



ComEd Home Energy Report 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 Home Energy Report (HER) Program. It provides a summary of the energy and demand impacts for the program in total and broken out by wave. The appendix presents the impact analysis methodology. PY9 covers June 1, 2016 through December 31, 2017.

2. PROGRAM DESCRIPTION

The HER program is designed to generate energy savings by providing residential customers with information about energy use and conservation. Program participants receive information in the form of regularly mailed and emailed¹ home energy reports that give customers information, including:

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

In PY9, the HER program had 1,995,540 participants and 294,295 controls across 11 waves (Wave 7 has two components), as shown in Table 2-1. Participants and controls in Table 2-1 represent active accounts at the beginning of PY9.

Table 2-1. PY9 Volumetric Findings Detail (in thousands)

Participation	Wave 1	Wave 2	Wave 3	Wave 4	Wave 5	Wave 6	Wave 7 Low	Wave 7 High	Wave 8	Wave 9	Wave 10	New Mover
Participants	25.9	2.0	141.5	15.7	5.3	74.7	485.5	509.9	65.1	316.2	161.9	191.5
Controls	30.9	2.1	36.8	15.8	6.8	22.6	40.5	42.6	8.7	19.9	19.9	48.0

Source: ComEd tracking data and Navigant team analysis.

3. PROGRAM SAVINGS

Table 3-1 summarizes the incremental energy savings the HER 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.

¹ The frequency of reports sent through direct mail varied across the waves, where customers identified by the program implementer as having a greater propensity to save received more frequent reports. Additionally, treatment customers with email addresses on file were sent monthly electronic reports.

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†	444,877,822	NA	NA

Source: ComEd tracking data and Navigant team analysis.

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

† This value is after the uplift adjustment.

Table 3-2 shows PY9 HER 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.

Table 3-2. PY9 Total Program Net Electric Savings

Savings Category	Energy Savings (kWh)
Ex Ante Net Savings	462,142,000
Verified Net Savings, Prior to Uplift Adjustment	448,085,144
PY9 Uplift Adjustment	620,949
Legacy Uplift Adjustment	2,586,374
Final Verified Net Savings	444,877,822
Program Net Realization Rate*	96%

Source: ComEd tracking data and Navigant team analysis.

* This value is after the uplift adjustment.

The program realization rate compared to the savings estimated by the implementer was 96 percent. The uplift adjustment resulted in a one percent change in the net savings which is not accounted for in the implementer’s savings estimate. The remaining three percent difference in the realization rate was likely due to small differences in the regression models used by Navigant and the implementer.

4. PROGRAM SAVINGS BY MEASURE

The HER program only has a single measure, behavioral savings from the reports. In PY9, the measure life for the reports was one year. Detailed savings by wave are presented in Section 5.

5. IMPACT ANALYSIS FINDINGS AND RECOMMENDATIONS

5.1 Impact Parameter Estimates

The HER program does not have relevant impact parameters.

5.2 Other Impact Findings and Recommendations

Across all waves, Navigant estimated savings for approximately 2 million participants. Total PY9 verified savings were 448,085,144 kWh prior to uplift and 444,877,822 kWh after the uplift adjustment.

Finding 1. From PY8 to PY9, the average program savings rate remained steady (1.45 percent vs 1.44 percent respectively), despite ComEd adding two additional waves with 478,133 new participants. Waves 9 and 10 had low savings (0.34 percent and 0.56 percent) relative to previous waves. Increases in savings for the New Mover wave and Wave 7 made up for the low savings in Wave 9 and 10.

Finding 2. Waves 9 and 10 both had relatively low savings rates with 90 percent confidence bounds that approached zero. The savings rates of these new waves will likely increase in years to come, based on the ramp up of other waves in the past.

Recommendation 1. ComEd should consider the feasibility of adding higher usage customers to the HER program by transferring customers from existing control groups, such as in Waves 1 and 3, into new treatment groups as participants. ComEd and the implementation contractor should work with Navigant to use a power analysis to first review the statistical significance for both the new and old waves prior to transferring customers.

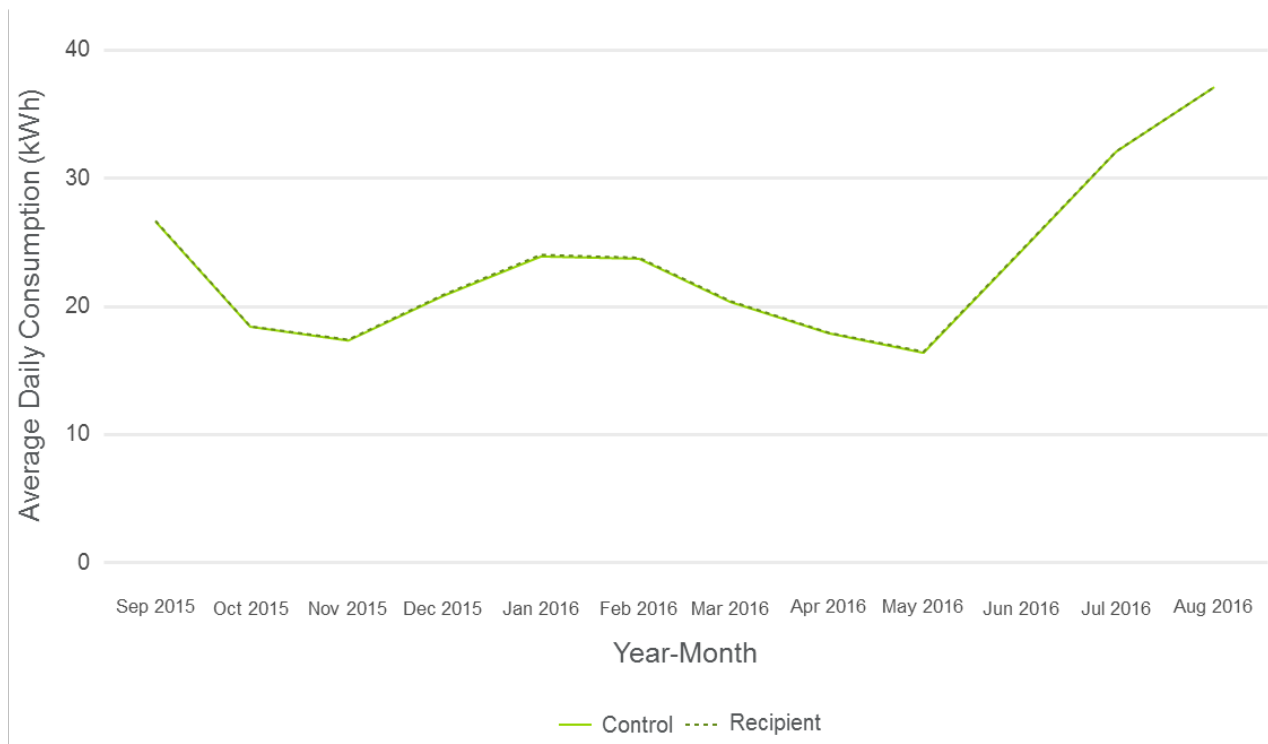
6. APPENDIX 1. IMPACT ANALYSIS METHODOLOGY

6.1 Graphs for New Wave RCT Checks

To test that the new PY9 waves (Waves 9 and 10) are consistent with an RCT, Navigant compared treatment and control usage for each month during the pre-program period. If the allocation of households across participants and controls is truly random, the two groups should have the same distribution of energy usage during these twelve months. Navigant conducted variance tests and t-tests comparing participant and control usage for each month of the pre-period, and found that mean usage was not statistically different. As an additional check, Navigant performed a regression analysis in which average daily usage in the pre-program period was a function of monthly binary variables and a binary participation variable.

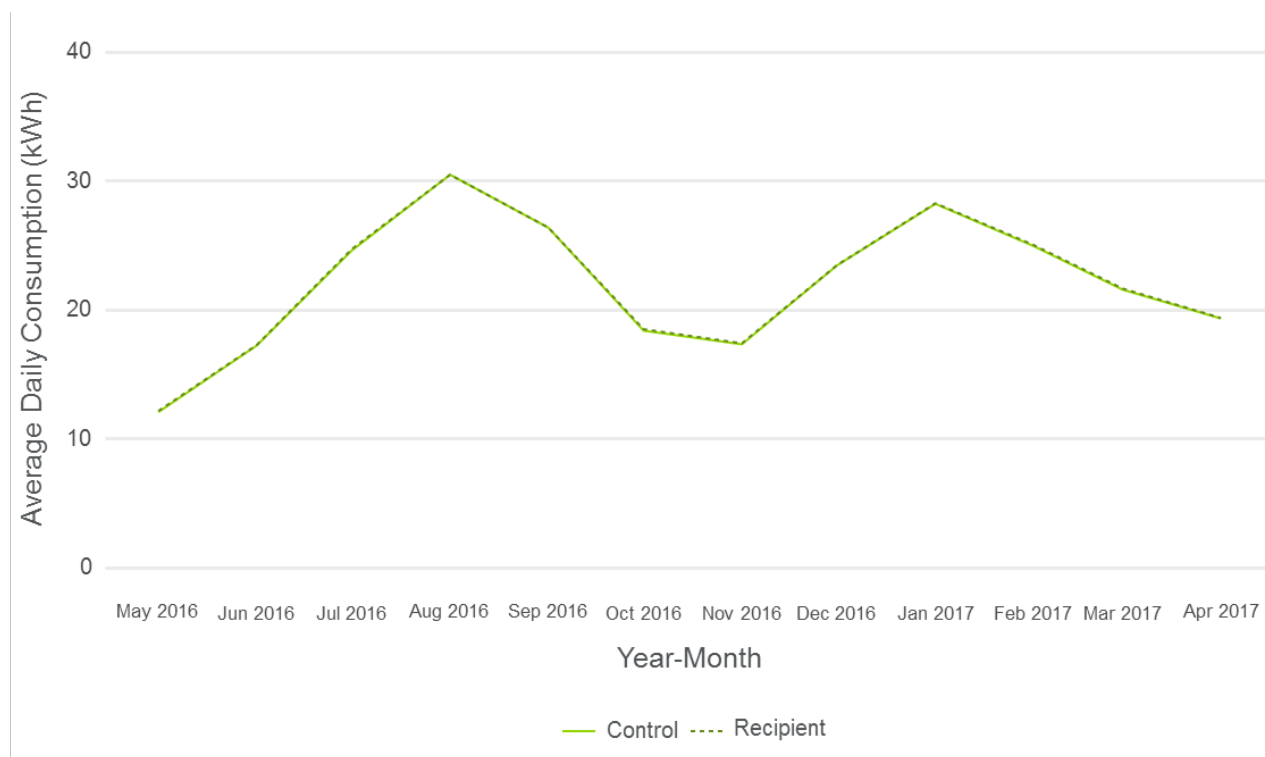
Figure 6-1 and Figure 6-2 illustrate control and participant (treatment recipient) usage during the twelve-month pre-period for Waves 9 and 10 that started during PY9. These graphs illustrate what Navigant’s statistical analysis confirmed, namely that the assignment of customers into the treatment and control groups was consistent with randomization.

Figure 6-1. RCT Usage Comparison for Wave 9



Source: ComEd data and Navigant team analysis.

Figure 6-2. RCT Usage Comparison for Wave 10



Source: ComEd data and Navigant team analysis.

6.2 Detailed Data Cleaning

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

- Observations outside PY9 and each wave's relevant pre-program year
- Observations with a bill duration of zero days
- Observations missing usage
- Outliers, defined as observations with average daily usage more than one order of magnitude from the median usage

After selecting program and pre-program year data for each wave, cleaning steps removed approximately 3.5% of customers and 7% of observations², evenly distributed across participants and controls. This suggests that non-random biases were not introduced into the data by Navigant's cleaning steps.

6.3 Detailed Impact Methodology

The LDV and LFER models generated similar results for program savings estimates. Navigant used the LDV results for reporting PY9 total program savings. Across the two models, the parameter estimates were not statistically different; that is, the estimates for each model are within the 90 percent confidence bounds for the other model. Furthermore, the pattern across the different program waves between the two models is very similar. This supports the methodological approach, and indicates the results are robust. The following sections present the specifications for each model.

² Waves 9, 10, and the New Mover Wave dropped more observations than the other waves (19%, 30%, and 48%) because they were more frequently missing pre-period usage.

6.3.1 Lagged Dependent Variable Model³

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

Equation 1. Lagged Dependent Variable Regression Model

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

Where:

ADU_{kt}	is average daily consumption of kWh by household k in bill period t
$Treatment_k$	is a binary variable taking a value of 0 if household k is assigned to the control group, and 1 if assigned to the treatment group
$ADUlag_{kt}$	is household k 's energy use in the same calendar month of the pre-program year as the calendar month of month t
$Month_{jt}$	is a binary variable taking a value of 1 when $j = t$ and 0 otherwise ⁴
ε_{kt}	is the cluster-robust error term for household k during billing cycle t ; cluster-robust errors account for heteroskedasticity and autocorrelation at the household level. ⁵

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

6.3.2 Linear Fixed Effects Regression Model

The LFER model used by Navigant is one in which average daily consumption of kWh by household k in bill period t , denoted by ADU_{kt} , is a function of the following three terms:

1. The binary variable $Treatment_k$.
2. The binary variable $Post_t$, taking a value of 0 if month t is in the pre-treatment period, and 1 if in the post-treatment period.
3. The interaction between these variables, $Treatment_k \cdot Post_t$.

Formally, the LFER model is shown in Equation 2.

Equation 2. Linear Fixed Effects Regression Model

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

Three observations about this specification deserve comment. First, the coefficient α_{0k} captures all household-specific effects on energy use that do not change over time, including those that are unobservable. Second, α_1 captures the average effect *across all households* of being in the post-

³ The model is identical to the post-program regression (PPR) model used in previous evaluations (e.g., PY8). We have changed the nomenclature to better align with academic research and because LDV is more descriptive of the model structure than PPR.

⁴ 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.

⁵ Ordinary Least Squares (OLS) regression models assume that the data are homoskedastic and not autocorrelated. If either of these assumptions is violated, the resulting standard errors of the parameter estimates are incorrect (usually underestimated). A random variable is heteroskedastic when the variance is not constant. A random variable is autocorrelated when the error term in one period is correlated with the error terms in at least some of the previous periods.

treatment period. Third, the effect of being both in the treatment group and in the post period, i.e., the effect directly attributable to the program, is captured by the coefficient α_2 . In other words, whereas the coefficient α_1 captures the change in average daily kWh use across the pre- and post-treatment for the *control* group, the sum $\alpha_1 + \alpha_2$ captures this change for the treatment group, and so α_2 is the estimate of average daily kWh energy savings due to the program.

6.4 Accounting for Uplift in Other Energy Efficiency Programs

6.4.1 Accounting for Uplift in PY9

The home energy reports sent to participating households include energy-saving tips, some of which encourage participants to enroll in other ComEd energy efficiency (EE) programs. If participation rates in other EE programs are the same for HER treatment and control groups, the savings estimates from the regression analyses are already “net” of savings from other programs as this indicates the HER program does not increase or decrease participation in other EE programs. However, if the HER program affects participation rates in other EE programs, then savings across all programs are lower than indicated by the simple summation of savings in the HER and EE programs. For instance, if the HER program increases participation in other EE programs, the increase in savings may be allocated to either the HER program or the EE program, but cannot be allocated to both programs simultaneously.⁶ Note that when the HER 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 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 control group, and the rate of participation during the year before the start of the HER program is two percent for the treatment group and one percent for the control group, then the rate of uplift due to the HER program is one percent, as reflected in Equation 3.

Equation 3. DID Statistic Calculation

$$\begin{aligned} & (PY8 \text{ treatment group participation} - \text{prePY treatment group participation}) \\ & - (PY8 \text{ control group participation} - \text{prePY control group participation}) \\ & = \text{DID statistic} \\ & \quad (5\% - 2\%) - (3\% - 1\%) = 1\% \end{aligned}$$

The DID statistic generates an unbiased estimate of uplift when the baseline average rate of participation is the same for the treatment and 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 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 treatment and control groups. Navigant uses this alternative statistic in cases where the EE program did not exist in the 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

⁶ 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.

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 wave of the HER program and for the LR subgroup in Waves 1 and 3.

6.4.2 Accounting for Legacy Uplift

The uplift adjustment methodology described in Section 6.4.1 only accounts for uplift which occurs in the current program year because EE program tracking files in any given program year only capture the new measures installed in that year, regardless of the expected measure life.⁷ However, for other EE programs that include measures with multi-year measure lives, HER program savings capture the portion of their savings due to uplift in each year of that program’s measure life. For instance, a measure with a ten-year measure life that was installed in PY2 would generate savings captured in the HER program savings not just in PY2, but in PY3 through PY11 as well.

Consider the following example. A household receiving home energy reports through the HER 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 HER 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 6.4.1 FFR second year savings would be included in the PY7 HER 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 that include measures with a multiple-year measure life.

Navigant accounts for legacy uplift by subtracting the double counted savings from previous years, adjusted for the average annual move-out rate, from PY9 HER savings through the measure lives of measures from other EE programs.⁸ The legacy uplift adjustment is shown in Equation 4.

Equation 4. Legacy Uplift Calculation

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

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

The legacy uplift adjustment goes back to PY4 when Navigant first considered uplift for the HER program. In PY4, Navigant considered double-counted savings for the Fridge Freezer Recycle Rewards (FFRR), the Central Air Conditioning Efficiency Services (CACES), and the Single-Family Home Performance (SFHP) programs. In PY5, Navigant considered double-counted savings for the 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, except for the CW

⁷ 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.

⁸ Since HER program participants are dropped from that program when they move, other EE programs’ savings are no longer captured in the HER program savings from that point forward.

program which was discontinued. In PY7 and PY8 Navigant considered legacy uplift savings for the MESP, HEA, Rebate, and FFR programs.

6.4.3 Uplift Analysis Results

LDV program savings estimates include savings resulting from the uplift in participation in other EE programs caused by the HER program. To avoid double-counting savings, program savings due to this uplift must be counted towards either the HER program or the other EE programs, but not both programs. The uplift of savings in other EE programs was a very small proportion of the total savings: 3,207,323 kWh, or 0.7 percent. The uplift can be broken down into uplift in PY9 and legacy uplift from previous program years. The PY9 uplift was 620,949 kWh or 0.1 percent of total program savings and the legacy uplift was 2,586,374 kWh or 0.6 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.⁹ 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. Under the more reasonable assumption that participation occurs at a uniform rate throughout the year, the estimate of double-counted savings would be approximately 1,603,661 kWh, half the estimated value of 3,207,323 kWh. The upshot is that double counting of savings with other ComEd EE programs does not appear to be a significant issue for the HER program.

7. APPENDIX 2. IMPACT ANALYSIS DETAIL

This section disaggregates program savings according to individual waves and wave subgroups. To examine the persistence of savings, Oracle terminated reports in October 2012 for 10,000 customers in Waves 1 and 3, but accidentally restarted treatment in August 2013. These customers are referred to as the Waves 1 and 3 lapsed report (LR) subgroups. Customers in Waves 1 and 3 who continued to receive reports are referred to as the continued report (CR) subgroup. Wave 7 was divided into low and high users due to its size. Table 7-1 summarizes estimated program savings by participant wave. In PY9, 1,924,384 participants and 280,596 controls had sufficient data for inclusion in our regression. Navigant estimated separate savings for each wave and wave subgroup using regression analysis as described in Section 6.3.

⁹ ComEd has other residential programs that were not included in the analysis. The Residential Lighting and Elementary Education programs do not track participation at the customer level, and so do not have the data necessary for the uplift analysis. Double counting between the Residential New Construction and HER programs is not possible due to the requirement that HER participants have sufficient historical usage data.

Table 7-1. PY9 HER Program Results by Wave

Wave	Sample Size - Treatment	Sample Size - Control	Percent Savings	Percent Savings Std. Err.	Annualized Customer Savings, kWh*	Annualized Customer Savings Std. Err.	Net Savings, Prior to Uplift, kWh	Net Savings Std. Err.	PY9 Uplift, kWh†	Legacy Uplift, kWh‡	Verified Net Savings, kWh‡
Wave 1 CR	19,841	30,128	2.63%	0.28%	382	40	11,457,927	1,208,006	4,656	150,449	11,302,822
Wave 1 LR	6,087		2.25%	0.43%	324	61	3,002,726	568,601	4,656	153,057	2,845,013
Wave 2	2,047	2,102	2.26%	0.95%	308	130	958,619	403,775	-	6,639	951,980
Wave 3 CR	134,189	36,799	2.60%	0.17%	466	30	94,714,269	6,175,498	17,433	581,141	94,115,695
Wave 3 LR	7,278		3.06%	0.37%	549	66	6,044,377	722,872	17,433	37,488	5,989,456
Wave 4	15,728	15,813	2.44%	0.28%	295	34	7,016,461	804,568	15,505	30,253	6,970,703
Wave 5	5,346	6,841	1.74%	0.58%	367	123	2,875,193	964,543	15,926	46,970	2,812,298
Wave 6	74,264	22,516	2.11%	0.22%	337	35	37,557,287	3,909,657	36,916	141,349	37,379,023
Wave 7 Low	483,582	40,370	1.28%	0.14%	86	9	153,715,154	9,609,002	245,368	1,136,405	152,333,381
Wave 7 High	508,105	42,448	1.95%	0.12%	203	13	60,941,331	6,701,528	6,790	134,298	60,800,243
Wave 8	65,043	8,767	1.60%	0.33%	190	39	17,008,058	3,512,573	136,508	9,491	16,862,058
Wave 9	306,431	19,379	0.34%	0.17%	28	14	10,768,601	5,260,956	7,136	-	10,761,465
Wave 10	147,734	18,212	0.56%	0.25%	43	19	4,142,679	1,851,170	81,000	-	4,061,679
New Mover	148,709	37,221	1.57%	0.30%	159	30	37,882,464	7,158,283	31,623	158,834	37,692,007
Total	1,924,384	280,596	1.44%	-	157	-	448,085,144	-	620,949	2,586,374	444,877,822

Source: ComEd data and Navigant team analysis.

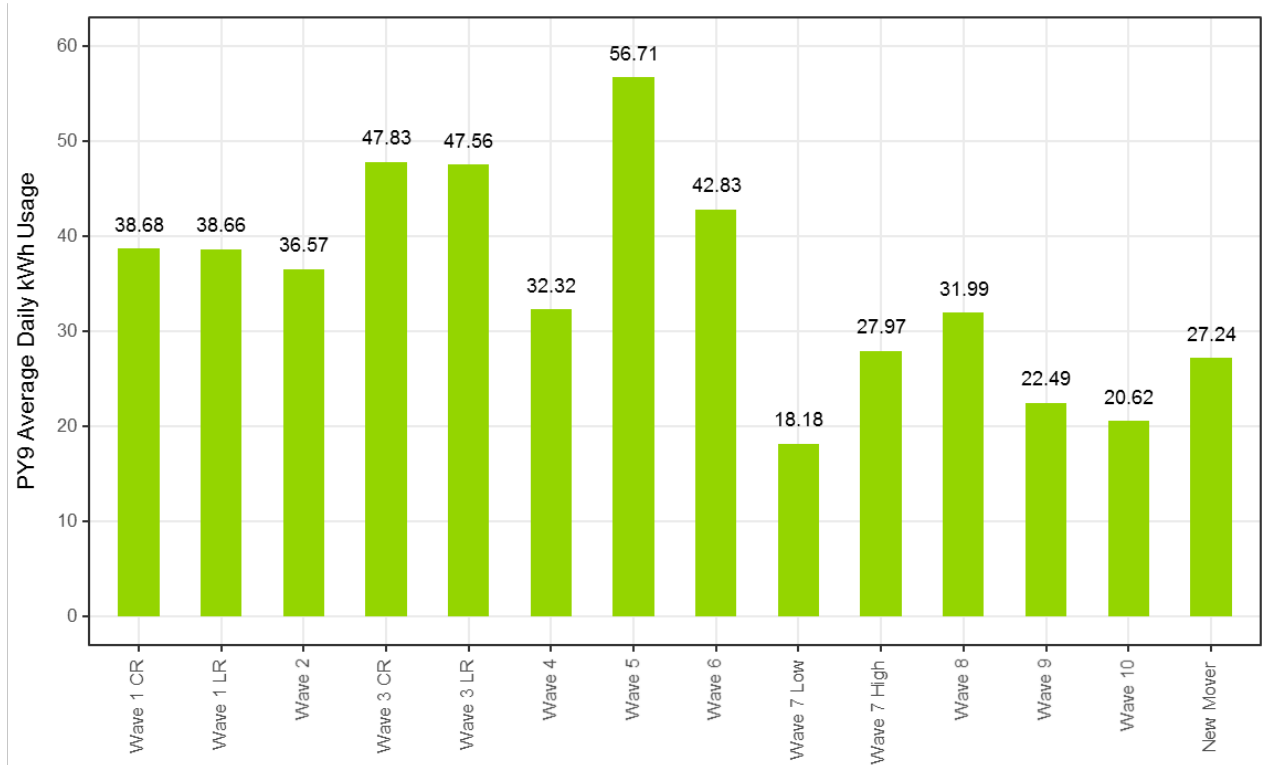
* Total savings are pro-rated for participants that closed their accounts during PY9.

† No adjustment was made to total savings for negative uplift, (i.e. cases where the HER program decreased participation in other programs).

‡ Verified Net Savings are equal to Net Savings, Prior to Uplift less PY9 Uplift and Legacy Uplift.

Daily electricity usage varied widely across waves (see Figure 7-1). Wave 7 Low had the lowest usage at 18 kilowatt-hours (kWh) per day, while Wave 5 had the highest at 57 kWh per day. Previous evaluations¹⁰ have identified that higher usage is often associated with greater HER program savings.

Figure 7-1. PY9 Average Daily Usage by Wave

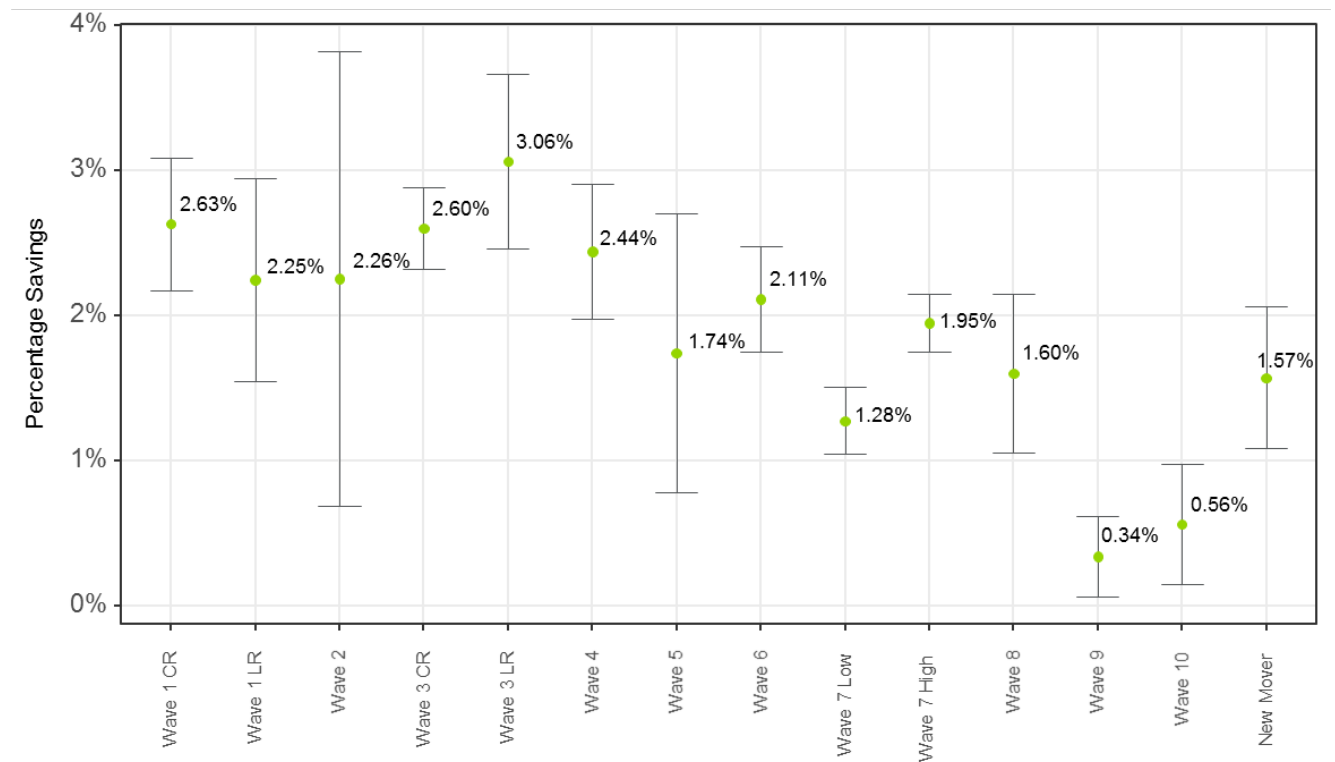


Source: ComEd data and Navigant team analysis.

Figure 7-2 shows energy savings for each wave with 90 percent confidence intervals. Waves with larger confidence bounds generally had smaller sample sizes, which reduced the level of certainty in the regression. For example, Wave 2 had a sample size of 2,047 participants and 2,102 controls and large confidence bounds, while Wave 7 Low had 485,540 participants and 40,370 controls and small confidence bounds.

¹⁰ Navigant. 2016. *ComEd Home Energy Report Program Evaluation Report*. Presented to Commonwealth Edison Company.

Figure 7-2. PY9 Percent Savings and 90 Percent Confidence Interval by Wave

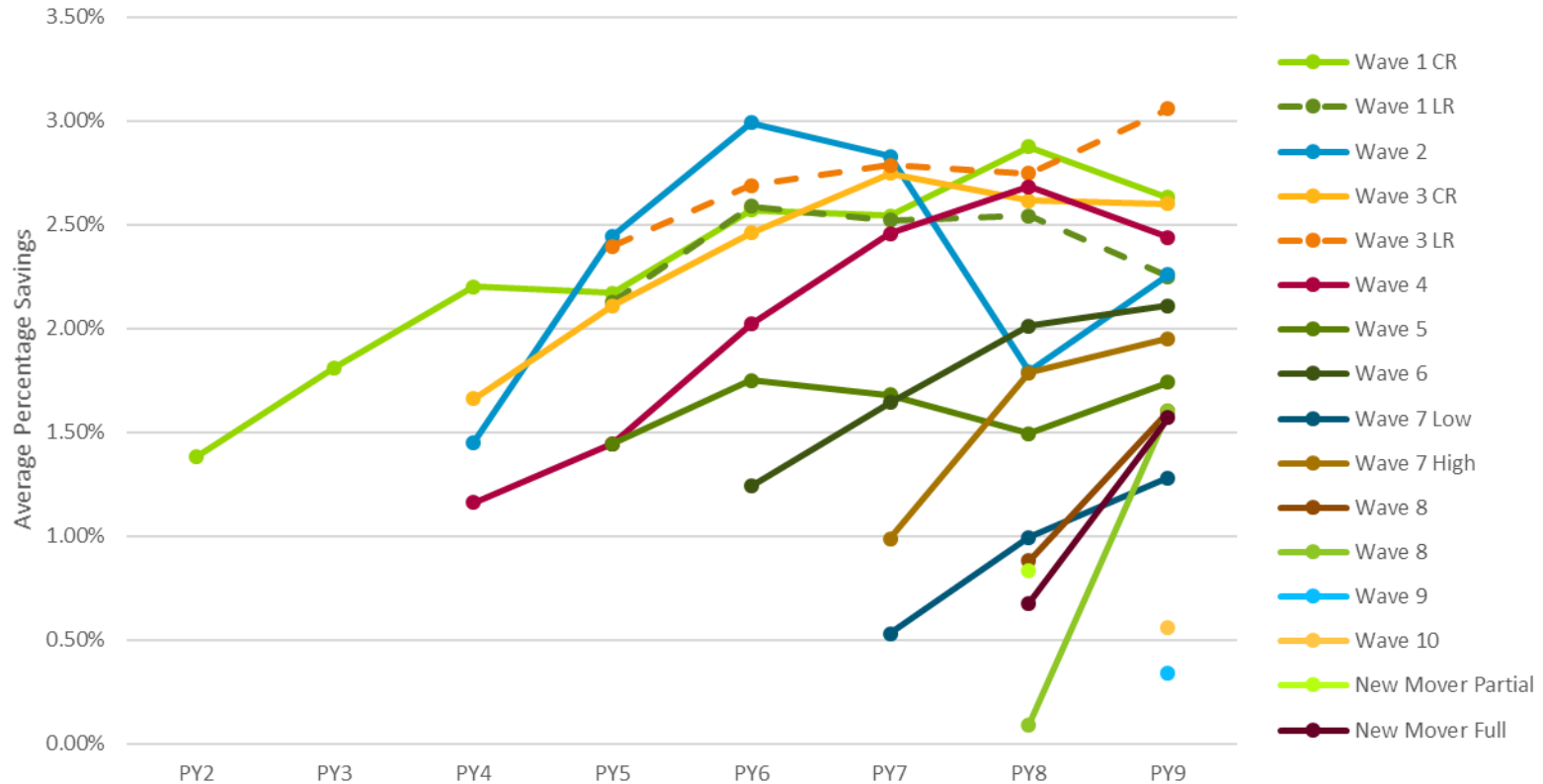


Source: ComEd data and Navigant team analysis.

Figure 7-3 combines PY9 results with those from previous evaluations to show how the estimated percentage savings have changed over program years for each wave. In general, wave savings show a consistent ramp-up from approximately 1 percent to between 2 and 3 percent over three to four years. Wave 7 Low continues to have lower-than-average savings, but that is likely due to its participants' relatively low usage. Based on program performance from the past several years, it is reasonable to expect Waves 9 and 10 to increase their savings rates, but perhaps not to the level of other waves with higher daily usage levels (e.g., Waves 1 and 3).

In PY8, the New Mover Wave was separated according to customers who received HERs for a full or partial year (New Mover Full and New Mover Partial, respectively). In the PY9 evaluation, these two subgroups were combined under the "New Mover Full" heading. As a result, New Mover Partial does not have a savings value for PY9 in Figure 7-3.

Figure 7-3. HER Program Savings over Time by Wave



Source: ComEd data and Navigant team analysis.

Tables with the regression outputs and detailed uplift results by wave are available upon request.

8. APPENDIX 3. TRC DETAIL

[To be added for the second draft.]