NAVIGANT

Citizens Utility Board Energy Saver Program

FINAL

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

Presented to
Commonwealth Edison Company

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E. Executive Summary

This report presents a summary of the findings and results from the impact evaluation of the PY7 [1] Citizens Utility Board Energy Saver (CUB-ES) Program. The CUB-ES Program is a third-party behavioral energy efficiency (EE) program being implemented under the Illinois Power Agency (IPA) funding mechanism.[2] CUB-ES is a free online rewards program that encourages residential households to save energy through a combination of information, incentives and community engagement. The program leverages behavioral and marketing best practices by encouraging opt-in web engagement and rewarding customers who save energy. The program was first launched in PY3 (June 2010). In PY7 the program implementer changed from C3 to Accelerate Group, LLC (Accelerate). In PY7, 2,118 new participants enrolled in the program[3], raising total participation from 8,494 to 10,612. New enrollment in PY7 was higher than enrollment in PY6 or PY5.

E.1. Program Savings

Table E-1 summarizes the PY7 electricity savings from the CUB-ES Program. PY7 verified savings (prior to adjustments for uplift from other EE programs) were 1,209 MWh. After adjusting for uplift from other EE programs (see Section 2.5), final verified savings were 1,224 MWh. The evaluation team calculated savings using regression analysis of monthly billing data comparing participants to a matched set of nonparticipants. As discussed in this report, 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 which case the estimate of savings from the analysis is net savings. Therefore, there was no free ridership and no NTGR was applied to this program.

Table E-1. PY7 Total Program Electric Savings

Savings Category	Energy Savings (MWh)
Verified Savings, Prior to Uplift Adjustment	1,209
PY7 Uplift Adjustment	4
Legacy Uplift Adjustment†	-19
Final Verified Savings	1,224

Source: Navigant analysis.
†Negative uplift savings indicates that the participation rate in the EE program is higher for the matched controls than the participants. The negative uplift lowers the baseline and increases CUB-ES Program savings.

E.2. Program Savings by Participant Type

The program implementer identified participants in the program as either active or inactive as of the time the data was provided to Navigant. The definition of active is based on a data feed that indicates whether

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[1] The PY7 program year 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] For the purposes of this evaluation, Navigant defined participants as customers who created an account on the CUB-ES website and linked that account to their ComEd account.

or not an account has been closed. A participant is considered active until the implementer receives information indicating their account has been closed.

Navigant estimated savings separately for active and inactive customers. As expected, active customers had higher savings than inactive customers (2.1 percent versus 1.6 percent), although statistical tests indicated that the two estimates were not statistically different at the 90 percent confidence level. Both groups had estimates of savings that were statistically different from zero at the 90 percent confidence level. The fact that inactive participants have statistically significant savings could indicate that these participants were active for part of PY7[4] or that savings persist after customers leave the program.[5]

Table E-2 summarizes estimated program savings by participant type. In this table, the number of participants, in the first row, represents the number of customers used to estimate program savings, while the sample sizes, in the second and third rows, indicate the number of customers (treatment and controls) with sufficient data for inclusion in the regression analysis. Navigant estimated separate savings for each participant type using regression analysis as described in Section 2.4. The weighted average per customer savings estimate across both customer types was 1.7 percent (139 kWh).

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[4] The program implementer does not associate a date with an account becoming inactive so Navigant was unable to determine how long the inactive accounts had been closed.

[5] For example, customers may have purchased equipment, such as a new furnace, that creates lasting savings or they may have made behavioral changes that they continued to engage in after closing their account, such as turning out lights.

Table E-2. PY7 CUB-ES Program Results, by Customer Type

Type of Statistic		Active Participants	Inactive Participants	Total
Number of Participants		2,592	7,886	10,478
Sample Size - Treatment		1,911	6,816	8,727
Sample Size - Control		1,836	6,418	8,254
Percentage Savings		2.05%	1.57%	1.69%
	Standard Error	*1.17%*	*0.48%*	-
Annualized Savings Per Customer, kWh		153	135	139
	Standard Error	*87*	*42*	-
Verified Gross Savings, Prior to Uplift Adjustment, MWh†		153	1,056	1,209
	Standard Error	*88*	*324*	-
Savings Uplift in Other EE Programs in PY7, MWh‡		23	-19	4
Legacy Savings Uplift in Other EE Programs, MWh§		-9.5	-9.5	-19
Verified Gross Savings, MWh*		139.5	1,084.5	1,224

Source: Navigant analysis
†Total savings are pro-rated for participants that closed their accounts during PY7.
‡Negative double counted savings indicate that the participation rate in the EE program is higher for the matched controls than the participants. This lowers the baseline and underestimates CUB-ES Program savings.
§ Past evaluations did not split results by active and inactive participants. Legacy uplift was split 50/50 across the two groups.
* Gross savings adjusted for savings uplift are equal to gross savings less the uplift of savings in other EE programs.

E.3.   *Findings and Recommendations*

The following summarizes key program findings and recommendations.[6] In PY7, there were approximately 10,000 participants in the CUB-ES Program, 2,592 of whom were identified as active when Navigant received data. Total program savings were 1,224 MWh; 139.5 from active participants and 1,084.5 from inactive participants.

Finding 1. In PY7, the average percent savings per participant was 1.7 percent, which is annualized savings of 139 kWh per participant. Savings for active participants were higher than for inactive participants, 2.1 percent versus 1.6 percent. Savings for active participants were similar to PY6 savings of 2.0 percent. Additionally, uplift was positive, 23 MWh, for active participants and negative, -19 MWh, for inactive participants meaning active participants were more likely to enroll in ComEd's other energy efficiency programs.

Recommendation 1. Since active customers save more, consider adding new content to the web portal to keep customers engaged in the program. Such content could include new energy saving tips, news of new or enhanced EE programs, expanded options for spending rewards points, societal comparisons, or more disaggregated or real-time feedback on usage patterns.

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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 2. Participant enrollment almost quadrupled in PY7 compared to PY6. This is likely due to renewed recruitment efforts by the new program implementer. In addition to the approximately 2,000 new participants who linked their CUB-ES account to their ComEd account there were approximately 3,000 participants who created a CUB-ES account but did not link it to their ComEd account.

Recommendation 2. To continue the trend of increased enrollment, encourage the program implementer to maintain and expand upon their current recruitment efforts. In addition, encourage customers who have created a CUB-ES account but not linked it to their ComEd account to do so. Also, consider efforts to make it easier for participants to link their accounts, for example allowing customers to link with their name or address, rather than an account number. These efforts need to be balanced with concerns regarding data privacy.

Finding 3. Customer self-selection into the program, which could bias estimated savings, continues to be a concern as the program is not an experimental design.

Recommendation 3. Given the high level of effort required to convert the program to an experimental design[7], ComEd, in conjunction with the program implementer and Navigant, should instead design a brief survey to be administered to new enrollees when they join the program asking when and how the new participant heard about the CUB-ES Program and why they decided to join. Such survey results would allow Navigant to examine the reasons customers join the program which could shed light on possible self-selection bias.

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[7] One example of such an experimental design would be a recruit-and-deny strategy where customers who desire to enroll in the program would be sorted into a participant group who has access to the website and a control group who does not. An experimental design would have the benefit of being free of self-selection bias.

1 Introduction

1.1 Program Description

The PY7 [8] Citizens Utility Board Energy Saver (CUB-ES) Program is a third-party behavioral energy efficiency (EE) program being implemented under the Illinois Power Agency (IPA) funding mechanism.[9] CUB-ES is a free online rewards program that encourages residential households to save energy through a combination of information, incentives and community engagement. The program leverages behavioral and marketing best practices by encouraging opt-in web engagement and rewarding customers who save energy. The program was first launched in PY3 (June 2010). In PY7 the program implementer changed from C3 to Accelerate Group, LLC (Accelerate).

In PY7, there were a total of 8,494 participants enrolled at the start of the program year and 10,612 participants enrolled at the end of the program year, making new enrollment in PY7 2,118 customers.[10] This is an increase is new enrollment compared to PY6 and PY5. Figure 1-1 shows new enrollment in each month since the program's inception in PY3, while Figure 1-2 aggregates new enrollment to the annual level by program year.

Figure 1-1. CUB-ES Monthly Enrollment, June 2010 – May 2015
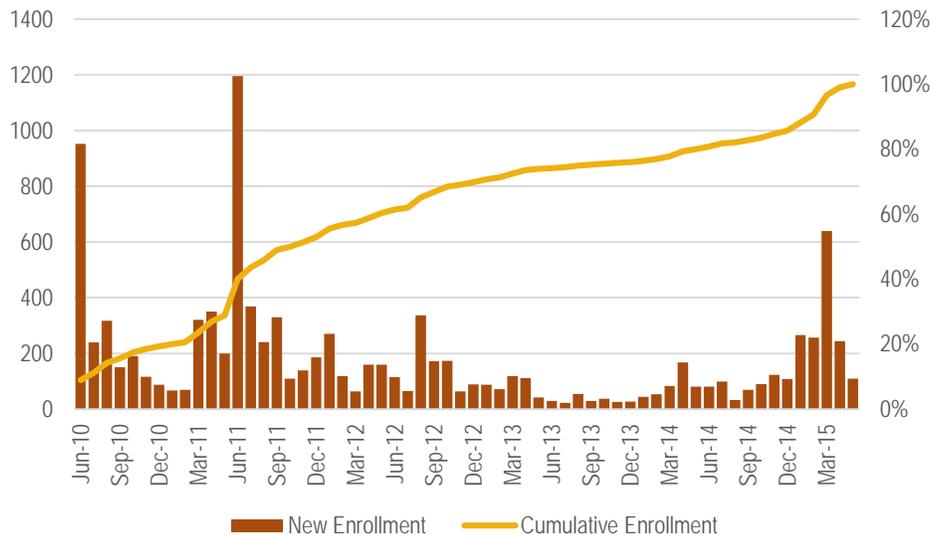
Source: Navigant analysis

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[8] The PY7 program year began June 1, 2014 and ended May 31, 2015.

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

[10] For the purposes of this evaluation, Navigant defined participants as customers who created an account on the CUB-ES website and linked that account to their ComEd account.

Figure 1-2. CUB-ES Annual Enrollment, PY3 – PY7
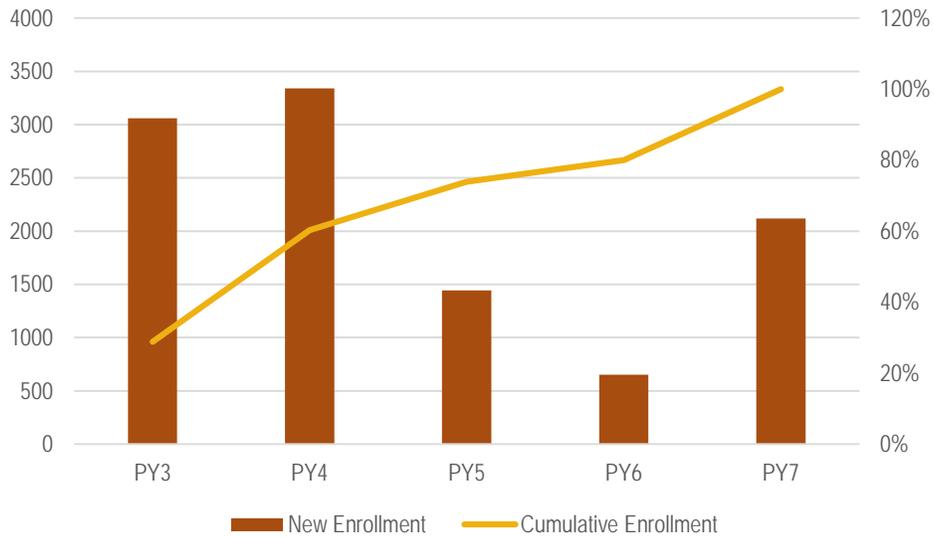
Source: Navigant analysis

The program implementer identified participants in the program as either active or inactive as of the time the data was provided to Navigant. The definition of active is based on a data feed which indicates whether or not an account has been closed. A participant is considered active until the implementer receives information indicating their account has been closed. The data from the program implementer identified 2,654 active participants.

1.2   Evaluation Objectives

The objective of this evaluation was to determine the PY7 energy savings generated by the CUB-ES Program.

2 Evaluation Approach

The evaluation approach in PY7 was consistent with the PY6 evaluation, 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

Navigant received program tracking data and monthly billing data for all program participants and a large group of potential matched control customers for the period of September 2008 to May 2015. Details are provided in Table 2-1.

Table 2-1. Primary Data Collection Methods

Collection Method	Subject Data	Quantity	Net Impact	Net Impact less Joint Impact with other EE Programs
Billing Data	Program participants and potential matches	All	X	
Tracking Data	Program participants and potential matches	All	X	
Tracking Data for Other Programs	Participants in Other Programs	All		X

Source: Navigant

2.2 Sampling Plan

The CUB-ES Program was executed as an opt-in web-based program. The program targeted residential single- and multi-family customers in ComEd's service territory. While it is possible for anyone to create an account on the website, customers must enter their ComEd account information in order to view personalized usage information and tips. Only those customers who linked to their ComEd account are included in our evaluation. Accelerate marketed the program using a combination of direct and community marketing. Direct marketing channels, including mail and e-mail, encouraged customers to enroll online for savings recommendations and reward points to earn discounts at national and local stores. Community marketing strategies included on-the-ground community outreach, development of partnerships with local retailers, and creation of custom-branded community and team pages on the website.

2.3 Data Used in the Impact Analysis

In preparation for the impact analysis, Navigant combined and cleaned data provided by the program implementer. Navigant received data for 11,243 participants in the CUB-ES Program and a large pool of non-participants. Billing data used in the analysis extended from January 2008 (29 months before the start of the program in June 2010) to May 2015. Data during the twelve month pre-period for each participant and during PY7 was used in the regression analysis described in Section 2.4.

Navigant calculated total savings using 10,920 participants who enrolled in or after June 2010[11] and had at least one observation in the billing data dataset.

Navigant cleaned the data used for the billing analysis by removing the following from the dataset:
- All billing data for 931 customers with fewer than 8 bills in the matching period;
- Matched pair observations[12] with missing billing data;
- Matched pair observations with less than 20 or more than 40 days in the billing cycle; and
- Matched pair observations with an outlier, defined as observations with average daily usage more than one order of magnitude from the median usage in the targeted sample for the analysis.[13]

This data cleaning resulted in a sample size of 8,727 participants and 8,254 unique matched controls used in the billing analysis. Overall, the cleaned data included 1,911 active participants with 1,836 unique controls and 6,816 inactive participants with 6,418 unique controls.

2.4 Statistical Approach used in the Impact Evaluation

To estimate energy savings, Navigant used regression with pre-program matching (RPPM) described in Ho, Imai, King, and Stuart (2007).[14] Using the RPPM method, Navigant has successfully evaluated many opt-in behavioral programs. In PY7, Navigant modified the regression from PY6 to estimate savings for active and inactive participant separately. Additional detail about the statistical approach used in this evaluation is described in Section 6.1.1.

2.4.1 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 300,000 ComEd residential customers. Additional detail about the matching methods used for this evaluation is included in Section 6.1.2.

For each program participant with monthly billing data extending at least twelve months prior to program enrollment, energy consumption in each month in the twelve months before program enrollment was compared to that of all customers in the available pool with billing data over the same twelve months. For most of the CUB-ES participants who enrolled prior to the start of PY7, Navigant used the same matched controls as were selected for the PY6 evaluation. New matched controls were selected for participants whose match from PY6 became inactivate during PY7 and for all the participants who enrolled during PY7. Figure 2-1 shows average energy use by participants and their matches for

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[11] Customers who enrolled prior to June 2010 were identified by the program implementer as test users. We received data for 323 such participants.

[12] Removal of a matched pair of observations means the observation for the participant and the corresponding observation for their matched control were removed if either observation met the specified criteria.

[13] The median usage for participants was 19.8 kWh per day; observations with usage values greater than 198 kWh per day or less than 1.98 kWh per day were excluded from the analysis. The median usage for matched controls was 20.2 kWh per day; observations with usage values greater than 202 kWh per day or less than 2.02 kWh per day were excluded from the analysis.

[14] 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.

those matches that were selected for the first time or selected again in PY7 during the matching period, the twelve months prior to the participant's enrollment in the program.

**Figure 2-1. Average energy use before program enrollment,
CUB-ES participants and their matches**
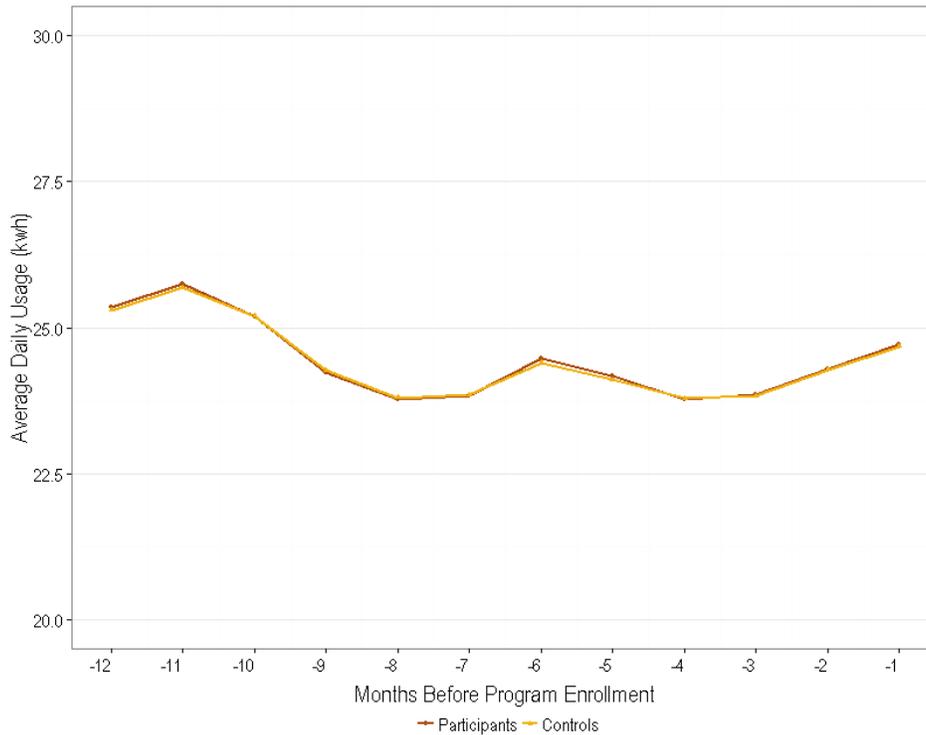
Source: Navigant analysis

2.5 Accounting for Uplift in other Energy Efficiency Programs

2.5.1 Accounting for Uplift in PY7

If participation rates in other EE programs are the same for the CUB-ES participants and their matched controls, then the savings estimates from the regression analyses are already "net" of savings from the other programs. This would indicate that the CUB-ES Program did not increase or decrease participation in the 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. 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 other EE program, but should not be allocated to both programs simultaneously.[15]

As data permitted, Navigant used a difference-in-difference (DID) statistic to estimate uplift in other EE programs. To calculate the DID statistic, Navigant subtracted the change in the participation rate in other

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[15] It is not possible to avoid double counting of savings generated by programs for which tracking data are not available, such as upstream compact fluorescent lamp (CFL) programs.

EE programs between PY7 and the pre-program year for the matched control group from the same change for the treatment group. For example, if the rate of participation in an EE program during PY7 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 CUB-ES 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 2-1.

Equation 2-1. DID Statistic Example Calculation

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

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 square footage of the residence.

An alternative statistic that generates an unbiased estimate of uplift when the baseline average rate of participation in the EE program is the same for the treatment and matched control groups is a simple difference in participation rates during PY7. Navigant uses this alternative statistic – the "post-only difference" (POD) statistic – in cases where the EE program did not exist for the entire pre-program year.

Navigant examined the uplift associated with four EE programs: the Fridge and Freezer Recycling (FFR) Program, the Home Energy Assessment (HEA) Program, the Home Energy Rebates (Rebate) Program, and the Multi-family Energy Savings Program (MESP). The FFR Program achieves energy savings through retirement and recycling of older, inefficient refrigerators, freezers, and room air conditioners. The HEA Program 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), programmable thermostats, low-flow showerheads, and low-flow bathroom and kitchen aerators. The Rebate program, which replaced the Complete System Replacement (CSR) Program from PY6, offers weatherization and incentives to residential customers to encourage customer purchases of higher efficiency heating, ventilating, and air-conditioning (HVAC) equipment. The MESP offers direct installation of low-cost efficiency measures, such as water efficiency measures and CFLs at eligible multifamily residences.

2.5.2 Accounting for Legacy Uplift

The uplift adjustment methodology described in Section 2.5.1 only accounts for uplift which occurs in the current program year because EE program tracking files in any given program year only capture the new measures installed in that year, regardless of the expected measure lives.[16] However, for other EE programs with multi-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.

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[16] 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.

The following example illustrates the legacy uplift savings associated with the CUB-ES Program. A household receiving home energy reports through the CUB-ES 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 CUB-ES Program savings in PY6. In PY7 this household is still getting savings from the FFR Program, but the PY7 uplift adjustment does not remove these savings in the second year of the household's enrollment in the FFR Program. Therefore, these savings are included in the PY7 CUB-ES Program's savings when only the adjustment described in Section 2.5.2 is applied. In fact, the savings from this FFR Program enrollment will be counted through PY13, which is inconsistent with Illinois's practice of only crediting utilities with first-year EE program savings.

Navigant accounted for legacy uplift by subtracting the double counted savings from previous years, adjusted for the average annual move-out rate, from the PY7 CUB-ES savings through the measure lives of the other EE programs.[17] The legacy uplift adjustment is shown in Equation 2-2.

<div align="center">

Equation 2-2. Legacy Uplift Calculation

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

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 PY5 when Navigant first evaluated the CUB-ES Program. In PY5, Navigant considered double-counted savings for the Fridge Freezer Recycle Rewards (FFRR), the 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.

2.6 Process Evaluation

The PY7 CUB-ES Program evaluation did not include a process evaluation.

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[17] Since CUB-ES Program participants are dropped from the evaluation when they move, as their billing data is no longer available, other EE programs' savings are no longer captured in the CUB-ES Program savings from that point forward.

3   Gross Impact Evaluation

Total program savings are summarized in Table 3-1. PY7 program verified net savings were 1,209 MWh prior to uplift adjustment. Final verified net savings were 1,224 MWh. Under the maintained assumption of no selection bias, gross savings are equal to net savings.

Table 3-1. PY7 Total Program Electric Savings

Savings Category	Energy Savings (MWh)
Verified Savings, Prior to Uplift Adjustment	1,209
PY7 Uplift Adjustment	4
Legacy Uplift Adjustment†	-19
Final Verified Savings	1,224

Source: Navigant analysis.
†Negative uplift savings indicates that the participation rate in the EE program is higher for the matched controls than the participants. The negative uplift lowers the baseline and increases CUB-ES Program savings.

3.1   Uplift of Savings in Other EE Programs

Program savings estimated from the statistical analysis are net savings *except* for the uplift in participation in other energy efficiency programs caused by the CUB-ES Program. To avoid double-counting savings, program savings due to this uplift must be counted towards either the CUB-ES Program or the other EE programs, but not both programs. The uplift of savings in other EE programs was a small proportion of the total savings: 4 MWh, which is 0.3 percent of net savings. This estimate breaks down into 23 MWh for active participants, 15 percent of their total savings, and -19 MWh for inactive participants, 1.7 percent of their total savings. This means that the program is successfully channeling active participants into other EE programs.

Table 3-2 presents a summary of the PY7 double-counted savings due to uplift in other EE programs. This table shows that uplift is positive for both participant types in every program but FFR. FFR has negative uplift for inactive participants indicating that matched controls are participating in this program at a higher rate than participants. Table 6-2 and Table 6-3 in the appendix present the details of the double-counted savings for each for the four ComEd energy efficiency programs considered in the analysis.

Table 3-2. PY7 Uplift of Savings in Other EE programs

		FFR	HEA	MESP	Rebate	Total
Participation uplift in other EE programs (# participants)						
	Active	16	20	2	6	44
	Inactive	-56	16	6	8	-26
	All	-40	36	8	14	18
Savings uplift in other EE programs (MWh)						
	Active	9.5	10.0	0.3	3.6	23.3
	Inactive	-33.2	8.0	0.9	4.7	-19.5
	All	-23.7	18.0	1.2	8.3	3.9

Source: Navigant analysis

The estimate of double-counted savings is most likely an *overestimate* because it presumes participation in the other EE programs occurs at the very start of PY7. Under the more reasonable assumption that participation occurs at a uniform rate throughout the year, the estimate of double-counted savings would be approximately 2 MWh, half the estimated value of 4 MWh. Overall, double counting of savings with other ComEd EE programs *is not a significant issue* for the CUB-ES Program.

Legacy uplift for the CUB-ES Program was not apportioned between active and inactive participants as PY7 is the first time Navigant has received this classification. Total legacy uplift from PY5 and PY6 was -19 MWh. The details of this calculation are described in Section 6.3.2.

3.2   Verified Program Impact Results

Navigant estimated savings separately for active and inactive customers. As expected, active customers had higher savings than inactive customers (2.1 percent versus 1.6 percent), although statistical tests indicated that the two estimates were not statistically different at the 90 percent confidence level.[18] For active customers these savings are very similar to savings in PY6. Both groups had estimates of savings that were statistically different from zero at the 90 percent confidence level. The fact that inactive participants have statistically significant savings could indicate that these participants were active for part of PY7[19] or that savings persist after customers leave the program.[20]

Table 3-3 summarizes estimated program savings by participant type. In this table, the number of participants, in the first row, represents the number of customers used to estimate program savings, while the sample sizes, in the second and third row, indicate the number of customers (treatment and controls) with sufficient data for inclusion in the regression analysis. The weighted average per customer savings estimate across both customer types was 1.7 percent (139 kWh). Detailed parameter estimates from the RPPM model are shown in Section 6.2.

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[18] An F-test of whether the two coefficients are equal returns an F-statistic of 0.03 and a p-value of 0.86.

[19] The program implementer does not associate a date with an account becoming inactive so Navigant was unable to determine how long the inactive accounts had been closed.

[20] For example, participants may have purchased equipment, such as a new furnace, that creates lasting savings or they may have made behavioral changes that they continued to engage in after closing their account, such as turning out lights.

Table 3-3. CUB-ES PY7 Program Savings

Type of Statistic		Active Participants	Inactive Participants	Total
Number of Participants		2,592	7,886	10,478
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Percentage Savings		2.05%	1.57%	1.69%
	Standard Error	*1.17%*	*0.48%*	-
Annualized Savings Per Customer, kWh		153	135	139
	Standard Error	*87*	*42*	-
Verified Gross Savings, Prior to Uplift Adjustment, MWh†		153	1,056	1,209
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Savings Uplift in Other EE Programs in PY7, MWh‡		23	-19	4
Legacy Savings Uplift in Other EE Programs, MWh§		-9.5	-9.5	-19
Verified Gross Savings, MWh*		139.5	1,084.5	1,224

Source: Navigant analysis
†Total savings are pro-rated for participants that closed their accounts during PY7.
‡Negative double counted savings indicate that the participation rate in the EE program is higher for the matched controls than the participants. This lowers the baseline and underestimates CUB-ES Program savings.
§ Past evaluations did not split results by active and inactive participants. Legacy uplift was split 50/50 across the two groups.
* Gross savings adjusted for savings uplift are equal to gross savings less the uplift of savings in other EE programs.

4 Net Impact Evaluation

A key feature of the match regression impact calculation for the CUB-ES 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 we expect that participants in the CUB-ES Program and their matched controls would have exhibited the same energy usage. In particular, in the absence of the program we expect that the participants and the matched controls would exhibit the same degree of energy-conserving behavior and purchases. Therefore, there is no free ridership, and no net-to-gross (NTG) adjustment is necessary.

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5   Findings and Recommendations

The following summarizes key program findings and recommendations.[21] In PY7, there were approximately 10,000 participants in the CUB-ES Program, 2,592 of whom were identified as active when Navigant received data. Total program savings were 1,224 MWh; 139.5 from active participants and 1,084.5 from inactive participants.

> **Finding 1.** In PY7, the average percent savings per participant was 1.7 percent, which is annualized savings of 139 kWh per participant. Savings for active participants were higher than for inactive participants, 2.1 percent versus 1.6 percent. Savings for active participants were similar to PY6 savings of 2.0 percent. Additionally, uplift was positive, 23 MWh, for active participants and negative, -19 MWh, for inactive participants meaning active participants were more likely to enroll in ComEd's other energy efficiency programs.
>
> **Recommendation 1.** Since active customers save more, consider adding new content to the web portal to keep customers engaged in the program. Such content could include new energy saving tips, news of new or enhanced EE programs, expanded options for spending rewards points, societal comparisons, or more disaggregated or real-time feedback on usage patterns.
>
> **Finding 2.** Participant enrollment almost quadrupled in PY7 compared to PY6. This is likely due to renewed recruitment efforts by the new program implementer. In addition to the approximately 2,000 new participants who linked their CUB-ES account to their ComEd account there were approximately 3,000 participants who created a CUB-ES account but did not link it to their ComEd account.
>
> **Recommendation 2.** To continue the trend of increased enrollment, encourage the program implementer to maintain and expand upon their current recruitment efforts. In addition, encourage customers who have created a CUB-ES account but not linked it to their ComEd account to do so. Also, consider efforts to make it easier for participants to link their accounts, for example allowing customers to link with their name or address, rather than an account number. These efforts need to be balanced with concerns regarding data privacy.
>
> **Finding 3.** Customer self-selection into the program, which could bias estimated savings, continues to be a concern as the program is not an experimental design.
>
> **Recommendation 3.** Given the high level of effort required to convert the program to an experimental design[22], ComEd, in conjunction with the program implementer and Navigant, should instead design a brief survey to be administered to new enrollees when they join the program asking when and how the new participant heard about the CUB-ES Program and why they decided to join. Such survey results would allow Navigant to examine the reasons customers join the program which could shed light on possible self-selection bias.

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[21] 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.

[22] One example of such an experimental design would be a recruit-and-deny strategy where customers who desire to enroll in the program would be sorted into a participant group who has access to the website and a control group who does not. An experimental design would have the benefit of being free of self-selection bias.

6   Appendix

6.1   Detailed Impact Methodology

6.1.1   Regression with Pre-Program Matching Model (RPPM)

As discussed in Section 2.4, 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 2.4.1. 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 –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.

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.[23] 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.

6.1.2   Matching Algorithm and Matching Results

As described in Section 2.4.1, we matched participant and comparison customers 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, energy use in the same calendar month in the 1-year period before program enrollment, and whether the customer is a program participant. Formally, the model is shown in Equation 6-1.

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[23] 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

$$ADU_{kt} = \beta_1 Treatment_k \cdot Active_k + \beta_2 Treatment_k \cdot Inactive_k$$
$$+ \sum_j \beta_{3j} Month_{jt} \cdot Active_k + \sum_j \beta_{4j} Month_{jt} \cdot Inactive_k$$
$$+ \sum_j \beta_{5j} Month_{jt} \cdot PREkWh_{kt} \cdot Active_k + \sum_j \beta_{6j} Month_{jt} \cdot PREkWh_{kt} \cdot Inactive_k + \varepsilon_{kt}$$

Where,

ADU_{kt}	=	Average daily energy use by household k in month t;
$Treatment_k$	=	A 0/1 indicator variable, taking a value of 1 if customer k is a CUB-ES participant, and 0 otherwise;
$Active_k$	=	A 0/1 indicator variable, taking a value of 1 if customer k is active, and 0 otherwise;
$Inactive_k$	=	A 0/1 indicator variable, taking a value of 1 if customer k is inactive, and 0 otherwise;
$Month_{jt}$	=	is a binary variable taking a value of 1 when j = t and 0 otherwise[24];
$PREkWh_{kt}$	=	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 $PREkWh_{kt}$ $PREkWh_{kt}$ for June 2012 is June 2011.
ε_{kt}	=	Model error term.

In this model β_1 is the treatment effect for active customers and β_2 is the treatment effect for inactive customers. We include a monthly fixed effect 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. Adding interactions with $active_k$ allows us to separately estimate impacts for active and inactive customers.

For the sake of expositional clarity below, we denote by t_k as 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 -12, t_k -1] were not matched.

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.

6.2 Detailed Impact Results: Parameter Estimates

Parameter estimates for Equation 6-1 are presented in Table 6-1.

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[24] 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.

Table 6-1. Parameter Estimates for RPPM Model

Variable	Parameter Estimate	Std. Err.	t-value	p-value
treatment:active0	-0.37108	0.11406	-3.25	0.00114
treatment:active1	-0.41932	0.23964	-1.75	0.08015
active0:yrmo201407	5.91137	0.25244	23.42	< 0.0000000000000002
active1:yrmo201407	4.61204	1.25616	3.67	0.00024
active0:yrmo201408	5.93431	0.23587	25.16	< 0.0000000000000002
active1:yrmo201408	4.05959	0.96	4.23	2.35124E-05
active0:yrmo201409	8.10096	0.35157	23.04	< 0.0000000000000002
active1:yrmo201409	4.98379	0.61545	8.1	5.6E-16
active0:yrmo201410	5.41512	0.25419	21.3	< 0.0000000000000002
active1:yrmo201410	3.81217	0.44386	8.59	< 0.0000000000000002
active0:yrmo201411	4.53898	0.35143	12.92	< 0.0000000000000002
active1:yrmo201411	3.48294	0.54788	6.36	2.06044E-10
active0:yrmo201412	5.67384	0.36959	15.35	< 0.0000000000000002
active1:yrmo201412	2.67046	0.63457	4.21	2.57429E-05
active0:yrmo201501	5.46326	0.28865	18.93	< 0.0000000000000002
active1:yrmo201501	4.5218	0.67917	6.66	2.78821E-11
active0:yrmo201502	4.79698	0.30746	15.6	< 0.0000000000000002
active1:yrmo201502	4.59858	0.60662	7.58	3.457E-14
active0:yrmo201503	5.84891	0.36886	15.86	< 0.0000000000000002
active1:yrmo201503	4.6577	0.46622	9.99	< 0.0000000000000002
active0:yrmo201504	4.51627	0.23701	19.06	< 0.0000000000000002
active1:yrmo201504	3.86175	0.48813	7.91	2.56E-15
active0:yrmo201505	4.38469	0.2696	16.26	< 0.0000000000000002
active1:yrmo201505	3.01412	0.32991	9.14	< 0.0000000000000002
active0:yrmo201406:pre.kwh	0.87421	0.00525	166.59	< 0.0000000000000002
active1:yrmo201406:pre.kwh	0.75434	0.0953	7.92	2.48E-15
active0:yrmo201407:pre.kwh	0.63397	0.0079	80.27	< 0.0000000000000002
active1:yrmo201407:pre.kwh	0.64617	0.04491	14.39	< 0.0000000000000002
active0:yrmo201408:pre.kwh	0.57364	0.00698	82.17	< 0.0000000000000002
active1:yrmo201408:pre.kwh	0.67244	0.03584	18.76	< 0.0000000000000002
active0:yrmo201409:pre.kwh	0.70827	0.01361	52.04	< 0.0000000000000002
active1:yrmo201409:pre.kwh	0.75138	0.02677	28.07	< 0.0000000000000002
active0:yrmo201410:pre.kwh	0.68504	0.01403	48.82	< 0.0000000000000002
active1:yrmo201410:pre.kwh	0.71018	0.02598	27.33	< 0.0000000000000002
active0:yrmo201411:pre.kwh	0.76114	0.01943	39.18	< 0.0000000000000002
active1:yrmo201411:pre.kwh	0.79018	0.03244	24.36	< 0.0000000000000002
active0:yrmo201412:pre.kwh	0.7534	0.01625	46.35	< 0.0000000000000002
active1:yrmo201412:pre.kwh	0.84347	0.03166	26.64	< 0.0000000000000002
active0:yrmo201501:pre.kwh	0.73908	0.01141	64.78	< 0.0000000000000002
active1:yrmo201501:pre.kwh	0.76541	0.03005	25.47	< 0.0000000000000002

Variable	Parameter Estimate	Std. Err.	t-value	p-value
active0:yrmo201502:pre.kwh	0.76681	0.01306	58.69	< 0.0000000000000002
active1:yrmo201502:pre.kwh	0.73019	0.02709	26.95	< 0.0000000000000002
active0:yrmo201503:pre.kwh	0.8026	0.01811	44.32	< 0.0000000000000002
active1:yrmo201503:pre.kwh	0.77694	0.02286	33.99	< 0.0000000000000002
active0:yrmo201504:pre.kwh	0.72353	0.0127	56.96	< 0.0000000000000002
active1:yrmo201504:pre.kwh	0.72324	0.02751	26.29	< 0.0000000000000002
active0:yrmo201505:pre.kwh	0.70891	0.0148	47.89	< 0.0000000000000002
active1:yrmo201505:pre.kwh	0.78578	0.02008	39.13	< 0.0000000000000002
Residual standard error: 10.1 on 164908 degrees of freedom				
Multiple R-squared: 0.876, Adjusted R-squared: 0.876				
F-statistic: 2.42e+04 on 48 and 164908 DF, p-value: <0.0000000000000002				

Source: Navigant analysis

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

6.3.1   **Uplift in PY7**

Table 6-2 and Table 6-3 present program savings due to participation uplift in other EE programs for active and inactive participants, respectively. A dash (-) in a row concerning the change in participation from the pre-program year (2009) 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 4 kWh.

Table 6-2. Estimates of Double Counted Savings in PY7, Active Participants

	FFR	HEA	MF	Rebate
Average program savings (annual kWh per participant)	592	500	155	593
Number of CUB-ES Treatment Customers	2,172	2,172	2,172	2,172
Program participation, PY7	47	21	2	7
Change in participation from pre-program Year	21	-	-	-
Number of Comparison Customers	2,172	2,172	2,172	2,172
Program participation, PY7	31	1	0	1
Change in participation from pre-program	5	-	-	-
DID/(POD) statistic	0.74%	0.92%	0.09%	0.28%
Participation uplift	16	20	2	6
Statistically Significant at the 90% Confidence Level?	Yes	Yes	No	Yes
Savings attributable to other programs (kWh)	9,472	10,000	310	3,560

Source: Navigant analysis

Table 6-3. Estimates of Double Counted Savings in PY7, Inactive Participants

	FFR	HEA	MF	Rebate
Average program savings (annual kWh per participant)	592	500	155	593
Number of CUB-ES Treatment Customers	7,387	7,387	7,387	7,387
Program participation, PY7	103	20	7	8
Change in participation from pre-program Year	-31	-	-	-
Number of Comparison Customers	7,387	7,387	7,387	7,387
Program participation, PY7	92	4	1	0
Change in participation from pre-program	25	-	-	-
DID/(POD) statistic	-0.76%	0.22%	0.08%	0.11%
Participation uplift	-56	16	6	8
Statistically Significant at the 90% Confidence Level?	Yes	Yes	Yes	Yes
Savings attributable to other programs (kWh)	-33,152	8,000	930	4,746

Source: Navigant analysis

6.3.2 Legacy Uplift

In PY5, Navigant considered double-counted savings for the following PY5 programs: FFRR, the CSR, the CW, the MF, and the SFHES programs. The measure lives for PY5 programs are taken from the PY5 total resource cost report.[25] The measure life for the SFHES program is a simple average of the three measures included in that program. Table 6-4 shows the double counted savings (kWh) from each program in PY5.

Table 6-4. Double Counted Savings (kWh) from PY5

	FFRR	CSR	CW	MF	SFHES
Measure Life	8	18	14	5.42	12
Double Counted Savings (kWh)	-11,451	14,611	18,491	-2574	-864

Source: Navigant analysis

In PY6, Navigant considered double-counted savings for the following PY6 programs: SFHES, CSR, FFRR programs, and MCEEP. The PY6 total resource cost report is not yet available, so the program measure lives for PY6 are not included, but for the PY7 legacy uplift adjustment we make the reasonable assumption that each of these programs has a measure life of at least two years and should be deducted in PY7. Table 6-5 shows the double counted savings (kWh) from each program in PY6.

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[25] Navigant Consulting, Inc. 2014. *Review of EPY5 Total Resource Cost Test Assumptions.* Presented to Commonwealth Edison Company.

Table 6-5. Double Counted Savings (kWh) from PY6

	SFHES	CSR	FFRR	MCEE
Measure Life	-	-	-	-
Double Counted Savings (kWh)	7,116	5,503	-49,828	-487

Source: Navigant analysis