



ComEd Citizens Utility Board Energy Saver Program Evaluation Report

Energy Efficiency / Demand Response Plan:
Plan Year 9 (PY9)

Presented to
Commonwealth Edison Company

DRAFT

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1. INTRODUCTION

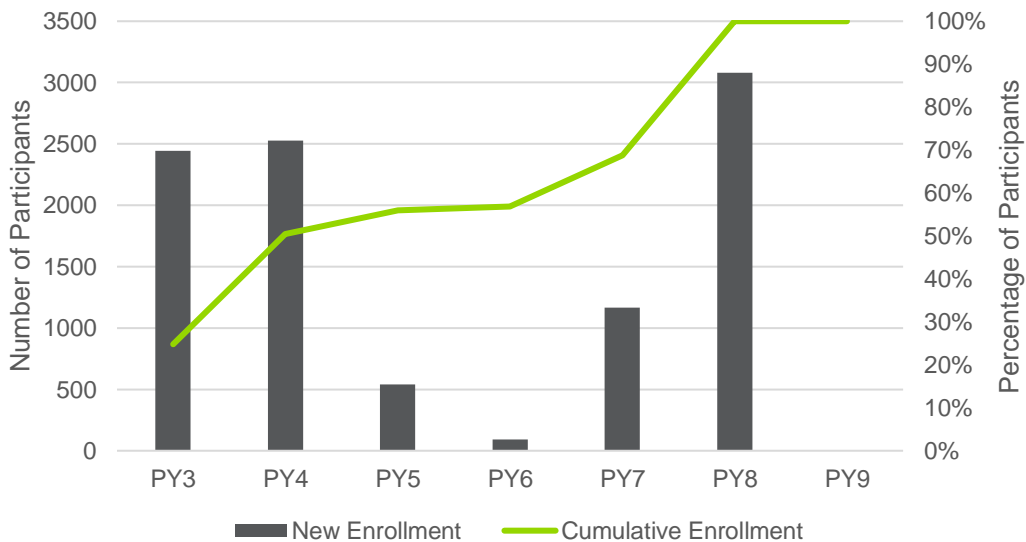
This report presents the results of the impact evaluation of ComEd’s PY9 Citizens Utility Board Energy Saver (CUB-ES) Program. It provides a summary of the energy impacts for the program in total and broken out by participation wave. The appendix presents the impact analysis methodology. The PY9 evaluation covers June 1, 2016 through May 31, 2017, when this program ended.¹

2. PROGRAM DESCRIPTION

CUB-ES was a free online rewards program that encouraged residential households to save energy through a combination of information, incentives and community engagement. The program leveraged behavioral and marketing best practices by encouraging opt-in web engagement and rewarding customers who saved energy. The program was first launched in ComEd PY3 (June 2010) and was implemented under the Illinois Power Agency (IPA) funding mechanism.²

Figure 2-1 shows new enrollment in each program year since the program launch; no new customers enrolled in the program during PY9.³ At the end of PY8 there were a total of 9,486 participants enrolled in the program. The Citizens Utility Board cancelled their contract with the vendor running the web-based platform in December 2016. Despite the cancellation of the contract, the Citizens Utility Board continued to operate other elements of the CUB-ES Program, including the direct outreach activities and the community marketing activities. This included regular emails and communication with energy-saving tips and engagement.

Figure 2-1. CUB-ES Annual Enrollment, PY3 – PY9



Source: ComEd tracking data and Navigant team analysis.

¹ PY9 ran through December 31, 2017.

² Created by Illinois Public Acts 97-0616 (“PA 97-0616”) and 97-0824 (“PA 97-0824”).

³ Figure 2-1 includes all participants from each program year including those who did not have an active account with ComEd during PY9.

3. PROGRAM SAVINGS

Table 3-1 summarizes the incremental energy savings the CUB-ES Program achieved in PY9. This program specifically focused on energy savings, and demand savings were not estimated. In addition, this type of analysis estimates net savings and no further net-to-gross (NTG) adjustment is necessary. Because of this, there is neither an ex ante estimate of gross savings nor a gross realization rate.

Table 3-1. PY9 Total Annual Incremental Savings

Savings Category	Energy Savings (kWh)	Demand Savings (kW)	Peak Demand Savings (kW)
Ex Ante Gross Savings	NA	NA	NA
Program Gross Realization Rate	NA	NA	NA
Verified Gross Savings	NA	NA	NA
Program Net-to-Gross Ratio (NTGR)*	NA	NA	NA
Verified Net Savings†	2,190,966	NA	NA

* This type of analysis estimates net savings, and no further net-to-gross adjustment is necessary.

† This value is after the uplift adjustment.

Source: ComEd tracking data and Navigant team analysis.

Table 3-2 shows PY9 CUB-ES Program savings including values before and after the uplift adjustment. As noted above, these totals do not include gross savings because the analysis estimates net savings. The total savings broke down to annualized savings of 295 kWh per household or 3.4 percent.

Table 3-2. PY9 Total Program Net Electric Savings

Savings Category	Energy Savings (kWh)
Ex Ante Net Savings	3,922,000
Verified Net Savings, Prior to Uplift Adjustment	2,368,965
PY9 Uplift Adjustment	47,300
Legacy Uplift Adjustment	130,699
Final Verified Net Savings	2,190,966
Program Net Realization Rate*	56%

* This type of analysis estimates net savings, and no further net-to-gross adjustment is necessary.

† This value is after the uplift adjustment.

Source: ComEd tracking data and Navigant team analysis.

The program realization rate compared to the savings estimated by the implementer was 56 percent. The low realization rate is primarily due to differences in the participant counts used by Navigant and the program implementer. Navigant attributed savings to 8,329 verified PY9 participants (see section 6.1 for details) whereas the implementer attributed savings to 14,590 accounts. This difference was driven by accounts on the CUB-ES that could not be linked to ComEd accounts. This issue was not unique to PY9; the PY8 evaluation included 9,486 accounts (most of whom were removed in PY9 due to the closure of their ComEd account).

4. PROGRAM SAVINGS BY MEASURE

The CUB-ES Program only has a single measure, behavioral savings. In PY9, the measure life for the program was one year.

5. IMPACT ANALYSIS FINDINGS AND RECOMMENDATIONS

5.1 Impact Parameter Estimates

The CUB-ES Program does not have relevant impact parameters.

5.2 Other Impact Findings and Recommendations

The evaluation team offers findings from the PY9 evaluation, as follows (no recommendations are offered as this program has ended):

- Finding 1.** In PY9, the average percent savings per participant was 3.4 percent (295 kWh/year). These savings were not statistically different from the savings in PY8 (which were 3.2 percent or 269 kWh/year).
- Finding 2.** Savings uplift into other programs was 7.5 percent of total savings. This was a similar portion of total savings as PY8 (when savings uplift was 6.4 percent of total savings).

6. APPENDIX 1. IMPACT ANALYSIS METHODOLOGY

6.1 Detailed Data Cleaning

ComEd was unable to supply Navigant with a list of ComEd account numbers for PY9 participants in the CUB-ES Program. Since no new participants enrolled in the program in PY9, Navigant used the verified participant list from PY8 (which had account numbers) and a list of PY9 customers provided by the implementer (which did not contain ComEd account numbers) to generate the list of PY9 participants. Navigant considered customers on the verified PY8 list who mapped (based on name, email, and address) to customers on the implementer's PY9 list as verified PY9 participants. The mapping matched 9,345 participants, 8,329 of whom were true participants and had an active account with ComEd in PY9 (see the first two cleaning steps in the list below).

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

- Participants who enrolled prior to June 2010⁴
- Participants who did not have an active account or were missing all data during PY9
- Observations with missing usage
- Customers with more than 100 unique bills between April 2009 and May 2017
- Outliers, defined as observations that are outside plus or minus one order of magnitude from the median average daily usage⁵
- Customers with fewer than 8 bills in the matching period
- Participants with no viable match⁶

After selecting program and pre-program year data for each participant wave, cleaning steps removed approximately 13 percent of treatment customers. Most of these customers were removed because Navigant could not get a match for them, i.e., in the last two cleaning steps of the list above.

6.2 Detailed Impact Methodology

To estimate energy savings, Navigant used the RPPM approach described in Ho, Imai, King, and Stuart (2007).⁷ Using the RPPM method, Navigant has successfully evaluated many opt-in behavioral programs. 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, PRE_kWh_{kt} , where k indexes the customer and t indexes the

⁴ Customers who enrolled prior to June 2010 were identified by the program implementer as test users. Data was received for 245 such participants.

⁵ The median usage for participants was 28.6 kWh per day; observations with usage values greater than 314.6 kWh per day or less than -257.4 kWh per day were excluded from the analysis.

⁶ Navigant removed customers who a sum of squared difference in usage of more than 150 (the mean sum of squared difference was 7). This removed 482 participants who all enrolled in PY3.

⁷ 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.

month. Therefore, for each program participant, energy consumption in the period spanning fourteen to three months before program enrollment (a 12 month period)⁸ was compared to that of all customers in the available non-participant pool with billing data over the same twelve months.

The basis of the comparison is the difference in monthly energy use between a participant and a potential match, D_{PM} (Difference between Participant and potential Match). 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.

For the purpose of matching, program enrollment was when a participant signed up for the CUB-ES program, i.e., when they created an account on the CUB-ES website. However, participants were not able to see their own data on the website until they linked their CUB-ES account to their ComEd account. Thus, for this evaluation the treatment period started after a participant's account was linked. The period between the signup date and the link date was a blackout period which was considered neither pre-program nor post-program.⁹ The non-participant with the most similar energy use to the participant during the 12-month matching period was used as that participant's match.

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.¹⁰ The regression controls for any remaining imbalance in the matching. 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 PRE_kWh_{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. Matching 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.

Navigant 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.

⁸ In order to draw a match, a CUB-ES participant had to have data in at least eight of the twelve months in the matching period.

⁹ Using this definition of the pre and post-program periods ensured that the evaluation picked up the impact of the full CUB-ES experience including viewing personalized information. Any effect of the program that came from a participant signing up for the CUB-ES website but not linking to a ComEd account was not captured.

¹⁰ 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.

Equation 6-1. RPPM Model

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

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 CUB-ES participant and 0 otherwise.
- $Month_{jt}$ = A binary variable taking a value of 1 when $j = t$ and 0 otherwise.¹¹
- PRE_kWh_{kt} = The average daily electricity use by household k during the most recent month before household k (or its match) enrolled in the CUB-ES program that is also the same calendar month as month t . For instance, if household k enrolled in August 2011, the value of PRE_kWh_{kt} for June 2012 is June 2011.
- 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 PRE_kWh_{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.

6.3 Accounting for Uplift in Other Energy Efficiency Programs

6.3.1 Accounting for Uplift in PY9

If participation rates in other EE programs are the same for CUB-ES participants and their matched controls, the savings estimates from the regression analyses are already “net” of savings from other programs, as this indicates the CUB-ES Program does not increase or decrease participation in other EE programs. However, if the CUB-ES 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 CUB-ES and EE programs. For instance, if the CUB-ES Program increases participation in other EE programs, the increase in savings may be allocated to either the CUB-ES Program or the EE program, but cannot be allocated to both programs simultaneously.¹² Note that when the CUB-ES 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 PY9 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 PY9 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 CUB-ES Program is one percent, as reflected in Equation 6-2.

¹¹ In other words, if there are T post-program months, there are T monthly dummy variables in the model, with the dummy variable $Month_{jt}$ the only one to take a value of 1 at time t . These are, in other words, monthly fixed effects.

¹² 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.

Equation 6-2. DID Statistic Calculation

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

The DID statistic generates an unbiased estimate of uplift when the baseline average rate of participation is the same for the treatment and 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 PY9. 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. The MESP offers direct installation of low-cost efficiency measures, such as water efficiency measures and CFLs at eligible multifamily residences.

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

6.3.2 Accounting for Legacy Uplift

The uplift adjustment methodology described in Section 6.3.1 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.¹³ However, for other EE programs with measures with multiple-year measure lives, CUB-ES 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 CUB-ES Program savings not just in PY2, but in PY3 through PY11 as well.

Consider the following example. A household in the CUB-ES 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 CUB-ES uplift adjustment does not remove these savings because the PY7 adjustment only accounts for measures installed in PY7, the initial year that the household entered a program. Thus, when only relying on the uplift adjustment described in Section 6.3.1, FFR second year savings would be included in the PY7 CUB-ES 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 savings from programs with measures with a multiple-year measure life.

¹³ 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.

Navigant accounts for legacy uplift by subtracting the double counted savings from previous years, adjusted for the average annual move-out rate, from PY9 CUB-ES savings through the measure lives of other EE programs.¹⁴ The legacy uplift adjustment is shown in Equation 6-3.

Equation 6-3. Legacy Uplift Calculation

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

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

The legacy uplift adjustment goes back to PY5 when Navigant first evaluated the CUB-ES Program. In PY5, Navigant considered double-counted savings for the Fridge Freezer Recycle Rewards (FFRR), the Complete System Replacement (CSR), the Clothes Washer Rebate (CW), the Multi-Family Home Energy Savings (MF), and the Single Family Home Energy Savings (SFHES) programs. The same programs were considered in PY6, with the exception of the CW Program which was discontinued. In PY7 and PY8 Navigant considered double-counted savings for the same four programs as PY9: the FFR Program, the HEA Program, the Rebate Program, and MESP.

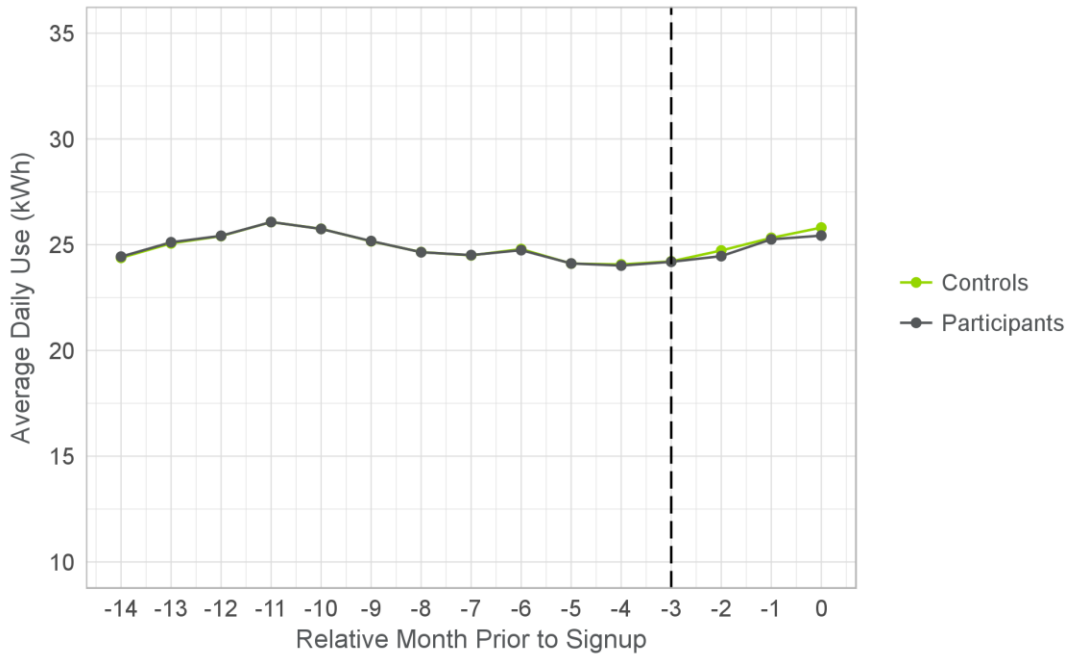
7. APPENDIX 2. IMPACT ANALYSIS DETAIL

7.1 Matching Results

Figure 7-1 presents the mean of average daily energy use by participants and their matches in the fourteen months before program enrollment, and Figure 7-2 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, as a whole, not statistically different than zero, with only one month statistically different during the twelve-month matching period and the three-month test period.

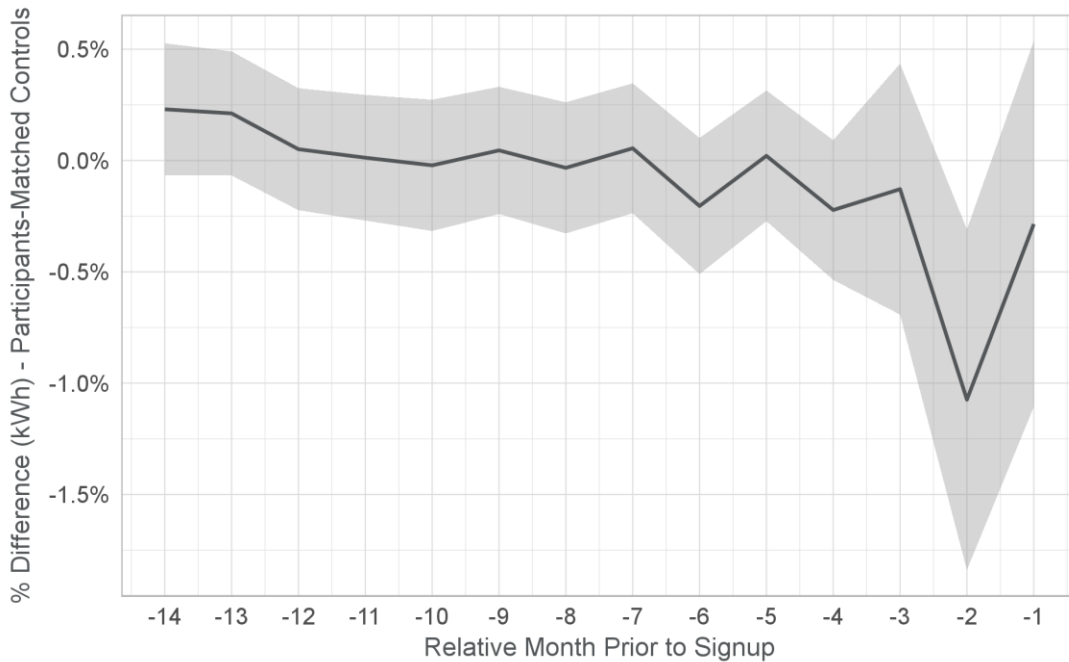
¹⁴ Since CUB-ES Program participants are dropped from that program when they move, other EE programs’ savings are no longer captured in the CUB-ES Program savings from that point forward.

Figure 7-1. Average Energy Use Before Program Enrollment, CUB-ES Participants and Matched Controls



Source: ComEd tracking data and Navigant team analysis.

Figure 7-2. Average Percent Difference in Energy Use Before Program Enrollment, CUB-ES Participants and Matched Controls



Source: ComEd tracking data and Navigant team analysis.

7.2 Uplift Results

The uplift of savings in other EE programs was a relatively small proportion of the total savings: 177,999 kWh, or 7.5 percent of pre-adjusted net savings. The uplift can be broken down into uplift in PY9 and legacy uplift from previous program years. The PY9 uplift was 47,300 kWh or 2.0 percent of total program savings and the legacy uplift was 130,699 kWh or 5.5 percent of total program savings. The programs included in the uplift analysis were the FFR program, the HEA program, the Rebate program and the MESP.^{15,16}

8. APPENDIX 3. TRC DETAIL

Table 8-1 shows the savings detail for the Total Resource Cost (TRC) cost-effectiveness analysis.

Table 8-1. TRC Detail

End Use Type	Research Category	Units	Quantity	Effective Useful Life	Ex Ante Net Savings (kWh)	Ex Ante Gross Peak Demand Reduction (kW)	Verified Net Savings (kWh)	Verified Gross Peak Demand Reduction (kW)
Behavioral	NA	Household	8,329	1	3,922,000	NA	2,190,966	NA

Source: ComEd tracking data and Navigant team analysis.

¹⁵ 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.

¹⁶ 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 PY9. It is more likely that participation varies across the year and not all of the first year program savings are captured by the billing analysis analysis.