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Great Energy Stewards Program
PY7 Evaluation Report

FINAL

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

Presented to
Commonwealth Edison Company

February 19, 2016

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Table of Contents

NAVIGANT

List of Figures and Tables

Figures:

Tables:

Equations:

NAVIGANT

E. Executive Summary

This report presents a summary of the findings and results from the impact of the Great Energy Stewards Program in Program Year 7 (PY7)[1]. 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). GES 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.

Restrictions on use of participants' personally identifiable information (PII) prevented Shelton from monitoring participants' energy usage which was a key feature of the program's strategy for tracking energy savings through behavior change.[4] As a partial solution, ComEd has provided Shelton with monthly (later 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, Shelton's inability to view participants' monthly usage levels limits Shelton's ability to track participants' progress in a timely fashion, which has limited Shelton's insights into participants' energy consumption patterns that could be helpful in tailoring the energy-saving tips to individual participants.

Notable program changes in PY7 included:

- Shelton stopped paying participants for savings, reflecting the fact that the unadjusted usage changes ("raw savings") are not an accurate representation of verified customer savings.
- In lieu of paying participants for savings, Shelton offered small ($5) gift cards as an enrollment incentive, redeemable at local fast food outlets (Dunkin Donuts or Subway).
- Shelton also held raffles or drawings with similar small ($5-$25) prizes to reward participation.
- ComEd sent the raw savings reports to Shelton quarterly rather than monthly.

Other than these changes, the main program design features remained unchanged from PY6:

- Shelton continued sending tips and usage information to participants in PY7 via monthly mailed postcards.
- Shelton continued recruiting both in local churches and at CEDA events.

[1] PY7 began June 1, 2014 and ended May 31, 2015.
[2] Created by Illinois Public Acts 97-0616 ("PA 97-0616") and 97-0824 ("PA 97-0824").
[3] "The Program will reward participants at a level 5 cents per kWh saved, up to $50." The 2013 Great Energy Stewards Program SCOPE OF WORK DOCUMENT final vers.pdf (June 3, 2013), p. 3.
[4] 2013 Great Energy Stewards SCOPE OF WORK DOCUMENT, loc. cit

- As was the case in PY6, the uptake rate was much higher at CEDA events, in part because many attendees bring a sample ComEd bill with them in anticipation of signing up for LIHEAP assistance. (ComEd also sends representatives to many of these events who can provide would-be GES enrollees with their ComEd customer account ID numbers on the spot.)

Shelton enrolled approximately 1,000 new ComEd customers on a rolling basis throughout PY7 starting in June 2014. These customers are referred to as Wave 2 in this report. Participants who remained in the program from PY6 are referred to as Wave 1. We analyzed each wave separately to enable us to detect whether there were any differences observed between the responses of the two groups, and whether any "ramp-up" in savings was observed among Wave 1 participants relative to their performance in the previous year.

Looking forward, we learned in discussions with Shelton that they began rolling out a new two-way electronic communication approach in PY8 aimed at increasing customer engagement with the program. "E-Tips" – emailed communications developed using the SurveyMonkey survey tool.[5] As of November 2015 roughly 400 GES participants had opted to receive E-Tips, which:

- Have a format similar to the GES mailed postcards.
- Have allowed Shelton to increase the number of tips from 12 per year to as many as 50 -- Shelton told us they are planning to experiment with increasing the frequency of tip delivery to biweekly.
- Are automated: Shelton loaded all the tips for the year at one time and they are automatically emailed by SurveyMonkey 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?"). Shelton offers an incentive to reward early responders ($5 gift cards) each month.
- Shelton estimates that approximately 10 percent of E-Tip recipients respond to the survey question each month.
- This approach is saving Shelton time and money on postage, printing and materials.

E.1 Program Savings

The evaluation team calculated energy savings for the GES Program using regression analysis of monthly billing data for participants and a group of matched controls. Table E-1 summarizes the electricity savings from the GES Program. Navigant's regression analysis of GES Program participant energy savings yielded estimated savings of 41.89 MWh. However, these results were not statistically significant and therefore are not distinguishable from zero. Navigant's primary finding is that the program achieved no verified energy savings in PY7. As explained in Section 4, a key feature of the regression analysis is that it inherently estimated net savings because there were no participants who otherwise might have received individualized reports in the absence of the program. Therefore, there was no free ridership and no NTG ratio was applied for this program (although we did perform an uplift adjustment to subtract savings jointly produced by the program and other energy efficiency programs).

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

Table E-1. PY7 Total Program Electric Savings

Savings Category	Energy Savings (MWh)
Verified Savings Prior to Uplift Adjustment	43.57
PY7 Uplift Adjustment*	0.09
Legacy Uplift Adjustment	1.59
Net Savings†	41.89
Final Verified Savings‡	0

Source: ComEd billing data, GES tracking data, and Navigant team analysis.
*The uplift adjustment reflects savings that are jointly produced by the program and other energy efficiency programs.
†Net savings adjusts for savings uplift are equal to gross savings less the uplift of savings in other energy efficiency programs.
‡The savings are not statistically significant, which means they are indistinguishable from zero.

E.2 Program Savings by Participant Wave

For the purposes of this report, Navigant characterized GES Program participants as comprising two waves that used rolling enrollment to acquire customers. These two waves (Wave 1 and Wave 2) began enrollment in June 2013 and June 2014 respectively. The rollout of these two waves is summarized in Table E- 1. The number of participants, in the first row, represents the number of customers receiving reports in PY7, while the sample size – treatment, in the second row, indicates the number of customers with sufficient data for inclusion in the regression analysis.

Table E- 1. PY7 GES Program Results, by Wave

Type of Statistic		Wave 1	Wave 2
Number of Participants		692	981
Sample Size – Treatment		510	750
Sample Size – Control		509	735
Percentage Savings	*Estimate:*	0.30	0.44
	Standard Error:	*1.73*	*1.62*
Savings Per Customer, kWh	*Estimate:*	31.01	22.54
	Standard Error:	*177.87*	*83.46*
Net Savings Prior to Uplift Adjustment, MWh	*Estimate:*	21.46	22.11
	Standard Error:	*123.09*	*81.87*
Savings Uplift in Other EE Programs in PY7, MWh*		-0.11	0.20
Legacy Savings Uplift in Other EE Programs, MWh		1.59	-
Net Savings After Uplift Adjustment, MWh†		19.98	21.92
Verified Net Savings, MWh‡		0	0

Source: ComEd billing data, GES tracking data, and Navigant team analysis.
*The uplift adjustment reflects savings that are jointly produced by the program and other energy efficiency programs. Negative double-counted savings indicate that the participation rate in the energy efficiency programs is higher for the control group than the treatment group. This lowers the baseline and underestimates GES program savings.
†Net savings after uplift adjustment deducts savings uplift in other energy efficiency programs.
‡The savings are not statistically significant, which means they are indistinguishable from zero.

E.3 Key Findings and Recommendations

Finding 1. While these results represent an improvement from PY6, when overall GES Program savings was negative (though not statistically significant), the verified energy savings rates observed among GES Program participants in PY7 were quite low (0.3 percent savings for Wave 1, 0.4 percent savings for Wave 2). Since the standard errors associated with these estimates are an order of magnitude larger in both cases, neither savings rate is statistically significant. Thus the verified net savings are indistinguishable from zero even though GES participants did have slightly lower overall energy use on average than the controls in PY7.

Finding 2. While the point estimates of PY7 energy savings for Wave 1 and Wave 2 do differ slightly from one another, there is no statistically significant difference between them.[6]

Finding 3. While the estimated energy savings of Wave 1 improved from -0.8 percent in PY6 to 0.3 percent in PY7 (a total swing in the savings direction of 1.1 percentage points), this change is not statistically significant.[7]

Recommendation 1. To attain statistically significant savings, the GES Program would have to accomplish one or more of the following: enroll a much larger number of participants, substantially raise the average energy savings rate per participant, broaden the energy savings experience so that more of the participants experience savings, or some combination of these.

Finding 4. Part of the reason for the program's relatively low level of energy savings may be the relatively modest level of energy usage of its participants. The average daily usage of households in Wave 1 and Wave 2 were 20.56 kWh and 18.77 kWh, respectively. 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 the energy savings rates GES participants have been able to achieve to date. Programs with only slight differences in energy use between treatment and control groups require much larger samples to prove statistical significance than programs with larger savings rates. Although the GES customers (on average) have already a modest level energy use and therefore a lower potential for saving energy, GES educates customers about saving energy which complements LIHEAP's direct installation of energy efficient measures. Both programs serve to increase energy savings.

Recommendation 2. If dramatic increases in program enrollment size are not feasible, then the best available option would be to look for ways to engage the participants more deeply in the project of saving energy so that their average savings rate increases. Navigant views Shelton's innovations with E-Tips as potentially promising in this regard.

[6] The t statistic on the difference is 0.06.

[7] The t statistic on the difference is 0.33.

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.[8] 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.

Other studies have shown that this set of information induces customers to reduce their energy use, creating average energy savings in the one to three percent range, and possibly even higher when they are able to leverage greater customer engagement using AMI technology or other means.[9]

This report presents a summary of the findings and results from the impact evaluation of the PY7 GES Program which began June 1, 2014 and ended May 31, 2015. The implementation contractor designed the program to generate energy savings by providing residential customers with sets of information about customer energy use and energy conservation.

ComEd rolled out the GES Program in PY7 in the following two waves:

- A rolling enrollment wave which kicked off in June, 2013. This wave contained 692[10] enrollees (Wave 1).
- A second rolling enrollment wave which started in June, 2014 and consisted of 981 participants (Wave 2).

1.2 Evaluation Objective

The sole objective of the analysis in this report is to determine the PY7 energy savings generated by the GES Program.

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

[9] Opower reports average steady state savings across its Home Energy Reports programs in multiple states (including Illinois) of 1.5–2.5 percent, including programs targeting low and moderate income customer segments (http://www.opower.com/results). Tendril cites savings of 1–3 percent for residential programs that incorporate smart thermostats, in-home energy displays, and online data portals ("Tendril Is Back: Could Nest and SolarCity Benefit from its Microtargeting Model?" http://www.greentechmedia.com/articles/read/tendril-models-and-micro-targets-the-home-energy-consumer, downloaded 12/11/2014). Bidgely reports even higher savings rates for some of its programs (http://www.bidgely.com/case_studies).

[10] Navigant's PY6 evaluation report indicated that the GES program had enrolled a total of 716 participants through the end of PY6. Thus, Wave 1 experienced 24 drop-outs in PY7, a rate of about 3 percent. This is within the expected range for on-going EE programs. Navigant, "Great Energy Stewards Program PY6 Evaluation Report" Final, April 1, 2015, p. 3.

2. Evaluation Approach

Similar to the evaluation approach used to analyze the GES Program in PY6, Navigant used a matching method that compared energy usage of program enrollees to that of a set of closely-matched non-program customers. This method is known as regression with pre-program matching (RPPM) as described in Ho, Imai, King, and Stuart.[11]

2.1 *Overview of Data Collection Activities*

Navigant received tracking data and monthly billing data for all program participants and control customers for the period of January 2012 to May 2015 from ComEd. Details are provided in Table 2-1.

Table 2-1. Primary Data Collection Activities

Data Source	Subject of Data	Quantity	Net Impact	Net Impact less Joint Impact with other EE Programs	Process
Interviews	ComEd and implementer program managers	2			X
Billing Data	Program participants and matches	All	X		NA
Tracking Data	Program participants and matches	All	X		NA
Tracking Data for Other Programs	Participants in Other Programs	All		X	NA

2.2 *Sampling Plan*

The matching approach used 510 program enrollees, and 509 unique control customers for Wave 1 and 750 program enrollees and 735 control customers for Wave 2. The reduction in the number of program enrollees from the total wave sample size was due to conditions necessary for proper matching. There were fewer control matches than participants because matching was done with replacement, which means any one control could be matched against more than one participant.

2.3 *Matching Algorithm*

The matching method relied on usage data from the bills of program participants, as well as from those of a set of matched comparison households, to estimate program savings. The pool of non-participant households available for matching consisted of 287,078 ComEd residential customers whose billing data were already accessible to Navigant.

[11] 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. In our PY6 evaluation we also attempted an alternative statistical approach, known as Variation-in-Adoption. However, the results of this model made clear that this approach was not suitable, and we did not attempt to use that method this year. See Navigant, "Great Energy Stewards Program PY6 Evaluation Report" Final, *op. cit.*, pp. 8, 20-23.

For each program participant with monthly billing data available extending back at least 14 months before program enrollment, Navigant compared average daily energy consumption in each month in the period spanning 3-14 months before enrollment (a twelve-month period) to that of all of the customers in the available pool of potential matches over the same 12 months. For the sake of expositional clarity below, we denote by t_k=0 the month t in which customer k enrolled in the program, with t_k -1 denoting the month immediately before enrollment, t_k +1 the month immediately after enrollment, and so on. Customers with missing bills during the designated matching period [t_k -14, t_k -3], but whose billing data extended past 14 months before program enrollment, were matched based on their most recent 12 bills before t_k -2 (that is, starting three months before enrollment and working backwards in time).

For each comparison, Navigant calculated the difference in average daily energy use in the given month 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 between the match and the participant over the 12 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 defined as $\sqrt{SSD}$.[12] The non-participant customer with the shortest Euclidean distance to a participant was chosen as the matched comparison for that participant. Matching was done with replacement.

It is not possible to statistically test the RPPM for selection bias, but Imbens and Wooldridge present a test that is suggestive (hereafter called the "IW test").[13] 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 prior to the start of the program period. A simple implementation of the test is to determine whether, given matching based on months t_k -3 to t_k -14, average D_{PM} in the two months before program enrollment, months t_k -1 and t_k -2, is practically or statistically different than zero.

2.4 Data Used in the Impact Analysis

In preparation for the impact analysis, Navigant combined and cleaned the data provided by ComEd. Billing data used in the analysis extended from January 2012 (17 months before the start of the program) through May 2015.

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

- Observations that did not fall into the relevant pre-program period or PY7;
- Observations with less than 20 or more than 40 days in the billing cycle;
- Outliers, defined as observations with average daily usage more than one order of magnitude from the median usage.

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

[12] See Chiang, Alpha C., *Fundamental Methods of Mathematical Economics* Third Edition (McGraw-Hill 1984), pp. 73-74.
[13] Imbens, Guido W., and Jeffrey M. Wooldridge, 2009, "Recent Developments in the Econometrics of Program Evaluation." *Journal of Economic Literature*, 47(1): 5-86.

2.5 *Statistical Approaches used in the Impact Evaluation*

Navigant used an RPPM method, briefly described above, to estimate program savings. Further details of the RPPM are presented in the appendix in Section 6.2.1. This approach treated matching as a "pre-processing" stage of the analysis and assumes that monthly energy use in the post-program period can be modeled as a linear regression function of month-specific fixed effects, a customer's usage from the same billing period of the prior year, and a participant indicator.

2.6 *Accounting for Uplift in Other Energy Efficiency Programs*

2.6.1 Accounting for Uplift in PY7

If participation rates in other energy efficiency programs are the same on average for GES participants compared to similar non-participants, the savings estimates from the statistical analyses presented here are already "net" of savings from the other programs, as this indicates the GES Program had no effect on participation in the other energy efficiency (EE) programs. However, if the GES Program affects participation rates in other energy efficiency programs, then savings across all programs are lower than indicated by the simple summation of savings in the GES and EE programs. For instance, if the GES Program increases participation in another EE program, the increase in savings may be allocated to either the GES Program or the other EE program, but cannot be allocated to both programs simultaneously.[14]

As data permitted, Navigant used a difference-in-difference (DID) statistic to estimate uplift in other EE programs, for which the change in enrollee participation rate in another EE program between PY7 and a pre-program period was subtracted from the same change for a control group. The group of nonparticipants used in the analysis included customers matched to participants for the RPPM method. The designated pre-program periods are June 2012 through May 2013 for Wave 1 and June 2013 through May 2014 for Wave 2, the 12 month periods before customers enrolled in the respective waves of the GES Program.

As an example, if the rate of participation in an EE program during PY7 was 5 percent for the treatment group and 3 percent for the matched comparison group, and the rate of participation during the 12 months before enrollment in the GES Program was 2 percent for the treatment group and 1 percent for the matched comparison group, then the rate of uplift due to the GES Program is 1 percent, which is reflected in the calculation (5%-2%)-(3%-1%)=1%. The DID statistic generates an unbiased estimate of uplift when the baseline average rate of participation is the same for the treatment and control groups, or when they are different due only to differences between the two groups in time-invariant factors, such as the square footage of the residence.

Navigant examined the uplift associated with four EE programs: the Fridge and Freezer Recycling (FFRR) Program, the Home Energy Assessment (HEA) Program, the Home Energy Rebates (Rebate) Program, and the Multi-family Energy Savings Program (MF). The FFRR Program achieves energy savings through retirement and recycling of older, inefficient refrigerators, freezers, and room air conditioners. The HEA

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

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 compacts 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 MF offers direct installation of low-cost efficiency measures, such as water efficiency measures and CFLs, at eligible multifamily residences.

2.6.2 Accounting for Legacy Uplift

The uplift adjustment methodology described in Section 2.6.1 only accounts for uplift which occurred 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.[15] However, for other EE programs with multi-year measure lives, GES Program savings captured 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 PY6 would generate savings captured in the GES Program savings not just in PY6, but in PY7 through PY15 as well.

Consider the following example. A household receiving energy usage information and conservation tips through the GES 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 GES 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 GES Program's savings when only the adjustment described in Section 2.6.2. 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 GES savings through the measure lives of the other EE programs.[16] The legacy uplift adjustment is shown in Equation 2-1.

Equation 2-1. Legacy Uplift Calculation

$$GES\ Savings_{PY}^{Adjusted} = GES\ Savings_{PY}^{Unadjusted} - Uplift\ Savings_{PY} - \sum_{i=1}^{PY-1} "Live"\ Legacy\ Uplift\ Savings_i \cdot (1 - MOR)^{PY-i}$$

[15] 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.

[16] 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.

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 only goes back to PY6, because that is the first year of the GES Program. In PY6, Navigant considered double-counted savings for the following programs: Fridge Freezer Recycle Rewards, CSR, Multi-Family Home Energy Savings, and Home Energy Rebate.

2.7 Process Evaluation

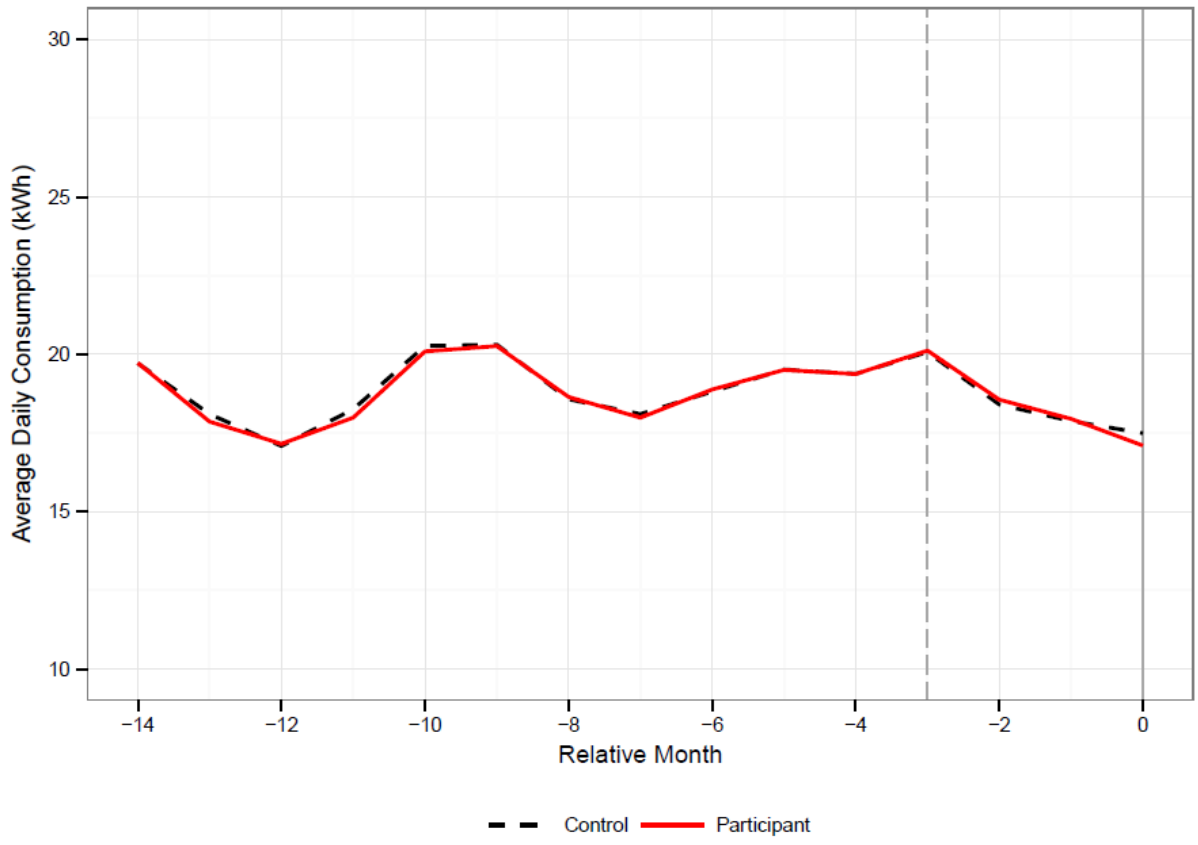
The PY7 evaluation did not include a process evaluation.

3. Gross Impact Evaluation

3.1 Matching Results

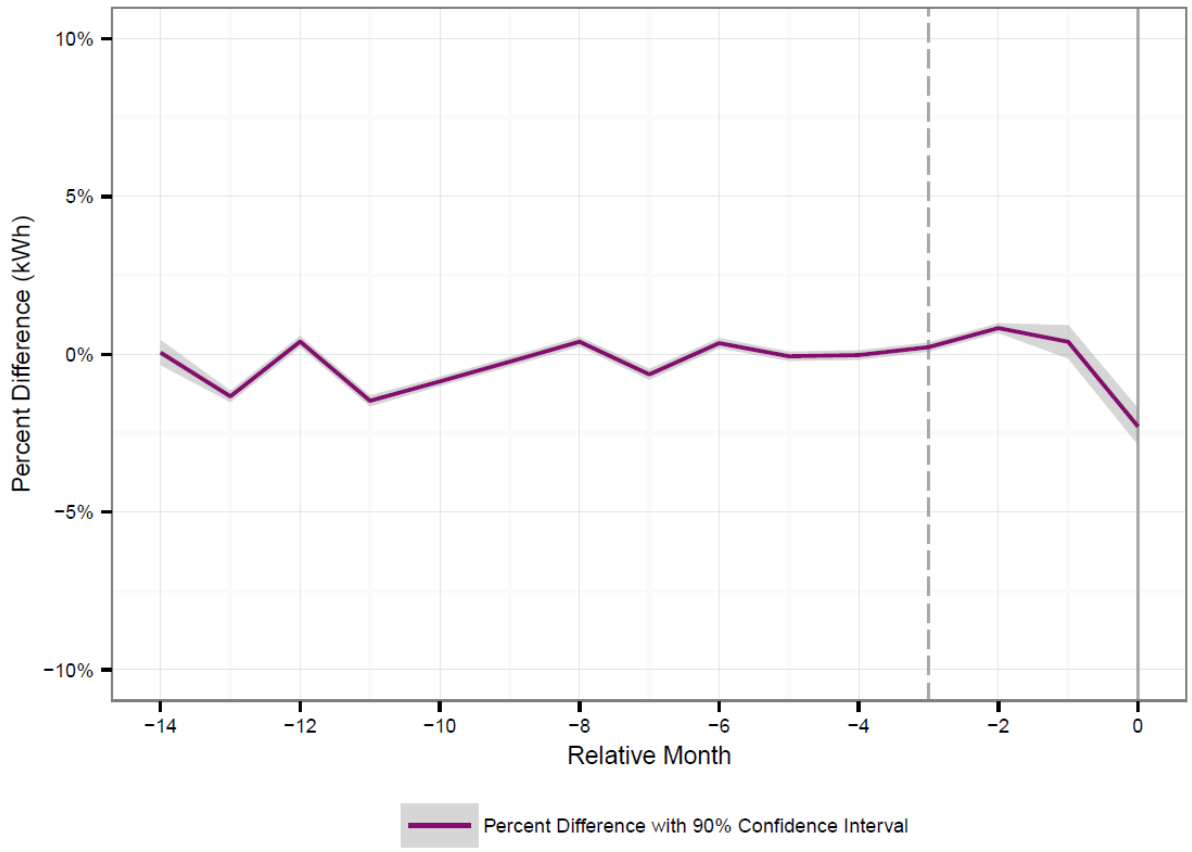
The matching method relied on a set of matched comparison households to estimate program savings. An analysis of the matching results for Wave 1 is available in Navigant's PY6 GES report. For Wave 2, Figure 3-1 presents the mean of average daily energy use by participants and their matches over the period *t*-14 to *t*-1, and Figure 3-2 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.

Figure 3-1. Average Monthly Energy Use Before Program Enrollment, GES Wave 2 Participants and Matched Controls



Source: Navigant analysis

Figure 3-2. Average Difference in Monthly Energy Use Before Program Enrollment, GES Wave 2 Participants Less Matched Controls, with 90 Percent Confidence Intervals



Source: Navigant analysis

3.2 *Model Parameter Estimates*

Navigant used a pre-program matching (RPPM) approach to estimate energy savings. RPPM parameter estimates for Wave 1 and Wave 2 are found in Table 6-2. RPPM Model Estimates, Wave 1 in the appendix. Estimated savings by wave are presented in Table 3-1.

In the RPPM approach, the estimated savings were derived directly from the estimate of α_2 in Model 1 in the appendix, and the standard error was based on the standard error of α_2. We estimated robust standard errors with clustering of errors by customer.

Table 3-1. GES Program Gross (and Net) Program Savings, PY7

Type of Statistic	Wave 1		Wave 2	
	Estimate	Std. Error	Estimate	Std. Error
Average Savings per Customer (%)	0.30	1.73	0.44	1.62
Lower 90% Confidence Bound on Estimate	*-2.55*		*-2.22*	
Upper 90% Confidence Bound on Estimate	*3.15*		*3.10*	
Annual Savings per Customer (kWh)	31.01	177.87	22.54	83.46
Lower 90% Confidence Bound on Estimate	*-261.59*		*-114.75*	
Upper 90% Confidence Bound on Estimate	*323.61*		*159.83*	
Net Savings Prior to Uplift Adjustment (MWh)	21.46	123.09	22.11	81.87
Lower 90% Confidence Bound on Estimate	*-181.02*		*-112.57*	
Upper 90% Confidence Bound on Estimate	*223.94*		*156.79*	
Savings Uplift in Other EE Programs in PY7 (MWh)*	-0.11		0.20	
Legacy Uplift in other EE Programs (MWh)*	1.59		-	
Net Savings After Uplift Adjustment (MWh)	19.98	123.09	21.92	81.87
Lower 90% Confidence Bound on Estimate	*-182.50*		*-112.76*	
Upper 90% Confidence Bound on Estimate	*222.46*		*156.60*	
Final Verified Net Savings, MWh	0		0	

Source: ComEd billing data, GES implementation data, and Navigant analysis.
*Total savings are pro-rated to reflect participants' actual periods of participation in the program during PY7.

It is clear from Table 3-1 that the program savings are not statistically significant. Whether savings are expressed in percentage terms, or as estimates of the total annual energy saved per customer, or in aggregate terms summing over all of the program participants during the (varying) periods that they belonged to the program during PY7, the 90 percent confidence intervals span negative as well as positive values.[17]

There are two main aspects driving these results: the low mean savings rates (less than one-half of one percent in both waves), and the relatively large standard errors of savings associated with each one. Our evaluation approach estimates an average savings rate per customer per day of being enrolled in the program.[18] Thus, if the impact of the program on customer energy usage varies widely, such that some participants save a relatively large percentage of their total energy usage each month while others save lesser amounts or none at all, the result is likely to be a low average savings rate that is obscured by a large amount of random statistical "noise". This is what we see in Table 3-1: the standard errors, which represent the random noise, are much larger than the savings estimates.

[17] The confidence intervals span the range of values that we are 90 percent confident contain the true average savings rate. This means that even though the point estimates of average savings shown in the top row of Table 3-1 are positive, there is also a non-trivial probability that they are actually negative, or zero.
[18] We work in terms of savings per day to standardize the differing lengths of billing periods to a common basis. Since there is rolling enrollment throughout the program year, we pro-rate the daily savings to credit participants for the days that they were enrolled.

Two other questions deserve attention: whether there is a statistically significant difference between the PY7 savings rates of Wave 1 and Wave 2, and whether the savings performance of Wave 1 differs significantly between PY6 (their first year of experience in the program) and PY7.

The first of these questions is addressed by the results shown in Table 3-2. As seen in the bottom row of the table, the difference in percent saved by the Wave 1 and Wave 2 is an order of magnitude smaller than the standard error of the difference, so that there is no statistically meaningful difference between them – the 90 percent confidence interval on the estimated difference encompasses negative values and zero as well as and positive values.

Table 2-2. Comparison of PY7 Mean Energy Savings Rates Between Waves

Wave	Percent Savings		90% CI on Percent Savings	
	Estimate	SE(Estimate)	Lower	Upper
1	0.30	1.73	-2.55	3.15
2	0.44	1.62	-2.22	3.10
Difference	0.14	2.37	-3.76	4.04

Source: ComEd billing data, GES tracking data, and Navigant team analysis. The analysis assumes that the mean savings in Wave 1 and Wave 2 are independent.

The question of whether the observed change in mean energy savings for Wave 1 between PY6 and PY7 is statistically significant is addressed by the results shown in Table 3-3. As seen in the bottom row of the table, even though the change in the savings estimate is relatively large, representing a swing of 1.1 percentage points, the standard error of the difference is three times is large, and encompasses negative and zero values as well as positive values. Thus, there is no statistically meaningful difference between the savings rates for Wave 1 between PY6 and PY7.

Table 3-3. Comparison of Wave 1 PY6 and PY7 Savings Rates

Program Year	Percent Savings		90% CI on Percent Savings	
	Estimate	SE(Estimate)	Lower	Upper
PY6	-0.82	2.92	-5.62	3.98
PY7	0.30	1.73	-2.55	3.15
Difference	1.12	3.39	-4.46	6.70

Source: ComEd billing data, GES tracking data, and Navigant team analysis. The analysis assumes that the mean savings for Wave 1 in PY6 and PY7 are independent.

3.3 Gross Savings

The evaluation team calculated energy savings for the GES Program using regression analysis of monthly billing data for participants. Table 3-3 summarizes the gross electricity savings from the GES Program. While the program appears to have generated 43.57 MWh of savings, they are not statistically significant and thus, not distinguishable from zero. Hence, our primary finding is that the program achieved no verified gross energy savings in PY7.

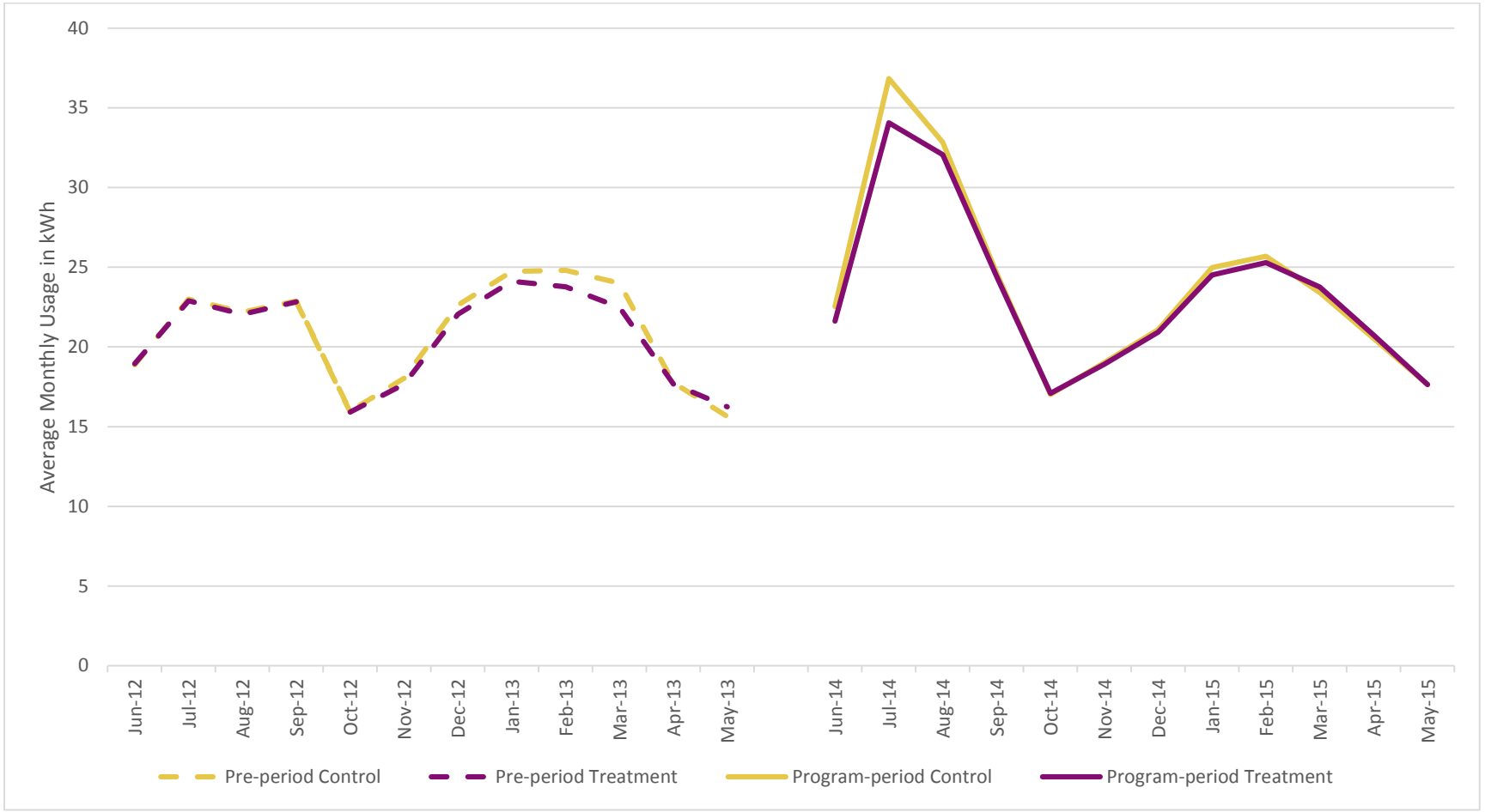
Table 3-3. PY7 Total Program IPA Electric Savings

Savings Category	Energy Savings (MWh)
As Calculated Verified Gross Savings Prior to Uplift Adjustment*	43.57†
Final Verified Gross Savings	0

Source: ComEd billing data, GES tracking data, and Navigant team analysis.
*The uplift adjustment reflects savings that are jointly produced by the program and other EE programs.
†Not statistically significant

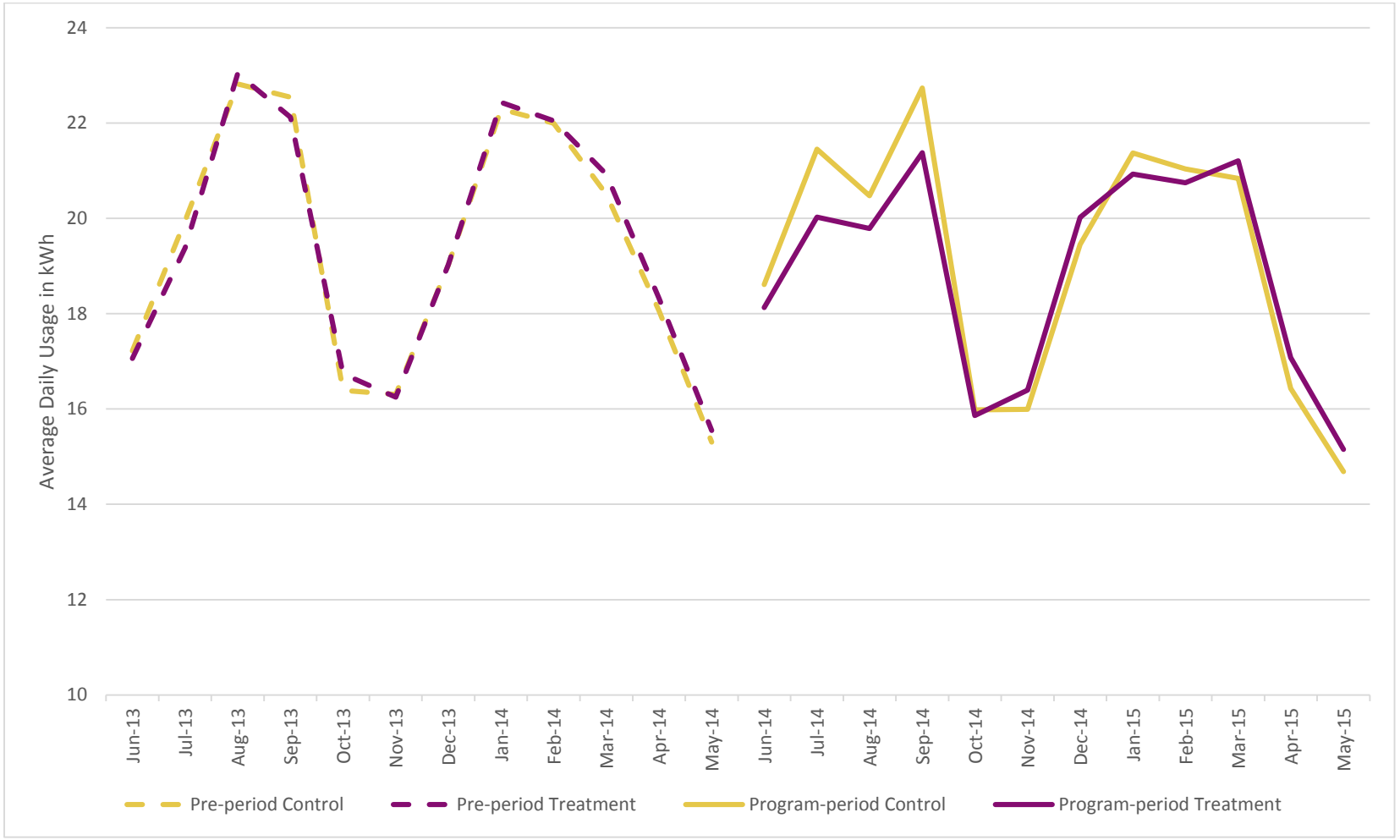
Figure 3-3 and Figure 3-4 provide a visual comparison of the treatment and control groups during relevant pre-periods and PY7 for Waves 1 and 2. These figures show that energy usage levels for both treatment and control groups were very similar during the pre-periods and remained consistent during the program year. They also show that the program only generated consistent savings during the summer months.

Figure 3-3. Average Monthly Usage of Wave 1 Treatment and Control Groups for PY7 Pre and Program Period



Source: Navigant analysis

Figure 3-4. Average Monthly Usage of Wave 2 Treatment and Control Groups for PY7 Pre and Program Period



Source: Navigant analysis

4. Net Impact Evaluation

Program savings calculated by the regression analysis were by nature net savings except for the uplift in participation in other energy efficiency programs caused by the GES Program. To avoid double-counting, program savings due to this uplift must be attributed to either the GES Program or other EE programs, but not both. For the GES Program, PY7 uplift was very small – 0.09 MWh and the legacy uplift was 1.58 MWh. Given that the program did not achieve any verified savings, the savings will automatically be counted towards the other EE programs.

Table 4-1 presents a summary of the PY7 double-counted savings due to uplift in other EE programs. Table 6-4 and Table 6-5 in the appendix present details of uplift calculation for the four ComEd energy efficiency programs considered in the analysis.

The estimate of double-counted savings is 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 0.05 MWh, half the estimated value of 0.09 MWh. In other words, double-counting of savings with other ComEd energy efficiency programs was not a significant issue for the GES Program.

Table 4-1. PY7 Uplift of Savings in Other EE Programs

	FFRR	HEA	MF	Rebate
Wave 1 Participation uplift in other EE programs (# participants)	*-4*	*2*	*-2*	*1*
Wave 2 Participation uplift in other EE programs (# participants)	*5*	*2*	*2*	*-*
Wave 1 Savings uplift in other EE programs (MWh)	*-0.14*	*0.08*	*-0.04*	*-0.01*
Wave 2 Savings uplift in other EE programs (MWh)	*0.12*	*0.05*	*0.02*	*-*
Total Savings uplift in other EE programs (MWh)	*-0.02*	*0.13*	*-0.02*	*-0.01*

Source: Navigant analysis

Table 4-2 summarizes the verified net electricity savings from the GES Program. The program savings were not statistically significant and thus not distinguishable from zero. Hence, our primary finding is that the program achieved no verified net energy savings in PY7.

Table 4-2. PY7 Total Program IPA Electric Savings

Savings Category	Energy Savings (MWh)
As Calculated Verified Net Savings	41.89*
Final Verified Net Savings	0

Source: ComEd billing data, GES tracking data, and Navigant team analysis.
*Not statistically significant

5. Findings and Recommendations

This section summarizes the key impact findings and recommendations.

Finding 1. While the energy savings results for GES Program participants in PY7 represent an improvement from what was achieved in PY6, when overall GES Program savings was negative (though not statistically significant), the verified energy savings rates observed among GES Program participants in PY7 were quite low (0.3 percent savings for Wave 1, 0.4 percent savings for Wave 2). Since the standard errors associated with these estimates are an order of magnitude larger in both cases, neither savings rate is statistically insignificant. Thus the verified net savings are indistinguishable from zero even though GES participants did have slightly lower overall energy use on average than the controls in PY7.

Finding 2. While the point estimates of PY7 energy savings for Wave 1 and Wave 2 do differ slightly from one another, there is no statistically significant difference between them.[19]

Finding 3. While the estimated energy savings of Wave 1 improved from -0.8 percent in PY6 to 0.3 percent in PY7 (a total swing in the savings direction of 1.1 percentage points), this change is not statistically significant.[20]

Recommendation 1. To attain statistically significant savings, the GES Program would have to accomplish one or more of the following:

- Enroll a much larger number of participants
- Substantially raise the average energy savings rate per participant
- Broaden the energy savings experience so that more of the participants attain meaningful savings.

Finding 4. Part of the reason for the program's relatively low level of energy savings may be the relatively modest level of energy usage of its participants. The average daily usage of households in Wave 1 and Wave 2 were 20.56 kWh and 18.77 kWh, respectively. 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 the energy savings rates GES participants have been able to achieve to date. Programs with only slight differences in energy use between treatment and control groups require much larger samples to prove statistical significance than programs with larger savings rates. Although the GES customers (on average) have already a modest level energy use and therefore a lower potential for saving energy, GES educates customers about saving energy which complements LIHEAP's direct installation of energy efficient measures. Both programs serve to increase energy savings.

Recommendation 2. If dramatic increases in program enrollment size are not feasible, then the best available option would be to look for ways to engage the participants more deeply in the project of saving energy so that their average savings rate increases. Navigant views Shelton's innovations with E-Tips as potentially promising in this regard.

[19] The t statistic on the difference is 0.06.
[20] The t statistic on the difference is 0.33.

6. Appendix

6.1 Detailed Data Cleaning

Table 6-1 provides a detailed account of the data cleaning done for this analysis. Navigant removed the following customers and data points from the analysis:

- Observations with less than 20 or more than 40 days in the billing cycle;
- Observations that fell outside relevant date periods;
- Outliers, defined as observations with average daily usage more than one order of magnitude from the median usage.

Table 6-1 gives counts and total percent of observations removed in each these three data cleaning steps.

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

Data Cleaning Step	Wave 1	Wave 2
Remove observations with >40 or <20 billing days	129 / 0.5%	181/ 0.7%
Limit bills to relevant dates*	10,207/42%	3,383/14%
Remove outliers (avg. daily use 10x above/below median)	268 / 1.9%	335 / 1.6%

*This data cleaning step removed so many customers from Wave 1 because it excluded billing records from the PY6 period (June 2013 through May 2014).

6.2 Detailed Impact Methodology

Navigant used a regression with pre-program matching (RPPM) to estimate impacts, which is presented below.

6.2.1 Overview of the Matching Method

The basic logic of matching is to balance 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 potential for model specification bias. Formally, if the outcome variable Y (in this case, customer energy usage) is independently distributed conditional on X and D, where X is a set of exogenous variables and D indicates program participation, 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 control observations.

In this evaluation, the outcome variable is the customer's average daily (post-program) energy use in a given bill period, and the available exogenous covariate with by far the greatest correlation with this outcome variable is the customer's average 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. The RRPM 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 –they are higher baseline energy users, in other words—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.

6.2.2 The RPPM Approach

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. 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.

As described in Section 2.3, we matched participant and comparison customers on energy use during the pre-treatment period, and then estimated the following model for all post-program observations:

Equation 6-1. Regression with Pre-Program Matching Model

$$ADU_{kt} = \beta_1 Treatment_k + \sum_j \beta_{2j} Month_{jt} + \sum_j \beta_{3j} Month_{jt} \cdot ADUlag_{kt} + \varepsilon_{kt}$$

where

ADU_{kt} is average daily energy usage (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[21]

ε_{kt} is the cluster-robust error term for household k during billing cycle t; cluster-robust errors account for heteroscedasticity and autocorrelation at the household level.[22]

[21] 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. They are monthly fixed effects.

[22] Ordinary Least Squares (OLS) regression models assume that the data are homoscedastic 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 heteroscedastic when the variance is not constant (we would not expect the error variances to be constant across customers). 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 (we would expect errors to be correlated over time for any given customer).

The coefficient β_1 is the estimate of average daily kWh energy savings due to the program in PY7.

6.3 Detailed Impact Results: Parameter Estimates

Table 6-2 shows the results for the RPPM model for each wave. Parameter estimates for the variables used in the RPPM model are presented along with estimated standard errors and t statistics.

Table 6-2. RPPM Model Estimates, Wave 1

	Estimate	Std. Error	t value	Pr(>|t|)
Treatment	-0.06225	0.357006	-0.1744	0.86
yrmoJun 2014	3.668297	0.547166	6.7042	0.00
yrmoJul 2014	4.216049	0.527217	7.9968	0.00
yrmoAug 2014	3.897262	0.593934	6.5618	0.00
yrmoSep 2014	4.480421	0.617932	7.2507	0.00
yrmoOct 2014	4.052458	0.611485	6.6272	0.00
yrmoNov 2014	4.507724	0.62227	7.244	0.00
yrmoDec 2014	2.300286	0.834337	2.757	0.00
yrmoJan 2015	4.479196	0.826027	5.4226	0.00
yrmoFeb 2015	5.002362	1.381032	3.6222	0.00
yrmoMar 2015	6.438901	1.073941	5.9956	0.00
yrmoApr 2015	5.367063	0.64379	8.3367	0.00
yrmoMay 2015	6.446465	1.481533	4.3512	0.00
yrmoJun 2014:pre.use	0.692443	0.028055	24.6819	0.00
yrmoJul 2014:pre.use	0.529601	0.015328	34.5514	0.00
yrmoAug 2014:pre.use	0.562595	0.02005	28.0597	0.00
yrmoSep 2014:pre.use	0.750012	0.026127	28.7069	0.00
yrmoOct 2014:pre.use	0.698927	0.036235	19.2886	0.00
yrmoNov 2014:pre.use	0.704788	0.036408	19.358	0.00
yrmoDec 2014:pre.use	0.954887	0.04502	21.2103	0.00
yrmoJan 2015:pre.use	0.807249	0.036974	21.8329	0.00
yrmoFeb 2015:pre.use	0.75749	0.061379	12.3413	0.00
yrmoMar 2015:pre.use	0.712335	0.05193	13.7173	0.00
yrmoApr 2015:pre.use	0.600066	0.033748	17.7807	0.00
yrmoMay 2015:pre.use	0.540571	0.089755	6.0227	0.00
Residual standard error: 9.00 on 10,883 degrees of freedom				
Multiple R-squared: 0.87, Adjusted R-squared: 0.87				
F-statistic: 3,028 on 25 and 10,883 DF, p-value: < 2.2e-16				

Source: Navigant analysis

Table 6-3. RPPM Model Estimates, Wave 2

	Estimate	Std. Error	t value	Pr(>|t|)
Treatment	-0.082643	0.305959	-0.2701	0.79
yrmoJun 2014	3.021656	0.601111	5.0268	0.00
yrmoJul 2014	3.779922	0.74703	5.0599	0.00
yrmoAug 2014	3.224089	0.811125	3.9748	0.00
yrmoSep 2014	3.921417	0.73692	5.3214	0.00
yrmoOct 2014	2.752479	0.4641	5.9308	0.00
yrmoNov 2014	3.646462	0.56546	6.4487	0.00
yrmoDec 2014	2.977767	0.582948	5.1081	0.00
yrmoJan 2015	5.167885	0.681724	7.5806	0.00
yrmoFeb 2015	4.664602	0.646163	7.2189	0.00
yrmoMar 2015	5.388429	0.70091	7.6878	0.00
yrmoApr 2015	5.030529	0.938513	5.3601	0.00
yrmoMay 2015	2.670171	0.422691	6.3171	0.00
yrmoJun 2014:pre.use	0.897786	0.039581	22.6823	0.00
yrmoJul 2014:pre.use	0.864358	0.039703	21.7706	0.00
yrmoAug 2014:pre.use	0.73912	0.037759	19.5746	0.00
yrmoSep 2014:pre.use	0.813733	0.031294	26.0032	0.00
yrmoOct 2014:pre.use	0.797508	0.030305	26.3162	0.00
yrmoNov 2014:pre.use	0.773949	0.037972	20.3821	0.00
yrmoDec 2014:pre.use	0.883288	0.033193	26.6105	0.00
yrmoJan 2015:pre.use	0.716298	0.032051	22.3488	0.00
yrmoFeb 2015:pre.use	0.738518	0.030438	24.2627	0.00
yrmoMar 2015:pre.use	0.756838	0.037548	20.1564	0.00
yrmoApr 2015:pre.use	0.646922	0.055719	11.6105	0.00
yrmoMay 2015:pre.use	0.796866	0.027658	28.8112	0.00
Residual standard error: 8.55 on 12,563 degrees of freedom				
Multiple R-squared: 0.86, Adjusted R-squared: 0.86				
F-statistic: 3,165 on 25 and 12,563 DF, p-value: < 2.2e-16				

Source: Navigant analysis

Since the treatment effects for Waves 1 and 2 were not statistically significant, we conclude that there is no measurable savings evident for the program.

6.4 *Savings Due to Participation Uplift in Other EE Programs*

Table 6-4 and Table 6-5 present program savings from Waves 1 and 2 due to participation uplift in other ComEd EE programs.

Table 6-4. Estimates of Double-counted Savings in PY7, Wave 1

	Program			
	FFR	HEA	MF	Rebate
Median program savings (annual kWh per participant)	592	665	295	151
# GES treatment households	692	692	692	692
Rate of participation, PY7 (percent)	0.43	0.29	0.14	0.00
Change in rate of participation from pre-program year (percent)	-0.58	0.29	-0.29	-0.14
# GES control households	692	692	692	692
Rate of participation, PY7 (percent)	-	-	-	-
Change in rate of participation from pre-program year (percent)	-	-	-	-
DID/POD statistic	-	-	-	-
Change in program participation due to GES program	-0.24	0.12	-0.12	-0.06
Statistically significant at the 90 percent confidence level?	-	-	-	-
Savings attributable to other programs (kWh)	>= -139	<= 78	>= -35	>= -9

Source: Navigant analysis

Table 6-5. Estimates of Double-counted Savings in PY7, Wave 2

	Program			
	FFR	HEA	MF	Rebate[23]
Average program savings (annual kWh per participant)	592	665	256	-
# GES treatment households	981	981	981	-
Rate of participation, PY7 (percent)	0.92	0.21	0.61	-
Change in rate of participation from pre-program year (percent)	0.51	0.20	0.21	-
# GES control households	981	981	981	-
Rate of participation, PY7 (percent)	-	-	-	-
Change in rate of participation from pre-program year (percent)	-	-	-	-
DID/POD statistic	-	-	-	-
Change in program participation due to GES Program	0.20	0.08	0.08	-
Statistically significant at the 90 percent confidence level?	-	-	-	-
Savings attributable to other programs (kWh)	<= 118	<= 53	<= 24	-

Source: Navigant analysis

Table 6-6. Double-counted Savings (kWh) from PY6

	FRR	HEA	MF	Rebate
Measure Life	-	-	-	-
Wave 1	1,800	NA	-155	NA
Move Out Rate (percent)	3	3	3	3
Legacy Uplift	**1,746**		**-150**	

[23] None of the households in Wave 2 treatment or control groups were in the Rebate program.