NAVIGANT

ComEd
Great Energy Stewards Program
Evaluation Report

FINAL
Energy Efficiency / Demand Response Plan:
Plan Year 8 (PY8)
(6/1/2015-5/31/2016)

Presented to
Commonwealth Edison Company

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Great Energy Stewards Program Evaluation Report

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E. EXECUTIVE SUMMARY

This report presents a summary of the findings and results from the impact evaluation of the PY8[1] Great Energy Stewards (GES) program. The Great Energy Stewards (GES) program is a third-party behavioral energy efficiency (EE) program being implemented under the Illinois Power Agency (IPA) funding mechanism.[2] It was designed and implemented by Shelton Solutions, Inc. (Shelton). The GES program is designed to generate energy savings by providing Commonwealth Edison (ComEd) residential customers with information on their energy usage and energy-saving tips through periodic postcards mailed to their homes, as well as small financial incentive payments for energy savings.[3] The GES program started in PY6. The implementation contractor enrolled approximately 538 new ComEd customers on a rolling basis throughout PY8 starting in June 2015.

In PY8, the implementation contractor employed a new two-way electronic communication approach aimed at increasing customer engagement with the program named "E-Tips", which had the following features:

- A format similar to the GES mailed postcards.
- Allowed the implementer to increase the number of tips from 12 per year to approximately 26.
- Automated: all the tips for the year are loaded at one time and they are automatically emailed by SurveyMonkey[4] to the recipients at the requested times.
- Include an opportunity for customer response: at the bottom of each E-Tip the customer is asked to respond to a survey question (e.g., "Did you find this tip helpful?", "Are you seeing reductions in your energy consumption on your bill?", "What would you like to know more about?"). An incentive is offered to reward early responders ($5 gift cards) each month.

The implementer estimates that approximately 10 percent of E-Tip recipients respond to the survey question each month. This approach is saving time and money on postage, printing and materials.

E.1. Program Savings

Table E-1 summarizes the PY8 electricity savings from the GES program. Navigant's regression analysis of the GES program participant energy savings yielded estimated savings of 226 MWh prior to the uplift adjustment. After adjusting for uplift from other energy efficiency programs (see Section 2.4), estimated savings were 197 MWh. However, these results were not statistically significant and therefore cannot be causally attributed to the program. Thus, Navigant's primary finding is that the program achieved no verified energy savings in PY8. The evaluation team calculated savings using regression analysis of monthly billing data comparing participants to a matched set of nonparticipants. As discussed in Section 4, this type of analysis estimates net savings and no further net-to-gross (NTG) adjustment is necessary.

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[1] The PY8 program year began June 1, 2015 and ended May 31, 2016.

[2] Created by Illinois Public Acts 97-0616 ("PA 97-0616") and 97-0824 ("PA 97-0824").

[3] Originally, the program offered customers 5 cents per kWh saved up to $50. Starting in PY7, the implementer instead offered small ($5) gift cards as an enrollment incentive, redeemable at local fast food outlets (Dunkin Donuts or Subway) and held raffles or drawings with similar small ($5-$25) prizes to reward participation.

[4] See https://www.surveymonkey.com/ for more information about SurveyMonkey.

Table E-1. PY8 Total Program Electric Savings

Savings Category	Energy Savings (MWh)
Implementer Estimated Savings †	-
Net Savings, Prior to Uplift Adjustment	226
Net Savings, After Uplift Adjustment	197
Final Verified Savings ‡	0
Realization Rate †	-

Source: ComEd tracking data and Navigant team analysis.
† Navigant did not receive implementer estimated savings for this program and as such was not able to calculate a realization rate.
‡ The savings are not statistically significant, which means they cannot be causally attributed to the program.

E.2. Program Savings by Wave

For the purposes of this report, Navigant characterized GES participants as comprising three waves that used rolling enrollment to acquire customers. These three waves correspond to program years since the GES program launched. The earliest wave, Wave PY6, began enrollment at the beginning of PY6 in June 2013 and the latest wave, Wave PY8, began enrollment at the beginning of PY8 in June 2015.[5]

Table E-2 summarizes estimated program savings by wave. In this table, the number of PY8 participants, in the first row, represents the number of customers in each wave in PY8, while the sample sizes, in the second and third rows, indicate the number of participants and controls with sufficient data for inclusion in the regression analysis. Navigant estimated separate savings for each wave using regression analysis as described in Section 2.3. The weighted average per customer savings estimate was 0.5 percent (44.23 kWh).

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[5] The PY6 Wave and the PY7 Wave were called Wave 1 and Wave 2 respectively in the PY7 report for this program.

Table E-2. PY8 GES Program Results by Wave

Type of Statistic	PY6 Wave	PY7 Wave	PY8 Wave	Total
Number of PY8 Participants	555	865	538	1958
Sample Size - Treatment	489	705	424	1618
Sample Size – Matched Control	429	620	414	1463
Percentage Savings	5.0%	0.9%	-4.7%	0.5%
Standard Error	*4.3%*	*2.5%*	*2.3%*	*-*
Annualized Savings Per Customer, kWh	376.72	61.59	-326.67	44.23
Standard Error	*326*	*164*	*158*	*-*
Net Savings, Prior to Uplift Adjustment, MWh †	192	47	-13	226
Standard Error	*166*	*125*	*6*	*-*
PY8 Uplift Adjustment, MWh	5	8	15	27
Legacy Uplift Adjustment, MWh	1	0	-	2
Net Savings, MWh ‡	185	39	-27	197

Source: ComEd tracking data and Navigant team analysis.
† Total savings are pro-rated for participants that closed their accounts during PY8.
‡ Net Savings are equal to Net Savings, Prior to Uplift Adjustment less the uplift of savings in other EE programs.

E.3. Findings and Recommendations

The following includes program findings and recommendations.[6]

Finding 1. The overall weighted average savings for the program was 0.5 percent which was not statistically significant. While savings increased for both the PY6 and PY7 Waves compared to their performance during PY7, the PY8 Wave showed negative savings and drove the overall weighted average for the program down. The increase in savings for the PY6 and PY7 Waves may indicate that the E-Tips were effective at driving higher savings but the negative savings for the PY8 Wave muddle this outcome.

Recommendation 1. The program implementation contractor should continue to implement and expand the E-Tips, which appear to help drive higher savings in the PY6 and PY7 Waves. Increasing average savings per participant will help increase the likelihood that the program will achieve statistically significant savings in future program years.

Finding 2. One factor that contributed to program savings not being statistically significant was the small size of the program waves. The PY8 Wave included 538 participants, which was fewer than the PY7 Wave (865 participants) and the PY6 Wave (555 participants).

Recommendation 2. The program implementation contractor should recruit more participants in future program waves. According to Navigant's back of the envelope power analysis using results from the PY7 Wave, if the average savings was around 1 percent, the program implementation contractor would need to recruit approximately 15,000 participants into the program in order to have the possibility of finding statistically significant savings at the 90 percent confidence level. Increasing the program savings per participant could reduce the necessary number of participants.

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[6] 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.

Finding 3. Part of the reason for the program's low level of energy savings may be due to the relatively low average daily usage of its participants. The average daily usage of households in each of the three waves was under 20 kWh per day. Previous studies of behavioral EE programs have shown a positive association between energy usage rates and energy savings levels. The fact that the average energy usage of GES participants is lower than that of other behavioral EE programs may be constraining this program's potential for achieving statistically significant energy savings.

Recommendation 3. The program implementation contractor should recruit higher usage customers into the program in future program years. Doing so could increase program savings per participant and help increase the likelihood that the program will achieve statistically significant energy savings in future program years. As described in Recommendation 2 above and according to Navigant's back of the envelope power analysis using results from the PY7 Wave, if the average savings for the program was increased to approximately 5 percent, a program consisting of approximately 1,000 participants would likely lead to statistically significant savings at the 90 percent confidence level.

Recommendation 4. The implementation contractor should identify those participants who are no longer interacting with the program in the program tracking system. Excluding participants who are no longer interacting with the program from future evaluation efforts, if they can be identified, could reduce the standard error and also help increase the likelihood that the program will achieve statistically significant savings in future program years.

1. INTRODUCTION

1.1 Program Description

The Great Energy Stewards (GES) program is a third-party behavioral energy efficiency (EE) program being implemented under the Illinois Power Agency (IPA) funding mechanism.[7] It was designed and implemented by Shelton Solutions, Inc. (Shelton) based on the hypothesis that local church congregations comprise a receptive audience for behavioral EE programs. Program participants received periodic postcards containing information on their energy consumption relative to the previous year and energy saving tips, and were offered small monetary incentives to reward energy savings.

Restrictions on use of participants' personally identifiable information (PII) prevented the implementation contractor from monitoring participants' energy usage which was a key feature of the program's strategy for tracking energy savings through behavior change.[8] As a partial solution, ComEd provided the implementer with quarterly reports since the start of the program in PY6 that show the unadjusted change in each participant's monthly kWh consumption compared to the same period in the last year. Since these do not compare the changes to those of a matched control group or after adjustment for weather and other differences, there is no way to know whether this unadjusted year-over-year change would be more, less, or equal to the verified savings. Also, the implementer's inability to view participants' monthly usage levels limits its ability to track participants' progress in a timely fashion, which has limited insights into participants' energy consumption patterns that could be helpful in tailoring the energy-saving tips to individual participants.

In PY8, the implementation contractor employed a new two-way electronic communication approach aimed at increasing customer engagement with the program named "E-Tips", which had the following features:

- A format similar to the GES mailed postcards.
- Allowed the implementer to increase the number of tips from 12 per year to as many as 50.
- Automated: all the tips for the year are loaded at one time and they are automatically emailed by SurveyMonkey[9] to the recipients at the requested times.
- Include an opportunity for customer response: at the bottom of each E-Tip the customer is asked to respond to a survey question (e.g., "Did you find this tip helpful?", "Are you seeing reductions in your energy consumption on your bill?", "What would you like to know more about?"). An incentive is offered to reward early responders ($5 gift cards) each month.

The implementer estimates that approximately 10 percent of E-Tip recipients respond to the survey question each month. This approach is saving time and money on postage, printing and materials.

In PY8, there were a total of 1,498 participants enrolled at the start of the program year and 1,958 participants enrolled at the end of the program year, making new enrollment in PY8 538 customers. Figure 1-1 shows new enrollment in each program year since the program launch.

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[7] Created by Illinois Public Acts 97-0616 ("PA 97-0616") and 97-0824 ("PA 97-0824").
[8] 2013 Great Energy Stewards SCOPE OF WORK DOCUMENT, loc. cit
[9] See https://www.surveymonkey.com/ for more information about SurveyMonkey.

Figure 1-1. GES Annual Enrollment, PY6 – PY8
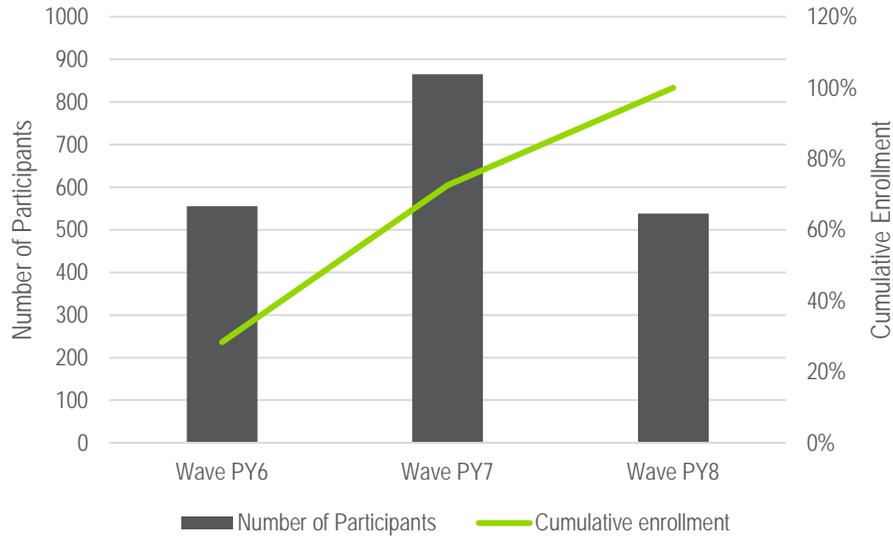
Source: ComEd tracking data and Navigant team analysis.

For the purposes of this report, Navigant characterized GES participants as comprising three waves that used rolling enrollment to acquire customers. These three waves correspond to program years since the GES program launched; thus the earliest wave, Wave PY6, began enrollment at the beginning of PY6 in June 2013 and the latest wave, Wave PY8, began enrollment at the beginning of PY8 in June 2015.[10]

1.2 Evaluation Objectives

The objective of this evaluation was to determine the PY8 energy savings generated by the GES program.

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[10] The PY6 Wave and the PY7 Wave were called Wave 1 and Wave 2 respectively in the PY7 report for this program.

2. EVALUATION APPROACH

The evaluation approach in PY8 was consistent with that of the evaluations in previous years, relying on statistical analysis appropriate for opt-in behavioral programs. Navigant used matching methods to create a matched control group and then estimated program impacts using a regression with pre-program matching (RPPM) analysis with lagged controls for pre-period energy usage.

2.1 Overview of Data Collection Activities

The core data collection activities included receiving billing and tracking data for the GES program, receiving tracking data for the other programs used in the uplift analysis, and conducting interviews with program staff. The full set of data collection activities is shown in Table 2-1.

Table 2-1. Primary Data Collection Activities

What	Who	Target Completes	Completes Achieved	When
GES Program Tracking Database	Participants and Potential Controls			May 2016
GES Program Billing Database	Participants and Potential Controls			January 2012 – May 2016
Other Program Tracking Database	Participants and Potential Controls			June 2009 – May 2016
In Depth Interviews	Program Manager/Implementer Staff	1	1	June 2016

2.2 Data Used in Impact Analysis

In preparation for the impact analysis, Navigant combined and cleaned data provided by the program implementer and ComEd. The dataset included 2,212 participants in the GES program and a large pool of non-participants. Billing data used in the analysis extended from January 2012 (17 months before the start of the program) to May 2016. Data during the twelve-month pre-period for each participant and during PY8 were used in the regression analysis described in Section 2.3.

Navigant removed customers and data points from the analysis in the following steps:

- Participants who did not have an active account on the first day of PY8.
- Observations with a bill duration of zero.
- Observations with missing or negative usage.
- Observations with less than 20 or more than 40 days in a billing cycle.
- Observations that were outliers, defined as having average daily usage more than one order of magnitude from the median usage.[11]
- Customers with fewer than eight bills in the matching period.

Detailed counts of the customers and observations removed by wave are included in Section 6.1 of the appendix.

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[11] The median kWh usages for Waves 1 through 3 were 17.43, 14.79, and 15.54, respectively.

2.3 Statistical Approach used in the Impact Evaluation

To estimate energy savings, Navigant used the RPPM approach described in Ho, Imai, King, and Stuart (2007).[12] Using the RPPM method, Navigant has successfully evaluated many opt-in behavioral programs. Additional detail about the statistical approach used in this evaluation is described in Section 6.2.1.

2.3.1 Matching Algorithm and Matching Results

Matching methods rely on a set of matched comparison households to estimate program savings. The pool of non-participant households available for matching consisted of approximately 275,000 ComEd residential customers. Additional detail about the matching methods used for this evaluation is included in Section 6.2.2.

For each program participant, energy consumption in the period spanning 14 months to three months before program enrollment (a 12-month period)[13] was compared to that of all customers in the available non-participant pool with billing data over the same 12 months. For the purpose of matching, program enrollment occurred when a participant signed up for the GES program, i.e., when they created an account on the GES website. The potential control with energy use most similar to a participant's during the 12 month matching period was used as the match.[14]

It is not possible to statistically test for self-selection bias,[15] but Imbens and Wooldridge (2009) present a test that is suggestive (hereafter called the "IW test").[16] In the current context, the logic of the test is that in the absence of selection bias there should be no difference between participants and matches in average energy use outside of the matching period and outside of the program period. A simple implementation of the test is to determine whether, given matches based on 14 months to three months before program enrollment, the average difference in energy use between a participant and their match in the two months before program enrollment is practically or statistically different than zero.

Figure 2-1 presents the mean of average daily energy use by participants and their matches in the 14 months before program enrollment, and Figure 2-2 amplifies differences between the two groups by presenting the average difference in energy use between participants and their matches in percentage terms, with 90 percent confidence intervals superimposed. The figures illustrate that on average, the energy use by matches was very similar to that of program participants. Mean differences in energy use were neither statistically nor practically different than zero during the 12-month matching period or the three subsequent months.

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[12] Ho, Daniel E., Kosuke Imai, Gary King, and Elizabeth Stuart. 2007. Matching as nonparametric preprocessing for reducing model dependence in parametric causal inference. *Political Analysis* 15(3): 199-236.

[13] In order to draw a match, a GES participant had to have data in at least eight of the twelve months in the matching period.

[14] For most of the GES participants who enrolled prior to the start of PY8, Navigant used the same matched controls as were selected for the PY7 evaluation. New matched controls were selected for participants whose match from PY7 became inactivate during PY8 and for all the participants who enrolled during PY8.

[15] Self-selection bias is bias due to the fact that customers who choose to join the program are different from those who do not in unobservable ways.

[16] Imbens, Guido W., and Jeffrey M. Wooldridge. 2009. "Recent Developments in the Econometrics of Program Evaluation." *Journal of Economic Literature*, 47(1): 5-86.

**Figure 2-1. Average Energy Use Before Program Enrollment,
GES Participants and Matched Controls**
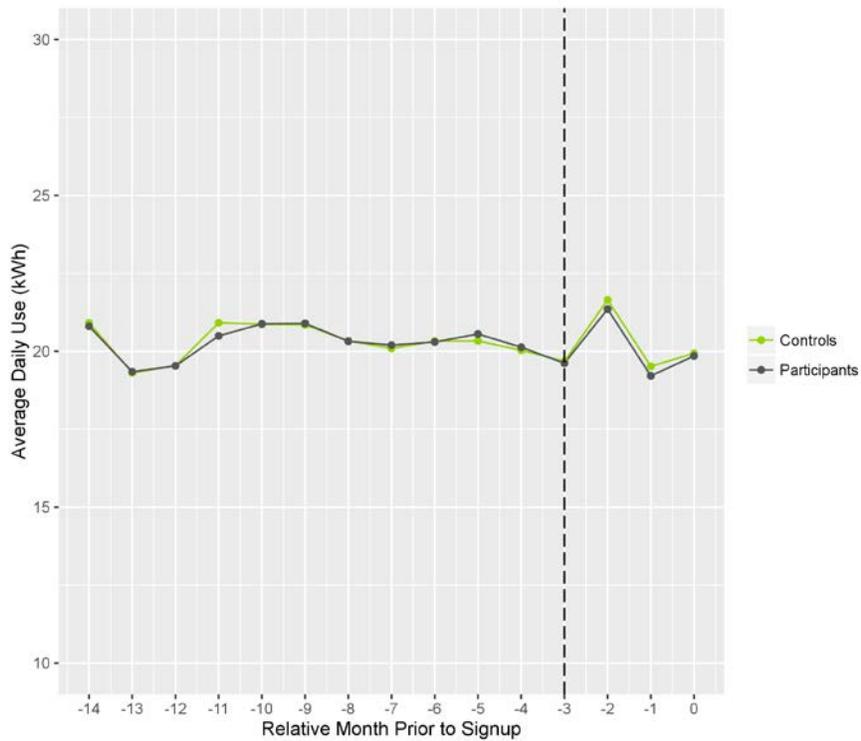
Source: ComEd tracking data and Navigant team analysis.

**Figure 2-2. Average Difference in Energy Use Before Program Enrollment,
GES Participants and Matched Controls**
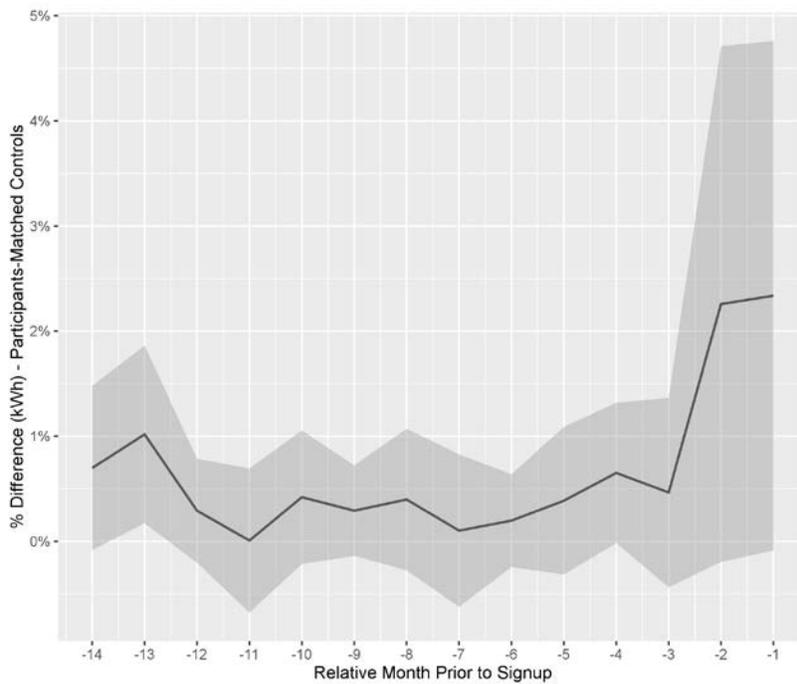
Source: ComEd tracking data and Navigant team analysis

2.4 Accounting for Uplift in other Energy Efficiency Programs

2.4.1 Accounting for Uplift in PY8

If participation rates in other EE programs are the same for GES participants and their matched controls, the savings estimates from the regression analyses are already "net" of savings from other programs, as this indicates the GES program does not increase or decrease participation in other EE programs. However, if the GES 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 GES and EE programs. For instance, if the GES program increases participation in other EE programs, the increase in savings may be allocated to either the GES program or the EE program, but cannot be allocated to both programs simultaneously.[17] Note that when the GES program decreases participation in other programs there is no issue of double-counting and thus no adjustment to the savings total is made.

Data permitting, Navigant uses a difference-in-difference (DID) statistic to estimate uplift in other EE programs. To calculate the DID statistic, the change in the participation rate in another EE program between PY8 and the pre-program year for the matched control group is subtracted from the same change for the treatment group. For instance, if the rate of participation in an EE program during PY8 is five percent for the treatment group and three percent for the matched control group, and the rate of participation during the year before the start of the program is two percent for the treatment group and one percent for the matched control group, then the rate of uplift due to the GES program is one percent, as reflected in Equation 2-1.

Equation 2-1. DID Statistic Calculation

$$(PY8\ treatment\ group\ participation - prePY\ treatment\ group\ participation)$$
$$- (PY7\ control\ group\ participation - prePY\ control\ group\ participation)$$
$$= DID\ statistic$$
$$(5\% - 2\%) - (3\% - 1\%) = 1\%$$

The DID statistic generates an unbiased estimate of uplift when the baseline average rate of participation is the same for the treatment and matched control groups, or when they are different due only to differences between the two groups in time-invariant factors, such as the residence's square footage.

An alternative to the DID statistic is the post-only difference (POD) statistic, which is the simple difference in participation rates between the treatment and matched control groups during PY8. The POD statistic generates an unbiased estimate of uplift when the baseline average rate of participation in the EE program is the same for the two groups. Navigant uses this alternative 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 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 CFLs and low-flow showerheads. The Rebate program offers weatherization and incentives to residential customers to encourage customer purchases of higher efficiency heating, ventilating, and air-conditioning (HVAC) equipment. MESP offers direct installation of low-cost efficiency measures, such as water efficiency measures and CFLs at eligible multifamily residences.

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[17] It is not possible to avoid double counting of savings generated by programs for which tracking data are not available, such as upstream lighting programs.

For each EE program, double-counted savings were calculated separately for each program year wave of the GES program.

2.4.2 Accounting for Legacy Uplift

The uplift adjustment methodology described in Section 2.4.1 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 life.[18] However, for other EE programs with multi-year measure lives, GES 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 GES program savings not just in PY2, but in PY3 through PY11 as well.

Consider the following example. A household in the GES program enrolls in the FFR program in PY6. The uplift adjustment subtracts FFR PY6 program savings to avoid double counting. In PY7 this household still receives savings from the FFR program because it has an eight-year measure life. However, the PY7 GES uplift adjustment does not remove these savings because the PY7 adjustment only accounts for a measure installed in PY7, the initial year that the household entered a program. Thus, when only relying on the uplift adjustment described in Section 2.4.2, FFR second year savings would be included in the PY7 GES program's savings, which is inconsistent with Illinois's practice of only crediting utilities with first-year EE program savings. Legacy uplift removes double counted energy saving from programs with a multiple-year measure life.

Navigant accounts for legacy uplift by subtracting the double counted savings from previous years, adjusted for the average annual move-out rate, from PY8 GES savings through the measure lives of other EE programs.[19] The legacy uplift adjustment is shown in Equation 2-2.

Equation 2-2. Legacy Uplift Calculation

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

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.

The legacy uplift adjustment goes back to PY6 when Navigant first evaluated the GES program. In PY6, Navigant considered double-counted savings for the Fridge Freezer Recycle Rewards (FFRR), the Complete System Replacement (CSR), the Multi-Family Home Energy Savings (MF), and the Single Family Home Energy Savings (SFHES) programs. In PY7 Navigant considered double-counted savings for the same four programs as PY8: the FFR program, the HEA program, the Rebate program, and MESP.

2.5 Process Evaluation

The PY8 GES program evaluation did not include a process evaluation.

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[18] 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.
[19] Since GES program participants are dropped from that program when they move, other EE programs' savings are no longer captured in the GES program savings from that point forward.

3. GROSS IMPACT EVALUATION

Total program savings are summarized in Table 3-1 below. Navigant's regression analysis of GES program participant energy savings yielded estimated savings of 226 MWh prior to the uplift adjustment. After adjusting for uplift from other energy efficiency programs (see Section 2.4), estimated savings were 197 MWh. However, these results were not statistically significant and therefore cannot be causally attributed to the program. Thus, Navigant's primary finding is that the program achieved no verified energy savings in PY8.

Table 3-1. PY8 Total Program Electric Savings

Savings Category	Energy Savings (MWh)
Implementer Estimated Savings †	-
Net Savings, Prior to Uplift Adjustment	226
Net Savings, After Uplift Adjustment	197
Final Verified Savings ‡	0
Realization Rate †	-

Source: ComEd tracking data and Navigant team analysis.
† Navigant did not receive implementer estimated savings for this program and as such was not able to calculate a realization rate.
‡ The savings are not statistically significant, which means they cannot be causally attributed to the program.

3.1 Uplift of Savings in Other EE Programs

RPPM program savings estimates include savings resulting from the uplift in participation in other EE programs caused by the GES program. To avoid double-counting savings, program savings due to uplift must be counted towards either the GES program or the other EE programs, but not both. Uplift in other EE programs was 29 MWh, or 12.9 percent, which can be broken into PY8 and legacy uplift. PY8 uplift was 27 MWh or 12.1 percent of total program savings. Legacy uplift was 2 MWh or 0.88 percent of total program savings. Table 3-2 shows how the uplift adjustment affects total savings.

Table 3-2. PY8 Uplift Adjustment

Savings Category	Energy Savings (MWh)
Net Savings, Prior to Uplift Adjustment	226
PY8 Uplift Adjustment	27
Legacy Uplift Adjustment	2
Net Savings, After Uplift Adjustment	197

Source: ComEd data and Navigant team analysis.

Subtracting the savings uplift from total savings (226 MWh) generates a final savings estimate of 197 MWh. To put this in perspective, across the two waves the weighted average percentage savings for PY8 due to the GES program was 0.5 percent, and removing the savings uplift in other EE programs reduces this value to 0.43 percent.[20]

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[20] Multiplying 0.5 percent (the percentage of total energy use saved) by 12.9 percent (the percentage of total savings uplift in other EE programs) generates the value 0.065 percent. Formally, as shown in the following calculation: 0.005 × 0.0129 =0.00065. Subtracting this value from 0.005 gives 0.0043, or 0.43 percent.

Table 3-1 presents a summary of the double-counted savings due to PY8 and legacy uplift in other EE programs and the estimated savings for the GES program obtained by removing these savings from the estimate of verified program savings prior to uplift adjustment, by program wave. Section 6.4 in the appendix presents the details of the calculation of the PY8 and Legacy uplift for each of the four ComEd EE programs considered in the analysis. As previously mentioned, the programs included in the uplift analysis in PY8 were the FFR program, the HEA program, the Rebate program and the MESP.[21]

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 PY8. Under the more reasonable assumption that participation occurs at a uniform rate throughout the year, the estimate of double-counted savings would be approximately 14.5 MWh, half the estimated value of 29 MWh. Overall, double counting of savings with other ComEd EE programs is larger for this program than for some of ComEd's other behavioral programs. This indicates that the GES program is doing a relatively good job of channeling participants into other ComEd EE programs.

3.2 Verified Program Impact Results

Table 3-3 summarizes estimated program savings by wave. In this table, the number of PY8 participants, in the first row, represents the number of customers in each wave in PY8, while the sample sizes, in the second and third rows, indicate the number of customers with sufficient data for inclusion in the regression analysis. Navigant estimated separate savings for each wave using regression analysis as described in Section 2.3. The weighted average per customer savings estimate was 0.5 percent (44.23 kWh). Detailed parameter estimates from the RPPM model are shown in Section 6.3.

Table 3-3. PY8 GES Program Results by Wave

Type of Statistic	PY6 Wave	PY7 Wave	PY8 Wave	Total
Number of PY8 Participants	555	865	538	1958
Sample Size - Treatment	489	705	424	1618
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Standard Error	*326*	*164*	*158*	*-*
Net Savings, Prior to Uplift Adjustment, MWh †	192	47	-13	226
Standard Error	*166*	*125*	*6*	*-*
PY8 Uplift Adjustment, MWh	5	8	15	27
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Net Savings, MWh ‡	185	39	-27	197

Source: ComEd tracking data and Navigant team analysis.
† Total savings are pro-rated for participants that closed their accounts during PY8.
‡ Net Savings are equal to Net Savings, Prior to Uplift Adjustment less the uplift of savings in other EE programs.

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[21] 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 GES program is not possible due to the requirement in our evaluation that GES participants have sufficient historical usage data.

Figure 3-1 shows the energy savings for each wave with the 90 percent confidence interval. Savings from Wave PY6 and PY7 were not statistically significant because each wave's confidence bounds include zero. Wave PY8 was statistically significant, but to a negative savings rate indicating its participants increased energy use relative to controls.

Figure 3-1. PY8 Percent Savings and 90 Percent Confidence Interval, by Wave
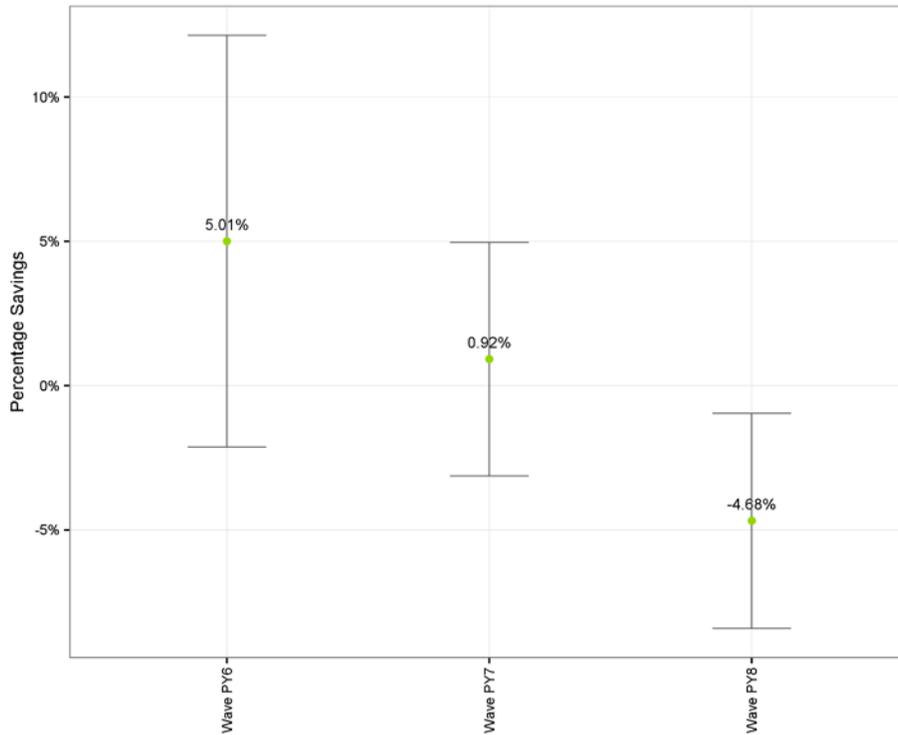
Source: ComEd tracking data and Navigant team analysis.

4. NET IMPACT EVALUATION

A key feature of the matched control group method used to estimate savings for the GES program is that the analysis assumes that with respect to unobserved variables that may affect program savings, on average program enrollees are no different than customers matched to them. In other words, in the absence of the program the expectation is that participants in the GES program and their matched controls would have exhibited the same energy usage. In particular, in the absence of the program the expectation is that participants and matched controls would exhibit the same degree of energy-conserving behavior and purchases. Therefore, this method estimates net savings and no further NTG adjustment is necessary.

5. FINDINGS AND RECOMMENDATIONS

The following includes program findings and recommendations.[22]

Finding 1. The overall weighted average savings for the program was 0.5 percent which was not statistically significant. While savings increased for both the PY6 and PY7 Waves compared to their performance during PY7, the PY8 Wave showed negative savings and drove the overall weighted average for the program down. The increase in savings for the PY6 and PY7 Waves may indicate that the E-Tips were effective at driving higher savings but the negative savings for the PY8 Wave muddle this outcome.

Recommendation 1. The program implementation contractor should continue to implement and expand the E-Tips, which appear to help drive higher savings in the PY6 and PY7 Waves. Increasing average savings per participant will help increase the likelihood that the program will achieve statistically significant savings in future program years.

Finding 2. One factor that contributed to program savings not being statistically significant was the small size of the program waves. The PY8 Wave included 538 participants, which was fewer than the PY7 Wave (865 participants) and the PY6 Wave (555 participants).

Recommendation 2. The program implementation contractor should recruit more participants in future program waves. According to Navigant's back of the envelope power analysis using results from the PY7 Wave, if the average savings was around 1 percent, the program implementation contractor would need to recruit approximately 15,000 participants into the program in order to have the possibility of finding statistically significant savings at the 90 percent confidence level. Increasing the program savings per participant could reduce the necessary number of participants.

Finding 3. Part of the reason for the program's low level of energy savings may be due to the relatively low average daily usage of its participants. The average daily usage of households in each of the three waves was under 20 kWh per day. Previous studies of behavioral EE programs have shown a positive association between energy usage rates and energy savings levels. The fact that the average energy usage of GES participants is lower than that of other behavioral EE programs may be constraining this program's potential for achieving statistically significant energy savings.

Recommendation 3. The program implementation contractor should recruit higher usage customers into the program in future program years. Doing so could increase program savings per participant and help increase the likelihood that the program will achieve statistically significant energy savings in future program years. As described in Recommendation 2 above and according to Navigant's back of the envelope power analysis using results from the PY7 Wave, if the average savings for the program was increased to approximately 5 percent, a program consisting of approximately 1,000 participants would likely lead to statistically significant savings at the 90 percent confidence level.

Recommendation 4. The implementation contractor should identify those participants who are no longer interacting with the program in the program tracking system. Excluding participants who are no longer interacting with the program from future evaluation efforts, if they can be identified, could reduce the standard error and also help increase the likelihood that the program will achieve statistically significant savings in future program years.

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[22] Numbered findings and recommendations in this section are the same as those found in the Findings and Recommendations section of the executive summary for ease of reference between each section.

6. APPENDIX

6.1 Detailed Data Cleaning

Navigant removed customers and data points from the analysis in the following steps:

- Participants who did not have an active account on the first day of PY8.
- Observations with a bill duration of zero.
- Observations with missing or negative usage.
- Observations with less than 20 or more than 40 days in a billing cycle.
- Observations that were outliers, defined as having average daily usage more than one order of magnitude from the median usage.[23]
- Customers with fewer than eight bills in the matching period.

Table 6-1, Table 6-2, and Table 6-3 give counts and percentages of data points removed for the data cleaning steps identified above. The percentages of customers and observations removed are similar across treatment and control groups for each wave, suggesting that data cleaning did not introduce non-random bias.

Table 6-1. Customers/Observations Removed by Data Cleaning Step, Wave PY6

Step	Customers	Observations	% Cust Chg	% Obs Chg
Raw Data	555	19,190		
Subset to pre/post periods	555	19,190	0.0%	0.0%
Bill duration does not equal 0	555	19,190	0.0%	0.0%
Bill Flattening	555	18,717	0.0%	2.5%
Remove duplicate bills	555	18,717	0.0%	0.0%
Exclude observations missing usage	555	18,717	0.0%	0.0%
Remove observations with negative usage	555	18,717	0.0%	0.0%
Exclude bills with long or short durations	555	18,657	0.0%	0.3%
Exclude outliers	553	18,377	0.4%	1.5%
Remove Customers with < eight months of pre-data	489	10,929	11.6%	40.5%

Source: ComEd data and Navigant team analysis.

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[23] The median kWh usages for Waves 1 through 3 were 17.43, 14.79, and 15.54, respectively.

Table 6-2. Customers/Observations Removed by Data Cleaning Step, Wave PY7

Step	Customers	Observations	% Cust Chg	% Obs Chg
Raw Data	865	29,324		
Subset to pre/post periods	865	29,324	0.0%	0.0%
Bill duration does not equal 0	865	29,324	0.0%	0.0%
Bill Flattening	865	28,712	0.0%	2.1%
Remove duplicate bills	865	28,712	0.0%	0.0%
Exclude observations missing usage	865	28,712	0.0%	0.0%
Remove observations with negative usage	865	28,712	0.0%	0.0%
Exclude bills with long or short durations	865	28,580	0.0%	0.5%
Exclude outliers	865	28,095	0.0%	1.7%
Remove Customers with < eight months of pre-data	705	15,635	18.5%	44.3%

Source: ComEd data and Navigant team analysis.

Table 6-3. Customers/Observations Removed by Data Cleaning Step, Wave PY8

Step	Customers	Observations	% Cust Chg	% Obs Chg
Raw Data	538	11,898		
Subset to pre/post periods	538	11,898	0.0%	0.0%
Bill duration does not equal 0	538	11,898	0.0%	0.0%
Bill Flattening	538	11,752	0.0%	1.2%
Remove duplicate bills	538	11,752	0.0%	0.0%
Exclude observations missing usage	538	11,752	0.0%	0.0%
Remove observations with negative usage	538	11,752	0.0%	0.0%
Exclude bills with long or short durations	538	11,659	0.0%	0.8%
Exclude outliers	537	11,506	0.2%	1.3%
Remove Customers with < eight months of pre-data	424	7,743	21.0%	32.7%

Source: ComEd data and Navigant team analysis.

6.2 Detailed Impact Methodology

6.2.1 Regression with Pre-Program Matching Model (RPPM)

As discussed in Section 2.3, the basic logic of regression with a matching model is to balance the participant and non-participant samples by matching on the exogenous covariates known to have a high correlation with the outcome variable. Doing so increases the efficiency of the estimate and reduces the potential for model specification bias. Formally, the argument is that if the outcome variable Y is independently distributed conditional on X and D (conditional independence assumption), where X is a set of exogenous variables and D is the program variable, then the analyst can gain some power in the estimate of savings and reduce potential model specification bias by assuring that the distribution of X is the same for treatment and matched control observations.

In this evaluation, the outcome variable is monthly post-program period energy use, and the available exogenous covariate with by far the greatest correlation with this outcome variable is energy use in the same month of the pre-program period, $PREkWh_{kt}$, where k indexes the customer and t indexes the month; this is why the matching takes the form described in Section 2.3.1. The RPPM approach can be

interpreted as using regression analysis to further control for any remaining imbalance in the matching on this variable. If, for instance, after matching the participants use slightly more energy on average in the pre-program period than their matches – in other words, they are higher baseline energy users – then including $PREkWh_{kt}$ as an explanatory variable in a regression model predicting monthly energy use during the post-program period prevents this remaining slight difference in baseline energy use from being attributed to the program.

In the RPPM approach the development of a matched comparison group is viewed as a useful pre-processing step in a regression analysis to assure that the distributions of the covariates (i.e., the explanatory variables on which the output variable depends) for the treatment group are the same as those for the comparison group that provides the baseline measure of the output variable.[24] This minimizes the possibility of model specification bias. The regression model is applied only to the post-treatment period, and the matching focuses on those variables expected to have the greatest impact on the output variable.

6.2.2 Matching Algorithm and Matching Results

As described in Section 2.3.1, participants and potential controls were matched on energy use during the pre-treatment period, and then estimated a model for all post-program observations in which energy use in month t is a function of a monthly fixed effect, a zip code level fixed effect, energy use in the same calendar month in the one-year period before program enrollment, and whether the customer is a program participant. Formally, the model is shown in Equation 6-1.

Equation 6-1. RPPM Model

$$ADU_{kt} = \beta_1 Treatment_k + \sum_J \beta_{2j} Month_{jt} + \sum_J \beta_{3j} Month_{jt} \cdot PREkWh_{kt} + \sum_L \beta_{4l} Zip_{kl} + \varepsilon_{kt}$$

Where,

ADU_{kt}	= Average daily energy use by household k in month t.
$Treatment_k$	= A binary variable taking a value of 1 if customer k is a GES participant and 0 otherwise.
$Month_{jt}$	= A binary variable taking a value of 1 when $j = t$ and 0 otherwise.[25]
$PREkWh_{kt}$	= The average daily electricity use by household k during the most recent month before household k (or its match) enrolled in the GES program that is also the same calendar month as month t. For instance, if household k enrolled in August 2011, the value of $PREkWh_{kt}$ for June 2012 is June 2011.
Zip_{kl}	= A binary variable taking a value of 1 if customer k is in zip code l and 0 otherwise.
ε_{kt}	= Model error term.

In this model β_1 is the treatment effect. The monthly fixed effect is included to account for unobserved time-related factors, such as weather, that affect all customers, and interact the monthly dummy variable with $PREkWh_{kt}$ to account for the fact that the relationship between energy use in the year before enrollment and energy use in the program year might vary by calendar month. The zip code fixed effect is included to account for geographic factors, such as school quality, that affect all customers.

For the sake of expositional clarity below, let t_k denote the month t in which customer k enrolled in the program, with t_k -1 denoting the month before enrollment, t_k +1 denoting the month after enrollment, and so on. Customers with more than four missing bills during the designated matching period [t_k -14, t_k -3] were not matched.

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[24] Ho, Daniel E., Kosuke Imai, Gary King, and Elizabeth Stuart. 2007. Matching as nonparametric preprocessing for reducing model dependence in parametric causal inference. *Political Analysis* 15(3): 199-236.

[25] In other words, if there are T post-program months, there are T monthly dummy variables in the model, with the dummy variable $Month_{tt}$ the only one to take a value of 1 at time t. These are, in other words, monthly fixed effects.

The basis of the comparison is the difference in monthly energy use between a participant and a potential match, D_{PM} (**D**ifference between **P**articipant and potential **M**atch). The quality of a match is denoted by the Euclidean distance to the participant over the twelve values of monthly D_{PM} used for matching; that is, denoting by SSD the sum of squared D_{PM} over the matching period, it is denoted by $SSD^{1/2}$. The non-participant customer with the shortest Euclidean distance to a participant was chosen as the matched comparison for the participant. Matching was done with replacement.

6.3 Detailed Impact Results: Parameter Estimates

Parameter estimates for Equation 6-1 are presented in Table 6-4, Table 6-5, and Table 6-6.

Table 6-4. Parameter Estimates for RPPM Model, Wave PY6

Variable	Parameter Estimate	Std. Err.	t-value	p-value
treatment	-1.03	0.89	-1.15	0.25
yrmo201506	0.59	2.33	0.25	0.80
yrmo201507	-0.39	1.67	-0.23	0.82
yrmo201508	-0.41	3.72	-0.11	0.91
yrmo201509	0.54	1.90	0.29	0.78
yrmo201510	5.91	1.54	3.84	0.00
yrmo201511	6.33	1.40	4.51	0.00
yrmo201512	7.29	1.92	3.80	0.00
yrmo201601	6.76	1.51	4.47	0.00
yrmo201602	8.81	1.95	4.52	0.00
yrmo201603	7.74	1.38	5.63	0.00
yrmo201604	7.43	1.02	7.28	0.00
yrmo201605	7.89	1.58	5.00	0.00
yrmo201506:pre_use	0.75	0.15	5.07	0.00
yrmo201507:pre_use	0.59	0.05	11.62	0.00
yrmo201508:pre_use	1.03	0.14	7.56	0.00
yrmo201509:pre_use	1.00	0.09	11.12	0.00
yrmo201510:pre_use	0.61	0.09	6.73	0.00
yrmo201511:pre_use	0.58	0.06	9.93	0.00
yrmo201512:pre_use	0.62	0.08	7.45	0.00
yrmo201601:pre_use	0.72	0.06	11.16	0.00
yrmo201602:pre_use	0.63	0.07	8.80	0.00
yrmo201603:pre_use	0.55	0.05	10.21	0.00
yrmo201604:pre_use	0.54	0.04	13.54	0.00
yrmo201605:pre_use	0.50	0.09	5.31	0.00
Residual standard error: 14.05 on 5098 degrees of freedom				
Multiple R-squared: 0.6989, Adjusted R-squared: 0.6974				
F-statistic: 473.3 on 25 and 5098 DF, p-value: <0.00				

Source: ComEd tracking data and Navigant team analysis.

Table 6-5. Parameter Estimates for RPPM Model, Wave PY7

Variable	Parameter Estimate	Std. Err.	t-value	p-value
treatment	-0.17	0.45	-0.37	0.71
yrmo201506	2.92	1.08	2.70	0.01
yrmo201507	3.68	0.95	3.87	0.00
yrmo201508	4.11	1.13	3.63	0.00
yrmo201509	4.59	1.05	4.39	0.00
yrmo201510	2.27	0.78	2.92	0.00
yrmo201511	3.43	0.79	4.35	0.00
yrmo201512	4.24	0.70	6.07	0.00
yrmo201601	6.82	1.04	6.53	0.00
yrmo201602	6.36	1.26	5.04	0.00
yrmo201603	6.62	0.97	6.80	0.00
yrmo201604	4.80	0.78	6.18	0.00
yrmo201605	2.64	0.65	4.05	0.00
yrmo201506:pre_use	0.78	0.06	13.64	0.00
yrmo201507:pre_use	0.71	0.04	17.90	0.00
yrmo201508:pre_use	0.84	0.04	20.19	0.00
yrmo201509:pre_use	0.76	0.04	20.71	0.00
yrmo201510:pre_use	0.80	0.03	24.57	0.00
yrmo201511:pre_use	0.71	0.04	18.00	0.00
yrmo201512:pre_use	0.72	0.03	21.99	0.00
yrmo201601:pre_use	0.60	0.04	17.10	0.00
yrmo201602:pre_use	0.66	0.04	18.24	0.00
yrmo201603:pre_use	0.57	0.03	16.95	0.00
yrmo201604:pre_use	0.62	0.04	15.35	0.00
yrmo201605:pre_use	0.79	0.03	22.99	0.00
Residual standard error: 8.852 on 14009 degrees of freedom				
Multiple R-squared: 0.8174, Adjusted R-squared: 0.817				
F-statistic: 2508 on 25 and 14009 DF, p-value: <0.00				

Source: ComEd tracking data and Navigant team analysis.

Table 6-6. Parameter Estimates for RPPM Model, Wave PY8

Variable	Parameter Estimate	Std. Err.	t-value	p-value
treatment	0.89	0.43	2.06	0.04
yrmo201506	1.83	1.73	1.06	0.29
yrmo201507	0.18	1.69	0.11	0.91
yrmo201508	3.35	2.21	1.51	0.13
yrmo201509	3.45	1.19	2.90	0.00
yrmo201510	3.24	1.37	2.36	0.02
yrmo201511	4.87	1.07	4.54	0.00
yrmo201512	4.82	0.73	6.61	0.00
yrmo201601	4.83	0.68	7.09	0.00
yrmo201602	4.01	0.76	5.31	0.00
yrmo201603	4.80	0.79	6.04	0.00
yrmo201604	3.59	0.65	5.54	0.00
yrmo201605	2.71	0.82	3.30	0.00
yrmo201506:pre_use	0.75	0.07	10.03	0.00
yrmo201507:pre_use	0.96	0.11	9.08	0.00
yrmo201508:pre_use	1.15	0.07	15.33	0.00
yrmo201509:pre_use	0.89	0.06	15.71	0.00
yrmo201510:pre_use	0.83	0.10	8.25	0.00
yrmo201511:pre_use	0.62	0.07	9.37	0.00
yrmo201512:pre_use	0.65	0.03	19.11	0.00
yrmo201601:pre_use	0.74	0.03	27.09	0.00
yrmo201602:pre_use	0.82	0.03	25.90	0.00
yrmo201603:pre_use	0.65	0.04	17.80	0.00
yrmo201604:pre_use	0.78	0.04	20.21	0.00
yrmo201605:pre_use	0.81	0.06	14.13	0.00
Residual standard error: 8.315 on 5865 degrees of freedom				
Multiple R-squared:0.8795, Adjusted R-squared: 0.879				
F-statistic: 1712 on 25 and 5865 DF, p-value: <0.00				

Source: ComEd tracking data and Navigant team analysis.

6.4 Savings Due to Participation Uplift in Other EE Programs

6.4.1 Uplift in PY8

Table 6-7, Table 6-8, and Table 6-9 present program savings due to participation uplift in other EE programs for each wave. A dash (-) in a row concerning the change in participation from the pre-program year indicates the EE program did not exist during the pre-program year. In these cases, the estimate of uplift is based on a POD statistic, otherwise it is based on a DID statistic. Overall, the empirical evidence indicates that the program caused a reduction in participation in other EE programs by 27 MWh.

Table 6-7. Estimates of Double Counted Savings in PY8, Wave PY6

	FFR	HEA	MF	Rebate
Median program savings (annual kWh per participant)	592	364	304	151
Number of treatment customers	489	489	489	489
Treatment rate of participation, PY8 (%)	1%	2%	0%	0%
Change in rate of treatment participation from pre-program year (%)	-1%	-	-1%	0%
Number of control customer	429	429	429	429
Control rate of participation, PY8 (%)	1%	1%	0%	1%
Change in rate of control participation from pre-program year (%)	-2%	-	0%	1%
DID or POD statistic	1%	1%	-1%	-1%
Participant uplift	6	3	-3	-6
Statistically significant at the 90% confidence level?	No	No	No	Yes
Savings attributable to other programs (kWh)	3788	1150	-913	-839
Percentage change in EE program participation rate for HER participants	-267%	46%	-100%	-100%

Source: ComEd tracking data and Navigant team analysis.

Table 6-8. Estimates of Double Counted Savings in PY8, Wave PY7

	FFR	HEA	MF	Rebate
Median program savings (annual kWh per participant)	592	277	261	432
Number of treatment customers	705	705	705	705
Program participation, PY8	1%	2%	0%	0%
Change in participation from pre-program year	0%	-	-2%	0%
Number of matched control customers	620	620	620	620
Matched control participation, PY8	0%	1%	0%	1%
Change in participation from pre-program	-1%	-	0%	0%
DID or POD statistic	1%	1%	-2%	0%
Participation uplift	10	7	-11	-2
Statistically significant at the 90% confidence level?	Yes	No	Yes	No
Savings attributable to other programs (kWh)	5977	1990	-2798	-984
Percentage change in EE program participation rate for GES participants	-166%	105%	-91%	-100%

Source: ComEd tracking data and Navigant team analysis.

Table 6-9. Estimates of Double Counted Savings in PY8, Wave PY8

	FFR	HEA	MF	Rebate
Median program savings (annual kWh per participant)	592	290	508	158
Number of treatment customers	424	424	424	424
Program participation, PY8	0%	7%	0%	0%
Change in participation from pre-program year	0%	7%	-1%	0%
Number of matched control customers	414	414	414	414
Matched control participation, PY8	0%	1%	0%	0%
Change in participation from pre-program	-3%	1%	0%	0%
DID or POD statistic	3%	6%	-1%	0%
Participation uplift	11	27	-3	-1
Statistically significant at the 90% confidence level?	Yes	Yes	Yes	No
Savings attributable to other programs (kWh)	6698	7805	-1523	-162
Percentage change in EE program participation rate for GES participants	-100%	657%	-100%	-100%

Source: ComEd tracking data and Navigant team analysis.

6.4.2 Legacy Uplift

In PY6, Navigant considered double-counted savings for the following PY6 programs: SFHES, CSR, FFRR programs, and MF. The measure lives for PY6 programs were taken from the PY6 total resource cost report.[26] The measure life for the SFHES and MF programs are the simple average of the measures included in that program. Table 6-10 shows the double counted savings (kWh) from each program in PY6.

Table 6-10. Double Counted Savings (kWh) from PY6

	SFHES	CSR	FFRR	MF
Measure Life	8.40	18	8	4.67
Wave PY6	1,800	0	0	-155
Double Counted Savings (kWh)	1,800	0	0	-155

Source: ComEd tracking data and Navigant team analysis.

In PY7, Navigant considered double-counted savings for the following PY6 programs: FFR, HEA, MESP, and Rebate. The PY7 total resource cost report is not yet available, so the program measure lives for PY7 are not included, however for the PY8 legacy uplift adjustment, each of these programs are assumed to have a measure life of at least two years and, consequently, should be deducted in PY8. Table 6-11 shows the double counted savings (kWh) from each program in PY7.

Table 6-11. Double Counted Savings (kWh) from PY7

	FFR	HEA	MESP	Rebate
Measure Life	-	-	-	-
Wave PY6	-139	78	-35	-9
Wave PY7	118	53	24	-
Double Counted Savings (kWh)	-21	131	-11	-9

Source: ComEd tracking data and Navigant team analysis.

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[26] Navigant Consulting, Inc. 2016. *Review of EPY6 Total Resource Cost Test Assumptions.* Presented to Commonwealth Edison Company.