Connecticut Light and Power Home Energy Reports Program: Spring and Summer Billing Analysis

INTERIM REPORT

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1 Introduction

This interim report summarizes the results of a billing analysis performed by NMR Group, Inc. (NMR) on households randomly selected to be a part of the Home Energy Reports (HERs) Program, implemented for Connecticut Light and Power (CL&P) by OPower. The billing analysis was funded by the Connecticut Energy Efficiency Fund (CEEF) in cooperation with CL&P. It covers the program months of March 2011 through August 11, 2011, as well as pre-

Throughout this report, NMR uses the following terms to refer to specific groups throughout the report:

- Treatment group: households actually receiving HERs reports
- Control group: households selected by the program implementer to serve as a comparison group to the treatment group
- Study group: all households included in the treatment and control groups
- Participants: reserved to refer to households either in the study group or outside of the study group that have taken part in other CEEF programs

1.1 Key Findings

- The HERs program induces savings among high usage customers, but provides much smaller savings for lower usage households. NMR examined participant savings by tercile for the entire period between February and August 2011. The results showed:
    - The highest one-third of electricity consumers in the study group saved about 1.4%, resulting in total savings of about 36 kWh per household.
    - The lowest one-third of electricity consumers in the study group, (who still use significantly more electricity than the average CL&P residential customer) saved only 0.3%, yielding only three kWh total savings per household.
    - At 0.5%, Tertile 2 energy savings were slightly higher than the lowest user group, yielding seven kWh across the study period.
- Introducing an electric-heat treatment variable to the models demonstrates that most of the savings are achieved by treatment households that heat with electricity. Introduction of this variable reduces the overall treatment effect from 2.2% to just 0.6% for February through August, but indicates that treatment households that heat with electricity saved 5.3 percentage points more than the average non-electric heat HERs household. The models control for weather and time of year, so the electric-heat treatment savings should not be the result of less heating use in the spring and summer months. Still, the evaluators caution that analysis of a full year of data may negate the strong electric heat effect currently being estimated by the models.
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- The program implementer estimated overall electricity savings of approximately 1.4% for the first three months of the program. NMR has confirmed these savings, with our models estimating savings of 1.5% through May and 1.8% through June.
- Expanding the analysis to include the entire period from February through August and controlling for weather and time of year increases the estimated savings. NMR found that the HERs program resulted in electricity savings of approximately 2.2% for households receiving monthly reports between February through August 2011 and 1.4% for households receiving quarterly reports during the same time period. That the quarterly report recipients saved less energy than monthly recipients suggests that savings are lower when reports are received less frequently than when they are received on a monthly basis.[1]
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- HERs treatment households participated in greater numbers than control households in the Home Energy Solutions program (the overall, not the income-eligible, version of this program).
- Due to the extremely high average monthly usage of the overall study group compared with most CL&P residential customers (1,700 kWh vs. 800 kWh, respectively), the results of the billing analysis and the analysis of participation in other programs cannot be directly applied to predict the impacts of expanding the HERs program to all residential customers. However, analyses performed to explore this question suggest that savings would be minimal in the general population because the greatest savings by far accrue to the highest users.
- The findings also suggest that participation in other CEEF programs may increase, but the increase would most likely be small and secondary to the other factors that currently lead individuals to take part in programs.
- Based on overall pre-program electricity use, mean program-induced savings for all monthly report recipients for the period of February through August 2011 are approximately 36.6 kWh per household (1,025 MWh overall), and those for quarterly report recipients for the same time period are 23.3 kWh per household (465 MWh overall).

1.2 Program Description

The HERs program seeks to reduce electricity use through behavioral changes induced by information presented in a report that documents recipients' electricity use, rates their use compared to similar "neighbors", and offers them tips for ways their households can save electricity. Reports are tailored to the individual household based on its electricity use and

[1] Future analyses will address the issue of persistence of savings more directly by examining changes in energy use before and after September 2011 for a sub-set of households formerly receiving monthly reports (the "persistence sample") that stopped receiving any mailed reports in September 2011.

characteristics (*e.g.,* heating fuel, presence of central air conditioning, *etc.*). One of the vital characteristics of the CL&P pilot program is its experimental design. The program implementer selected eligible households based on a number of criteria and then randomly assigned the eligible households to either a treatment group that receives the reports or a control group that does not receive the reports. Electricity savings are estimated by comparing the change in electricity use prior to the program to that after the program for both the treatment group and the control group. The criteria used by the implementer to select households for the HERs program included the following:

- Active account
- Sufficient billing history
- No gaps in the billing history
- High annual average electricity use

The HERs study population includes 48,000 households, split evenly between the treatment and control groups.[2] The large sample size is necessary because the expected program savings are relative small per household, about 2% according to the implementer. Finding such a small effect—and concluding that the effect is statistically significant—requires ample statistical power, which the study achieves through a large sample size.[3]

In addition to the overall experimental design, CL&P and OPower structure the pilot to allow additional experiments on the frequency of reports on electricity savings and how long savings persist after households stop receiving the reports. For this reason, the 24,000 participants were divided into three sub-treatment groups as follows[4]:

- 10,000 monthly customers receive monthly reports for an entire year
- 10,000 quarterly customers receive quarterly reports for an entire year
- 4,000 persistence customers receive monthly report for six months

All three sub-treatment groups have access to a HERs website (https://clp.opower.com/) for one full year. This report does not address website use but we expect to discuss patterns of website use in a later process assessment report that will be completed later in the study period.

1.3 Purposes of the Study

This study had three main purposes, named below and described in the sections that follow:

1. Estimate program-induced electricity savings

[2] The actual number of households used in our analyses is 48,080. OPower included a few extra records spread evenly across the treatment and control groups yielding a total study group size of 48,129. Our data cleaning efforts described in Section 1.4.1 reduced the size to 48,080.
[3] The program effect may still exist in smaller sample sizes, but the usual tests for statistical significance may suggest that they are not significant. This is known as the Type II error, concluding that an effect does not exist, when, in fact, it does. The Type I error involves concluding that an effect does exist, when it really does not.
[4]NMR assigned the control group to sub-control groups for analysis purposes. See Appendix A for details.

2. Identify any impact of the HERs program on participation in other CEEF programs
3. Predict the impacts of expanding the program to all of CL&P's residential customers

1.3.1 Estimate Program-Induced Electricity Savings

The main purpose of this study was to estimate the electricity savings resulting from the HERs program and to explore how other factors, such as weather, time of year, household characteristics, and the actual tips recommended to individual treatment households also affect the savings achieved. We estimate these savings for the entirety of the HERs treatment group but also for each of the sub-treatment groups. We accomplish this through an analysis of electricity usage as billed to the residence based on actual or estimated meter reads, employing statistical controls for the sub-treatment groups and the additional factors that could also influence electricity savings as needed.

1.3.2 Identify HERs Impact on Participation in other CEEF Program

Although many of the HERs tips seek to induce the treatment group to change their every day behavior in an effort to save electricity, some of the tips also suggest that the participants take actions that will likely involve their participation in other CEEF-funded programs. For example, one tip suggests that households have an energy audit performed on their home, which would feed into the Home Energy Solutions programs (HES and HES-IE). Other tips promote the purchase of energy efficient appliances and lighting, which relate to the ENERGY STAR® retail products programs. A second purpose of the impact evaluation, then, was to assess the degree to which the HERs program increased participation of the treatment group compared to the control group in other CEEF programs.

1.3.3 Predict Impacts of Program Expansion to all Residential Customers

CL&P requires information that will help them decide if the HERs program should be expanded to all residential customers. It was anticipated that this information would be available through the overall savings assessment process. However, the study sample was not selected in a way that allows a definitive estimation of savings across the residential customer base.

More specifically, the study group is not representative of the entire population. The HERs program design selected the study group from among CL&P's residential customers with the highest electricity use. Highest users have the most electricity savings to gain, and the likely impact of a behavioral program will be greatest for these users. However, the focus on high users also means that the study group systematically differs from the population of CL&P's residential customers. The average CL&P residential customer uses about 800 kWh per month while the average customer in the study population uses about 1,700 kWh per month, more than twice that of the average residential customer. Furthermore, only approximately 300 of the 48,000 combined treatment and control households had pre-usage below 1,000 kWh per month (which is still 25% more than the average). It is NMR's opinion that the study results cannot be safely generalized to estimate the savings customers as a whole would see if the program were expanded to all residential customers. However, as the best available substitute we include analysis in this report assessing the results found for the group of program customers with the lowest usage.

1.4 Methods

To fulfill these three purposes, NMR prepared a dataset containing billing, program, and weather data and then analyzed the data in STATA, a widely used statistical analysis software package. We highlight the methods used in this section, but see Appendix A for more detail on the data preparation process and Appendix B for more detail on the data analysis procedures.[5]

1.4.1 Data Preparation

The billing analysis relied on data obtained from three different sources: 1) CL&P, 2) OPower, and 3) the National Climate Data Center (NCDC) website (Table 1–1).

Table 1–1: Data Sources

CL&P	OPOWER	NCDC
Monthly billing data in kWh, presented as total usage and daily average usage	Household and demographic characteristics	Heating Degree Days (HDD) for four major weather stations in Connecticut
	Tips received by each treatment household and date(s) received	Cooling Degree Days (CDD)for four major weather stations in Connecticut
	Date of first report	
Participation in other CEEF programs since January 1, 2011	Assignment to treatment and control	
Flag for service disconnection		
Meter read date	Assignment to sub-treatment group (for treatment only)	
Rate codes to identify electric heat customers		

[a] Data provided for all treatment and control group households unless otherwise noted.

The data preparation process involved a series of steps that culminated in a database that included the following characteristics:

- Monthly billing data for all participants and non-participants from January 1, 2010 through August 31, 2011, limited to those billing accounts still active as of January 1, 2011
- Household characteristics
- Service address information

[5] No sample design was used or needed in this study because we performed the billing analyses on the entire population in the HERs study group as designed by OPower, although we do remove some records with insufficient data, as described in Section 1.4.1

- Monthly weather data including average temperature, total heating degree days, and total cooling degree days
- Participation in other CEEF programs since January 1, 2011
- Selection of the tips received by each treatment household and date(s) tips were received

The nature of the analysis necessitated that we remove households with the following criteria from the dataset:

- Lacked a full year of pre-program billing data
- Service disconnection prior to January 1, 2011
- Pre-program use of zero
- Records with duplicated billing account numbers
- Records not assigned to the treatment or control group

Table 1–2 summarizes the number of records included in the final data set.

Table 1–2: Participation and Usage

	Households	Total Usage (kWh)	Average Usage (kWh)
Treatment Group	24,038	771,355,555	32,089
Control Group	24,042	770,480,392	32,047
Entire Study Group	48,080	1,541,835,947	32,068

1.4.2 Billing Analysis Methods

We used a statistical modeling technique known as linear fixed-effects regression (LFER) to determine whether or not the program led to a statistically significant reduction of electricity use among the treatment group compared to the control group. We developed a series of models, each of them designed to test the impact of different factors (*e.g.,* weather, housing characteristics, sub-treatment group, time of year, *etc*) on electricity use and on the amount of savings attributable to the HER program.

We first used LFER to model the effect of receiving HERs on use, resulting in what we call the base model. The base model tested for changes in electricity use by comparing the pre- and post-program periods for the entire report recipient treatment group as well as any unique effects associated with being in the quarterly report recipient sub-treatment group.[6] Because factors other than the reports also affect electricity use, we developed additional models that controlled for weather, month of the year, and household characteristics (*e.g.,* electric heat, age of home,

[6] In other words, we ran the model on all treatment and control participants, but also created a flag variable to capture whether the quarterly treatment group differed in any way from the overall patterns of change in use. The base model did not include a flag for the persistence group because the entire persistence sample was still receiving monthly reports during the time period included in this analysis. The planned Spring 2012 billing analysis will include months in which the persistence sample no longer receives reports, allowing for an assessment of the persistence of savings.

etc.).[7] We also developed models to inform the analysis of possible impacts of program expansion to all residential customers, as described in Section 1.4.4. When interpreting the models, it is important to keep in mind that they work like a simple math equation for the treatment variables. The "overall treatment effect" describes the big picture of the program impact, and one adds to or subtracts from that effect to isolate the impact of being in the quarterly treatment group or the treatment group heating with electricity, for example. In the results section, we take care to explain how we calculated the effects for sub-groups.

1.4.3 Methods to Assess Participation in other CEEF Programs

One of the objectives of the HERs program is to increase participation in other CEEF-funded programs. NMR assesses if this objective was being met by comparing participation rates in other CEEF programs between households in the HERs treatment and control groups. CL&P provided the team with data on participation by HERs study group households in additional CEEF residential programs since January 1, 2011. CL&P provided data on participation in the following programs:

- HES
- HES-IE
- Residential HVAC
- Lighting Coupons
- Lighting Catalog
- Insulation Rebate
- Appliance Retirement (ARP)

We performed two separate analyses to assess the impact of HERs on participation in these other programs. First, we compared the numbers and percentages of HERs treatment and control group households that took part in other programs, searching for patterns that would suggest greater participation among the HERs treatment group. Second, we performed a statistical test known as a *Chi-Square* (X^2) test that captures whether participation rates among the treatment and control groups differed from what could be expected based on chance. To prepare the data for this test, we scored each treatment and control group household in the entire study group with a "one" if they had participated in each individual program and a "zero" if they had not participated in that same program. We then used STATA to run the X^2 test for each of the seven other CEEF programs for which we had data. If the treatment group participated at a greater rate than the control group and if the X^2 test were found to be statistically significant at the 0.10 level of

[7] We also tested the potential impact of selected tips (see Section 1.4.1 for the list of tips) received by the treatment households. However, the models were inconclusive, with some tips being associated with increased use and others with decrease use, which probably has more to do with the characteristics of the households receiving the tips than with reactions to the tips. NMR will return to the tip-specific analysis in the Spring 2012 billing analysis when we will have the benefit of the follow-up survey and self-reported adoption of tips to help explain the relationship between tip receipt, tip adoption, and electricity savings.

significance (meaning that the results could be expected to be based on chance about 10% of the time), we concluded that the HERs program increased participation in the other CEEF program.

1.4.4 Methods to Predict Program Expansion to all Residential Customers

NMR turned to two different approaches to predict the possible impacts of expanding the HERs program to all residential customers. These approaches address two different issues: 1) the amount of direct savings that could be expected, and 2) the likely increase in participation in other CEEF programs.

Direct Savings. NMR performed a billing analysis in which we compared the savings of the HERs study group by their pre-program period electricity use. We divided the study groups into thirds, creating terciles based on pre-program use (Table 1–3). Again, it is important to stress that, although use differs across these terciles, the lowest tercile in the HERs study still uses 18% more kWh per month than the average residential customer of CL&P.

Table 1–3: Baseline Monthly Use by Tercile

Tercile (kWh use category)	# Households in Study Group (n = 48,080)	Average Use (kWh)	% Greater than Average Customer
Tercile 1 (highest users in study group)	16,027	2,573	226%
Tercile 2 (moderate users in study group)	16,026	1,414	79
Tercile 3 (lowest users in study group)	16,027	933	18
Average CL&P residential customer	~1,000,000[a]	789	0

[a] Approximate number of residential customers as estimated from 2010 Census data on number of households in Connecticut, adjusted for service territories of other electric utilities.

We ran billing analysis models limited to Tercile 1 and to Tercile 3, as well as different combinations of the terciles in order to compare savings in each group. We use the results of this analysis to aid our assessment of the possible impact of program expansion on electricity savings among all CL&P residential customers.

Participation in other Programs. NMR explored how program expansion may affect participation in other CEEF programs among all residential customers. NMR obtained the statewide participation counts in HES for the period of January 1, 2011 through August 31, 2011.[8] We then compared the rates of participation in HES for the HERs treatment group, the HERs study group, and all other households in Connecticut to help us predict what may happen to HES participation if the HER was expanded.

[8] NMR leads the team performing market assessment and evaluation of the Residential Retrofit and Retail Products area and had access to this information through that role. The EEB project gave us permission to use those data for this analysis of HES.

2 Results

The analyses yielded a number of important findings regarding the HERs program. In summary, the HERs program is having a significant and positive impact on electricity savings and participation in other CEEF programs. However, the likely impacts of expanding the program to the full CL&P residential population remain unclear. This section provides more detail on these overall findings.

2.1 Electricity Savings Attributable to the HERs Program[9]

Table 2–1 shows the modeling results for the entire study group. The models in the table isolate the quarterly sub-treatment group from the monthly recipients through the use of a flag variable in which those receiving a quarterly report were scored as "one" and those receiving a monthly report were scored as "zero." This flag variable means that the overall treatment effect describes the savings for the monthly report recipients, while the quarterly treatment explains the differences in savings between the quarterly recipients and the monthly recipients.[10]

The base model in the first column shows that the overall treatment group used 2.9% less electricity than the control group; however, the quarterly treatment group used 0.8% more energy than did the monthly treatment group, yielding savings of just 2.1% for the quarterly recipients (calculated as 2.9% [overall treatment effect] minus 0.8% [quarterly treatment effect]). Although this difference of 0.8% seems small, in reality, the degree of statistical power in the study design allows us to conclude with statistical certainty that the quarterly recipients did not save as much as the monthly recipients, pointing to a smaller savings in households that receive reports less frequently than in the households receiving monthly reports to remind them to save energy. Future analyses will address the issue of persistence of savings more directly by examining changes in energy use before and after September 2011 for a sub-set of households formerly receiving monthly reports (*i.e.,* the so-called persistence sample) that stopped receiving any mailed reports in September 2011.

Next, we developed models that also controlled for weather and other monthly variations that influence electricity use; this model, presented in the second column, estimates the overall program-induced savings to be a 2.2% post-period energy reduction for the monthly treatment group and 1.4% post-period energy reduction for the quarterly treatment group (calculated as 2.2% [overall treatment group effect] minus 0.8% [quarterly treatment group effect]).

[9] Appendix C reports more statistical information such as standard errors and explained variance for these models.

[10] Throughout this analysis monthly treatment group refers to the participants who received monthly reports between February and August even if they are in the persistence treatment group that stopped receiving reports in or soon after the month of August.

The final column of Table 2–1 shows the best-performing model that included housing characteristics.[11] The addition of an electric-heat treatment variable to the model[12] suggests that the majority of savings accrue to electric-heat households receiving HERs. Specifically, the overall treatment effect points to savings of only 0.6%, while the electric-heat treatment households achieve savings of 5.3%—for a total savings of 5.9% (calculated as 0.6% [overall treatment effect] plus 5.3% [electric-heat treatment effect]) for electrically heated treatment homes.[13] At least two explanations exist for this concentration of savings among electric-heat treatment households. On the one hand, the billing analysis covers only spring and summer months, raising the possibility that the savings simply reflect the lower use of heating in those months. Because the model controls for weather and time of year and differentiates the effect of electric-heat *treatment* homes over all other homes, including electric-heat *control* homes (see Appendix B), it *should* remove reduced use of heat as an explanation for the greater savings. Yet, NMR recognizes it may be possible that the impact of heating less in spring and summer may be so large that it overwhelms other effects. An analysis of a full year of data, including the winter heating months, may negate the results in Table 2–1. On the other hand, it is also possible that electric-heat treatment households saved more energy from March through August because they are more likely to have air conditioning (*e.g.,* those relying on heat pumps) and can benefit from summer and winter savings tips, and/or because they were among the highest users and had the greatest savings to achieve by adopting the suggested tips and other efficiency behaviors and measures. The full-year billing analysis will clarify the role that electric heat plays in inducing energy savings among HERs treatment households.

Table 2–1: Program Induced Savings by Model Variations[a]

Type of Effect	Model Variation		
	Base	Controls for weather and month	Controls for household characteristics
Overall Treatment	2.9%	2.2%	0.6%
Quarterly Treatment	-0.8	-0.8	-0.8
Cooling Degree Days[b]	N/A	-0.1	-0.1
Electric Heat Treatment	N/A	N/A	5.3
# of Households	48,080	48,080	48,080

[a] The number in each cell is the percentage of savings in post-period energy use. Thus, the quarterly treatment group did not decrease use by 0.8%, instead they saved 0.8% less than indicated by the overall treatment effect.

[11] See Appendix B more detail on an alternative to this model. Although we tested a number of housing characteristics in alternative models, the only variable that showed a stable, statistically significant relationship was electric heat. Other variables (*e.g.,* age of the home) performed inconsistently depending on the other specifications used in the model.

[12] This is also a "flag" variable similar to that used for quarterly treatment such that the variable captures the effect of both being in the treatment group and heating with electricity.

[13] Like the other two models, the third model continues to indicate that the quarterly treatment group saved 0.8% less than the overall treatment effect.

[b] We also tested heating degree days but this variable failed to add any explanatory power or effect so we did not complicate the model with its inclusion. We expect that the Spring 2011 billing analysis will show larger and more stable effects associated with the heating season.

The second set of models addresses the issue of savings from the monthly sub-treatment group versus quarterly sub-treatment group using a slightly different technique. Instead of using a statistical flag variable, we developed individual models for each of these two sub-treatment groups.[14] Table 2–2 shows the results of these models, which are statistically identical to the savings described above for the base models. The group receiving quarterly reports saved 1.4%, on average, between the pre- and post-period compared to the quarterly control group. The monthly treatment group used 2.2% less electricity in the post-period than did the monthly control group. Again, the findings show that the monthly report recipients are better able to reduce their energy usage than are the quarterly report recipients indicating that more frequent reports lead to greater energy savings.

Table 2–2: Program Induced Savings by Sub-treatment Group[a]

Type of Effect	Sub-treatment Group Model	
	Quarterly	Monthly
Overall Treatment	1.4%	2.2%
Cooling Degree Day	-0.1	-0.1
# of Households	19,986	28,094

[a] The number in each cell is the percentage of savings in post-period energy use.

[14] Although they had received monthly reports through the time period covered by this analysis, NMR also developed a model for the persistence sub-treatment group. We found that their post-energy savings was statistically identical to the monthly sub-treatment group.

The program implementer provided CL&P and the EEB with an estimate of electricity savings resulting from the first three-months of the HERs program; they estimated that the program had induced a 1.4% reduction in electricity use. Because NMR was not certain on which three months the implementer based their estimated savings, we developed two models to verify the implementer's estimate: one model estimated savings through May 2011 and the second through June 2011. Table 2–3 shows that, when controlling for treatment groups, weather, and month, we find very similar results to those reported by the implementer. At 1.5% reduction in use through May and 1.8% reduction in use through June, our efforts suggest that the effect of treatment on usage during the first three months was slightly higher than the 1.4% reported by the implementer. The quarterly treatment group also showed a reduction of electricity use but to a slightly smaller degree (1.4% through May and 1.3% through June). Compared to the entire period described in Table 2–1 and Table 2–2, these results also indicate that the monthly sub-treatment group continued to deepen their savings after June to achieve savings of about 2.2%, while those of the quarterly sub-treatment group remained stagnant at about 1.4%. Again, this points to the importance of monthly reports in inducing deeper program savings. Note also that we used heating degree days in these models and not cooling degree days, as the first three months (including some of June) tend to be part of the heating and not the cooling season.

Table 2–3: Program Induced Savings for First Three Months[a]

Type of Effect	Model for First Three Month of the Program	
	Through May	Through June
Overall Treatment	1.5%	1.8%
Quarterly Treatment	-0.1*	-0.5
Heating Degree Days[b]	-5.95×10^3	-5.98×10^3
# of Households	48,080	48,080

* Not statistically significant at the 0.10 level.

[a] The number in each cell is the percentage of savings in post-period energy use, with negative numbers indicating increased use for that variable after controlling for the others.

[b] The effect of heating degree days is significant, but small, so we show the coefficient in its exponential form.

In order to isolate the effect of the program on the summer season, we created a summer treatment variable. The summer treatment variable is an interaction variable composed of a dichotomous variable indicating whether or not the meter read date occurred in July or August 2011 and the treatment interaction variable described above. We ran this model both with and without the electric-heat treatment variable described above (see Table 2–1). The first column in Table 2–4 shows that the program had the effect of reducing electricity usage by 1.8% when controlling for summer treatment but not electric-heat treatment, but the additional reduction in summer treatment use is not statistically significant, suggesting that the program did not experience a boost in savings in the summer months. The model summarized in the second column incorporates the electric-heat treatment variable, and confirms the findings described for Table 2–1 above that the program-induced savings are concentrated among electric-heat treatment households; again, we will explore this question more in the full-year billing analysis to be performed in Spring 2012.

Table 2–4: Program Induced Summer Savings Estimate[a]

Type of Effect	Without Electric Heat	With Electric Heat
Overall Treatment	1.8%	0.2%*
Summer Treatment	0.4*	0.4*
Cooling Degree Days	-0.1	-0.1
Electric Heat Treatment	N/A	5.3
# of Households	48,080	48,080

*Not significant at the 0.10 level.

[a] The number in each cell is the percent change in post-period energy use.

We performed one additional set of billing analyses to inform an assessment of the possible savings that may result if the program were expanded to all residential customers. We discuss the results of this modeling effort in Section 2.3.2.

2.2 Participation in other CEEF Programs

The analysis of participation in other CEEF programs supports the conclusion that HERs increases participation in at least some of these programs, but especially in HES. Table 2–5 shows a comparison of the number and percentage of HERs treatment and control group households that took part in other CEEF programs between January 1, 2011 and August 31, 2011. For five of the seven programs, HERs treatment households took part at a greater rate than did the control group households. The differences between participation rates are highest for HES and HES-IE, and these two programs also have the greatest rates of participation among the HERs study groups across all the programs in the analysis.

Table 2–5: Participation in other CEEF Programs

Program	HES-IE	HES	Insulation Rebate	Lighting Catalog	Lighting Coupon	Res HVAC	ARP
# Treatment Group	58	107	4	1	11	34	2
# Control Groups	47	71	2	2	6	31	2
# Study Group	**105**	**178**	**6**	**3**	**17**	**65**	**4**
% of all Treatment	0.241%	0.445%	0.017%	0.004%	0.046%	0.141%	0.008%
% of all Control	0.195%	0.295%	0.008%	0.008%	0.025%	0.129%	0.008%

Although the patterns of participation in other CEEF programs suggest differential participation rates, very few of the 48,129 HERs study group actually took part in any of these other CEEF programs.[15] Yet, as mentioned previously (Section 1.2), the large sample size of the HERs study group provides ample statistical power for identifying small program effects. Therefore, NMR ran a X^2 test to see whether the participation pattern translated into statistically significant differential participation rates. We found that only the HES program (not HES-IE) demonstrated statistically different participation rates between the treatment and control groups (X^2=7.3 and p-value =.007), supporting the conclusion that HERs increased participation in HES among the treatment group. Chi-square tests for the other programs were not statistically significant.

Table 2–6: Chi-Square Test of HES Participation

Statistics	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	7.321	1	.007
Number of Households	48,129		

These straightforward analyses do not allow us to conclude that these households were acting on specific tips when choosing to take part in these other CEEF programs. However, we can say with certainty that receiving the reports has led the treatment group to seek out programs to help them reduce their energy use.

[15] We included all 48,129 study group households as, even if their billing data were not sufficient to be included in the billing analysis, these households still receive reports that may induce participation in other CEEF programs.

2.3 Predicting Impacts for all CL&P Residential Customers

As mentioned in Section 1.4.4, NMR performed two separate analyses designed to provide CL&P with information to help them assess the possible impacts of expanding the program to all CL&P residential customers. These approaches address two different issues pertaining to the possible impacts of expanding the program: 1) the amount of direct savings that could be expected, and 2) the likely increase in participation in other CEEF programs. Each of these analyses yields interesting insights into electricity savings and program participation, but they also provide further evidence that the HERs study population differs substantially from all CL&P households, making it difficult to draw conclusions about the likely impact of expanding the HERs program to all residential customers.

2.3.1 Comparison of Electricity Savings by Pre-Program Use

We ran a series of four models designed to capture differences in savings based on pre-program electricity use: Tercile 1 alone (highest use in study group), Tercile 2 alone (mid use in the study group), Tercile 3 alone (lowest use in the study group), Terciles 2 and 3 combined, and Tercile 1 and 2 combined (Table 2–7). It is important to recall that the average pre-program use among Tercile 3 was still higher than that of the average CL&P residential customer (see Table 1–3 above). These models show that the program induced an electricity savings of 1.4% in Tercile 1, the highest users, while the reduction in electricity use for Tercile 3, the lowest use group and the one most similar to the CL&P residential customer base was only 0.3%. In other words, the highest users saved almost five times as much as the lowest use group and thereby accounted for the greatest amount of program-induced savings. At 0.5%, Tertile 2 energy savings were slightly higher than the lowest user group. The electric-heat treatment variable shows a similar pattern of greatest savings among the highest users—electric-heat treatment households in the Tercile 1 saved 4.4%, while those in Tercile two and three saved a minimal amount. The models combining Terciles 1 and 2 and Terciles 2 and 3 confirm this finding—savings of one percent or more for the overall treatment or for the electric-heat treatment households were only evident if the highest users were included in the model. Reminding the reader of the caveats expressed above regarding the limits of generalizing the results of this study to the entire customer population, the results presented here suggest that the program would not achieve substantial savings if expanded to all residential customers, as lower users in the program save considerably less electricity than high users.

Table 2–7: Program Induced Savings by Baseline Electricity Use[a]

Type of Effect		Model Limited to Specified Terciles			
	Tercile 1 (highest use in study group)	**Tercile 2 (mid use in study group)**	**Tercile 3 (lowest use in study group)**	**Tercile 1 and 2**	**Tercile 2 and 3**
Overall Treatment	1.4%	0.5%	0.3%	1.2%	0.6%
Quarterly Treatment	-1.0	-0.2	-0.3	-1.7	-0.4
CDD	-0.1	0.0	0.0*	0.0	-0.1
Electric Heat Treatment	4.4	0.2*	0.2*	4.3	0.5
# of Households	16,027	16,026	16,027	32,053	32,053

*Not significant at the 0.10 level

[a] The number in each cell is the percentage of savings in post-period energy use, with negative numbers indicating increased use for that variable after controlling for the others.

2.3.2 Comparison of Participation in HES

As discussed in Section 2.2, our findings demonstrate that the HERs treatment group participates in the HES program at a statistically higher rate than HERs control group. Therefore, NMR believes it is accurate to conclude that the HERs program increases participation in HES among the treatment group. In order to understand the degree to which the HERs experience may translate to the general residential population, NMR also compared the participation in HES among the HERs study group with HES participation among all households in Connecticut. We stress that our analysis is simple and preliminary in nature. The estimates we had available for HES participation included participants of UI and CL&P rather than CL&P alone. Moreover, although we subtracted the number of households in the HERs program from all residences in Connecticut, we did not adjust for households served by municipal utilities. Despite these shortcomings, the results make clear that the highest users among CL&P's residential population participate in HES less frequently than lower users do.

Table 2–8 summarizes the results of this analysis. They indicate that households in Connecticut that are not part of the HERs pilot participate in HES at a greater rate (0.8%) than do the households included in the HERs program (0.4% for the treatment group and 0.3% for the control group).[16] NMR believes that the correct interpretation of these results is that HERs increases HES participation among the highest electricity use households in the CL&P residential customer population, but the high users participate in HES at a lower rate than all other use groups. Given the differences in the HES participation rates, it is difficult to predict whether the HERs program would similarly boost participation among all residential customers. While the statistically higher HES participation rate among the HERs treatment group suggests that expanding the program to all residential customers would increase HES participation overall, the underlying differences between the study and overall population are too great to predict this outcome with any certainty.[17]

Table 2–8: HES Participation among HERs Households and Other Households

	HERs Treatment	HERs Control	Other Residences
Population	24,060	24,069	1,279,500[a]
# HES Participants	107	71	10,543[b]
% HES Participants	0.445%	0.295%	0.824%

[a] Includes customers of the United Illuminating Company and municipal utilities but subtracts out the 48,000 CL&P HERs households; rounded to the nearest 100.

[b] 10,721 minus the 178 households in the HERs program.

[16] Because these are population data, there was no need to perform tests of statistical significance.

[17] Some of the underlying differences include that the households in the HERs study group tend to be wealthier, own their homes at a greater rate, and are more likely to have amenities such as pools and spas than the average Connecticut household. Their responses to high electricity bills and home energy reports may be markedly different than the general residential population.

3 Conclusions

The key conclusions resulting from the work described in this report are as follows:

- The program implementer estimated electricity savings of approximately 1.4% for the first three months of the program. NMR has confirmed these savings for the first 3 months, with our models estimating savings of 1.5% through May and 1.8% through June.
- Expanding the analysis to include the entire period from February through August and controlling for weather and time of year increases the estimated savings. NMR found that the HERs program resulted in electricity savings of approximately 2.2% for households receiving monthly reports between February through August 2011 and 1.4% for households receiving quarterly reports during the same time period. The fact that quarterly report recipients saved less than energy than monthly recipients suggests that savings are lower when reports are received less frequently than when they are received on a monthly basis. Future analyses will address the issue of persistence of savings more directly by examining changes in energy use before and after September 2011 for a sub-set of households formerly receiving monthly reports (the persistence sample) that stopped receiving any mailed reports in September 2011.
- Introducing an electric-heat treatment variable to the models demonstrates that most of the savings are achieved by treatment households that heat with electricity. Taking account of the electric-heat effect, the overall measured treatment effect declines from 2.2% to just 0.6% for February through August. This analysis indicates that treatment households that heat with electricity saved 5.3% more than the average non-electric heat HERs household. The models control for weather and time of year, so the electric-heat treatment savings should not be the result of less heating use in the spring and summer months. Still, the evaluators caution that analysis of a full year of data may negate the strong electric heat effect currently being estimated by the models.
- HERs treatment households participated in greater numbers than control households in the Home Energy Solutions program (the overall, not the income-eligible, version of this program).
- Due to the extremely high average monthly usage of the study group versus most CL&P residential customers (1,700 kWh vs. 800 kWh, respectively), the results of the billing analysis and the analysis of participation in other programs do not provide adequate information to predict the impacts of expanding the HERs program to all residential customers. However, analyses performed to explore this question suggest that savings would be minimal in the general population because the greatest savings by far accrue to high users. The findings also suggest that participation in other CEEF programs may increase, but the increase would most likely be small and secondary to the other factors that currently lead individuals to take part in programs.

Table 3–1 on the next page summarizes the average savings achieved by monthly and quarterly report recipients as well as by the terciles of users from February through August 2011. Based on average pre-program electricity use, average program-induced savings for all monthly report recipients for the period of February through August are approximately 36.5 kWh per household (1,025 MWh overall), and those for quarterly report recipients in the same time period are 23.3 kWh per household (465 MWh overall). Savings for the lowest tercile energy users are about 2.8 kWh per household (45 MWh overall) from February through August, while those for the highest tercile are 36 kWh per household (577 MWh overall) for the same time period. Despite reservations about extrapolating these results to all CL&P customers, these findings suggest that, if the HERs program was expanded to all residential customers, CL&P could expect to save no more than about three kWh for an average participating household for the months of February through August.

In the next few months, the NMR team will perform the following additional tasks:

- Follow-up surveys with samples of the study group exploring program satisfaction, adoption of recommended tips and other energy saving behavior as a result of the reports, and process-oriented questions, such as satisfaction with the reports
- Second billing analysis in the Spring 2012 covering the first full year of the program: objectives of the second billing analysis will include estimating winter and annual savings, monitoring the persistence of savings for all groups but especially the persistence sample, and attempting to isolate savings associated with particular tips
- Continued tracking of HERs-induced increases in participation in other CEEF programs
- Further exploration of the likely impacts of expanding HERs to all residential customers, if CL&P desires further assessment of this issue

Table 3–1: Estimates of Program-induced Electricity Savings, February through August 2011

Group	Average Pre-program use (kWh)	Percent Savings	Savings per household (kWh)[a]	Number of Households	Overall Savings (MWh)[b]
Monthly Treatment	1,659	2.2	36.50	28,094	1,025.43
Quarterly Treatment	1,662	1.4	23.29	19,986	465.47
Tercile 1	2,573	1.4	36.02	16,027	577.32
Tercile 2	1,414	0.5	7.07	16,026	113.30
Tercile 3	933	0.3	2.80	16,027	44.86

[a] Calculated as the average pre-program use multiplied by the percent savings.

[b] Calculated as the savings per household multiplied by the number of households in the group, divided by 1,000 to yield MWh instead of kWh.

Appendix A Data Preparation Process

The billing analysis relied on data obtained from three different sources: 1) CL&P, 2) OPower, and 3) the National Climate Data Center (NCDC) website (Table A–1).[18] This appendix describes the process of preparing these data for inclusion in the billing analysis.

Table A–1: Data Sources[a]

CL&P	OPOWER	NCDC
Monthly billing data in kWh, presented as total usage and daily average usage	Household and demographic characteristics	Average daily temperature for four major weather stations in Connecticut
Flag for treatment households who opted out of program	Tips received by each treatment household and date(s) received	Heating Degree Days (HDD), calculated from the average daily temperature data
Assignment to treatment and control	Date of first report	Cooling Degree Days (CDD), calculated from the average daily temperature data
Assignment to sub-treatment group for treatment only	Data on web-based users[b]	
Participation in other CEEF programs since January 1, 2011	Electric heat as listed by third-party sources, not CL&P[b]	
Flag for service disconnection		
Meter read date		
Rate codes to identify electric heat customers		

[a] Data provided for all treatment and control group households unless otherwise noted. Some of the data provided by CL&P originated with OPower but CL&P actually sent the data to NMR. The data listed as coming from OPower are covered by a separate non-disclosure agreement and were sent directly by OPower to NMR.

[b] Signifies a variable received that has not been used in the present analysis but will be used in future process or impact analyses and reports. We do not discuss these data in the current report.

CL&P provided the billing data used in this analysis. These data included monthly electricity use (overall and average daily) per service account for both the HERs treatment group and control group as well as the meter read dates from January 1, 2010 through August 31, 2011. CL&P included rate codes so we could determine households with electric heat and flags for whether service had been disconnected. Although they originated with OPower, CL&P also sent data on treatment and control group assignments, sub-treatment group assignments (*i.e.,* quarterly, monthly, and persistence samples) for the treatment group only, and if members of the HERs treatment had opted out of (*i.e.,* asked to be excluded from) the study.

The estimate of electricity use we used in the analysis had to be normalized so that we could interpret it as a percent change in use instead of the average reduction in use in terms of kWh.

[18] Accessed at http://www7.ncdc.noaa.gov/CDO/cdoselect.cmd?datasetabbv=GSOD&countryabbv=&georegionabbv=

We normalized use for both the treatment and control groups use by dividing their monthly use by the average post-period control group consumption and multiplying the result by 100.

We also assigned a meter read month for each meter read date from the billing data using the 15th of each month as a cutoff: if the reading was before the 15th of the month, the use was attributed to the previous month; if the reading was after the 15th, it was attributed to the read month. This means that the pre-program period actually extends back to December 2009, as the January 1 through January 14, 2010 read dates were assigned to that month. We also created a variable to designate the post-treatment time period (post-treatment). This is a dichotomous variable, meaning it is scored zero if pre-treatment and one if post-treatment. We assigned to the post-period any meter reading that occurred 40 days or more after the initial HERs report.[19] For the control group, the post-period was defined as any meter reading that occurred after March 6, 2011, 40 days after the first large mailing of the HERs. The actual variable that captures the effect of the HERs on use (treatment) is an interaction variable, developed by multiplying the treatment group variable and the post-treatment variable, to capture the relationship between being in the treatment group after the program had started.

To support the examination of whether the HERs program boosts participation in other CEEF programs, NMR examined data on whether households in the HERs treatment and control groups had taken part in additional CEEF residential programs since January 1, 2011.[20] NMR created dummy variables to indicate participation in each of these other programs.

OPower provided NMR with data they had obtained from third-party sources on household characteristics such as the dwelling type, number of occupants, age and size of the home, and the presence of air conditioning in the home. NMR cautions that these third-party data are not available for all households, and their quality and accuracy varies, but in ways that are equally true for both the treatment and control groups.[21] Data sent by OPower also showed the date that they mailed the first report to each treatment household, which we used to determine the post-treatment time period as described above.

OPower also provided data collected on the tips received by each treatment household and the date that tip was mailed to each household. As of August 31, 2011, a total of 58 different tips had been distributed to treatment group households. We could not explore all 58 in the analysis for the following reasons:

[19] This method and rationale follows the work of *Alcott, H., Social norms and energy conservation, J. Public Econ (2011)*

[20] Additional CEEF residential programs included in this study: Home Energy Solutions, Residential HVAC, Lighting Coupons, Lighting Catalog, Residential New Construction, Insulation Rebate, and Appliance Retirement.

[21] We only removed households lacking data on these characteristics in the models in which we tested for the impacts of these characteristics on energy use and savings. This is because the information is actually "missing" for them, and the model excludes cases that are missing data on the variables being tested. Excluding households lacking the housing data may introduce bias into the analysis if the households for which we do and do not have housing data differ systematically from each other, which is possible. However, due to the random assignment process, the treatment and control groups are identical, and any bias that may be introduced by removing households lacking housing data will be in the same, although unknown, direction for the treatment and control groups.

- Some tips had been received by too many or too few recipients so that there was not sufficient variation in tip receipt for the model to capture differential impacts
- Some tips suggested broad behaviors not easily captured in an analysis of specific behaviors
- Some tips were too closely related to provide differential impacts

We prioritized the tips with ties to CL&P programs considering the following:

- The percentage of participants receiving the tips was between 20% and 70% so that the tip was not saturated among the participants but still prevalent enough to show an effect.
- The tips were not ubiquitous in larger society (for example: turn off lights when not in use, don't leave the refrigerator door open too long, etc.).

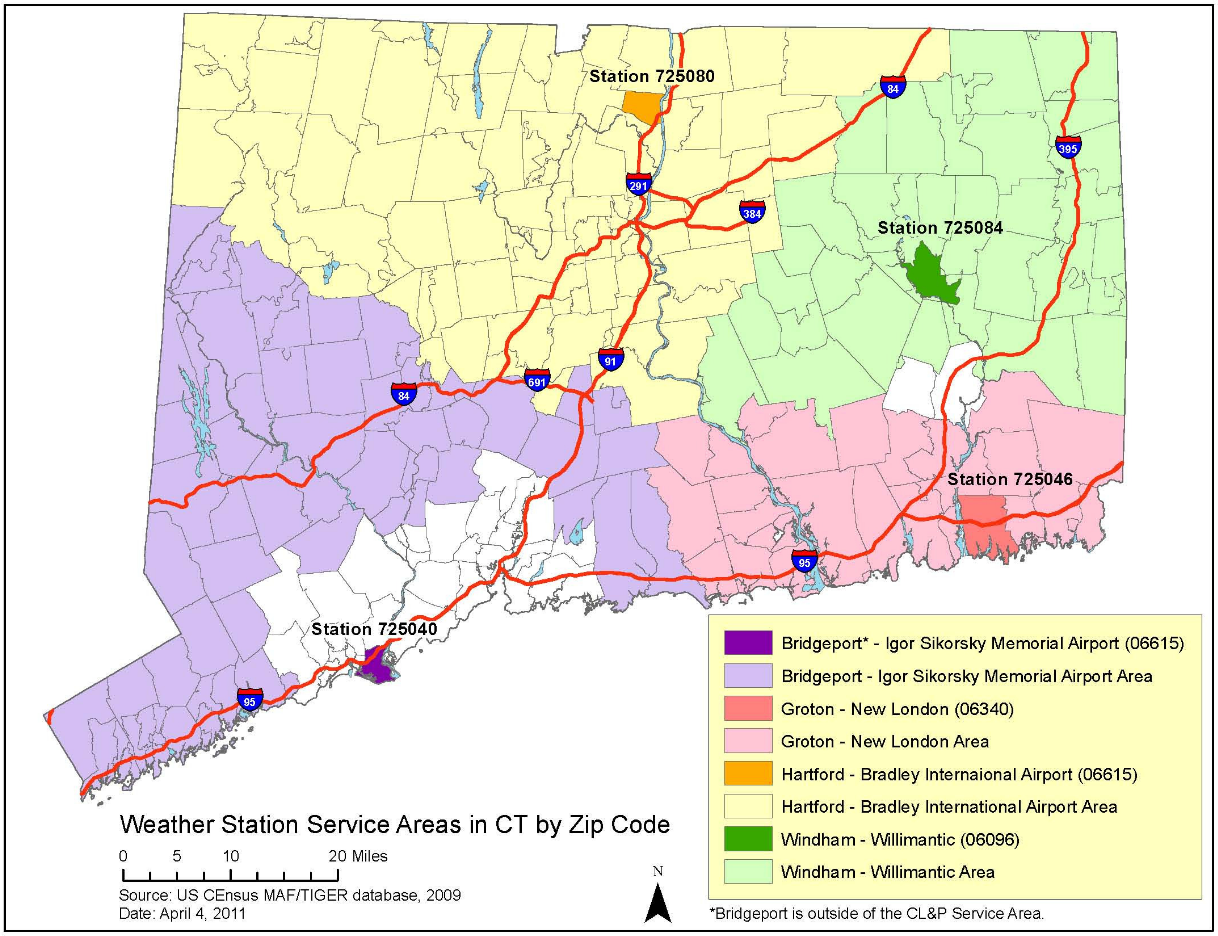
NMR included the following tips in the initial billing analysis:[22,23]

- Care for your refrigerator
- Choose efficient clothes washer
- Choose efficient freezer
- Choose efficient light fixtures
- Seal window air conditioner
- Upgrade central air conditioning
- Use fans for cooling
- Improve insulation
- Test ducts for leaks
- Set thermostat wisely in the summer
- Adjust television display setting
- Adopt a plug power meter

[22] For reasons discussed in Section 1.4.3, we do not report the models with tips, but will instead explore the impact of individual tips on savings in future billing analyses.
[23] The implementer provided us with summaries of tips and not specific tip language. Therefore, the actual tip may be more specific than indicated in our list.

Weather data came from four regional stations in Connecticut. Using GIS, we created a map and assigned service account zip codes to the nearest of the four weather stations (Figure A-1). The areas in white are served by municipal utilities and the United Illuminating Company. Also, the Igor Sikorsky Memorial Airport is outside of the CL&P service territory, but it still is the closest weather station to many of the CL&P towns located in the southwest corner of the state.

Figure A-1: Weather Station Assignment



For each region, the team calculated average monthly temperature, total monthly heating degree days, and total monthly cooling degree days from daily data available from the NCDC website for December 2009 through August 2011.

OPower assigned each treatment household to a sub-treatment group based on frequency and duration of the reports: 1) monthly group receives a report reach month for 12 months; 2) quarterly group receives a report every three months for one year; and 3) persistent group receives a monthly report a certain duration but then ceases to receive the report.[24] However,

[24] This duration was originally planned to be six months, but NMR has learned that at least some—and perhaps all—of the persistence households received reports for eight months. This difference does not matter for the current analysis, as all persistence sample participants received reports the entire period of analysis.

OPower did not assign the control group to corresponding sub-control groups that matched the sub-treatment groups. NMR needed such assignment among the control group for our analysis, so we randomly assigned each control household to a sub-control group to correspond with the sub-treatment groups. We tweaked these households within the sub-control groups until their total average use was similar the use of the corresponding sub-treatment group.

We needed to remove some households from the analysis. The greatest number of cases was excluded because they did not have billing data for the full pre-program time period (2010 calendar year). We also removed households that had their service disconnected prior to January 1, 2011, accounting for most of the remaining removals. We excluded households from the analysis because they lacked a unique billing account, and another six household had not been assigned to a treatment or control group. In total, this process reduced the number of records from 48,129 to 48,080, with 22 records removed from the treatment group and 27 from the control group.

The final database included household characteristics, monthly billing data, monthly regional weather data, CEEF program participation, and a selection of tips received through the program. Table 2 summarizes the final sample sizes used in the analysis.

Table A–2: Participation and Use

	Households	Total Usage (kWh)	Average Usage (kWh)
Treatment Group	24,038	771,355,555	32,089
Control Group	24,042	770,480,392	32,047
Entire Study Group	48,080	1,541,835,947	32,068

Appendix B Detailed Discussion of Billing Analysis

The results described in Section 2.1 highlight the key results from the numerous models NMR ran to estimate the impact of the HERs program on electricity savings. This appendix is meant to provide more detail on the inputs into the fully specified models and an example of an alternative model that includes household characteristics. We present this appendix for those readers who may be interested in some of the statistical details of the analyses.

The treatment variables throughout the analysis are all created so that each study household is scored with either a zero or a one. The benefit of the approach is that the effects we find in the models apply to only those households scored with a one. For example, in the overall treatment variable, those records (*i.e.,* an individual month's billing data for a household) scored one represent treatment household in the post-period; all remaining records—the control households no matter the time period and treatment households in the pre-period—get scored as zero. As we narrow the treatment variables in order to analyze separate effects, the treatment variable refers to a more limited set of records*;* for example, in the quarterly treatment variable, those scored as one refers only to the records of treatment households in the post-period that have received quarterly reports. This allows us to control for specific treatment effects and identify the impact of each treatment on changes in energy use. Therefore, in a model containing the overall treatment variable and other treatment variables, the overall treatment variable describes the typical effect across all cases, controlling for such things as quarterly treatment and electric heat treatment. The other treatment variables capture the additional effect of that factor among the treatment group during the post-period. This method is what allows us to isolate the treatment effect to a specific time, to a specific type of report reception as well as to specific demographic differences. The complete effect for any group is the sum of the various treatment effects that apply to them.

Table B–1 is an example of the full model that NMR used to estimate electricity savings for the entire population. The model presented below is the same as that presented in the third column of Table 2–1. However, the information in Table B–1 includes not only the treatment, sub-treatment, weather, and electric heat effects but also lists the effects associated with monthly controls and various lower level interactions. The lower level interactions are included in the models so that the treatment estimate will not be biased. The models include monthly controls to account for variability in use that was not due to weather or treatment. We excluded the month of January from the models to avoid introducing perfect collinearity into the models, making then unable to estimate coefficients for the inputs.

Table B–1: Population Electricity Savings Estimate—Full Model

Input	Coefficient
Overall Treatment	0.63% (0.846)
Quarterly Treatment	-0.78 (1.004)
Post	1.42 (1.492)
CDD	-0.05 (0.004)
Electric Heat Treatment	5.28 (1.603)
Electric Heat* Post	21.46 (1.074)
February	7.17 (0.414)
March	24.91 (0.541)
April	49.06 (0.869)
May	58.41 (1.083)
June	51.80 (1.557)
July	25.78 (1.776)
August	18.68 (1.531)
September	32.48 (1.369)
October	50.02 (1.173)
November	45.83 (0.911)
December	23.17 (0.685)
2011	1.19 (0.541)
February 2011	-6.94 (0.499)
March 2011	-9.56 (1.154)
April 2011	-17.90 (1.586)
May 2011	-7.51 (1.580)
June 2011	-6.16 (1.571)
July 2011	4.82 (1.650)
August 2011	-4.12 (1.629)
Explained Variance (R^2)	0.21
# of Households	48,080

The next model is an example of one we rejected; this model includes the comprehensive set of household characteristics tested in the analysis (Table B–2). At first glance it looks as though a number of household characteristics (*i.e.,* electric heat, single family residence and, home age) were significant predictors of electricity use. However, other inputs (*i.e.,* home size, number of occupants, and presence of central air conditioning) were not significant. When we reran the model and included only those variables originally found to be statistically significant, the variables for single family residence and home age ceased being significant predictors of electricity use. Electric heat remained the only household variable that significantly predicted electricity use. Note also that, because we did not have household variables for all 48,080 households in the study group, inclusion of household variables caused the sample size to drop by nearly 20,000. It is likely that the homes for which we did not have households variables differed in systematic ways from those that did, although the bias was likely similar in the treatment and control groups.

Table B–2: Example of Savings Estimate with Household Characteristics[a]

	Estimate
Overall Treatment	0.55% (1.153)
Quarterly Treatment	-0.74 (1.234)
CDD	-0.05 (0.005)
Electric Heat	6.08 (2.446)
Single Family	-0.60 (1.112)
Home Age	-0.45 (0.875)
Home Size	0.11* (0.960)
Number of Occupants	-0.02* (0.864)
Central AC	0.18* (0.819)
Explained Variance (R^2)	0.22
# of Households	28,820

*Not significant at the 0.10 level

[a] The lower level interactions and month controls were excluded from the table for the sake of brevity.

Appendix C Statistical Details for Final Models

The tables presented in this section represent the same models presented in Section 2. The tables below are an expanded version of the tables in Section Results2, they include the standard error and the explained variance (*i.e.,* R-squared values). The standard error will give the 90% confidence interval by adding and subtracting the standard error from the effect in the top row of each cell. The explained variance (given as a percent) can be thought of as the amount of variance in energy usage that is explained by the model and is not due to extraneous factors. The higher the R-square, the better the model is at explaining the factors that lead to changes in energy use among the study group. Because we discuss the implications of these results in the full body of the report, we only present the more detailed tables here for those interested in assessing the models from a statistical perspective.

Table C–1: Program Induced Savings by Model Variations[a]

Type of Effect	Model Variation		
	Base	Controls for weather and month	Controls for household characteristics
Overall Treatment	2.9% (0.91)[b]	2.2% (0.908)	0.6% (0.846)
Quarterly Treatment	-0. 8 (1.18)	-0. 8 (1.182)	-0. 8 (1.004)
Cooling Degree Days[b]	N/A	-0.1 (0.004)	-0.1 (0.004)
Electric Heat Treatment	N/A	N/A	5.3 (1.603)
Explained Variance (R^2)	1%	20%	21%
# of Households	48,080	48,080	48,080

[a] The number in each cell is the percentage of savings in post-period energy use. Thus, the quarterly treatment group did not decrease use by 0.8%, instead they saved 0.8% less than indicated by the overall treatment effect.
[b] Numbers in parentheses refer to standard error.

Table C–2: Program Induced Savings by Sub-treatment Group[a]

Type of Effect	Sub-treatment Group Model	
	Quarterly	Monthly
Overall Treatment	1.4% (1.211)[b]	2.2% (1.00)
Cooling Degree Day	-0.1 (0.006)	-0.1 (0.005)
Explained Variance (R^2)	20%	20%
# of Households	19,986	28,094

[a] The number in each cell is the percentage of savings in post-period energy use. Thus, the quarterly treatment group did not decrease use by 0.8%, instead they saved 0.8% less than indicated by the overall treatment effect.
[b] Numbers in parentheses refer to standard error.

Table C–3: Program Induced Savings for First Three Months[a]

Type of Effect	Model for First Three Month of the Program	
	Through May	Through June
Overall Treatment	1.5% (0.805) [b]	1.8% (0.657)
Quarterly Treatment	-0.1* (0.981)	-0.5 (0.838)
Heating Degree Days	-5.95×10^3 (0.002)	-5.98×10^3 (0.002)
Explained Variance (R^2)	22%	21%
# of Households	48,080	48,080

[a] The number in each cell is the percentage of savings in post-period energy use. Thus, the quarterly treatment group did not decrease use by 0.8%, instead they saved 0.8% less than indicated by the overall treatment effect.
[b] Numbers in parentheses refer to standard error.
*Not significant

Table C–4: Program Induced Summer Savings Estimate[a]

Type of Effect	Without Electric Heat	With Electric Heat
Overall Treatment	1.8% (0.570) [b]	0.2%* (0.747)
Summer Treatment	0.4* (1.760)	0.4* (1.757)
CDD	-0.1 (0.004)	-0.1 (0.004)
Electric Heat Treatment	N/A	5.3 (1.603)
Explained Variance (R^2)	20%	21%
# of Households	48,080	48,080

[a] The number in each cell is the percentage of savings in post-period energy use. Thus, the quarterly treatment group did not decrease use by 0.8%, instead they saved 0.8% less than indicated by the overall treatment effect.
[b] Numbers in parentheses refer to standard error.
*Not significant

Table C–5: Program Induced Savings by Baseline Energy Use[a]

Type of Effect	Model Limited to Specified Terciles				
	Tercile 1 (highest use in study group)	**Tercile 2 (mid use in study group)**	**Tercile 3 (lowest use in study group)**	**Tercile 1 and 2**	**Tercile 2 and 3**
Overall Treatment	1.4% (1.727) [b]	0.5% (0.412)	0.3% (0.451)	1.2% (1.028)	0.6% (0.479)
Quarterly Treatment	-1.0 (1.977)	-0.2 (0.465)	-0.3 (0.510)	-1.7 (1.232)	-0.4 (0.535)
CDD	-0.1 (0.008)	0.0 (0.002)	0.0* (0.002)	0.0 (0.005)	-0.1 (0.002)
Electric Heat Treatment	4.4 (3.008)	0.2* (0.777)	0.2* (0.785)	4.3 (2.047)	0.5 (0.839)
Explained Variance (R^2)	32%	2%	0.8%	22%	12%
# of Households	16,027	16,006	16,027	32,053	32,053

[a] The number in each cell is the percentage of savings in post-period energy use. Thus, the quarterly treatment group did not decrease use by 0.8%, instead they saved 0.8% less than indicated by the overall treatment effect.

[b] Numbers in parentheses refer to standard error.

*Not significant

Appendix D Pre-Program Electricity Use for Different Household Groups

Given the concentration of program-induced savings among electric-heat treatment households, NMR examined the pre-program use of electric-heat households versus all other households to understand whether their baseline differed from other groups. Electric heat households account for just 28% of the households in the sample and are pretty evenly spread throughout the three terciles of use (see Table 1–3 for more on terciles). Therefore, we examined the data further to tease out why the electric heat households are having such a large impact on the results. We broke the population out by baseline energy use to determine if the electric-heat households differed from other households. We found that electric-heat households had higher baseline energy use than did the non-electric heat households for the entire study population and for treatment households (Table D-1). It was also the case, however, that pre-program use among electric heat treatment and control houses was statistically identical, so the finding that electric-heat-treatment households save more electricity cannot be explained by their usage being higher than control-group electric heat households. It is clear, then, that the electric heat households had the greatest opportunity to reduce their electricity use during the course of the program because their initial baseline energy use was so high, but also that electric heat use did not differ between treatment and control groups.

Table D–1: Mean Monthly Baseline Energy Usage in KWh by Electric Heat

Type of Effect	All Households		Treatment only Households		Electric Heat Households		Non-electric Heat Households	
	Electric Heat	Non-Electric Heat	Electric Heat	Non-Electric Heat	Treat-ment	Control	Treat-ment	Control
Use in kWh: All households	1,832	1,593	1,839	1,596	1,839	1,825	1,596	1,589
Sample size	13,528	34,552	6,760	10,826	6,844	6,768	17,194	17,274
Use in kWh: Highest Tercile	2,614	2,396	2,614	2,389	2,614	2,615	2,404	2,389
Sample size	5,722	10,305	2,900	5,108	2,281	2,256	5,731	5,758