



# **Home Energy Report C3 Energy Program PY7 Evaluation Report**

**Final**

**Energy Efficiency/Demand Response Plan:  
Plan Year 7  
(6/1/2014-5/31/2015)**

**Presented to  
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## E. Executive Summary

This report presents a summary of the findings and results from the impact evaluation of the portion of the PY7 Home Energy Report (HER) Program implemented by C3 Energy (C3).<sup>1</sup> Commonwealth Edison Company (ComEd) designed the program to generate energy savings by providing residential customers with sets of information about customer energy use and energy conservation. Program participants received information in the form of quarterly home energy reports that gave customers various types of information, including the following:

- Assessment of how their recent energy use compared to their energy use in the past.
- Tips on how to reduce energy consumption, some of which were tailored to the customer's circumstances.
- Information on how their energy use compared to that of neighbors with similar homes.

PY7 was the first year that C3 implemented a portion of the HER Program. ComEd targeted 200,000 residential customers to participate in this implementer's portion of the program. This wave also included 50,000 control customers. The program was implemented as a randomized control trial (RCT) where customers were randomly split between a treatment group who received reports and a control group who did not. The program implementer sent reports on six dates between August 2014 and May 2015.

### E.1 Program Savings

Table E-1 summarizes the electricity savings from the HER Program. The PY7 planning target for this program was 32,825 MWh. Total savings prior to uplift were 715 MWh, which is per customer savings of 0.10 percent or 6.57 kWh annually. After adjusting for uplift from other energy efficiency programs (see Section 3.2), total savings were 772 MWh.<sup>2</sup> However, the total savings estimate was not statistically significant at the 90 percent confidence level and thus final verified savings are reported as zero.<sup>3</sup> Report timing and frequency was inconsistent, which may have contributed to the low savings.

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<sup>1</sup> The PY7 program year began June 1, 2014 and ended May 31, 2015.

<sup>2</sup> An increase in savings after adjusting for uplift indicates that the program caused fewer customers to join ComEd's other energy efficiency programs. This is discussed in more detail in Sections 2.5 and 3.2.

<sup>3</sup> As explained in Section 4, a key feature of the randomized controlled trial (RCT) design is that the analysis inherently estimated net savings because there were no participants who otherwise might have received individualized reports in the absence of the program. Thus, there was no free ridership and no NTGR was applied for this program.

**Table E-1. PY7 Total Program Electric Savings**

Savings Category	Energy Savings (MWh)
Ex-Ante Savings†	-
Verified Savings, Prior to Uplift Adjustment	715
PY7 Uplift Adjustment	-57
Verified Savings, After Uplift Adjustment	772
Final Verified Savings‡	0
Final Verified Realization Rate*	-

Source: ComEd tracking data and Navigant analysis.

† Navigant did not receive an estimate of ex-ante savings for this program.

‡ Because the savings estimate was not statistically significant at the 90 percent confidence level final verified savings are reported as zero.

\* The realization rate for this program could not be calculated as there is no estimate of ex-ante savings.

## E.2 Detailed Program Savings

Table E-2 summarizes estimated program savings. The number of participants, in the first row, represents the number of customers in the treatment group, while the sample sizes, in the second and third row, indicate the number of customers with sufficient data for inclusion in the regression analysis. Average per customer savings were 6.57 kWh or 0.10 percent.

**Table E-2. PY7 HER C3 Program Results**

Type of Statistic	C3 Wave
Number of Participants	200,000
Sample Size – Treatment	149,797
Sample Size - Control	22,524
Percentage Savings	0.10%
	Standard Error 0.19%
Annualized kWh Savings Per Customer	6.57
	Standard Error 12.36
Verified Savings, Prior to Uplift Adjustment, MWh†	715
	Standard Error 1,346
Savings Uplift in Other EE Programs in PY7, MWh‡	-57
Verified Savings, After Uplift Adjustment, MWh*	772
Final Verified Savings, MWh**	0

Source: Navigant analysis

† Total savings are pro-rated for participants that closed their accounts during PY7.

‡ Negative double counted savings indicate that the participation rate in the EE program is higher for the control group than the treatment group. This lowers the baseline and underestimates HER program savings.

\* Net savings adjusted for savings uplift are equal to net savings less the uplift of savings in other EE programs.

\*\* Because the savings estimate was not statistically significant at the 90 percent confidence level final verified savings are reported as zero.

### E.3 Findings and Recommendations

The following section includes program findings and recommendations.<sup>4</sup>

**Finding 1.** The point estimates of per customer savings were 0.10 percent or 6.57 kWh per year.

While the program appears to have generated savings of 772 MWh, these results were not statistically significant and, thus not distinguishable from zero. Hence, our primary finding is that the program achieved no verified energy savings in PY7. This was the first year that a portion of ComEd's HER Program was implemented by C3. While the impact evaluation is not designed to determine why savings are lower than expected, we have identified three potential causes: inaccurate data, type of customer in the program, and program design and implementation. Data was reviewed both before and during the analysis, and neither check revealed problems with the raw data received from ComEd and the program implementer. Based on energy usage, the customers in this wave resembled those in Wave 7 Low of the Opower portion of ComEd's HER Program,<sup>5</sup> thus we do not think the type of customer in the program led to the low, statistically insignificant savings. This impact evaluation does not review the program design, but in terms of the implementation, the timing and frequency of reports was inconsistent which may have contributed to the low savings.

**Recommendation 1.** ComEd should engage in a process review of the program to examine the program design. A materials review of the report content and a short customer survey could shed light on why this implementer has achieved lower savings than expected.

**Recommendation 2.** Going forward, the program implementer should create a regular cadence of report mailings (for example, monthly or quarterly) and ensure that each participant is sent a report on each mailing date. This will increase the consistency of the HER Program experience across participants and may lead to increased savings in the future.

**Finding 2.** The uplift analysis indicated that HER participants were less likely than controls to enroll in other energy efficiency (EE) programs in PY7.

**Recommendation 3.** The implementation contractor should include prominent advertisements for other EE programs on the HERs to increase participant enrollment in those programs. Which programs are highlighted could be tied to the season or to the tips a customer receives. This could increase participant uplift into other EE programs in the future.

**Finding 3.** Two aspects of program implementation affected the RCT design. First, the first report date for each participant was not randomly assigned, that is, higher usage customers got their first report earlier than low usage customers. Second, 13 percent of participants never received a report due to either insufficient billing data<sup>6</sup> or an inaccurate mailing address. Navigant applied an ex-post adjustment to customer savings to account for these problems, however, the adjustment was very small (from 0.08 percent savings to 0.10 percent).

**Recommendation 4.** In the future, the implementation contractor should ensure that the program roll-out does not compromise the RCT design. This means that the timing of the first report

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<sup>4</sup> Numbered findings and recommendations in this section are the same as those found in the Findings and Recommendations section of the evaluation report for ease of reference between each section.

<sup>5</sup> Navigant Consulting, Inc. 2015. *Home Energy Report Opower Program PY7 Evaluation Report*.

<sup>6</sup> Sufficient billing data was defined by C3 as twelve months of data, including the two months prior to the treatment start date.

should be random rather than correlated with usage; alternatively, control customers could be assigned a first report date using the same criteria as participants. Additionally, when treatment customers are excluded due to visible characteristics, such as insufficient data, control customers with the same characteristics should also be identified. Adhering to the RCT design will avoid the need for ex-post adjustments to the savings in the future.

Introduction

## 1.2 *Program Description*

This report presents the findings and results from the impact evaluation of the portion of the PY7 Home Energy Report (HER) Program implemented by C3 Energy (C3).<sup>7</sup> Commonwealth Edison Company (ComEd) designed the program to generate energy savings by providing residential customers with sets of information about customer energy use and energy conservation. Program participants received information in the form of quarterly home energy reports that gave customers various types of information, including the following:

- Assessment of how their recent energy use compared to their energy use in the past
- Tips on how to reduce energy consumption, some of which were tailored to the customer's circumstances (e.g., customers with pools received information on how to reduce energy use related to pools).
- Information on how their energy use compared to that of neighbors with similar homes.

PY7 was the first year that C3 was used as an implementer for this program. ComEd targeted 200,000 residential customers as participants. In PY7 participants in this wave used approximately 18.09 kWh of electricity per day. This wave also included 50,000 control customers. The program implementer sent reports on six dates between August 2014 and May 2015.

An important feature of the HER Program is that it was a randomized controlled trial (RCT). Customers in the feasible set of customers (that is, those customers meeting program criteria) were randomly assigned to a treatment (participant) group or control (non-participant) group for the purpose of estimating changes in energy use due to the program.

## 1.3 *Evaluation Objectives*

The primary objective of the analysis in this report is to determine the extent to which participants in the PY7 HER Program reduced their energy consumption.

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<sup>7</sup> The PY7 program year began June 1, 2014 and ended May 31, 2015.



## 2 Evaluation Approach

The evaluation approach used in this report is consistent with that of the evaluation used for other implementers in the HER Program, relying on statistical analysis appropriate for RCTs. Navigant estimated program impacts using two approaches: a simple post-program regression (PPR) analysis with lagged controls and a linear fixed-effects regression (LFER) analysis applied to monthly billing data.

### 2.1 Overview of Data Collection Activities

Navigant received tracking data and monthly billing data for all program participants and control customers from May 2013 to June 2015 from the program implementer. Table 2-1 provides details.

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

Collection Method	Subject Data	Quantity	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

*Source: Navigant analysis*

### 2.2 Sampling Plan

The HER Program was executed by the program implementer as a RCT, in which individuals were randomly assigned to either a treatment (participant) group or control (non-participant) group.<sup>8</sup> Data for all participants and controls were included in this impact evaluation.

### 2.3 Data Used in Impact Analysis

In preparation for the impact analysis, Navigant combined and cleaned the data provided by the implementer. The dataset included 200,000 treatment customers and 30,000 controls. During PY7 this program ran from August 2014 until May 2015. Data during this program period and during the corresponding ten month pre-period, August 2013 to May 2014, was used in the regression analysis for each of the two models described in Section 2.4.

Navigant removed the following customers and data points from the regression analysis:

- Customers with an active account and less than eight bills and any customer with more than 11 bills during PY7 (4770 participants, 31,823 controls);
- Customers with less than eight or more than eleven bills during the pre-program year (32 participants, 184 controls);
- Observations with missing or negative usage (0 participant observations, 0 control observations);
- Observations with less than 20 or more than 40 days in the billing cycle (84,557 participant observations and 12,475 control observations);
- Outliers, defined as observations with average daily usage more than one order of magnitude from the median usage (21,089 participant observations and 3,096 control observations).<sup>9</sup>

<sup>8</sup> In this design, treatment customers receive HERs, while control customers do not.

<sup>9</sup> Median usage was 34.20 kilowatt-hours (kWh) per day, so usage above 342.0 and below 3.420 was removed.

## 2.4 Statistical Models Used in the Impact Evaluation

As indicated above, Navigant estimated program impacts using two approaches: a simple post-program regression (PPR) analysis with lagged controls and a linear fixed-effects regression (LFER) analysis applied to monthly billing data. Navigant uses the PPR results for reporting total program savings for PY7 but ran both models as a robustness check.<sup>10</sup> Although the two models are structurally very different, assuming the RCT is well balanced with respect to the drivers of energy use, in a single sample they generate very similar estimates of program savings.

The PPR model combines both cross-sectional and time-series data in a panel format. It uses the post-program data as the dependent variable, with lagged energy use from the same calendar month of the pre-program period serving as a control for any small, systematic differences between the treatment and control customers. The lagged energy use term is similar to the customer fixed effect included in the LFER model explained below.

As with the PPR model, the LFER model combines both cross-sectional and time-series data in a panel format. 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 factors affecting electricity usage that do not change over time, including those that are unobservable. Examples include the square footage of a residence or the number of occupants. The fixed effect represents an attempt to control for any small, systematic differences between the treatment and control customers that might occur due to chance.

Section 6.1 presents the PPR and LFER models used in the analysis. Additionally, Section 6.2 describes two aspects of the implementation which compromised the RCT design and the ex-post adjustment Navigant applied to correct for them.

## 2.5 Accounting for Uplift in Other Energy Efficiency Programs

### 2.5.1 Accounting for Uplift in PY7

The home energy reports sent to participating households included energy-saving tips, some of which encouraged participants to enroll in other ComEd energy efficiency (EE) programs. If participation rates in other EE programs are the same for the HER participant and control groups, the savings estimates from the regression analyses are already “net” of savings from the other programs, as this indicates the HER Program did not increase or decrease participation in the other EE programs. However, if the HER Program affects participation rates in other EE 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 EE program, but cannot be allocated to both programs simultaneously.<sup>11</sup> Note

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<sup>10</sup> Navigant prefers to report out the PPR model for two reasons. One, the implementer is also using a post-only model for evaluation. Two, although both the LFER and PPR models generate unbiased estimates of program savings, as an empirical matter—based on our past analyses and those in the academic literature—estimated savings from the PPR model tend to have lower standard errors than those from the LFER model, though the differences are usually very small.

<sup>11</sup> It is not possible to avoid double counting of savings generated by programs for which tracking data are not available, such as upstream compact fluorescent lamp (CFL) programs.

that when the HER Program decreases participation in other programs, this implies the baseline usage is too low (more control customers are participating in other EE programs), which reduces the savings estimate. In this situation, accounting for double-counted savings increases the net verified savings for the HER program.

As data permitted, Navigant used a difference-in-difference (DID) statistic to estimate uplift in other EE programs. To calculate the DID statistic, Navigant subtracted the change in the participation rate in another EE program between PY7 and the pre-program year for the control group from the same change for the treatment group. For instance, if the rate of participation in an EE program during PY7 is five percent for the treatment group and three percent for the control group, and the rate of participation during the year before the start of the HER Program is two percent for the treatment group and one percent for the control group, then the rate of uplift due to the HER Program is one percent, as reflected in Equation 2-1.

#### Equation 2-1. DID Statistic Calculation

$$\begin{aligned} & (PY7 \text{ treatment group participation} - \text{prePY treatment group participation}) \\ & - (PY7 \text{ control group participation} - \text{prePY control group participation}) \\ & = DID \text{ statistic} \\ & (5\% - 2\%) - (3\% - 1\%) = 1\% \end{aligned}$$

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 PY7. Navigant uses this alternative statistic –the “post-only difference” (POD) statistic –in cases where the EE program did not exist for the entire pre-program year.

Navigant examined the uplift associated with four EE programs: the Fridge and Freezer Recycling (FFR) Program, the Home Energy Assessment (HEA) Program, the Home Energy Rebates (Rebate) Program, and the Multi-family Energy Savings Program (MESP). The FFR Program achieves energy savings through retirement and recycling of older, inefficient refrigerators, freezers, and room air conditioners. The HEA Program replaced two PY6 programs: the Home Energy Savings (HES) Program and the Home Energy Jumpstart (HEJ) Program. The HEA Program is offered jointly with the local gas utilities and achieves savings by providing direct installation of low-cost efficiency measures for single family homes, such as compact fluorescent lightbulbs (CFLs) and low-flow showerheads. The Rebate program, which replaced the Complete System Replacement (CSR) Program from PY6, offers weatherization and incentives to residential customers to encourage customer purchases of higher efficiency heating, ventilating, and air-conditioning (HVAC) equipment. The MESP offers direct installation of low-cost efficiency measures, such as water efficiency measures and CFLs at eligible multifamily residences.

### 2.5.2 Accounting for Legacy Uplift

The uplift adjustment methodology described in Section 2.5.1 only accounts for uplift which occurs in the current program year because EE program tracking files in any given program year only capture the new

measures installed in that year, regardless of the expected measure lives.<sup>12</sup> However, for other EE programs with multi-year measure lives, HER Program savings capture the portion of their savings due to uplift in each year of that program's measure life. For instance, a measure with a ten-year measure life that was installed in PY2 would generate savings captured in the HER Program savings not just in PY2, but in PY3 through PY11 as well.

Consider the following concrete example. A household receiving home energy reports through the HER Program enrolls in the FFR Program, which has an eight year measure life, in PY6. The uplift adjustment described in the previous section subtracts the double counted savings from the HER Program savings in PY6. In PY7 this household is still getting savings from the FFR Program, but the PY7 uplift adjustment does not remove this savings in the second year of the household's enrollment in the FFR Program. Thus, these savings are included in the PY7 HER Program's savings when only the adjustment described in Section 2.5.1 is applied. In fact, the savings from this FFR Program enrollment will be counted through PY13, which is inconsistent with Illinois's practice of only crediting utilities with first-year EE program savings.

Navigant accounted for legacy uplift by subtracting the double counted savings from previous years, adjusted for the average annual move-out rate, from the PY7 HER savings through the measure lives of the other EE programs.<sup>13</sup> The legacy uplift adjustment is shown in Equation 2-2.

#### Equation 2-2. Legacy Uplift Calculation

$$\text{HER Savings}_{\text{PY}}^{\text{Adjusted}} = \text{HER Savings}_{\text{PY}}^{\text{Unadjusted}} - \text{Uplift Savings}_{\text{PY}} - \sum_{i=1}^{\text{PY}-1} \text{"Live" Legacy Uplift Savings}_i \cdot (1-\text{MOR})^{\text{PY}-i}$$

where "Live" Legacy Uplift Savings" refers to uplift savings where the other EE programs' measure lives have not yet run out (i.e., where measure life exceeds the difference between PY and i) and MOR refers to the move out rate.

Since PY7 is the first year of the program for this wave of customers there is no need to account for legacy uplift. This method will be used to account for legacy uplift in future years for this program.

## 2.6 Process Evaluation

The PY7 HER Program evaluation did not include a process evaluation.

<sup>12</sup> Tracking data files are set-up this way because, in conformity the Illinois Technical Reference Manual Section 3.2, savings are first-year savings, not lifetime savings.

<sup>13</sup> Since HER program participants are dropped from that program when they move, other EE programs' savings are no longer captured in the HER program savings from that point forward.

### 3 Gross Impact Evaluation

Total program savings are summarized in Table 3-1 below. The PY7 planning target for this program was 32,825 megawatt-hours (MWh). Verified savings, prior to uplift, were 715 MWh. An additional 57 MWh were added to this amount due to PY7 uplift in other EE programs. However, these results were not statistically significant and, thus not distinguishable from zero. Hence, our primary finding is that the program achieved no verified energy savings in PY7.

**Table 3-1. PY7 Total Program Electric Savings**

Savings Category	Energy Savings (MWh)
Implementer Savings Estimate†	-
Verified Savings, Prior to Uplift Adjustment	715
PY7 Uplift Adjustment	-57
Verified Savings, After Uplift Adjustment	772
Final Verified Savings	0
Final Verified Realization Rate	-

Source: ComEd tracking data and Navigant analysis.

† This estimate comes from the implementation contractor's ex-post analysis of the program.

#### 3.1 PPR and LFER Model Parameter Estimates

The PPR and LFER models generated statistically indistinguishable estimates of program savings. Navigant uses the PPR results for reporting total program savings for PY7.<sup>14</sup> For the PPR model the estimated impact was 0.015 kWh per day with a 90 percent confidence interval from -0.031 to 0.060. For the LFER model the estimated impact was 0.006 kWh per day with a 90 percent confidence interval of -0.040 to 0.051. Neither of these estimates was statistically significant at the 90 percent confidence level, and the parameter estimates were not statistically different across the two models; that is, the estimates for each model were within the 90 percent confidence bounds for the other model. Section 6.3 includes detailed outputs for each model.

#### 3.2 Uplift of Savings in Other EE Programs

PPR program savings estimates include savings resulting from the uplift in participation in other EE programs caused by the HER Program. To avoid double-counting savings, program savings due to this uplift must be counted towards either the HER Program or the other EE programs, but not both programs. The uplift of savings in other EE programs was 57 MWh, or 8.0 percent of total savings.

<sup>14</sup> Navigant prefers to report out the PPR model because although both the LFER and PPR models generate unbiased estimates of program savings, as an empirical matter—based on our past analyses and those in the academic literature—estimated savings from the PPR model tend to have lower standard errors than those from the LFER model, though the differences are usually very small.

Adding the savings uplift to from total savings (715 MWh) generates a final savings estimate of 772 MWh. To put this in perspective, the percentage savings for PY7 due to the HER Program was 0.099 percent, and adding the savings uplift from other EE programs increases this value to 0.108 percent.<sup>15</sup>

Section 6.4 in the appendix presents the details of the calculation of the PY7 uplift for each of the four ComEd EE programs considered in the analysis. As previously mentioned, the programs included in the uplift analysis in PY7 were the FFR Program, the HEA Program, the Rebate Program and the MESP.<sup>16</sup> Navigant used a DID statistic to estimate double-counted savings for each program.

The estimate of double-counted savings is most likely an *overestimate* because it presumes participation in the other EE programs occurs at the very start of PY7. Under the more reasonable assumption that participation occurs at a uniform rate throughout the year, the estimate of double-counted savings would be approximately 28.5 MWh, half the estimated value of 57 MWh. The upshot is that double counting of savings with other ComEd EE programs *is not a significant issue* for the HER Program.

### Verified Program Impact Results

Table 3-2 summarizes estimated program savings.<sup>17</sup> The number of participants, in the first row, represents the number of customers receiving reports, while the sample size – treatment, in the second row, indicates the number of customers with sufficient data for inclusion in the regression analysis. Annual customer savings were 6.57 kWh or 0.10 percent.

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<sup>15</sup> Multiplying 0.099 percent (the percentage of total energy use saved) by 8.0 percent (the percentage of total savings uplift in other EE programs) generates the value 0.00008 percent. Formally, as shown in the following calculation:  $0.00099 \times 0.08 = 0.00008$ . Adding this value to 0.00099 gives 0.00108, or 0.108 percent.

<sup>16</sup> ComEd has other residential programs that were not included in the analysis. The Residential Lighting and Elementary Education programs do not track participation at the customer level, and so do not have the data necessary for the uplift analysis. Double counting between the Residential New Construction and HER programs is not possible due to the requirement that HER participants have sufficient historical usage data.

<sup>17</sup> Per customer and percentage savings in this table are after the adjustment described in Section 6.2.

**Table 3-2. PY7 HER Program Results**

Type of Statistic	C3 Wave
Number of Participants	200,000
Sample Size – Treatment	149,797
Sample Size - Control	22,524
Percentage Savings	0.10%
	<i>Standard Error</i> 0.19%
Annualized kWh Savings Per Customer	6.57
	<i>Standard Error</i> 12.36
Verified Net Savings, Prior to Uplift Adjustment, MWh†	715
	<i>Standard Error</i> 1,346
Savings Uplift in Other EE Programs in PY7, MWh‡	-57
Verified Net Savings, After Uplift Adjustment, MWh*	772
Final Verified Net Savings, MWh**	0

Source: Navigant analysis

† Total savings are pro-rated for participants that closed their accounts during PY7.

‡ Negative double counted savings indicate that the participation rate in the EE program is higher for the control group than the treatment group. This lowers the baseline and underestimates HER Program savings.

\* Net savings adjusted for savings uplift are equal to net savings less the uplift of savings in other EE programs.

\*\* Because the savings estimate was not statistically significant at the 90 percent confidence level final verified savings are reported as zero.

### 3.3 Timing and Frequency of Reports

The program implementer sent reports on six dates between August 2014 and May 2015. Figure 3-1 and Figure 3-2 illustrate the variability in the timing and frequency of when participants received reports. The inconsistent receipt of reports may have affected the efficacy of the HER Program and may have played a role in the program achieving lower savings than expected.

As Figure 3-1 shows, the number of participants receiving a report on each of the six dates varied widely. In particular, only 47,933 participants received a report on 11/17/2014; this is just 28 percent of the customers who received at least one report. This analysis indicates that means most HER participants in the C3 portion of the program had a relatively long span from October 2014 to January 2015 without receiving a report. Other HER Program evaluations have found that it is important for treatment customers to consistently receive reports, especially at the beginning for the program. The long period of time between reports near the beginning of the program may have negatively affected program savings.

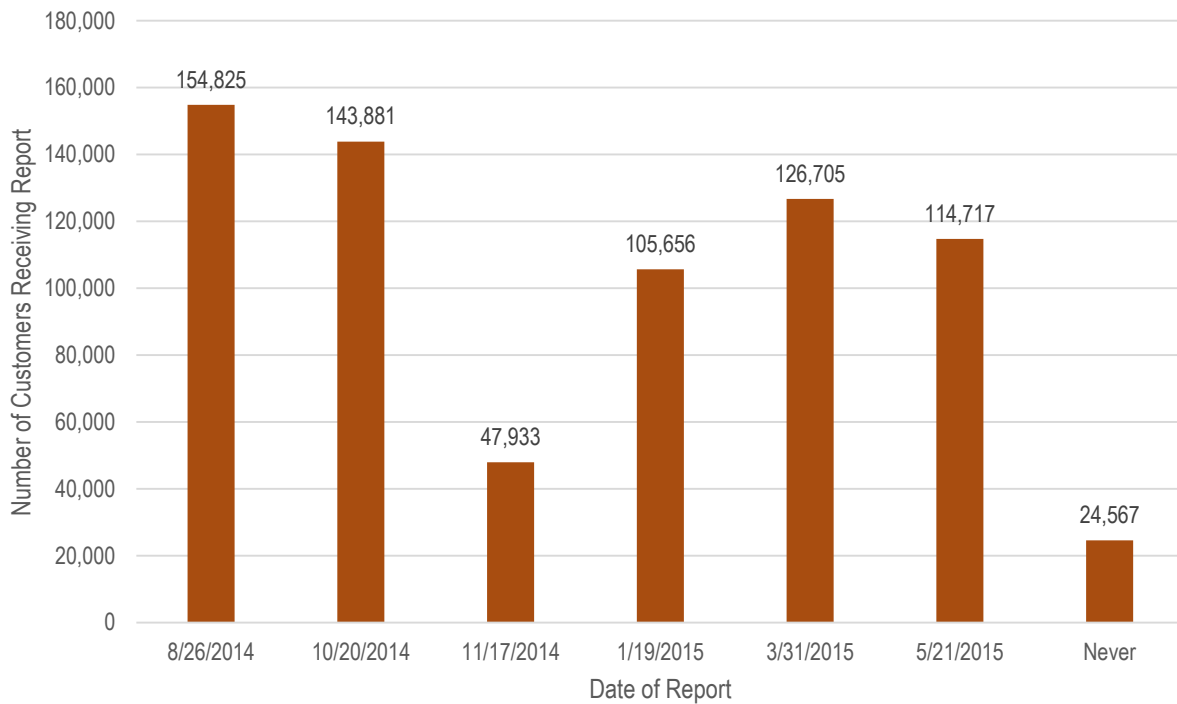
Given the disparities in the number of customers receiving a report on each mailing date it is clear that most participants did not receive all six reports. To further explore this, we looked at the number of reports sent in PY7 to participants who received their first report on 8/26/2014.<sup>18</sup> Figure 3-2 shows the total number of reports participants received in PY7. Only 15 percent of participants received reports on all six dates reports were mailed. Most participants (48 percent) received five of the six reports. Another

<sup>18</sup> Participants who received their first report on 8/26/2014 made up 98 percent of participants who received at least one report.



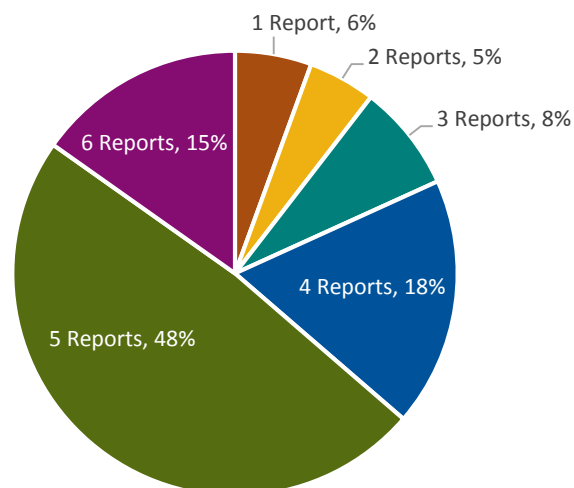
18 percent of participants received four reports and 19 percent received three or fewer reports over the ten month period.

**Figure 3-1. Number of C3 Participants Receiving a Report on Various Dates**



Source: Navigant analysis

**Figure 3-2. Number of Reports Participants Received in PY7**



Source: Navigant analysis



## 4 Net Impact Evaluation

A key feature of the RCT design of the HER Program is that the analysis inherently estimates net savings because there are no participants who otherwise might have received the individualized reports in the absence of the program. While some customers receiving reports may have taken energy-conserving actions or purchased high-efficiency equipment anyway, the random selection of program participants (as opposed to voluntary participation) implies that the control group of customers *not* receiving reports is expected to exhibit the same degree of energy-conserving behavior and purchases. Thus, there is no free ridership, and no “net-to-gross” (NTG) adjustment is necessary.

## 5 Findings and Recommendations

The following section includes program findings and recommendations.<sup>19</sup> Total verified savings for PY7 were 715 MWh prior to uplift and 772 MWh after the uplift adjustment. However, these results were not statistically significant and, thus not distinguishable from zero. Hence, our primary finding is that the program achieved no verified energy savings in PY7.

**Finding 1.** The point estimates of per customer savings were 0.10 percent or 6.57 kWh per year. While the program appears to have generated savings of 772 MWh, these results were not statistically significant and, thus not distinguishable from zero. Hence, our primary finding is that the program achieved no verified energy savings in PY7. This was the first year that a portion of ComEd's HER Program was implemented by C3. While the impact evaluation is not designed to determine why savings are lower than expected, we have identified three potential causes: inaccurate data, type of customer in the program, and program design and implementation. Data was reviewed both before and during the analysis, and neither check revealed problems with the raw data received from ComEd and the program implementer. Based on energy usage, the customers in this wave resembled those in Wave 7 Low of the Opower portion of ComEd's HER Program,<sup>20</sup> thus we do not think the type of customer in the program led to the low, statistically insignificant savings. This impact evaluation does not review the program design, but in terms of the implementation, the timing and frequency of reports was inconsistent which may have contributed to the low savings.

**Recommendation 1.** ComEd should engage in a process review of the program to examine the program design. A materials review of the report content and a short customer survey could shed light on why this implementer has achieved lower savings than expected.

**Recommendation 2.** Going forward, the program implementer should create a regular cadence of report mailings (for example, monthly or quarterly) and ensure that each participant is sent a report on each mailing date. This will increase the consistency of the HER Program experience across participants and may lead to increased savings in the future.

**Finding 2.** The uplift analysis indicated that HER participants were less likely than controls to enroll in other energy efficiency (EE) programs in PY7.

**Recommendation 3.** The implementation contractor should include prominent advertisements for other EE programs on the HERs to increase participant enrollment in those programs. Which programs are highlighted could be tied to the season or to the tips a customer receives. This could increase participant uplift into other EE programs in the future.

**Finding 3.** Two aspects of program implementation affected the RCT design. First, the first report date for each participant was not randomly assigned, that is, higher usage customers got their first report earlier than low usage customers. Second, 13 percent of participants never received a report due to either insufficient billing data<sup>21</sup> or an inaccurate mailing address.

<sup>19</sup> Numbered findings and recommendations in this section are the same as those found in the Findings and Recommendations section of the evaluation report for ease of reference between each section.

<sup>20</sup> Navigant Consulting, Inc. 2015. *Home Energy Report Opower Program PY7 Evaluation Report*.

<sup>21</sup> Sufficient billing data was defined by C3 as twelve months of data, including the two months prior to the treatment start date.

Navigant applied an ex-post adjustment to customer savings to account for these problems, however, the adjustment was very small (from 0.08 percent savings to 0.10 percent).

**Recommendation 4.** In the future, the implementation contractor should ensure that the program roll-out does not compromise the RCT design. This means that the timing of the first report should be random rather than correlated with usage; alternatively, control customers could be assigned a first report date using the same criteria as participants. Additionally, when treatment customers are excluded due to visible characteristics, such as insufficient data, control customers with the same characteristics should also be identified. Adhering to the RCT design will avoid the need for ex-post adjustments to the savings in the future.

## 6 Appendix

### 6.1 Detailed Impact Methodology

Navigant used two regression models to estimate impacts, a PPR model and an LFER model. The following sections present each model.

#### 6.1.1 Post Program Regression Model

The PPR model controls for non-treatment differences in energy use between treatment and control customers using lagged energy use as an explanatory variable. In particular, the model frames energy use in calendar month  $t$  of the post-program period as a function of both the treatment variable and energy use in the same calendar month of the pre-program period. The underlying logic is that systematic differences between control and treatment customers will be reflected in differences in their past energy use, which is highly correlated with their current energy use. Formally, the model is shown in Equation 6-1.

**Equation 6-1. Post Program Regression Model**

$$ADU_{kt} = \beta_1 Treatment_k + \sum_j \beta_{2j} Month_{jt} + \sum_j \beta_{4j} Month_{jt} \cdot ADUlag_{kt} + \varepsilon_{kt}$$

Where

$ADU_{kt}$	is average daily consumption of kWh by household $k$ in bill period $t$
$Treatment_k$	is a binary variable taking a value of 0 if household $k$ is assigned to the control group, and 1 if assigned to the treatment group
$ADUlag_{kt}$	is household $k$ 's energy use in the same calendar month of the pre-program year as the calendar month of month $t$
$Month_{jt}$	is a binary variable taking a value of 1 when $j = t$ and 0 otherwise <sup>22</sup>
$e_{kt}$	is the cluster-robust error term for household $k$ during billing cycle $t$ ; cluster-robust errors account for heteroskedasticity and autocorrelation at the household level. <sup>23</sup>

The coefficient  $b_1$  is the estimate of average daily kWh energy savings due to the program in PY6.

<sup>22</sup> In other words, if there are  $T$  post-program months, there are  $T$  monthly dummy variables in the model, with the dummy variable  $Month_{jt}$  the only one to take a value of 1 at time  $t$ . These are, in other words, monthly fixed effects.

<sup>23</sup> Ordinary Least Squares (OLS) regression models assume that the data are homoskedastic and not autocorrelated. If either of these assumptions is violated, the resulting standard errors of the parameter estimates are incorrect (usually underestimated). A random variable is heteroskedastic when the variance is not constant. A random variable is autocorrelated when the error term in one period is correlated with the error terms in at least some of the previous periods.

### 6.1.2 Linear Fixed Effects Regression Model

The simplest version of an 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 the following three terms:

1. The binary variable  $Treatment_k$
2. 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
3. The interaction between these variables,  $Treatment_k \cdot Post_t$

Formally, the LFER model is showing in as shown in Equation 6-2.

#### Equation 6-2. Linear Fixed Effects Regression Model

$$ADU_{kt} = \alpha_{0k} + \alpha_1 Post_t + \alpha_2 Treatment_k \cdot Post_t + \varepsilon_{kt}$$

Three observations about this specification deserve comment. First, the coefficient  $\alpha_{0k}$  captures all household-specific effects on energy use that do not change over time, including those that are unobservable. Second,  $\alpha_1$  captures the average effect *across all households* of being in the post-treatment period. 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  $\alpha_2$ . In other words, whereas the coefficient  $\alpha_1$  captures the change in average daily kWh use across the pre- and post-treatment for the *control* group, the sum  $\alpha_1 + \alpha_2$  captures this change for the treatment group, and so  $\alpha_2$  is the estimate of average daily kWh energy savings due to the program in PY7.

## 6.2 Savings Adjustment

In the course of our analysis, Navigant discovered two aspects of the program implementation that interfered with the RCT design in terms of the treatment and control customers being balanced in terms of pre-period usage. First, participants in this program received their first report on one of six different dates, however, the distribution of participants across these dates was non-random. Second, 13 percent of the 200,000 treatment customers did not receive any reports.

As shown in Table 6-1 below, the timing of the first report was correlated with energy usage, with the highest users receiving their reports the earliest. The majority of households (85%) got their first report in August 2014, but others did not receive their first report until May 2015. Control households were not assigned a first report date and as a result, they were unable to be grouped similarly to the treatment customers making the distribution of customers across the two groups appear non-random. In the future, the first report dates should either be randomly assigned to treatment customers or control customers should also be assigned a first report date using the same criteria as treatment customers.

**Table 6-1. Average Daily Usage by First Report Date**

First Report Date†	Percentage of Treatment Customers	Average Daily Usage (kWh)
8/26/2014	84.94%	18.67
10/20/2014	0.12%	16.22
11/17/2014	0.01%	11.92
1/19/2015	0.60%	6.67
3/31/2015	0.82%	5.92
5/21/2015	0.03%	4.93
NA‡	13.48%	11.46
Control Customers	-	11.79

Source: Navigant analysis

† This is the report date in the C3 dataset when a report was generated. Participants likely received their first report slightly after this date.

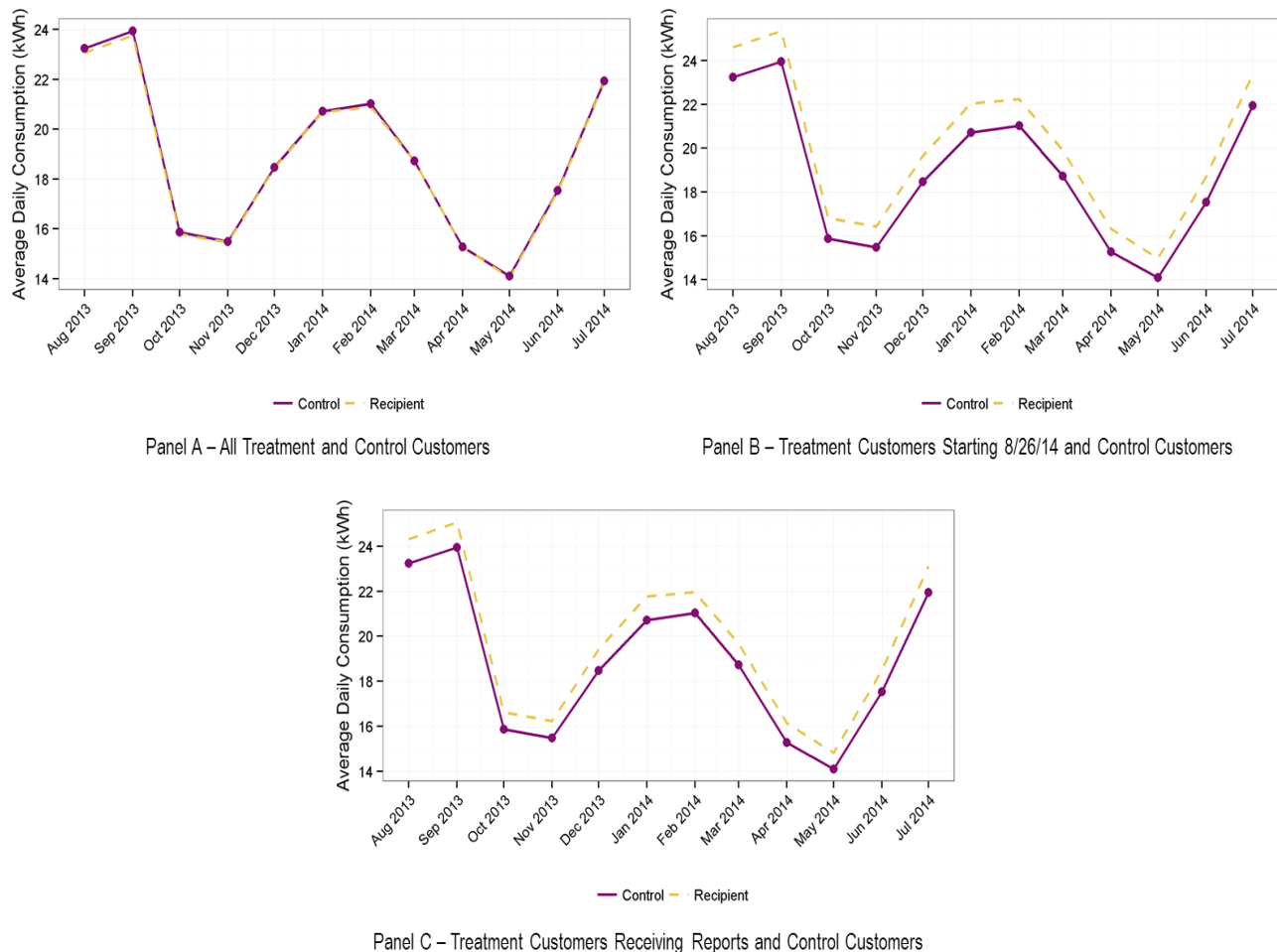
‡ These were customers who did not have a first report date and never received any reports. They were identified by C3 as either having insufficient billing data to generate a report or having an inaccurate mailing address.

Thirteen percent of treatment customers did not receive any reports. The two reasons treatment customers did receive any reports were insufficient billing data<sup>24</sup> and inaccurate mailing addresses. Control customers with these two problems were not identified. Since inaccurate mailing addresses were identified by returned mail it is not feasible for the program implementer to identify control customers with inaccurate addresses. However, the implementer could identify control customers with insufficient billing data using the same criteria as applied to the treatment customers. If control customers with these problems were identified, we could remove both the treatment and control customers from the analysis preserving the randomization. Without the identification of control customers, treatment customers who received no reports were kept in our billing analysis to preserve the randomization of the RCT.

<sup>24</sup> Sufficient billing data was defined by C3 as twelve months of data, including the two months prior to the treatment start date.

The impact of these two aspects of the implementation on the RCT is illustrated in Figure 6-1. Panel A shows usage during the pre-program period for all assigned treatment and control customers, Panel B shows the same usage using only the treatment customers who received their first report on August 26<sup>th</sup>, 2014, and Panel C shows the same usage excluding the treatment customers who did not receive reports. The pre-program usage is only the same across the two groups when all of the treatment customers are included.

**Figure 6-1. Pre-Program Energy Usage by Treatment and Control Customers**



Source: Navigant analysis

Panel A plots usage for all treatment and control customers.

Panel B plots usage for those treatment customers who received their first report on 8/26/15 and all control customers.

Panel C plots usage for those treatment customers who received at least one report and all control customers.

Since the distribution of treatment and control customers is only consistent with an RCT when all treatment customers are included, subsetting the treatment customers is not an option as the result would be biased due to the violation of the RCT design. Instead, Navigant assigned all customers a program start date of August 1st, 2014 and applied an ex-post savings adjustment, described below, to get an estimate of per customer savings for customers who received at least one report in PY7 for the period after the first report was received.

The two regression models described in Section 6.1 each estimate average daily savings. To calculate total savings, Navigant multiplies the average daily savings estimate times the number of participant-days, as shown in Equation 6-3. Participant-days for each participant are calculated from the program start date until the end of PY7 or the date a customer's account went inactive, whichever occurred first. Assigning all participants a program start date of August 1<sup>st</sup>, 2014 lowers the estimate of average daily savings, because there are days considered after the program start which actually occur before a customer receives their first report and starts saving, but increases the number of participant-days, leaving the estimate of total program savings the same.

#### Equation 6-3. Total Savings Calculation

$$TotalSavings = AvgDailySavings * ParticipantDays$$

In order to get an adjusted estimate of per customer savings that captures savings for customers who received at least one report for the period after the first one was received, Navigant applied an ex-post adjustment as shown in Equation 6-4 and Equation 6-5. To do so, Navigant recalculated participant-days from the date a customer received their first report until the end of PY7 or the date a customer's account went inactive, whichever occurred first and multiplied it by daily baseline usage (usage in the absence of the program) to get total baseline usage in the period customers were receiving report. Total savings divided by total baseline usage gives adjusted per customer percentage savings. The percentage savings can then be used to calculate adjusted per customer daily savings.

#### Equation 6-4. Adjusted Per Customer Percentage Savings

$$AdjPerCustomer\%Savings = \frac{TotalSavings}{AdjParticipantDays * DailyBaselineUsage}$$

#### Equation 6-5. Adjusted Per Customer Absolute Savings

$$AdjPerCustomerDailySavings = AdjPerCustomer\%Savings * DailyBaselineUsage$$

Table 6-2 presents per customer and percentage savings before and after this adjustment. The adjustment made a very small difference, increasing the percentage savings by 0.02 percentage points and the per customer daily savings by 0.003 kWh.

**Table 6-2. Adjusted Percentage and Per Customer Savings**

Type of Statistic	Unadjusted	Adjusted
Participant Days	48,911,136	39,772,860
Total Baseline Usage (kWh)	720,039,965	-
Percentage Savings	0.08%	0.10%
Per Customer Average Daily Savings	0.015	0.018

Source: Navigant analysis



### 6.3 Detailed Impact Results: Parameter Estimates

Table 6-3 and Table 6-4 show the results of the PPR and LFER models, respectively. Across the two models, the parameter estimates are not statistically different; that is, the estimates for each model are within the 90 percent confidence bounds for the other model.

**Table 6-3. PPR Model Estimates**

	Estimate	Std. Error	t value	Pr(> t )
treatment	-0.01463	0.02753	-0.53	0.6
yrmo201408	3.14741	0.04967	63.36	<0.0000000000000002
yrmo201409	2.32147	0.04643	50	<0.0000000000000002
yrmo201410	2.75569	0.04585	60.1	<0.0000000000000002
yrmo201411	2.52378	0.05319	47.45	<0.0000000000000002
yrmo201412	2.8021	0.05079	55.17	<0.0000000000000002
yrmo201501	3.50159	0.04986	70.23	<0.0000000000000002
yrmo201502	4.75048	0.05367	88.51	<0.0000000000000002
yrmo201503	3.99525	0.06096	65.54	<0.0000000000000002
yrmo201504	3.40065	0.0582	58.43	<0.0000000000000002
yrmo201505	2.47141	0.0553	44.69	<0.0000000000000002
yrmo201408:pre.use	0.80447	0.0021	383.64	<0.0000000000000002
yrmo201409:pre.use	0.82623	0.00184	450.2	<0.0000000000000002
yrmo201410:pre.use	0.74326	0.00272	273.33	<0.0000000000000002
yrmo201411:pre.use	0.82091	0.00335	245.02	<0.0000000000000002
yrmo201412:pre.use	0.82918	0.00271	305.81	<0.0000000000000002
yrmo201501:pre.use	0.77594	0.00237	327.8	<0.0000000000000002
yrmo201502:pre.use	0.67969	0.0026	261.18	<0.0000000000000002
yrmo201503:pre.use	0.75736	0.00337	224.68	<0.0000000000000002
yrmo201504:pre.use	0.71826	0.0037	194.13	<0.0000000000000002
yrmo201505:pre.use	0.79704	0.00374	213.23	<0.0000000000000002
Residual standard error: 6.44 on 1532546 degrees of freedom				
Multiple R-squared: 0.91, Adjusted R-squared: 0.91				
F-statistic: 7.39e+05 on 21 and 1532546 DF, p-value: <0.0000000000000002				

Source: Navigant analysis

**Table 6-4. LFER Model Estimates**

	Estimate	Std. Error	t value	Pr(> t )
post	-1.04704	0.02564	-40.8	<0.0000000000000002
post.trt	-0.00562	0.02755	-0.2	0.84
Total Sum of Squares: 173000000, Residual Sum of Squares: 172000000				
R-Squared: 0.00511, Adj. R-Squared : 0.00483				
F-statistic: 7812.23 on 2 and 3043982 DF, p-value: <0.0000000000000002				

*Source: Navigant analysis*

## 6.4 Savings Due to PY7 Participation Uplift in Other EE Programs

Table 6-5 presents program savings due to participation uplift in other EE programs. Uplift is for each of four EE programs for which estimates of deemed savings are available: the Fridge and Freezer Recycling (FFR) Program, the Home Energy Assessment (HEA) Program, the Multifamily (MF) Program, and the Home Energy Rebates (Rebate) Program. Average FFR Program savings are average net verified savings. Average HEA and Rebate program savings are ex-ante savings. Average MESP savings are average gross verified savings.

**Table 6-5. Estimates of Double-Counted Savings**

	Program			
	FFR	HEA	MF	Rebate
Median program savings (annual kWh per participant)	592	374	215	611
# HER treatment households	182,268	182,268	182,268	182,268
Rate of participation, PY7 (%)	0.66%	0.06%	0.27%	0.01%
Change in rate of participation from pre-program year (%)	-0.14%	0.02%	-0.06%	-0.20%
# HER control households	27,393	27,393	27,393	27,393
Rate of participation, PY7 (%)	0.65%	0.06%	0.31%	0.02%
Change in rate of participation from pre-program year (%)	-0.12%	0.04%	-0.04%	-0.19%
DID/POD statistic	-0.02%	-0.02%	-0.02%	-0.01%
Change in program participation due to HER Program	-42	-40	-37	-14
Statistically significant at the 90% confidence level?	No	Yes	No	No
Savings attributable to other programs (kWh)	-25,115	-14,902	-8,063	-8,559

Source: Navigant analysis