



## Energy Efficiency / Demand Response Plan: Plan Year 4 (6/1/2011-5/31/2012)

### Evaluation Report: Home Energy Reports

FINAL

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## E. Executive Summary

This document presents the PY4 evaluation results for the ComEd Home Energy Reports behavioral program.<sup>1</sup> The program is designed to generate energy savings by providing residential customers with sets of information about customer energy use and energy conservation. The information is provided in the form of home energy reports (HERs) that give customers various types of information, including: a) how their recent energy use compares to their energy use in the past; b) tips on how to reduce energy consumption, some of which are tailored to the customer's circumstances; and c) information on how their energy use compares to that of neighbors with similar homes. Currently, participating households receive the reports bimonthly. This type of information has been shown in other studies to stimulate customers to reduce their energy use, creating average energy savings in the 1% to 3% range, depending on local energy use patterns.

The ComEd HER program has been rolled out in four waves: A pilot program involving approximately 50,000 residential customers initiated in Summer 2009 (Wave 1); a wave of about 3,000 customers (Wave 2) that started the program in Fall 2010 to "fill in" for Wave 1 inactive accounts; a major expansion of approximately 200,000 customers in Spring 2011 (Wave 3); and another "fill in" wave of about 20,000 in Winter 2011-2012 (Wave 4).

### E.1 Evaluation Objectives

The primary objective of the analysis in this report is to determine the extent to which participants in each wave of the HER program reduced their energy consumption due to the reports in PY4, and whether this reduction varied seasonally. A secondary question addressed in this report concerns the persistence of program savings by Wave 1 participants over the past three years of the program.

### E.2 Evaluation Methods

The HER program is implemented as a randomized controlled trial (RCT), in which individuals are randomly assigned to the treatment group and a control group, for the purpose of estimating changes in energy use due to the program. The treatment and control groups are approximately equal in size for Waves 1, 2, and 4. The control group for Wave 3 is approximately one-fourth the size of the participant group. Statistical analysis by Navigant designed to test for the implementation of an RCT indicated that an RCT was indeed implemented in Waves 2-4. With this in mind, Navigant used a statistical method—linear fixed effects regression (LFEER)—appropriate for use with RCTs to quantify the energy savings for Waves 2-4.

Statistical testing of an RCT for Wave 1 did not support the conclusion that the program was implemented as an RCT. Initially Wave 1 involved three groups of program households and their associated control households: approximately 20,000 households with relatively high energy consumption that received monthly HERs in the first year of the program comprised Group 1; about 15,000 households with relatively low energy consumption that received bi-monthly HERs comprised

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<sup>1</sup> The program implementer, OPower, designed the program, including the substance of the reports and the allocation of households between participant and control groups.

Group 2; and about 15,000 households with relatively low energy consumption that received quarterly HERs comprised Group 3. For all three groups the number of control households was about equal to the number of treatment households. In its RCT testing Navigant found strong evidence against an RCT design for Group 1, and weaker evidence against an RCT for Groups 2 and 3. The program implementer then identified an issue expected to be the source of the observed statistical results and provided a revised data set from which 2,629 customers in the control group in the original data set were deleted. For this revised data set, evidence against the RCT design persisted for Group 1, but not for Groups 2 and 3. This being the case, Navigant applied the standard LFER analysis using the revised data set to estimate program energy savings for Groups 2 and 3, but used this method and an alternative matching method for Group 1. The two methods generated estimates of energy savings that were not statistically different. The energy savings for Group 1 presented in this report are for the alternative matching method.

### ***E.3 Key Impact Findings and Recommendations***

The program savings for PY4 are presented in Table E-1. Seasonal impacts for PY4 are reported in Table 3-1 in Section 3 of the report. Findings include:

- Total program net savings in PY4 are 66,176 MWh.
- On a percentage basis, savings per customer are highest for Wave 1 participants (2.20%).
- Over the past two years energy savings by Wave 1 customers do not show signs of diminishing.
- On an absolute basis, savings per customer were virtually the same for Wave 1 and Wave 3 customers (see Table E-1). Navigant expects savings for Wave 3 customers to rise in PY5 only modestly above the 1.66% savings of PY4.
- On a percentage basis, savings per customer are lowest for Wave 4 participants (1.16%). Participants in this group started receiving reports during the winter of 2011-2012 and their savings are likely in a ramp-up phase. Navigant expects that savings for Wave 4 participants will increase by at least 50% over the next year.

The program appears to be performing well and so recommendations are limited:

- Continuing the program in its current form for at least another year.
- If the program is expanded, Navigant should receive the billing data for the new treatment and control households for the year prior to the date households are added to the program, which is *before* the home energy reports are initially sent to the new treatment households. Navigant will verify that the allocation of households across the two groups is consistent with a randomized controlled trial.

**Table E-1. PY4 Savings**

Period	Type of Statistic	Wave 1	Wave 2	Wave 3	Wave 4
		<i>Standard errors are in italics</i>			
	Number of Participants	46,142	2,973	193,902	20,188
	Sample Size, Treatment	39,488	2,687	183,288	19,857
	Sample Size, Control	31,350	2,670	45,323	19,898
<b>PY4</b>	Percent Savings	2.20%	1.45%	1.66%	1.16%
		<i>0.11%</i>	<i>0.39%</i>	<i>0.07%</i>	<i>0.31%</i>
	kWh Savings per customer	330.80	201.48	325.44	28.46
		<i>16.81</i>	<i>54.77</i>	<i>13.86</i>	<i>7.64</i>
	<b>Total MWh Savings</b>	<b>13,571</b>	<b>559</b>	<b>51,552</b>	<b>494</b>
		<i>691</i>	<i>151</i>	<i>2078</i>	<i>133</i>

Source: Navigant Analysis

#### ***E.4 Key Process Findings and Recommendations***

No process evaluation was conducted for this program.

## 1. Introduction to the Program

### 1.1 Program Description

The Home Energy Report (HER) program is designed to generate energy savings by providing residential customers with sets of information about their specific energy use and related energy conservation suggestions and tips. The information is provided in the form of Home Energy Reports that give customers various types of information, including: a) how their recent energy use compares to their energy use in the past; b) tips on how to reduce energy consumption, some of which are tailored to the customer's circumstances; and c) information on how their energy use compares to that of neighbors with similar homes. Currently, participating households receive the reports bimonthly. This set of information has been shown in other studies to stimulate customers to reduce their energy use, creating average energy savings in the 1% to 3% range, depending on local energy use patterns.

The ComEd program has been rolled out in four waves: A pilot program involving approximately 50,000 residential customers initiated in Summer 2009 (Wave 1); a wave of about 3,000 customers (Wave 2) that started the program in Fall 2010 to "fill in" for Wave 1 drops; a major expansion of approximately 200,000 customers in Spring 2011 (Wave 3); and another "fill in" wave of about 20,000 in Winter 2011-2012 (Wave 4). Table 1-1 presents a synopsis of the program rollout.

Wave 1 of the program received initial reports during August-September 2009, and involved three groups of customers that received different treatments in the first year of the program, as follows:

- Group 1: approximately 20,000 customers receive bimonthly reports after having started the program with six monthly reports. This group was randomly drawn from a set of about 40,000 high-use customers (that is, customers with relatively high energy consumption in the pre-program year), with the remaining 20,000 customers assigned to serve as control households for evaluating program savings.
- Groups 2 and 3, and sets of control households of equal size, were randomly drawn from a set of approximately 60,000 households with relatively low energy consumption in the pre-program year:
  - Group 2: about 15,000 customers receive bimonthly reports for the duration of the program.
  - Group 3: about 15,000 customers received monthly reports for the first three months of the program, and then switched to quarterly reports for two quarters, and then switched to bimonthly reports at the start of PY3.



**Table 1-1. Synopsis of the HER program**

Wave	Group	First Report Date <sup>†</sup>	Targeted Number of Participants <sup>‡</sup>	Targeted Number of Controls <sup>‡</sup>	Reporting Frequency
1	1	July 2009	20,000	20,000	six monthly reports, then bimonthly
1	2	July 2009	15,000	15,000	bimonthly reports
1	3	July 2009	15,000	15,000	three monthly reports, two quarterly reports, then bimonthly
2	-	September 2010	3,000	3,000	bimonthly reports
3	-	May 2011	195,000	50,000	bimonthly reports
4	-	January 2012	20,000	20,000	bimonthly reports

<sup>†</sup> This is the “first generated date” in the OPower dataset. Participants likely received their first report approximately one month later than this date.

<sup>‡</sup> These numbers are the targeted numbers for each wave. The actual number of participants is used in the evaluation.

## 1.2 Evaluation Questions

The primary objective of the analysis in this report is to determine the extent to which participants in each wave of the HER program reduced their energy consumption due to the reports in PY4, and whether this reduction varied seasonally. A secondary question addressed in this report concerns the persistence of program savings by Wave 1 participants over the past three years of the program.

## 2. Evaluation Methods

### 2.1 Primary Data Collection

From the program implementer Navigant received tracking data and monthly billing data for all program participants and control customers for the period of September 2008 to May 2012. Details are provided in Table 2-1.

**Table 2-1. Primary Data Collection Methods**

Collection Method	Subject Data	Quantity	Gross Impact	Net Impact	Process
Billing Data	Program participants and controls	All	X		N/A
Tracking Data	Program participants and controls	All	X		N/A
Tracking Data for Other Programs	Participants in Other Programs	All		X	N/A

#### 2.1.1 Sampling Plan

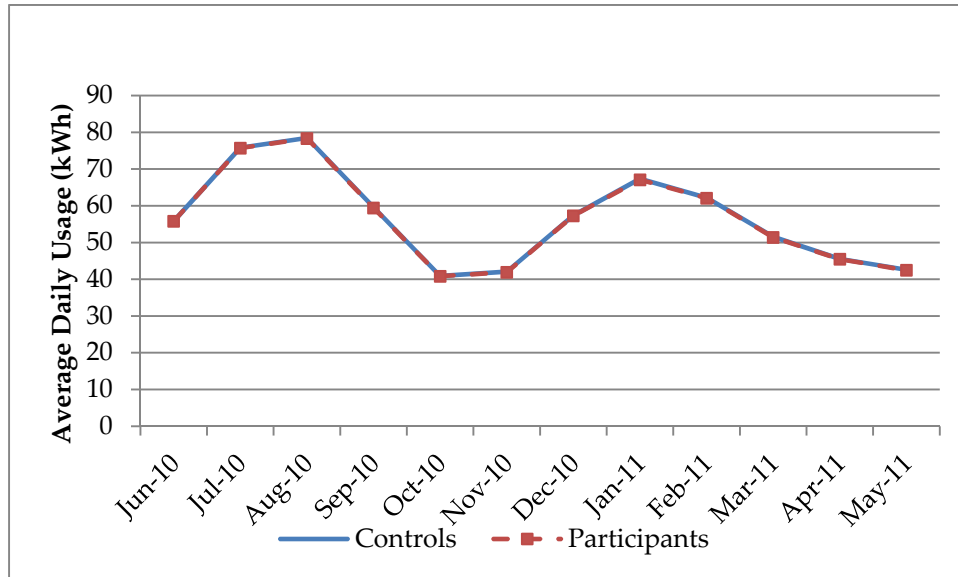
The HER program was implemented by the program implementer as a randomized controlled trial (RCT) in which individuals are randomly assigned to a treatment (participant) group and a control group, for the purpose of estimating changes in energy use due to the program.

##### 2.1.1.1 Statistical verification of the RCT design

Statistical analysis can be used to determine whether the assignment of customers to the treatment and control groups is consistent with an RCT design. The analysis involves comparing the means of the two groups with respect to demographic variables and energy use in the pre-program year. Navigant did not have available demographic variables for Waves 2-4, and so it conducted the analysis by making comparisons of the mean energy use for each wave in each month of the wave's pre-program year. Under the assumption of an RCT, and at the 90% confidence level, we would expect that for each wave chance alone would yield a statistical difference in mean consumption between the treatment and control groups for 0-2 months of the pre-program year.

Results for Waves 2-4 are consistent with an RCT. Figure 2-1 below provides an illustration of the results of the analysis, comparing the mean energy use of the control and treatment groups of Wave 3 during the pre-program year (June 2010 to May 2011). In light of these results, and as detailed in section 2.2, Navigant used a statistical method—linear fixed effects regression (LFER)—appropriate for use with RCTs to quantify the energy savings for Waves 2-4.

**Figure 2-1. Wave 3 Average Daily Energy Use during the Pre-Program Year**



Source: Navigant analysis

This statistical testing for Wave 1 did *not* support the conclusion that the program was implemented as an RCT. The program implementer then identified an issue expected to be the source of the observed statistical result and provided an alternative data set from which 2,629 customers in the control group in the original data set were deleted. The issue was that a number of program households with undeliverable mailing addresses were dropped from the program, while their control counterparts with the same particular issue of an undeliverable address were not dropped from the analysis. The revised data set reflects the removal of control households satisfying a known selection criterion for undeliverable address.

For this revised data set, evidence against the RCT design persisted for Group 1 of Wave 1, but not for Groups 2 and 3; results of the statistical tests for the three groups are reported in Table 5-1 in the Appendix. Since evidence against the RCT persisted for Group 1, Navigant applied the standard LFER analysis using the revised data set to estimate program energy savings for Groups 2 and 3, but used this method and an alternative matching method for Group 1. The two methods—the LFER analysis and the matching method—generated estimates of energy savings for Group 1 that were not statistically different. Navigant presents results for both methods in the discussion below, but uses the results from the matching method in reporting program savings.

### 2.1.2 Data Used in Impact Analysis

In preparation for the impact analysis, Navigant combined and cleaned the data provided by the implementer. The dataset included 279,313 participants and 121,023 controls. Navigant removed the following customers and data points from the analysis:

- Three customers in the control group with an opt-out date
- One customer without a control/recipient designation

- Customers with less than 11 or more than 13 bills during PY4
- Customers with less than 11 or more than 13 bills during the pre-program year
- Customers with no first report generation date
- Customers marked as “do not include in the analysis”<sup>2</sup>
- Participants with undeliverable addresses and controls with the same address problem
- For LFER analysis using the revised data set for Wave 1, the 2,529 customers indicated by the implementer as requiring removal
- Observations with less than 20 or more than 40 days in the billing cycle
- Observations missing billing usage data
- Observations outside of the twelve month pre-program period or the PY4 post period
- Outliers, defined as observations with average daily usage less than the 1<sup>st</sup> percentile or greater than the 99<sup>th</sup> percentile<sup>3</sup>

## 2.2 *Impact Evaluation Methods*

Navigant estimated program impacts using linear fixed effects regression (LFER) analysis applied to monthly billing data. The LFER model combines both cross-sectional and time series data in a panel dataset. The regression essentially compares pre- and post-program billing data for participants and controls to identify the effect of the program. The customer-specific fixed effect is a key feature of the LFER analysis and captures all customer-specific effects on electricity usage that do not change over time, including those that are unobservable. Examples include the square footage of a residence, the number of occupants, and thermostat settings.

For Wave 1/Group 1, Navigant estimated program savings using the LFER analysis as well as a regression analysis using matched controls. The matching method was used due to the concern that LFER analysis might not properly account for the differences between control and treatment households for Group 1 observed during the pre-program year. The analysis follows the approach advocated by Ho et al (2012) and Stuart (2010).<sup>4</sup> Matching is done on a seasonal basis. In the first step of the analysis, each participant household is matched to a control household based on a minimum distance criterion – in this case, the minimum sum of squared deviations in monthly energy consumption for the three months of the specified season in the pre-program year. In the second step, a panel data set consisting of the monthly energy use by program households and their matched controls is constructed for the same season in the program year, and used in a regression model predicting monthly energy use for the season.

Figure 2-2 presents the average energy use during the pre-program year for program households in Group 1 and their associated control households for three data sets: (a) the original data set

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<sup>2</sup> In the original dataset from the implementer, all Wave 2 customers were marked as do not include in the analysis. Navigant confirmed with the implementer that this was incorrect and subsequently included all Wave 2 customers in the analysis.

<sup>3</sup> Observations with average daily usage less than 9 kWh or greater than 165 kWh were removed from the dataset.

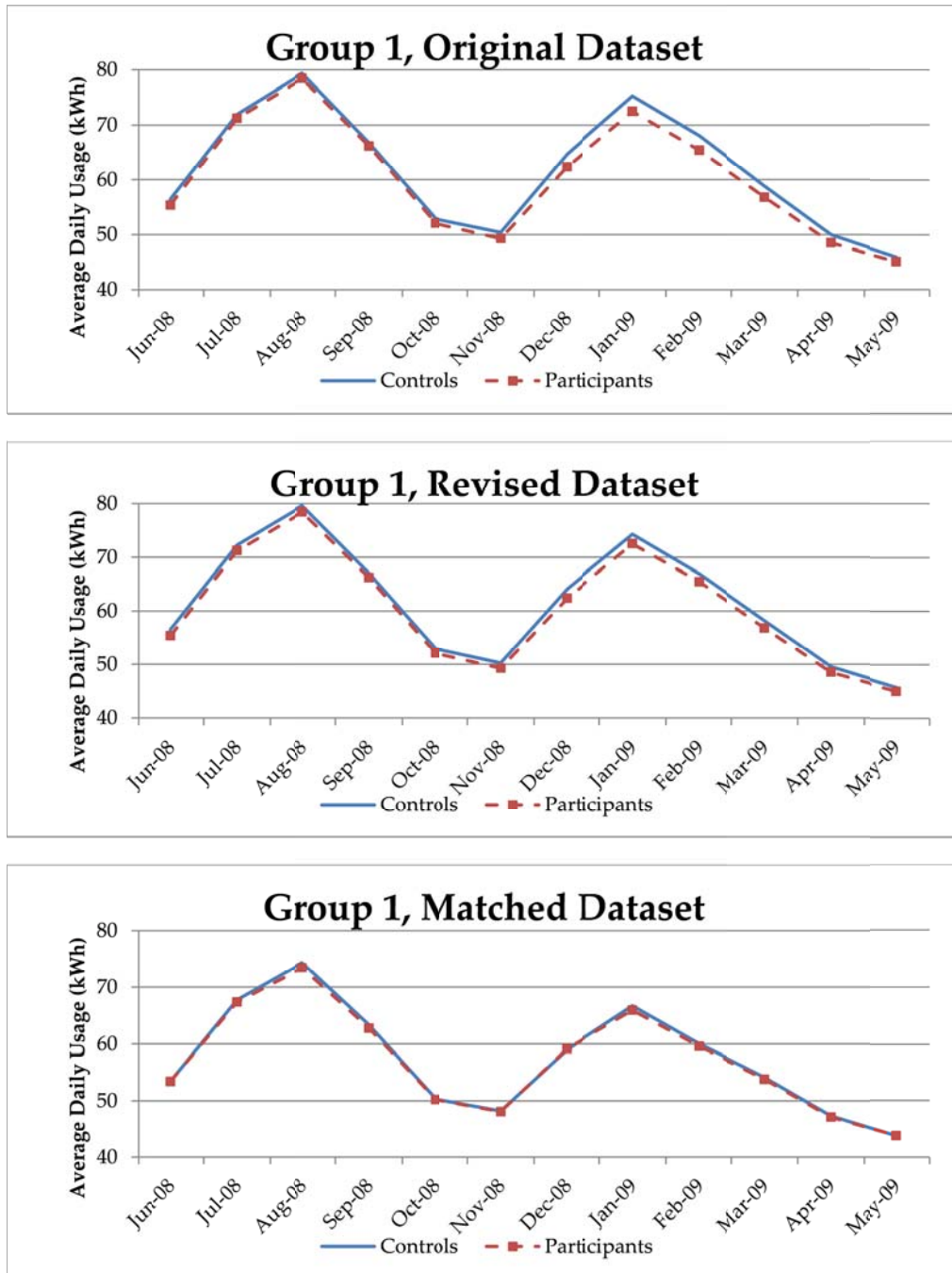
<sup>4</sup> References: (i) Stuart, E.A. 2010. “Matching Methods for Causal Inference: A Review and a Look Forward”. *Statistical Science*, 25(1): 1-21; (ii) Ho, Daniel E., Kosuke Imai, Gary King, and Elizabeth Stuart. 2007. “Matching as nonparametric preprocessing for reducing model dependence in parametric causal inference.” *Policy Analysis* 15(3): 199-236.

received from the program implementer; (b) the revised data set received from the program implementer; and (c) the data set constructed by the matching method. By construction the average energy use for treatment and control customers is closest in the matched control data set.

Applying the LFER analysis to the revised data set reflects the implicit assumption that after ex-post balancing of the control and treatment groups based on a known selection criterion for undeliverable addresses, any remaining bias is eliminated via the inclusion of household-specific fixed effects. In contrast, the matching method described above assumes that balancing the original data set based on total energy consumption during the season of interest in the pre-program year, and then applying regression analysis to account for any remaining imbalance in the sample, is sufficient to remove any potential bias in the estimate of savings. It should be noted that neither approach is theoretically superior to the other.

Section 5.2 of the appendix presents the LFER model and the regression model used in the matching analysis.

Figure 2-2. Average energy use of program households in Group 1 and their associated control households, June 2008 – May 2009



Source: Navigant analysis

### 2.2.1 Accounting for Uplift in other Energy Efficiency Programs

The HERs include energy saving tips, some of which encourage participants to enroll in other ComEd energy efficiency programs. If participation rates in other energy efficiency programs are the same for HER participants and controls, the savings estimates from the regression analysis are already “net” of savings from the other programs, as this indicates the HER program had no effect on participation in the other EE programs. However, if the HER program affects participation rates in other energy efficiency programs, then savings across all programs are lower than indicated by the simple summation of savings in the HER and EE programs. For instance, if the HER program increases participation in other EE programs, the increase in savings may be allocated to either the HER program or the energy efficiency program, but cannot be allocated to both programs simultaneously.<sup>5</sup>

As data permitted, Navigant used a difference-in-difference (DID) statistic to estimate uplift in other EE programs, in which the change in the participation rate in another EE program between PY4 and the pre-program year for the control group was subtracted from the same change for the treatment group. For instance, if the rate of participation in an EE program during PY4 is 5% for the treatment group and 3% for the control group, and the rate of participation during the year before the start of the HER program is 2% for the treatment group and 1% for the control group, then the rate of uplift due to the HER program is 1%, which is reflected the calculation  $(5\% - 2\%) - (3\% - 1\%) = 1\%$ . The DID statistic generates an unbiased estimate of uplift when the baseline average rate of participation is the same for the treatment and control groups, or when they are different due only to differences between the two groups in time-invariant factors, such as the square footage of the residence.

An alternative statistic that generates an unbiased estimate of uplift when the baseline average rate of participation in the EE program is the same for the treatment and control groups is a simple difference in participation rates during PY4. Navigant uses this alternative statistic –the “post-only difference” (POD) statistic –in cases where the EE program did not exist during the pre-program year, a situation relevant to Wave 1, for which the HER program began in June 2009.

Navigant examined the uplift associated with three energy efficiency programs: Appliance Recycling, CACES (three subprograms –DTUP, SEER 13, SEER 14+), and HES (Single Family). For each EE program, double-counted savings were calculated separately for each wave of the HER program.

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<sup>5</sup> It is not possible to avoid double counting of savings generated by programs for which tracking data is not available, such as upstream CFL programs.

## 3. Evaluation Results

This section presents the estimation results of the PY4 impact evaluation of the Home Energy Reports program.

### 3.1 *Impact Evaluation Results*

#### 3.1.1 **Verification and Due Diligence Procedure Review**

There were no verification and due diligence reviews related to this program.

#### 3.1.2 **Tracking System Review**

There was no tracking system review for this program.

#### 3.1.3 **Gross Program Impact Parameter Estimates**

Parameter estimates for the estimated models are found in the Appendix, Section 5.3.

Table 5-2 in the appendix presents the parameter estimates for the LFER model applied to the three groups of Wave 1, Table 5-3 presents the parameter estimates of the LFER model applied to Waves 2-4, and Table 5-4 presents the parameter estimates of the regression analysis using matched controls, applied to Wave 1/Group 1. Models were estimated seasonally with summer defined as June-August, fall as September-November, winter as December-February, and spring as March-May.

#### 3.1.4 **Gross Program Impact Results**

Table 3-1 presents estimated program savings. The estimated savings for Wave 1/Group 1 are based on the matching method described in the previous section (Model 2 in the appendix, section 5.1); all other estimates are based on the LFER analysis (Model 1 in the appendix, section 5.1). Multiplying the estimate of average daily savings for the season by the total number of participant-days for the season (91.25 participant-days for participants in the program for the entire season, less for participants in the program for only part of the season) generates seasonal savings. Annual savings are the sum of savings across the four seasons.

Figure 3-1 and Figure 3-2 graphically present seasonal average savings and percent savings.

Highlights from Table 3-1:

- Total gross program savings in PY4 are 66,176 MWh.
- On a percentage basis, savings per customer are highest for Wave 1 participants (average of 2.20%).
- After relatively low savings in the first season of the program (1.42% in summer 2011), savings by Wave 3 customers averaged about 1.8% over the rest of the program year.



#### *3.1.4.1 Comparison of model predictions for energy savings by Wave 1/Group 1*

As noted in Section 2, statistical evidence is not consistent with an RCT for Wave 1/Group 1, even for the revised data set developed by the program implementer. For this reason we estimated two models of energy use to derive estimates of program savings: the standard LFER model and a matching method using regression analysis. Comparisons of estimated savings for the two models are presented in Table 3-2. Differences between the two models are not statistically significant. Navigant's estimates of program savings are based on the matching method.

#### *3.1.4.2 Persistence of savings by Wave 1 customers*

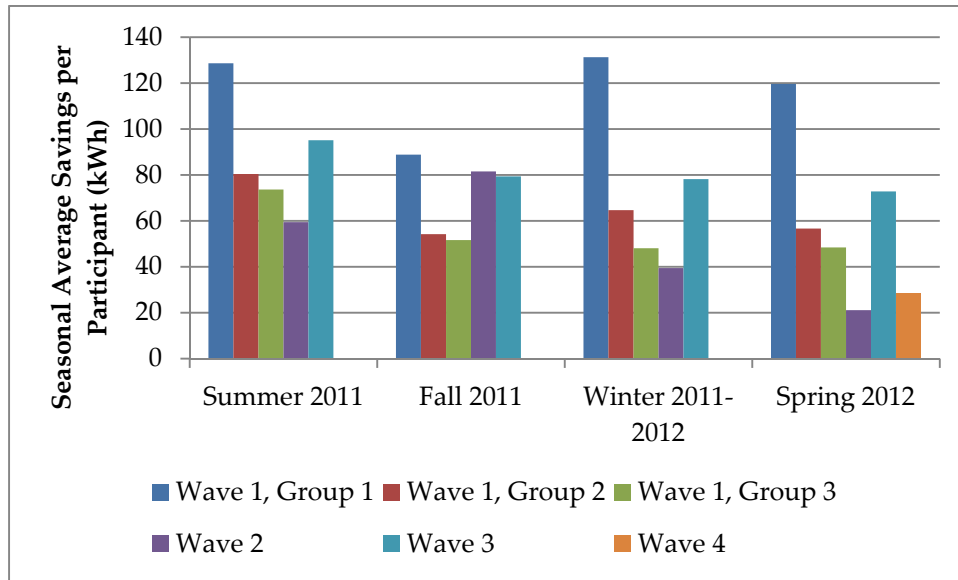
Wave 1 customers entered the HER program in July 2009 - through PY4 they have been in the program for almost three years. Table 3-3 summarizes seasonal percent savings from Fall 2009 through Spring 2012. Caution is warranted in interpreting the results presented in the table, as savings can be influenced by weather and other factors, and standard errors are fairly large. Nonetheless, results indicate no decline in savings over time as customers continue in the program for several years.

**Table 3-1. PY4 savings, annual and seasonal**

Period	Type of Statistic	Wave 1, Group 1	Wave 1, Group 2	Wave 1, Group 3	Wave 2	Wave 3	Wave 4
<i>Standard errors are provided in italics</i>							
	Number of Participants	18,492	13,794	13,856	2,973	193,902	20,188
	Sample Size, Treatment	16,107	11,725	11,656	2,687	183,288	19,857
	Sample Size, Control	9,292	11,051	11,007	2,670	45,323	19,898
PY4	Percent Savings	2.38% <i>0.18%</i>	2.23% <i>0.19%</i>	1.94% <i>0.19%</i>	1.45% <i>0.39%</i>	1.66% <i>0.07%</i>	1.16% <i>0.31%</i>
	kWh Savings per customer	468.40 <i>35.14</i>	255.88 <i>21.74</i>	221.77 <i>21.56</i>	201.48 <i>54.77</i>	325.44 <i>13.86</i>	28.46 <i>7.64</i>
	Total MWh Savings	7,805 <i>583</i>	3,079 <i>262</i>	2,687 <i>261</i>	559 <i>151</i>	51,552 <i>2078</i>	494 <i>133</i>
SUMMER 2011	Percent Savings	2.07% <i>0.31%</i>	2.09% <i>0.33%</i>	1.92% <i>0.32%</i>	1.39% <i>0.65%</i>	1.42% <i>0.14%</i>	-
	kWh Savings per customer	128.65 <i>19.24</i>	80.42 <i>12.63</i>	73.66 <i>12.41</i>	59.42 <i>28.04</i>	95.14 <i>9.42</i>	-
	Total MWh Savings	2,180 <i>326</i>	986 <i>155</i>	909 <i>153</i>	168 <i>79</i>	8,753 <i>866</i>	-
FALL 2011	Percent Savings	1.98% <i>0.35%</i>	2.10% <i>0.36%</i>	2.01% <i>0.36%</i>	2.55% <i>0.78%</i>	1.89% <i>0.13%</i>	-
	kWh Savings per customer	88.83 <i>15.93</i>	54.17 <i>9.26</i>	51.61 <i>9.22</i>	81.50 <i>25.05</i>	79.33 <i>5.38</i>	-
	Total MWh Savings	1,486 <i>264</i>	654 <i>112</i>	627 <i>112</i>	226 <i>70</i>	14,899 <i>1,011</i>	-
WINTER 2011-2012	Percent Savings	2.66% <i>0.38%</i>	2.34% <i>0.43%</i>	1.75% <i>0.43%</i>	1.12% <i>0.86%</i>	1.61% <i>0.14%</i>	-
	kWh Savings per customer	131.29 <i>18.96</i>	64.67 <i>11.88</i>	48.06 <i>11.93</i>	39.46 <i>30.34</i>	78.16 <i>6.56</i>	-
	Total MWh Savings	2,176 <i>311</i>	771 <i>142</i>	577 <i>143</i>	108 <i>83</i>	14,512 <i>1,219</i>	-
SPRING 2012	Percent Savings	2.94% <i>0.39%</i>	2.47% <i>0.40%</i>	2.12% <i>0.40%</i>	0.73% <i>0.89%</i>	1.86% <i>0.14%</i>	1.16% <i>0.31%</i>
	kWh Savings per customer	119.63 <i>15.85</i>	56.62 <i>9.28</i>	48.43 <i>9.14</i>	21.10 <i>25.80</i>	72.82 <i>5.60</i>	28.46 <i>7.64</i>
	Total MWh Savings	1,963 <i>260</i>	668 <i>109</i>	574 <i>108</i>	57 <i>69</i>	13,388 <i>1030</i>	494 <i>133</i>

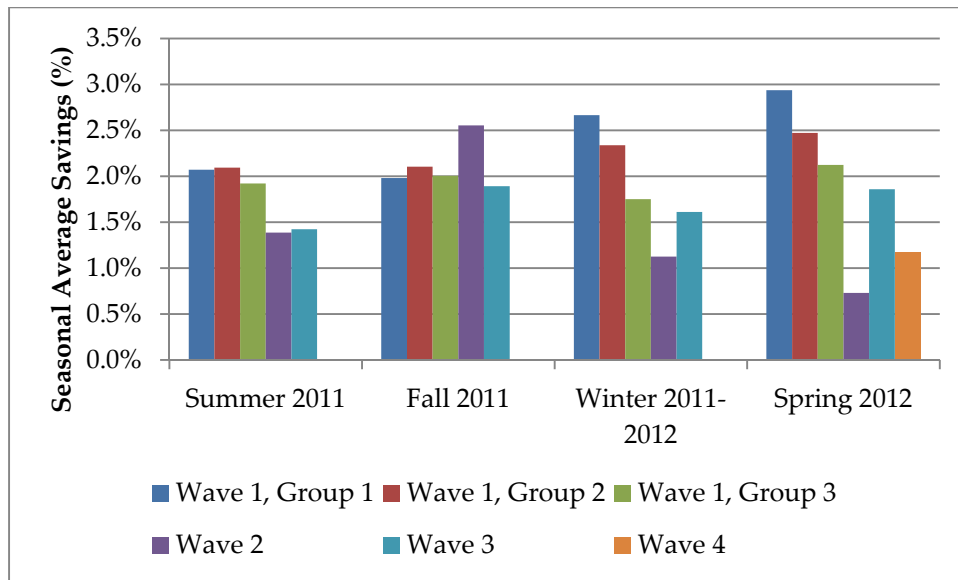
Source: Navigant Analysis. Total MWh savings include pro-rated savings for inactive accounts and participants with delayed first report dates.

**Figure 3-1. PY4 savings by season**



Source: Navigant analysis

**Figure 3-2. PY4 percent savings by season**



Source: Navigant analysis

**Table 3-2. Savings for Wave 1/Group 1 using two methods of estimation**

Period	Type of Statistic	Matching method	LFER analysis
<i>Standard errors are provided in italics</i>			
	Number of Participants	18,492	18,492
	Sample Size, Treatment	16,107	16,191
	Sample Size, Control	9,292	15,294
PY4	Percent Savings	2.38% <i>0.18%</i>	2.16% <i>0.15%</i>
	kWh Savings per customer	468.40 <i>35.14</i>	424.71 <i>30.38</i>
	Total MWh Savings	7,805 <i>583</i>	7,044 <i>504</i>
SUMMER 2011	Percent Savings	2.07% <i>0.31%</i>	1.93% <i>0.26%</i>
	kWh Savings per customer	128.65 <i>19.24</i>	119.53 <i>16.06</i>
	Total MWh Savings	2,180 <i>326</i>	2,026 <i>272</i>
FALL 2011	Percent Savings	1.98% <i>0.35%</i>	2.02% <i>0.30%</i>
	kWh Savings per customer	88.83 <i>15.93</i>	91.87 <i>13.59</i>
	Total MWh Savings	1,486 <i>264</i>	1,520 <i>225</i>
WINTER 2011-2012	Percent Savings	2.66% <i>0.38%</i>	2.32% <i>0.34%</i>
	kWh Savings per customer	131.29 <i>18.96</i>	115.03 <i>16.83</i>
	Total MWh Savings	2,176 <i>311</i>	1,886 <i>276</i>
SPRING 2012	Percent Savings	2.94% <i>0.39%</i>	2.43% <i>0.35%</i>
	kWh Savings per customer	119.63 <i>15.85</i>	98.28 <i>14.03</i>
	Total MWh Savings	1,963 <i>260</i>	1,613 <i>230</i>

Source: Navigant Analysis.

**Table 3-3. Persistence of HER program savings by Wave 1 participants**

Season	Group 1		Group 2		Group 3	
	Percent Savings	Standard Error	Percent Savings	Standard Error	Percent Savings	Standard Error
Fall 2009	1.46%	0.27%	0.90%	0.40%	1.51%	0.30%
Winter 2009-10	1.22%	0.36%	1.63%	0.36%	1.14%	0.36%
Spring 2010	1.89%	0.32%	1.07%	0.35%	1.41%	0.36%
Summer 2010	1.63%	0.27%	0.83%	0.32%	1.36%	0.32%
Fall 2010	2.53%	0.35%	2.38%	0.39%	1.85%	0.41%
Winter 2010-11	1.81%	0.35%	2.54%	0.41%	1.64%	0.42%
Spring 2011	2.47%	0.33%	2.08%	0.36%	1.83%	0.37%
Summer 2011	2.07%	0.31%	2.09%	0.33%	1.92%	0.32%
Fall 2011	1.98%	0.35%	2.10%	0.36%	2.01%	0.36%
Winter 2011-12	2.66%	0.38%	2.34%	0.43%	1.75%	0.43%
Spring 2012	2.94%	0.39%	2.47%	0.40%	2.12%	0.40%

Source: Navigant Analysis

### 3.1.5 Net Program Impact Parameter Estimates

No parameters were estimated in the assessment of net impacts.

### 3.1.6 Net Program Impact Results

Program savings are net savings *except* for the uplift in participation in other energy efficiency programs caused by the HER program. Program savings due to this uplift must be counted towards only one program, but not both programs. Table 3-4 to Table 3-8 present uplift savings for each Wave/Group for three ComEd energy efficiency programs; one of the programs, ComEd’s CACES program, is presented as three sub-programs. As noted in the previous section, where possible Navigant used a difference-in-difference (DID) statistic to estimate uplifted savings, and otherwise used a simple comparison of the rate of participation in EE programs by treatment and control households in PY4 –the “post-only difference” (POD) estimate of uplifted savings. The statistic used for each calculation of uplifted savings is indicated in the tables. The data available to Navigant indicates that none of the Wave 2 participant or control customers participated in any of these EE programs, and so there is no uplift for Wave 2.

The analysis reveals that the HER program has little effect on the rate of participation in these other EE programs.<sup>6</sup> The uplift in these other programs caused by the HER program is generally not statistically significant, and the total estimate of double-counted savings *assuming uplift occurs*

<sup>6</sup> The results in Tables 3-4 to 3-6 report Wave 1 results by group. Overall uplift for Wave 1 is the sum of uplift for each group, and is statistically significant for the Appliance Recycling program but not for the other four programs.

at the start of the program year is 354 MWh. Given the total estimate of HER program savings is 66,176 MWh, this amounts to 0.53% of estimated savings. To put this in perspective, the weighted average percent savings for PY4 due to the HER program is 1.71% of total energy use, and double counting reduces this value to 1.70%. In other words, the percentage point estimate of total energy use saved is overstated by only 1/100<sup>th</sup> of a percentage point.<sup>7</sup>

This estimate of double-counting is surely an *overestimate* because it presumes participation in the other EE programs occurs at the very start of PY4. Under the more reasonable assumption that participation occurs at a uniform rate throughout the year, the estimate of double counting would be roughly half the estimated value, -177 MWh. The upshot is that double counting of savings with other ComEd energy efficiency programs is not a significant issue for the HER program.

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<sup>7</sup> Multiplying 1.71% (the percent of total energy use saved) by 0.53% (the percentage of total savings double-counted) generates the value 0.01%. Formally,  $0.0171 \cdot 0.0053 = 0.0001$ . Subtracting this value from 0.0171 gives 0.0170, or 1.70%.

**Table 3-4. Estimates of Double Counted Savings: Wave 1, Group 1.**

	Program				
	Appliance Recycling	CACES - DTUP	CACES - SEER 13	CACES - SEER 14+	HES
Average program savings (annual kWh per participant)	653	213	366	592	482
# HER Treatment Households	18,492	18,492	18,492	18,492	18,492
Rate of participation, PY4 (%)	2.61%	0.39%	0.02%	0.03%	0.065%
Change in rate of participation from pre-program Year (%)	+2.28%	-	-	-	-
# HER control households	17,451	17,451	17,451	17,451	17,451
Rate of participation, PY4 (%)	2.38%	0.40%	0.05%	0.04%	0.063%
Change in rate of participation from pre-program Year (%)	+1.98%	-	-	-	-
DID/(POD) statistic	+0.30%	(-0.01%)	(-0.03%)	(-0.01%)	(+0.002%)
Change in program participation due to HER program	56.42	-2.18	-5.54	-2.42	0.34
Statistically Significant at the 90% Confidence Level?	Yes	No	No	No	No
<b>Savings attributable to other programs (kWh)</b>	<b>36,842</b>	<b>-463</b>	<b>-2,026</b>	<b>-1,431</b>	<b>166</b>

Source: Navigant analysis. A dash (-) indicates the EE program did not exist during the pre-program year. If the percentage in the row labeled "DID/(POD) statistic" is in parentheses, the estimate of uplift is based on a POD statistic; otherwise it is based on a DID statistic. Average Appliance Recycling, CACES, and HES program savings are from Navigant evaluations.

**Table 3-5. Estimates of Double Counted Savings: Wave 1, Group 2.**

	Program				
	Appliance Recycling	CACES - DTUP	CACES - SEER 13	CACES - SEER 14+	HES
Average program savings (annual kWh per participant)	653	213	366	592	482
# HER Treatment Households	13,794	13,794	13,794	13,794	13,794
Rate of participation, PY4 (%)	2.46%	0.26%	0.02%	0.01%	0.01%
Change in rate of participation from pre-program Year (%)	+1.96%	-	-	-	-
# HER control households	13,065	13,065	13,065	13,065	13,065
Rate of participation, PY4 (%)	2.32%	0.21%	0.01%	0.02%	0.05%
Change in rate of participation from pre-program Year (%)	+1.91%	-	-	-	-
DID statistic /(POD statistic)	+0.05%	(0.05%)	(0.01%)	(-0.01%)	(-0.04%)
Change in program participation due to HER program	8.11	7.49	1.94	-1.11	-5.39
Statistically Significant at the 90% Confidence Level?	No	No	No	No	Yes
<b>Savings attributable to other programs (kWh)</b>	<b>5,293</b>	<b>1,596</b>	<b>712</b>	<b>-658</b>	<b>-2,598</b>

Source: Navigant analysis. A dash (-) indicates the EE program did not exist during the pre-program year. If the percentage in the row labeled "DID/(POD) statistic" is in parentheses, the estimate of uplift is based on a POD statistic; otherwise it is based on a DID statistic. Average Appliance Recycling, CACES, and HES program savings are from Navigant evaluations.



**Table 3-6. Estimates of Double Counted Savings: Wave 1, Group 3.**

	Program				
	Appliance Recycling	CACES - DTUP	CACES - SEER 13	CACES - SEER 14+	HES
Average program savings (annual kWh per participant)	653	213	366	592	482
# HER Treatment Households	13,856	13,856	13,856	13,856	13,856
Rate of participation, PY4 (%)	2.42%	0.21%	0.02%	0.007%	0.058%
Change in rate of participation from pre-program Year (%)	+1.91%	-	-	-	-
# HER control households	12,958	12,958	12,958	12,958	12,958
Rate of participation, PY4 (%)	2.18%	0.24%	0.03%	0.008%	0.054%
Change in rate of participation from pre-program Year (%)	+1.68%	-	-	-	-
DID statistic /(POD statistic)	+0.23%	(-0.03%)	(-0.01%)	(-0.001%)	(0.004%)
Change in program participation due to HER program	30.89	-4.15	-1.28	-0.07	0.51
Statistically Significant at the 90% Confidence Level?	No	No	No	No	No
<b>Savings attributable to other programs (kWh)</b>	<b>20,173</b>	<b>-884</b>	<b>-467</b>	<b>-41</b>	<b>248</b>

Source: Navigant analysis. A dash (-) indicates the EE program did not exist during the pre-program year. If the percentage in the row labeled "DID/(POD) statistic" is in parentheses, the estimate of uplift is based on a POD statistic; otherwise it is based on a DID statistic. Average Appliance Recycling, CACES, and HES program savings are from Navigant evaluations.

**Table 3-7. Estimates of Double Counted Savings: Wave 3.**

	Program				
	Appliance Recycling	CACES - DTUP	CACES - SEER 13	CACES - SEER 14+	HES
Average program savings (annual kWh per participant)	653	213	366	592	482
# HER Treatment Households	199,073	199,073	199,073	199,073	199,073
Rate of participation, PY4 (%)	2.12%	0.12%	0.02%	0.01%	0.07%
Change in rate of participation from pre-program Year (%)	-0.10%	-0.24%	-0.02%	-0.04%	-0.02%
# HER control households	49,161	49,161	49,161	49,161	49,161
Rate of participation, PY4 (%)	1.84%	0.09%	0.03%	0.01%	0.03%
Change in rate of participation from pre-program Year (%)	-0.30%	-0.30%	+0.01%	-0.03%	-0.06%
DID statistic	+0.20%	+0.06%	+0.03%	-0.01%	+0.04%
Change in program participation due to HER program	409.31	105.21	-54.15	-15.16	69.43
Statistically Significant at the 90% Confidence Level?	Yes	Yes	Yes	No	Yes
<b>Savings attributable to other programs (kWh)</b>	<b>267,281</b>	<b>22,411</b>	<b>-19,818</b>	<b>-8,975</b>	<b>33,467</b>

Source: Navigant analysis. Average Appliance Recycling, CACES, and HES program savings are from Navigant evaluations.

**Table 3-8. Estimates of Double Counted Savings: Wave 4.**

	Program				
	Appliance Recycling	CACES - DTUP	CACES - SEER 13	CACES - SEER 14+	HES
Average program savings (annual kWh per participant)	653	213	366	592	482
# HER Treatment Households	20,831	20,831	20,831	20,831	20,831
Rate of participation, PY4 (%)	0.58%	0.00%	0.00%	0.00%	0.01%
Change in rate of participation from pre-program Year (%)	+0.27%	-0.07%	-0.02%	-0.01%	-0.10%
# HER control households	20,836	20,836	20,836	20,836	20,836
Rate of participation, PY4 (%)	0.54%	0.00%	0.00%	0.00%	0.00%
Change in rate of participation from pre-program Year (%)	+0.25%	-0.07%	-0.01%	-0.01%	-0.12%
Change in program participation due to HER program	4.01	1.00	-2.00	0.00	2.99
Statistically Significant at the 90% Confidence Level?	No	No	No	No	No
<b>Savings attributable to other programs (kWh)</b>	<b>2,620</b>	<b>212</b>	<b>-732</b>	<b>0</b>	<b>1,443</b>

Source: Navigant analysis. Because Wave 4 participants had been in the program for less than a year at the time of the evaluation, the DID statistic is based on a comparison of the post-program months with the same set of months during the pre-program year. Average Appliance Recycling, CACES, and HES program savings are from Navigant evaluations.

### 3.2 Process Evaluation Results

There was no process evaluation for this program.

## 4. Findings and Recommendations

### 4.1 Key Impact Findings and Recommendations

Key findings include the following:

- Total program net savings in PY4 are 66,176 MWh.
- On a percentage basis, savings per customer are highest for Wave 1 participants (2.20%; see Table E-1). Over the past two years energy savings by Wave 1 customers have not diminished.
- On an absolute basis, savings per customer were virtually the same for Wave 1 and Wave 3 customers (see Table E-1). Moreover, after the first season (summer) of PY4, the percent savings for Wave 3 were very similar to those for Wave 1/Group 3 (see Table 3-1). Based on this comparison, Navigant expects savings for Wave 3 customers to rise in PY5 only modestly above the 1.66% savings of PY4.
- On a percentage basis, savings per customer are lowest for Wave 4 participants (1.16%). Participants in this group started receiving reports during the Winter of 2011-2012 and their savings are likely in the ramp-up phase. Navigant expects savings for Wave 4 participants will increase by at least 50% over the next year.

The program continues to generate consistent energy savings for Wave 1 customers after three years, and is highly likely to generate consistent program savings for all waves for the foreseeable future. Navigant recommends continuing the program in its current form for at least another year.

Navigant understands that ComEd has executed a change in the HER program in which, to examine the persistence of program effects after termination of HER reports, 20,000 program households were removed from the program in September 2012. Half of these were from Wave 1 and half were from Wave 3. These households were replaced in the program by a new wave of participants. Removing a set of participants from the program to examine the persistence of savings in the absence of the home energy reports was Navigant's primary recommendation for program change last year. Currently Navigant does not recommend any additional changes in the program.

Finally, if additional customers are added to the program, Navigant recommends that it receive billing data during the pre-program year for the new treatment and control households so that it can verify that the allocation of households across the two groups is consistent with a randomized controlled trial.

In summary, Navigant recommends the following:

- Continuing the program in its current form for at least another year.
- If the program is expanded, Navigant should receive the billing data for the new treatment and control households for the year before these households are added to the program, *before* the home energy reports are initially sent to the new treatment

households. Navigant will verify that the allocation of households across the two groups is consistent with a randomized controlled trial.

#### ***4.2 Key Process Findings and Recommendations***

There was no process evaluation for this program.

## 5. Appendix

### 5.1 Results from Statistical Tests of Differences in Energy Use during the Pre-Program Year, Wave 1

**Table 5-1. Percent difference in energy use between participant and control households, Wave 1, pre-program year**

Month	Group 1		Group 2		Group 3	
	% Difference	Prob(diff=0)	% Difference	Prob(diff=0)	% Difference	Prob(diff=0)
Jun-08	2.14%	0.0008	-0.36%	0.3580	-0.88%	0.0266
Jul-08	1.46%	0.0152	-0.65%	0.1212	-0.56%	0.1830
Aug-08	1.48%	0.0111	-0.30%	0.4758	-0.49%	0.2484
Sep-08	1.26%	0.0432	-0.38%	0.3622	-0.28%	0.5007
Oct-08	1.61%	0.0102	-0.04%	0.9234	0.08%	0.8416
Nov-08	1.96%	0.0015	0.42%	0.2597	0.16%	0.6749
Dec-08	2.69%	0.0000	0.09%	0.8328	-0.19%	0.6569
Jan-09	2.42%	0.0004	-0.27%	0.5695	0.40%	0.3858
Feb-09	2.23%	0.0035	0.25%	0.6603	0.19%	0.7391
Mar-09	2.37%	0.0002	0.18%	0.6789	-0.01%	0.9785
Apr-09	2.13%	0.0004	-0.12%	0.7524	-0.28%	0.4431
May-09	1.60%	0.0158	0.13%	0.7523	-0.06%	0.8773

Source: Navigant Analysis. Differences apply to the revised data set provided by the program implementer. A negative difference indicates the participants have greater average consumption than the control households. A probability less than 0.05 indicates that the difference in consumption is statistically significantly different from 0 at the 95% confidence level.

### 5.2 Detailed impact methodology

The simplest version of a linear fixed effects regression (LFER) model convenient for exposition is one in which average daily consumption of kWh by household  $k$  in bill period  $t$ , denoted by  $ADU_{kt}$ , is a function of three terms: the binary variable  $Treatment_k$ , taking a value of 0 if household  $k$  is assigned to the control group, and 1 if assigned to the treatment group; the binary variable  $Post_t$ , taking a value of 0 if month  $t$  is in the pre-treatment period, and 1 if in the post-treatment period; and the interaction between these variables,  $Treatment_k \cdot Post_t$ . Formally,

**Model 1**

$$ADU_{kt} = a_{0k} + a_1 Post_t + a_2 Treatment_k \times Post_t + e_{kt}$$

Three observations about this specification deserve comment. First, the coefficient  $a_{0k}$  captures **all** household-specific effects on energy use that do not change over time, including those that are unobservable. Second,  $a_1$  captures the average effect *across all households* of being in the post-treatment period. In other words, the effects of exogenous factors, such as an economic recession, that affect all households in the post-treatment period are absorbed in the *Post* variable. **Third, the effect of being both in the treatment group and in the post period—the effect directly attributable to the program—is captured by the coefficient  $a_2$ .** This term captures the *difference in the difference* in average daily kWh use between the treatment group and the control group across the pre- and post-treatment periods. In other words, whereas the coefficient  $a_1$  captures the change in average daily kWh use across the pre- and post-treatment for the *control* group, the sum  $a_1 + a_2$  captures this change for the treatment group, and so  $a_2$  is the coefficient analogous to the difference-in-difference statistic indicating the effect on the program on average monthly household energy use.

For Wave 1/Group 1, Navigant supplemented the LFER analysis of savings by using regression analysis of program households and matched controls. Matching was done for each season of the year. Each program household was matched to the control household with the most similar energy use during the season in the pre-program year, as measured by the sum of squared deviations in monthly energy use for the season. The summer season covered June-August; the fall season covered September-November; the winter season covered December-February; and the spring season covered March-May. Matches were very close, with control households averaging 0.66% more energy use per month during the pre-program year, compared to an average difference of 1.95% in the revised data set provided by the program implementer (see Figure 3-2 in the text).

Using the program households and their matched controls, the following regression equation was estimated for each season of the program year:

**Model 2**

$$ADU_{kt} = a_1 + a_2 D_2 + a_3 D_3 + a_4 D_1 ADU1_k + a_5 D_2 ADU2_k + a_6 D_3 ADU3_k + a_7 Treatment_k + e_{kt}, \tag{1}$$

where,

- $D_i =$  A dummy variable indicating the  $i^{th}$  month of the season,  $i=1,2,3$ ;
- $ADU_i =$  Average daily energy use in the  $i^{th}$  month of the season in the pre-program year;

and  $Treatment_k$  was defined previously. This model accounts for remaining average differences in monthly energy consumption between treatment households and their control matches that are *not* due to the HER program by using energy use in each month of the pre-program year as a predictor of energy use for the month in the program year. The program effect on average daily energy use is captured by the estimated coefficient  $\alpha_7$ . The model uses standard errors clustered on the household.

### 5.3 Detailed impact results: parameter estimates

**Table 5-2. LFER Parameter Estimates for Wave 1**

Variable	Group 1		Group 2		Group 3	
	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
<i>Summer Model</i>						
Post	2.972	23.60	4.528	45.84	4.419	45.49
Post*Treatment	-1.299	-7.44	-0.874	-6.37	-0.801	-5.94
<i>Fall Model</i>						
Post	-4.722	-44.39	-1.289	-17.51	-1.359	-18.84
Post*Treatment	-0.999	-6.76	-0.595	-5.85	-0.567	-5.60
<i>Winter Model</i>						
Post	-8.711	-66.51	-3.902	-41.87	-4.027	-43.65
Post*Treatment	-1.250	-6.84	-0.711	-5.44	-0.528	-4.03
<i>Spring Model</i>						
Post	-4.549	-41.28	-1.567	-21.73	-1.522	-21.64
Post*Treatment	-1.068	-7.00	-0.615	-6.10	-0.526	-5.30

Source: Navigant Analysis.



**Table 5-3. LFER Parameter Estimates for Waves 2-4**

Variable	Wave 2		Wave 3		Wave 4	
	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
<i>Summer Model</i>						
Post	8.543	38.82	3.493	38.16	-	-
Post*Treatment	-0.646	-2.12	-1.034	-10.10	-	-
<i>Fall Model</i>						
Post	-1.405	-7.01	-1.407	-26.55	-	-
Post*Treatment	-0.896	-3.25	-0.872	-14.74	-	-
<i>Winter Model</i>						
Post	-4.194	-18.03	-6.526	-101.1	-	-
Post*Treatment	-0.434	-1.30	-0.859	-11.91	-	-
<i>Spring Model</i>						
Post	-2.074	-10.45	-3.648	-67.00	-2.877	-48.39
Post*Treatment	-0.229	-0.82	-0.792	-13.00	-0.309	-3.73

Source: Navigant Analysis.

**Table 5-4. Parameter Estimates of Regressions Using Matched Controls, Wave 1/Group 1**

Variable	Coefficient	t-statistic
<i>Summer Model</i>		
Intercept	14.466	39.24
D <sub>2</sub>	1.868	4.22
D <sub>3</sub>	5.182	9.93
D <sub>1</sub> *ADU1	0.753	106.64
D <sub>2</sub> *ADU2	0.790	119.71
D <sub>3</sub> *ADU3	0.816	126.26
Treatment	-1.398	-6.69
<i>Fall Model</i>		
Intercept	11.445	29.13
D <sub>2</sub>	-2.170	-5.18
D <sub>3</sub>	-2.068	-4.07
D <sub>1</sub> *ADU1	0.752	113.84
D <sub>2</sub> *ADU2	0.678	88.38
D <sub>3</sub> *ADU3	0.736	80.99
Treatment	-0.976	-5.64
<i>Winter Model</i>		
Intercept	13.585	33.58
D <sub>2</sub>	2.179	5.05
D <sub>3</sub>	2.584	5.93
D <sub>1</sub> *ADU1	0.642	85.69
D <sub>2</sub> *ADU2	0.602	84.97
D <sub>3</sub> *ADU3	0.606	85.31
Treatment	-1.443	-7.00
<i>Spring Model</i>		
Intercept	12.291	34.79
D <sub>2</sub>	0.866	2.17
D <sub>3</sub>	-1.918	-4.33
D <sub>1</sub> *ADU1	0.659	93.67
D <sub>2</sub> *ADU2	0.598	66.99
D <sub>3</sub> *ADU3	0.742	75.20
Treatment	-1.300	-7.55

Source: Navigant Analysis