treatment and post-treatment relative to the savings and cost of continual treatment.[27] To the extent possible, the analysis used the actual achieved statistically significant savings, degradation, and ramp-up rates. Table 11 notes any deviations. In all cases, assumptions about multi-year or continual treatment relied on the average ramp-up rate achieved by high-use continued or average-use continued groups.[28] The analyses presented in Appendix B included the same delivery options, but also examined the average degradation rate and the low and high degradation rates identified in the benchmarking effort.

The total savings achieved under the different scenarios suggests that one or two years of treatment can achieve a high percentage of savings at a substantially lower cost than continual treatment. The total savings—treatment and post-treatment—for households that received reports for one or two years fell between 50% to 90% of likely savings under continual treatment. However, the cost per kWh saved under cycling scenarios ranged from 14% to 70% of continual treatment, with typical costs per kWh of about 50% for a single year of treatment and 50% to 70% for two years of treatment.

Shorter length of treatment and average pre-program use led to lower total savings (treatment and post-treatment) and cost effectiveness. Across all scenarios, the high-use discontinued persistence group (received reports for only eight months) and the average-use continued group routinely exhibited the lowest benefit from cycling, due to lower savings and higher degradation rates.

[27] The scenarios explored here examine 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.

[28] This decision reflected the fact that the second year of treatment showed a negative ramp-up rate for high-use continued households due to the four month hiatus in treatment in Year 2.

2.4.1.2 Tables and Figures

The first section of Table 11 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. This information is also presented separately in Figure 3, Figure 4, and Table 10 above. As with other tables in this report, shaded cells denote the treatment period for each group. The second section of Table 11 presents program delivery for a single year without considering persistence. It lists the first year's savings and cost per kWh saved.

Table 11: 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%

	High-use Discontinued				Continued	
	Monthly[1]	Quarterly	Persistence[1]	Overall	High-Use	Average-Use
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%
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.

2.4.2 Cyclical Households Through the Program

2.4.2.1 Key Findings

The current analysis demonstrated that cycling may be more cost-effective and maximize savings compared to continual treatment. The analysis also demonstrated that cycling can free up funding for other programs that can deliver additional savings. The study examined the possible impact of cycling households through the program—also called crop rotation—compared to continual treatment to a single set of households. Prior research by Rogers and Allcott suggested that cycling customers may be more cost effective than continual delivery of HERs. By cycling, they meant sending reports to rotating groups of households and banking both their treatment and post-treatment savings rather than continuously treating the same households year after year.[29] The R32 Eversource Behavior report came to the same conclusion, but the scope of that project did not include direct comparisons of achieved savings between discontinued and continued households.[30] The current study provided that direct comparison in Table 20 to Table 27. Table 20 to Table 23 focus on high-use households, while Table 24 to Table 27 examine average-use households. The schedules mirror those used in Table 11 above. Table 13 summarizes the savings and costs across all scenarios.

Highlights of the exploration of cycling include the following:

- **Cycling approaches can touch more households for the same cost** as continually treating the same households year after year.
- **High-use households achieve greater savings at lower costs** per kWh saved from cycling than average-use households.
- **Average-use households exhibit mixed results from cycling**, in part because the high 40% ramp-up rate can eclipse persistence savings post-treatment.
- In the scenario when two high-use cycled groups simultaneously receive reports, (e.g., Table 20 and Table 24) the cost per household and total program budget are greater than continual treatment, but the cost per kWh remains lower. This is only sometimes true for average-use cycled groups, again because of the ramp-up rate.

The implementer and Eversource have voiced concerns about the cycling approach. Table 12 provides a summary of those concerns and the study's response to them. Whether Eversource decides to pursue cycling 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.

[29] Allcott and Rogers (2014) Ibid.
[30] NMR Group (2016) Ibid.

2.4.2.2 Tables and Figures

Table 12 provides a summary of implementer and Eversource concerns regarding cycling, and responses to those concerns. Table 13 summarizes the savings and costs across all scenarios. Appendix C provide details of the cycling scenarios examine in this study.

Table 12: Implementer and Eversource Concerns Regarding Cycling

Concern	Evaluator Response
Cycling may lead to avoided cost in implementation but would still incur analytic costs, which makes up a significant portion of the program budget	The evaluation team concurs, and such costs must be taken into consideration in a more thorough cost-effectiveness analysis. However, the extra evaluation costs would not be expected to be high, and the savings from cycling should cover the costs. The evaluation budget accounts for about 1.35% of Connecticut's Conservation and Load Management budget. The program savings from cycling are substantially higher than this percentage. This latest program evaluation update cost less than 1% of the program's costs, and falls far below the is less than the 115% cost savings that could be gained by a one-year on/three-year off cycle.
Cycling could lead to a disjointed customer experience that may engender negative associations	The Year 2 evaluation results showed no evidence of negative associations with the HERs program among customers who experienced a four-month hiatus[1]
The current program targets average to high-use customers since they have the greatest propensity to save. Touching more customers would require reaching out to lower users and would require more reports to produce a fraction of the behavioral savings from the average- to high-users. This would actually decrease overall cost-effectiveness.	The evaluation team concurs that expanding to low-use customers does not make programmatic sense from either an energy savings or cost-effectiveness perspective. However, the current program sends reports to over 300,000 households, and it seems that at least a portion of these could be placed on an experimental cycling schedule to explore program impacts and cost effectiveness.
Eversource would lose the ability to market other energy efficiency programs through HERs tips and messaging.	Previous evaluations have shown that the HERs do provide a small boost in customer engagement in other energy efficiency programs (specifically Home Energy Solutions), but it is likely that Eversource's highly successful marketing campaigns reach customers regardless of their inclusion or exclusion from the HERs program.[2]

[1] 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

[2] HES participation among the treatment and control groups were significantly different with treatment HES participation of 4.7% and control HES participation of 4.0%. The active behavioral high-use treatment group adopted insulation at a statistically higher rate when compared to the control group—7.9% vs. 7.1%. 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. 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

Table 13 Comparison of Costs and Savings Under All Cycling Scenarios

Program Delivery Scenario		Accumulated Five-Year Savings (kWh)	Accumulated Five-Year Costs	Cost Effective-ness	Percent Greater Savings from Cycling	Percent Improvement in Cost-effectiveness
Cycling High-Use Households, Single Year with Reports, One Year No Reports	Program Total	4,793	$87.50	$0.018	117%	55%
	Five Years Continual	2,214	$62.50	$0.028		
Cycling High-Use Households, Single Year with Reports, Three Years No Reports	Program Total	3,981	$50.00	$0.013	80%	115%
	Five Years Continual	2,214	$62.50	$0.028		
Cycling High-Use Households, Two Year with Reports, Two Years No Reports	Program Total	3,697	$75.00	$0.020	63%	35%
	Five Years Continual	2,274	$62.50	$0.027		
Cycling High-Use Households, Two Years with Reports, Three Years No Reports	Program Total	3,521	$62.50	$0.018	55%	50%
	Five Years Continual	2,274	$62.50	$0.027		
Cycling Average-Use Households, Single Year with Reports, One Year No Reports	Program Total	888	$87.50	$0.098	66%	19%
	Five Years Continual	535	$62.50	$0.117		
Cycling Average-Use Households, Single Year with Reports, Three Years No Reports	Program Total	738	$50.00	$0.068	38%	72%
	Five Years Continual	535	$62.50	$0.117		
Cycling Average-Use Households, Two Year with Reports, Two Years No Reports	Program Total	820	$75.00	$0.091	-8%	-23%
	Five Years Continual	887	$62.50	$0.070		
Cycling Average-Use Households, Two Years with Reports, Three Years No Reports	Program Total	805	$62.50	$0.078	-9%	-10%
	Five Years Continual	887	$62.50	$0.070		

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). OPower provided 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. These data also included 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). Additionally, data sent by OPower 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 5 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. The study included the heating and cooling degree days as a control for the impact model.

Table 14: 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 5: Weather Station Assignment

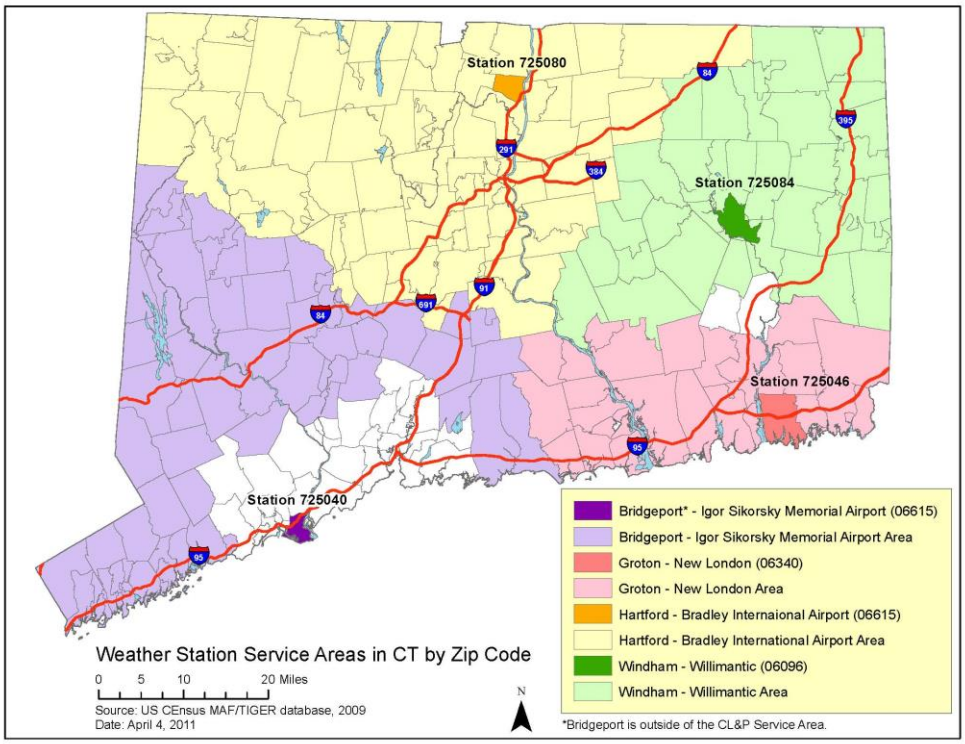

Table 15 summarizes the final sample sizes used in the billing analysis as well as the monthly pre-treatment electricity use for the households.

Table 15: Total Pre-Program Electricity Usage for Households Included in Current Analysis[1]

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

Table 16: 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

	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 11), but vary the assumed degradation rate. While Table 11 relied on annual degradation rates, Table 17 turns to the average degradation rates, Table 18 the low degradation rate identified in the literature, and Table 19 the high degradation rate identified in the literature.

Table 17: 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

	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 18: 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%

	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 19: 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

	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

	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.

Appendix C Detailed Examination of Cycling Scenarios

Table 20 to Table 27 provide detailed accountings of various cycling approaches 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

Table 20: Cycling High-Use Households, Single Year with Reports, One Year No Reports[1]

		Group A	Group B	Group C	Program Total[3]	Five Years Continual
	Assumed Treatment Group Size	*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

		Group A	Group B	Group C	Program Total[3]	Five Years Continual
	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
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. Note that cost-effectiveness is better when cycling "sets of years" match the continual treatment cycle (e.g. 1 year on, 2 years off is most appropriately compared to 3 years of continual treatment, rather than to 5 year cycles; otherwise the next investment is incurred but the retention is not fully realized in the period).
[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 21: Cycling High-Use Households, Single Year with Reports, Three Years No Reports[1]

		Group A	Group B	Group C	Program Total[3]	Five Years Continual
	Assumed Treatment Group Size	*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

		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 22: Cycling High-Use Households, Two Year with Reports, Two Years No Reports[1]

		Group A	Group B	Group C	Program Total[3]	Five Years Continual
	Assumed Treatment Group Size	*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

		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 23: Cycling High-Use Households, Two Years with Reports, Three Years No Reports[1]

		Group A	Group B	Group C	Program Total[3]	Five Years Continual
	Assumed Treatment Group Size	*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

		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 24: Cycling Average-Use Households, Single Year with Reports, One Year No Reports[1]

		Group A	Group B	Group C	Program Total[3]	Five Years Continual
	Assumed Treatment Group Size	*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

		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 25: Cycling Average-Use Households, Single Year with Reports, Three Years No Reports[1]

		Group A	Group B	Group C	Program Total[3]	Five Years Continual
	Assumed Treatment Group Size	*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

		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 26: Cycling Average-Use Households, Two Year with Reports, Two Years No Reports[1]

		Group A	Group B	Group C	Program Total[3]	Five Years Continual
	Assumed Treatment Group Size	*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

		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 27: Cycling Average-Use Households, Two Years with Reports, Three Years No Reports[1]

		Group A	Group B	Group C	Program Total[3]	Five Years Continual
	Assumed Treatment Group Size	*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

		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.