NAVIGANT

ComEd Home Energy Report Impact Evaluation Report

**Energy Efficiency / Demand Response Plan:
Program Year 2018 (CY2018)
(1/1/2018-12/31/2018)**

**Presented to
ComEd**

DRAFT

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TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

1. INTRODUCTION

This report presents the results of the impact evaluation of ComEd's CY2018 Home Energy Report (HER) Program. It presents a summary of the energy and demand impacts for the total program and broken out by relevant measure and program structure details. The appendix presents the impact analysis methodology. CY2018 covers January 1, 2018 through December 31, 2018.

2. PROGRAM DESCRIPTION

The HER Program is designed to generate energy savings by providing residential customers with information about energy use and conservation strategies. Program participants receive information in the form of regularly mailed and emailed home energy reports[1] 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

The program had 1,832,373 participants in CY2018 and 285,635 controls across 13 waves (Wave 7 has two components) as shown in Table 2-1. Participants and controls in the table represent active accounts at the beginning of CY2018.

Table 2-1. CY2018 Volumetric Findings Detail (in thousands)

Wave	Participants	Controls
Wave 1	23.8	27.6
Wave 2	1.9	1.9
Wave 3	129.5	33.7
Wave 4	14.4	14.5
Wave 5	4.6	6.0
Wave 6	66.4	20.1
Wave 7 Low	417.0	34.7
Wave 7 High	449.7	37.6
Wave 8	50.0	6.8
Wave 9	254.7	16.1
Wave 10	132.2	16.3
Wave 11	83.4	20.0
Wave 12	83.5	20.0
New Mover	121.4	30.4
Total	1,832.4	285.6

Source: ComEd tracking data and Navigant team analysis.

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[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.

3. PROGRAM SAVINGS DETAIL

Table 3-1 summarizes the incremental savings the HER Program achieved in CY2018. This program evaluation specifically focused on energy savings, and demand savings were not estimated. Additionally, since the randomized controlled trial (RCT) design inherently estimates net savings, neither the evaluation team nor the implementer estimated gross savings and there is no gross realization rate and no NTG ratio. The net realization rate, along with savings before and after the uplift adjustment,[2] are shown in Table 3-2.

Table 3-1. CY2018 Total Annual Incremental Electric Savings

Savings Category	Energy Savings (kWh)	Demand Savings (kW)	Summer Peak Demand Savings (kW)
Electricity			
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 (NTG)	NA	NA	NA
Verified Net Savings	279,539,772	NA	NA
Converted from Gas*			
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 (NTG)	NA	NA	NA
Verified Net Savings	NA	NA	NA
Total Electric Plus Gas			
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 (NTG)	NA	NA	NA
Verified Net Savings	279,539,772	NA	NA

Note: The coincident Summer Peak period is defined as 1:00-5:00 PM Central Prevailing Time on non-holiday weekdays, June through August. NA = Not Applicable
* Gas savings converted to kWh by multiplying therms * 29.31 (which is based on 100,000 Btu/therm and 3,412 Btu/kWh).
Source: ComEd tracking data and Navigant team analysis.

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[2] The uplift adjustment is made to account for participation in other ComEd energy efficiency programs. See Section 7.4 for a detailed explanation.

Table 3-2. CY2018 Total Program Net Electric Savings

Savings Category	Energy Savings (kWh)
Ex Ante Net Savings	292,635,765
Verified Net Savings, Prior to Uplift Adjustment	286,794,794
PY9 Uplift Adjustment	2,949,762
Legacy Uplift Adjustment	4,305,260
Final Verified Net Savings	279,539,772
Program Net Realization Rate*	96%

* 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 96%. The uplift adjustment resulted in a 3% change in the net savings, which is not accounted for in the implementer's savings estimate. The remaining 1% difference in the realization rate was likely due to small differences in the regression models used by the evaluation team and the implementer.

4. CUMULATIVE PERSISTING ANNUAL SAVINGS

The wave-specific and total verified gross and net savings for the HER Program and the cumulative persisting annual savings (CPAS) for reports mailed in CY2018 are shown in the following table and figure. The total CPAS across all waves is 279,539,772 kWh. Waves 3 and 7 remained the largest contributors to the overall savings, primarily due to the large number of participants enrolled, relative to other waves.

This evaluation did not assess gas savings and as such electric CPAS is equivalent to total CPAS. In addition, this type of analysis estimates net savings and no further net-to-gross (NTG) adjustment is necessary. Because of this, there is no NTG ratio and no gross savings estimate.

Table 4-1. Cumulative Persisting Annual Savings (CPAS) – Electric

End Use Type	Research Category	EUL	CY2018 Verified Gross Savings	NTG*	Lifetime Net Savings†	Verified Net kWh Savings								
						2018	2019	2020	2021	2022	2023	2024	2025	2026
Behavioral	Wave 1 CR	5.0	NA	NA	15,286,172	6,174,016	4,435,413	2,688,526	1,385,985	602,233	-	-	-	
Behavioral	Wave 1 LR	5.0	NA	NA	3,840,523	1,551,170	1,114,361	675,470	348,217	151,306	-	-	-	
Behavioral	Wave 2	5.0	NA	NA	1,106,228	446,801	320,982	194,563	100,301	43,582	-	-	-	
Behavioral	Wave 3 CR	5.0	NA	NA	126,738,254	51,189,009	36,774,184	22,290,672	11,491,254	4,993,135	-	-	-	
Behavioral	Wave 3 LR	5.0	NA	NA	7,987,615	3,226,162	2,317,675	1,404,858	724,231	314,690	-	-	-	
Behavioral	Wave 4	5.0	NA	NA	11,248,671	4,543,288	3,263,898	1,978,412	1,019,908	443,166	-	-	-	
Behavioral	Wave 5	5.0	NA	NA	4,890,010	1,975,053	1,418,878	860,053	443,373	192,653	-	-	-	
Behavioral	Wave 6	5.0	NA	NA	49,390,731	19,948,693	14,331,141	8,686,821	4,478,217	1,945,858	-	-	-	
Behavioral	Wave 7 Low	5.0	NA	NA	83,868,721	33,874,198	24,335,224	14,750,796	7,604,308	3,304,195	-	-	-	
Behavioral	Wave 7 High	5.0	NA	NA	221,192,707	89,338,737	64,180,948	38,903,282	20,055,362	8,714,378	-	-	-	
Behavioral	Wave 8	5.0	NA	NA	16,624,730	6,714,653	4,823,807	2,923,951	1,507,351	654,968	-	-	-	
Behavioral	Wave 9	5.0	NA	NA	45,792,717	18,495,472	13,287,147	8,054,004	4,151,988	1,804,106	-	-	-	
Behavioral	Wave 10	5.0	NA	NA	20,818,176	8,408,367	6,040,571	3,661,492	1,887,567	820,178	-	-	-	
Behavioral	Wave 11	5.0	NA	NA	27,745,846	11,206,422	8,050,694	4,879,928	2,515,693	1,093,109	-	-	-	
Behavioral	Wave 12	5.0	NA	NA	9,619,393	3,885,230	2,791,149	1,691,855	872,183	378,977	-	-	-	
Behavioral	New Mover	5.0	NA	NA	45,958,679	18,562,503	13,335,302	8,083,193	4,167,036	1,810,644	-	-	-	
CY2018 Program Total Electric CPAS			**NA**		692,109,172	279,539,772	200,821,372	121,727,875	62,752,974	27,267,179	-	-	-	-
CY2018 Program Expiring Electric Savings‡							78,718,400	157,811,897	216,786,798	252,272,593	279,539,772	279,539,772	279,539,772	279,539,772

Note: The green highlighted cell shows program total first year electric savings.
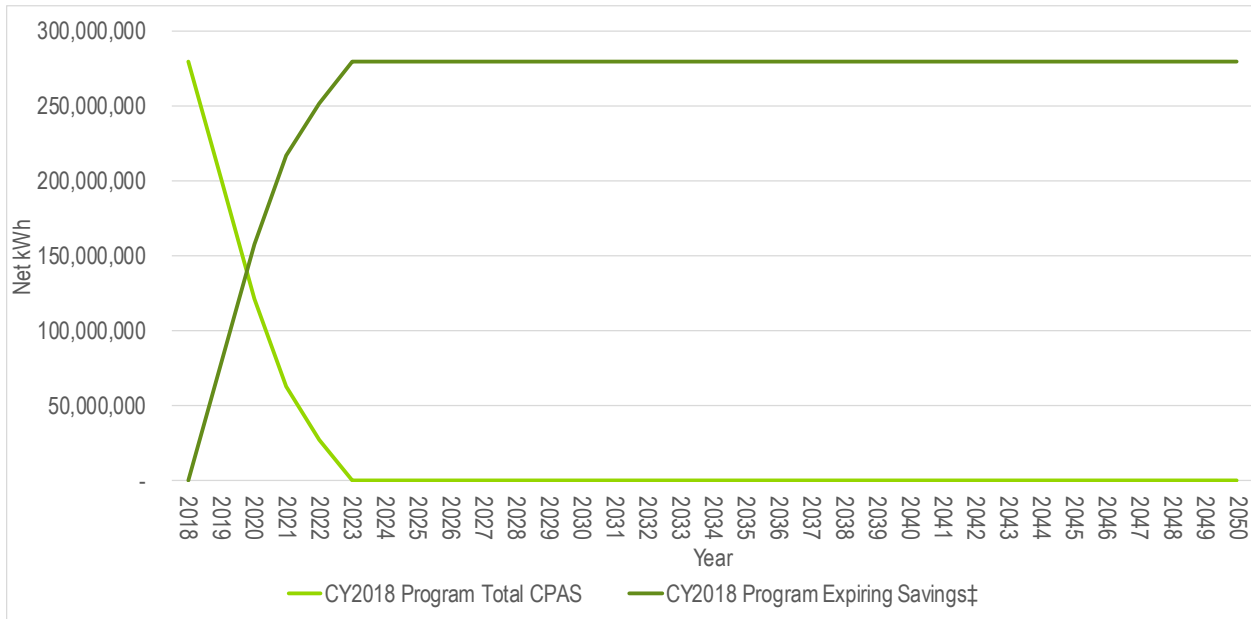
NA = Not Applicable

* The randomized controlled trial used for this evaluation produces net savings and as such the NTG ratio is not applicable.

† Lifetime savings are the sum of CPAS savings through the EUL.

‡ Expiring savings are equal to CPAS Yn-1 - CPAS Yn + Expiring Savings Yn-1.

Source: Navigant team analysis

Figure 4-1. Cumulative Persisting Annual Savings

‡ Expiring savings are equal to CPAS Yn-1 - CPAS Yn + Expiring Savings Yn-1.
Source: Navigant team analysis

5. PROGRAM SAVINGS BY MEASURE

The HER Program includes only one measure, behavioral savings, and so the program savings and measure savings are the same. Detailed savings by wave are presented in Section 8.

6. IMPACT ANALYSIS FINDINGS AND RECOMMENDATIONS

6.1 Impact Parameter Estimates

The HER Program does not have relevant impact parameters.

6.2 Other Impact Findings and Recommendations

The evaluation team developed recommendations based on findings from the CY2018 evaluation, as follows:

Finding 1. From PY9 to CY2018, the average program savings rate increased slightly (from 1.44 to 1.52%), despite savings from participants in Waves 11 and 12 (166,936 newly added customers) being lower than average. In fact, savings for Wave 12 participants were the lowest of all waves, at 0.52%. Average daily consumption for Wave 12 participants in the pre-period was among the lowest of all participating waves, which could be a contributing factor to the low percentage savings. However, increases in average percentage savings for several waves, in particular Waves 4, 5, and 9, helped negate the low average percentage savings in Waves 11 and 12.

Finding 2. With close to two million customers enrolled, ComEd's program has a broad reach and currently captures over half of ComEd's eligible customer base. The remaining customer

base is likely comprised of a disproportionate percent of customers with lower usage. Historically, customers with lower usage tend to deliver lower savings, both in absolute and relative percent terms.

Recommendation 1. ComEd and the implementer should consider the impact of expansions of the program on average customer savings and should continue to target the highest usage customers available.

Finding 3. The CPAS framework took effect in CY2018. Measure life for the program was revised from one to five years. Under the CPAS framework and the associated measure life, continued treatment of existing participants will result in reduced savings in the next five years to account for treatment persistence captured in lifetime savings from CY2018 interventions.

Recommendation 2. Given the CPAS framework, it is important for ComEd to adjust its program strategy to optimize program performance to balance both CPAS and the applicable annual incremental goal (AAIG). Such an approach will likely be multi-pronged and may include new customer enrollment, optimization of the high usage alerts, and discontinuing treatment for select existing waves. We understand that ComEd has been working closely with Oracle on a range of scenarios. Engaging the evaluation team in the discussions will be beneficial to ensure the evaluability of the program as well as the feasibility of the assumptions.

7. APPENDIX 1. IMPACT ANALYSIS METHODOLOGY

7.1 Graphs for New Wave RCT Checks

To test that the new CY2018 waves (Waves 11 and 12) are consistent with a RCT, the evaluation team 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 the twelve months prior to receiving the program intervention. The evaluation team 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, the evaluation team 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 which showed participation did not impact usage.

Figure 7-1 and Figure 7-2 illustrate control group and report recipient group usage during the twelve-month pre-period for Waves 11 and 12. These graphs illustrate what the evaluation team's statistical analysis confirmed, namely that the assignment of customers into the treatment and control groups was consistent with randomization.

Figure 7-1. RCT Usage Comparison for Wave 11

Source: ComEd data and Navigant team analysis.

Figure 7-2. RCT Usage Comparison for Wave 12

Source: ComEd data and Navigant team analysis.

7.2 Detailed Data Cleaning

The evaluation team removed customers and data points from the analysis in several steps:

- Observations outside CY2018 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, these cleaning steps removed 0.9% of customers and 4.1% of observations,[3] evenly distributed across participants and controls. This suggests that non-random biases were not introduced into the data by the evaluation team's cleaning steps.

7.3 Detailed Impact Methodology

The evaluation team used lagged dependent variable (LDV) and linear fixed effects regression (LFER) models to estimate program savings. The evaluation team used the LDV results for reporting CY2018 total program savings.[4] The following sections present the specifications for each model.

7.3.1 Lagged Dependent Variable Model

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 7-1.

Equation 7-1. 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
$Month_{jt}$	is a binary variable taking a value of 1 when j = t and 0 otherwise[5]
$ADUlag_{kt}$	is household *k*'s energy use in the same calendar month of the pre-program year as the calendar month of month *t*
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.

The coefficient β₁ is the estimate of average daily kWh energy savings due to the program.

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[3] The New Mover Wave dropped more observations than the other waves (60%) because they were more frequently missing pre-period usage.

[4] Across the two models, the parameter estimates were not statistically different; that is, the estimates for each model are within the 90% 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.

[5] 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.

7.3.2 Linear Fixed Effects Regression Model

The LFER model used by the evaluation team 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 7-2.

Equation 7-2. 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-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.

7.3.3 Weather Normalization

Version 6.0 of the IL Technical Reference Manual (TRM) recommends that evaluators consider normalizing energy savings by weather to achieve "typical year savings", or average savings for a standard weather year, as part of their custom savings calculation. Such normalization can be important when estimating CPAS savings for the program, as it controls for the confounding effects of differences in weather in future years. The evaluation team gave careful consideration to using weather normalization and chose not to weather normalize savings in CY2018. The key reason behind the decision is the appropriateness of the most recent weather collection (Typical Meteorological Year 3 or TMY3). TMY3 data uses weather data from 1,020 weather stations collected from 1991 to 2005. The variation in weather during that time frame is likely different than the future expectations, given the effects of climate change. As such, weather normalization may produce a biased estimate, likely toward lower savings. Additionally, the evaluation team conducted a weather normalization assessment in 2018 that found limited model sensitivity to weather terms, which suggests a limited impact of applying weather normals when estimating the energy impacts from the program.

7.4 Accounting for Uplift in Other Energy Efficiency Programs

7.4.1 Accounting for Uplift in CY2018

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, the evaluation team 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 CY2018 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 CY2018 is 5% for the treatment group and 3% for the control group, and the rate of participation during the year before the start of the HER Program is 2% for the treatment group and 1% for the control group, then the rate of uplift due to the HER Program is 1%, as reflected in Equation 7-3.

<div align="center">

Equation 7-3. DID Statistic Calculation

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$$(CY2018\ treatment\ group\ participation - prePY\ treatment\ group\ participation)$$
$$- (CY2018\ control\ group\ participation - prePY\ control\ group\ participation)$$
$$= DID\ statistic$$
$$(5\% - 2\%) - (3\% - 1\%) = 1\%$$

The DID statistic generates an unbiased estimate of uplift when the baseline average rate of participation is the same for the treatment and 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 CY2018. 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. The evaluation team uses this alternative statistic in cases where the EE program did not exist in the pre-program year.

In CY2018 the evaluation team examined the uplift associated with the following EE programs[7]:
- Fridge Freezer Recycling (FFR) Program. This program achieves energy savings through retirement and recycling of older, inefficient refrigerators, freezers, and room air conditioners.
- Home Energy Assessments (HEA) Program. This 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 LEDs, low-flow showerheads, faucet aerators, programmable thermostats and smart thermostats.
- Single Family Retrofits Program: This program achieves energy savings through offering a range of weatherization improvements, including window and door weatherization, heating system replacements, and electric baseload reduction. The program is offered through two components, one implemented by Franklin Energy Services with the Chicago Bungalow Association (CBA) and one implemented by Resource Innovations leveraging the Illinois Home Weatherization Assistance Program (IHWAP).
- Multi-family Retrofits Program. This program includes free home energy upgrades and weatherization improvements for qualifying multi-family properties. The program is offered through two components, one implemented by Elevate Energy and one implemented by Resource Innovations leveraging IHWAP.

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[6] It is not possible to estimate and remove double counted savings generated by programs for which tracking data are not available, such as upstream lighting programs.
[7] ComEd has other residential programs that were not included in the analysis. The Appliance Rebate, Elementary Education, Lighting Discounts, Middle School Take-Home Kits, Food Bank LED Distribution, and Low Income Kits 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 Affordable Housing New Construction Programs and HER is not possible due to the requirement that HER participants have sufficient historical usage data.

- Weatherization (Wx) Rebates Program. This program is offered jointly with the local gas utilities and achieves savings by providing incentives for insulation and air sealing improvements for non-income-qualified customers.
- Heating and Cooling (HVAC) Rebates Program. This program offers incentives to residential customers to encourage customer purchases of higher efficiency heating, ventilating, and air conditioning (HVAC) equipment.

For each EE program, double counted savings were calculated separately for each wave of the HER Program and for the lapsed report (LR) subgroup in Waves 1 and 3. Because of pre-period data not being available for Single Family Retrofit, Multi-family Retrofit, Wx, and HVAC programs, we relied on the POD statistic to determine uplift. For all other programs, we used the DID statistic.

7.4.2 Accounting for Legacy Uplift

The uplift adjustment methodology described in Section 7.4.1 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.[8] 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 CY2019 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 7.4.1 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.

The evaluation team accounts for legacy uplift by subtracting the double counted savings from previous years, adjusted for the average annual move out rate,[9] from CY2018 HER savings through the measure lives of measures from other EE programs. The legacy uplift adjustment is shown in Equation 7-4.

Equation 7-4. Legacy Uplift Calculation

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

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. Notably, to streamline the analysis, instead of using individual measure lives in developing legacy uplift savings, and subsequently removing measures one-by-one once they reach the end of their effective useful live, the evaluation team calculated effective useful lives at the program level by weighting measure-specific effective useful lives by savings. Once the program reaches its weighted average measure life, it is removed from the legacy uplift calculation.

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[8] Tracking data files are set-up this way because, in conformity with the IL TRM Section 3.2, savings are first-year savings, not lifetime savings.

[9] 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.

The legacy uplift adjustment goes back to PY4 when the evaluation team first considered uplift for the HER Program. In PY4, the evaluation team considered double counted savings for the Fridge Freezer Recycle Rewards (FFRR), the Central Air Conditioning Efficiency Services (CACES),[10] and the Single Family Home Performance (SFHP) programs. In PY5, the evaluation team considered double counted savings for the FFRR, the Complete System Replacement (CSR), Clothes Washer Rebate (CW), Multi-Family Home Energy Savings (MF), and Single Family Home Energy Savings (SFHES) programs. The same programs were considered in PY6, except for the CW Program which was discontinued. In PY7, PY8, and PY9 the evaluation team considered legacy uplift savings for the Multi-family Energy Savings Program (MESP), and the HEA, HVAC and Weatherization, and FFR programs.

7.5 Accounting for Savings Persistence and Participant Retention

Continued implementation of HER programs in Illinois and across the country has demonstrated persistence of savings beyond the first year leading Illinois to adopt a measure decay framework in Version 6.0 of the IL TRM. This framework assumes that savings persist over five years but the persistence decays in each year. The TRM recommends using the persistence factors presented in Table 7-1 over the five-year life to estimate lifetime electric energy savings for the program.

Table 7-1. HER Electric Savings Persistence Factors

Year	Electric Persistence Factor
Year 1 (program year under evaluation)	100%
Year 2	80%
Year 3	54%
Year 4	31%
Year 5	15%

Source: IL TRM, Measure 6.1.1, Volume 4, Version 6.0

In addition to applying persistence rate factors, lifetime savings need to account for customer attrition over time due to move-outs and account closures.[11] Based on the observations evaluating ComEd's HER Program, as well as other EE programs in Illinois and across the country, the evaluation team concludes that multiple factors can drive attrition:

- Macroeconomic factors – economic downturns or upturns can drive customer mobility in a given year resulting in account closures
- Sociodemographic characteristics – household income levels, home ownership status, and home type are among key characteristics likely to drive differences in the attrition rate within each customer segment
- Length of customer participation in the HER Program – attrition is generally higher in the first year upon program launch and decreases over time

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[10] Due to the expiring weighted average measure life, legacy savings from the PY4 CASES program are no longer considered in the CY2018 legacy uplift.

[11] It is possible that some savings resulting from HER program interventions persist after customers move out as either (a) energy efficient improvements to the residence that continue to deliver savings or (b) habituated energy conservation behaviors that customers continue to exercise at their new residence (as long as that residence is within a utility's service territory). As of this time, no definitive data exists to estimate the extent to which either of these two scenarios occurs. Version 6.0 of the IL TRM therefore assumes no persisting savings upon customer move-out, though it encourages additional research on the matter.

To best balance these competing priorities in the prospective retention rate estimate, the evaluation team chose to develop a prospective retention rate for the program by developing a weighted average rate across all program waves, except for the New Mover Wave,[12] for the last five years. Using customers across all program waves allowed us to capture the various customer segments (e.g., high users, low users, etc.) that can have differing attrition due to move out or other reasons in the estimate. Using a five-year period allowed for a balance between capturing the general decrease in attrition over time, which is important to consider for existing participants, and possible economic changes affecting customer transiency, which is important from a forward-looking perspective.

To calculate the retention rate using this approach, we specified a simple linear regression, shown in Equation 7-5, to calculate a change in retention after each month of program treatment.

Equation 7-5. Prospective Retention Rate Regression Model

$$Retention\ Rate_{it} = \alpha_i + \beta_1 Months\ Treated_{it}$$

Where:

Retention Rate_{it}	is the retention rate for wave *i* in program year *t*
α_i	is the model intercept
β_1	is the model coefficient of interest
Months Treated_{it}	is the number of treated months for wave *i* in program year *t*

The model intercept (α_i) represents the average weighted retention rate at the start of each wave, and the regression coefficient represents the increase in the retention rate for each additional treatment month. We then calculated the overall participant weighted treatment months from the last five years and included it in the regression output to calculate the overall weighted average retention rate. Table 7-2 below summarizes key outputs from the analysis. As can be seen in the table, the weighted average retention rate is 89.8%. We used this rate as a multiplier when estimating lifetime savings from the HER Program.

Table 7-2. Prospective Retention Rate

Output Type	Value
Regression Model Intercept	86.3%
Regression Model Coefficient	0.13%
Weighted Average Treatment Months	38
Weighted Average Retention Rate	89.8%

Source: ComEd data and Navigant team analysis

8. APPENDIX 2. IMPACT ANALYSIS DETAIL

This appendix presents savings by wave and aggregated uplift analysis results. Tables with the regression outputs and detailed uplift results by wave are available upon request.

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[12] We excluded the New Mover wave participants because the continuous enrollment of customers into that wave over time could result in a year-over-year retention rate exceeding 100%.

8.1 Savings by Wave

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 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 8-1 summarizes estimated program savings by participant wave. In CY2018, savings were attributed to 1,832,373 treatment customers. The evaluation team estimated separate savings for each wave and wave subgroup using regression analysis as described in Section 7.3.

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Table 8-1. CY2018 HER Program Results by Wave

Wave	Treatment Customer Count*	Control Customer Count*	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.	2018 Uplift, kWh‡	Legacy Uplift, kWh‡	Verified Net Savings, kWh§
Wave 1 CR	18,135	27,635	2.57%	0.30%	363	42	6,420,734	750,581	46,132	200,586	6,174,016
Wave 1 LR	5,615		2.24%	0.30%	316	43	1,732,096	232,681	35,793	145,134	1,551,170
Wave 2	1,874	1,901	1.93%	1.10%	257	148	471,294	270,317	18,433	6,061	446,801
Wave 3 CR	122,873	33,739	2.49%	0.19%	438	33	52,479,889	3,905,341	478,329	812,552	51,189,009
Wave 3 LR	6,651		2.91%	0.19%	511	33	3,309,684	210,899	25,951	57,571	3,226,162
Wave 4	14,355	14,470	2.79%	0.33%	328	39	4,590,227	549,978	10,122	36,817	4,543,288
Wave 5	4,589	5,981	2.19%	0.65%	462	137	2,050,300	607,419	4,714	70,532	1,975,053
Wave 6	66,358	20,078	2.02%	0.24%	316	38	20,354,524	2,434,437	224,613	181,218	19,948,693
Wave 7 Low	417,011	34,745	1.29%	0.17%	85	11	34,238,102	4,556,947	221,551	142,353	33,874,198
Wave 7 High	449,699	37,571	2.06%	0.11%	210	11	91,665,781	4,944,257	872,943	1,454,102	89,338,737
Wave 8	50,018	6,766	1.19%	0.42%	145	51	6,864,963	2,410,649	30,071	120,238	6,714,653
Wave 9	254,675	16,081	0.92%	0.23%	81	20	19,337,995	4,830,125	279,923	562,601	18,495,472
Wave 10	132,220	16,263	0.88%	0.26%	74	22	8,939,118	2,647,943	289,526	241,225	8,408,367
Wave 11	83,449	19,990	1.20%	0.22%	154	29	11,369,326	2,130,106	162,904	-	11,206,422
Wave 12	83,487	19,995	0.52%	0.28%	51	28	3,955,918	2,154,184	70,688	-	3,885,230
New Mover	121,364	30,420	1.57%	0.32%	171	34	19,014,843	3,827,200	178,070	274,270	18,562,503
Total	1,832,373	285,635	1.52%	-	163	-	286,794,794	36,463,064	2,949,762	4,305,260	279,539,772

* These counts are for active customers at the beginning of CY2018.
† Total savings are pro-rated for participants that closed their accounts during CY2018.
‡ 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 CY2018 Uplift and Legacy Uplift.
Source: ComEd data and Navigant team analysis.

Figure 8-1 shows energy savings for each wave with 90% confidence intervals overlaid on average pre-period daily electricity usage for each wave. Waves with larger confidence bounds generally had smaller sample sizes, which reduced the level of certainty in the savings results. For example, Wave 2 had a sample size of 1,874 participants and 1,901 controls and large confidence bounds compared to the other waves, while Wave 7 Low had 417,011 participants and 34,745 controls and small confidence bounds compared to the other waves. Notably, all of the waves had statistically significant savings at the 90% confidence level.

Average pre-period daily electricity usage varied widely across waves. Wave 7 Low had the lowest average usage at 18 kWh per day, while Wave 5 had the highest at 61 kWh per day. Previous evaluations[13] have identified that higher usage is often associated with greater HER Program savings. Overlaying average pre-period daily usage with savings for each wave confirms that association. There is a strong positive correlation between pre-period usage and savings (0.744), indicating that energy savings increase with energy usage.

**Figure 8-1. Savings and Pre-Period Usage by Wave**
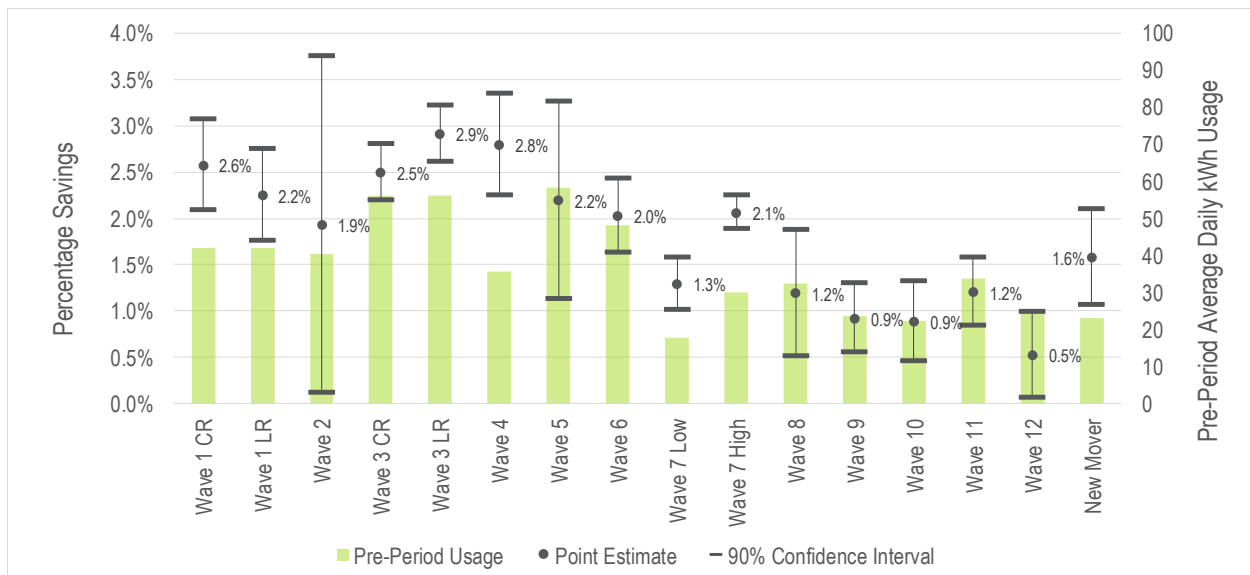
Source: ComEd data and Navigant team analysis.

Figure 8-2 combines CY2018 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 in the first couple to a few years post-enrollment. After that savings tend to either plateau, decrease, or fluctuate from year to year.

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[13] Navigant. 2016. *ComEd Home Energy Report Program Evaluation Report.* Presented to Commonwealth Edison Company.

Figure 8-2. HER Program Savings over Time by Wave
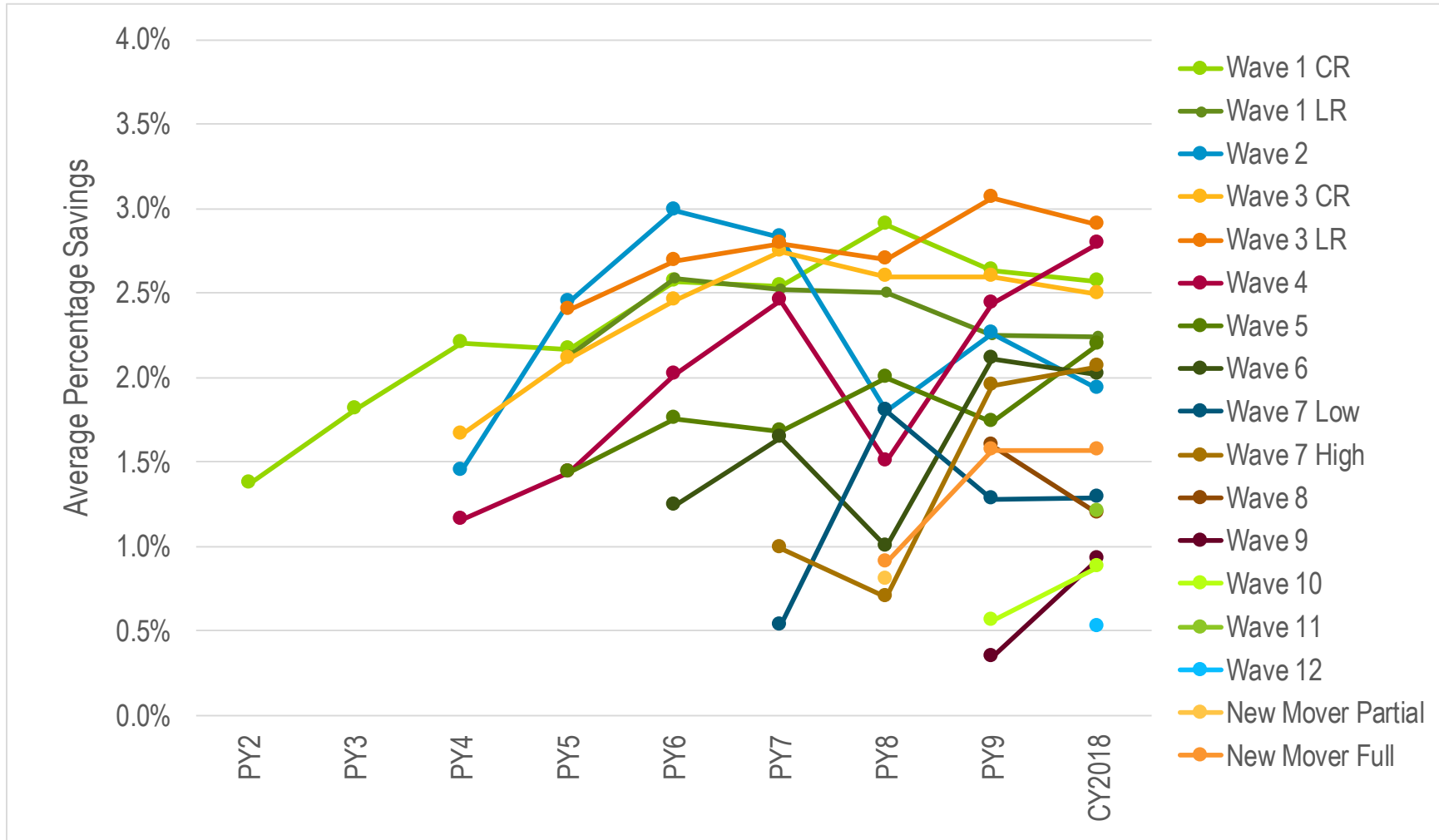
Note: In PY8, the New Mover Wave was separated according to customers who received HERs for a full or partial year (New Mover Full and New Mover Partial, respectively). In the PY9 and CY2018 evaluations, these two subgroups were combined under the "New Mover Full" heading. As a result, New Mover Partial does not have a savings value for PY9 or CY2018.
Source: ComEd data and Navigant team analysis.

8.2 Uplift Analysis Results

The uplift of savings in other EE programs was a very small proportion of the total savings: 7,255,022 kWh, or approximately 3%. The uplift can be broken down into uplift in CY2018 and legacy uplift from previous program years. The CY2018 uplift was 2,949,762 kWh or 1% of total program savings and the legacy uplift was 4,305,260 kWh or 2% of total program savings.[14] 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.

9. APPENDIX 3. TOTAL RESOURCE COST DETAIL

Table 9-1, below, shows the Total Resource Cost (TRC) table. It includes only the cost-effectiveness analysis inputs available at the time of finalizing this impact evaluation report. Additional required cost data (e.g., measure costs, program level incentive and non-incentive costs) are not included in this table and will be provided to evaluation later.

Table 9-1. Total Resource Cost Savings Summary

End Use Type	Research Category	Units	Quantity	Effective Useful Life	Ex Ante Gross Savings (kWh)*	Ex Ante Gross Peak Demand Reduction (kW)	Verified Gross Savings (kWh)*	Verified Gross Peak Demand Reduction (kW)
Behavioral	All Waves	Household	1,832,373	5	292,635,765	NA	279,539,772	NA

NA = Not Applicable
* Due to the design of the program, this evaluation inherently estimates net savings which are listed here.
Source: ComEd tracking data and Navigant team analysis.

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[14] 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 the program year. It is more likely that participation varies across the year and not all of the first year program savings are captured by the HER analysis.