Guidehouse

ComEd Residential Behavior Impact Evaluation Report

Energy Efficiency / Demand Response Plan: Program Year 2020 (CY2020) (1/1/2020-12/31/2020)

Prepared for:

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1. Introduction

This report presents results from the CY2020 impact evaluation of ComEd's Residential Behavior Program.[1] It summarizes the total energy and demand impacts for the program broken out by relevant measure and program structure details. Based on guidance from the Illinois Stakeholder Advisory Group (SAG), Guidehouse normalized CY2020 program savings for the coronavirus pandemic.[2] The appendices provide the impact analysis methodology and details of the total resource cost (TRC) inputs. CY2020 covers January 1, 2020 through December 31, 2020.

2. Program Description

The Residential Behavior Program is designed to generate energy savings by providing residential customers with information about energy use and conservation strategies. Program participants receive information from regularly mailed and emailed home energy reports,[3] 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 1,922,170 participants in CY2020 and 252,134 controls across 13 waves (Wave 7 has two components) as Table 2-1 shows. Wave 13 was new in CY2020. The implementer stopped treatment of Wave 3 through the program at the end of CY2018 and did not resume its treatment in CY2020. As such, the evaluation team did not evaluate Wave 3 in CY2020. Participants and controls in the table represent active accounts at the beginning of CY2020.

[1] Note that this program is also referred to as the Home Energy Report (HER) Program.

[2] This decision is documented in meeting notes from the June 11 and August 24, 2020 SAG meetings (available at https://www.ilsag.info/events/list).

[3] 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, the implementer sent monthly electronic reports to treatment customers with email addresses on file.

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Table 2-1. CY2020 Volumetric Findings Detail (In Thousands)

Wave	Participants	Controls
Wave 1	21.4	24.9
Wave 2	1.7	1.7
Wave 4	13.0	13.1
Wave 5	4.0	5.2
Wave 6	58.7	17.7
Wave 7 Low	357.5	29.7
Wave 7 High	395.8	33.0
Wave 8	40.2	5.4
Wave 9	200.2	12.6
Wave 10	92.5	11.5
Wave 11	51.4	12.2
Wave 12	57.3	13.7
Wave 13	541.6	49.6
New Mover Wave	86.9	21.7

Source: ComEd tracking data and evaluation team analysis

Due to the pandemic, the implementer modified program reports to focus on low cost and no cost energy efficiency tips. Cross-promotion of other ComEd energy efficiency programs in the reports was also limited in CY2020.

3. Program Savings Detail

Table 3-1 summarizes the incremental savings the Residential Behavior Program achieved in CY2020. The savings values in the table represent savings normalized for the effects of COVID-19 using an approach agreed upon by Guidehouse, ComEd, and the implementer, which leverages historical savings trends. These savings reflect adjustments for uplift, as well as CY2018 and CY2019 persisting savings under the cumulative persisting annual savings (CPAS) framework. This program evaluation specifically focused on energy savings. Demand savings were calculated using a conversion formula and inputs specified in the Illinois Statewide Technical Reference Manual (TRM v8.0). Additionally, since the randomized control 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 net-to-gross (NTG) ratio.

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Table 3-1. CY2020 Total Annual Incremental Electric Savings

Savings Category	Energy Savings (kWh)	Summer Peak* Demand Savings (kW)
Electricity		
Ex Ante Gross Savings	NA	NA
Program Gross Realization Rate	NA	NA
Verified Gross Savings	NA	NA
Program Net-to-Gross Ratio (NTG)	NA	NA
Verified Net Savings	79,014,639	13,638
Converted from Gas†		
Ex Ante Gross Savings	NA	NA
Program Gross Realization Rate	NA	NA
Verified Gross Savings	NA	NA
Program Net-to-Gross Ratio (NTG)	NA	NA
Verified Net Savings	NA	NA
Total Electric Plus Gas		
Ex Ante Gross Savings	NA	NA
Program Gross Realization Rate	NA	NA
Verified Gross Savings	NA	NA
Program Net-to-Gross Ratio (NTG)	NA	NA
Verified Net Savings	79,014,639	13,638

NA = not applicable (refers to a piece of data that cannot be produced or does not apply).
* The evaluation did not estimate coincident summer peak demand savings for this program.
† The evaluation did not estimate gas savings for this program.
Source: ComEd tracking data and evaluation team analysis

Table 3-2 provides verified normalized savings adjusted for uplift, CPAS adjustments, and final verified net savings, and compares the latter to ex ante net savings provided by the implementer. CY2020 savings, after accounting for uplift but before subtracting persisting savings, are 218,705,640 kWh.[4] These savings were developed using historical program savings and uplift data, as opposed to actual savings occurring in CY2020, and reflect program attributable energy savings normalized for COVID-19-related impacts. In CY2018 and CY2019, the program claimed 139,691,001 kWh for CY2020 as part of the CPAS and decay framework. These savings need to be subtracted from the CY2020 savings of 218,705,640 kWh, resulting in final verified net savings of 79,014,639 kWh this program year. The evaluation team calculated a program realization rate of 1.27 compared to the savings estimated by the implementer.

Part of the difference in savings is driven by the implementer's ex ante value representing actual, rather than normalized, savings. Comparing normalized savings gives a realization rate of 1.15 rather than 1.27. The remaining difference seems to be driven by differences in the way the implementer and the evaluation team calculate persistence, particularly in the calculation of retention rates. The implementer and the evaluation team will be working together to reconcile these discrepancies for the CY2021 evaluation.

[4] Note uplift (both current year and legacy) is inherently accounted for in the normalization method described in Section 7.1.

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Table 3-2. CY2020 Total Program Net Electric Savings

Savings Category	Energy Savings (kWh)
Ex Ante Net Savings*	62,409,000
Verified Unadjusted Net Savings	218,705,640
Persistence Adjustment	139,691,001
Final Verified Net Savings	79,014,639
Program Net Realization Rate**	1.27

* Note that this value represents ex ante savings prior normalization for COVID-19. Normalized ex ante savings equal 68,928,140 and result in a net realization rate of 115%.

** This value is after the uplift adjustment.

Source: ComEd tracking data and evaluation team analysis

4. Cumulative Persisting Annual Savings

Table 4-1 show the wave-specific and total verified net savings for the Residential Behavior Program and the cumulative persisting annual savings (CPAS) for the home energy reports sent to treatment customers in CY2020. Figure 4-1 shows the savings across the useful life of the Program. The electric CPAS across all waves in CY2020 is 79,014,639 kWh (Table 4-1). The historic rows in the table are the CPAS contributions back to CY2018. The Program Total Electric CPAS row is the sum of the CY2020 contribution and the historic contribution.

There are several items worth noting related to CPAS:

- The historic program total electric contribution to CPAS is inclusive of Wave 3, which ComEd dropped from the program after CY2018. The historic contribution excluding that wave is 137,725,639 kWh.

- Coming from the CY2018 and CY2019 evaluations, the evaluation team adjusted the historic program total electric contribution to CPAS for CY2020 using a prospective retention rate of 90%. When calculating the persistence adjustment for CY2020, we relied on the retrospective retention rate[5] as opposed to the prospective retention rate to develop an estimate of savings attributed to prior years, as TRM v8.0 prescribes. This switch from the prospective retention rate to the retrospective retention rate resulted in 1,965,361 kWh of savings unclaimed as part of the historic program total electric contribution to CPAS or CY2020 verified net savings (i.e., the persisting savings attributed to CY2018 and CY2019 in the CY2020 evaluation is 1,965,361 kWh higher than the CPAS claimed for CY2020 from the CY2018 and CY2019 evaluations).

The evaluation team did not assess gas savings for this program and as such electric CPAS is equivalent to total CPAS. In addition, this analysis estimates net savings and no further NTG adjustment is necessary. Because of this, there is no NTG ratio and no gross savings estimate.

[5] We calculated retrospective retention rate for each wave and applied it to each wave's savings as part of the analysis. The retrospective retention rates range from 82% to 96% across the waves. Table 8-1 includes these percentages.

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Table 4-1. CPAS - Electric

End Use Type	Research Category	EUL	CY2020 Verified Gross Savings (kWh)	NTG*	Lifetime Net Savings (kWh)†	Verified Net kWh Savings 2018	2019	2020	2021	2022	2023	2024	2025	2026
Behavioral	Wave 1 CR	5.0	NA	NA	6,092,395			2,454,824	1,767,473	1,073,740	554,766	241,592		
Behavioral	Wave 1 LR	5.0	NA	NA	1,502,137			605,260	435,787	264,741	136,783	59,567		
Behavioral	Wave 2	5.0	NA	NA	380,443			153,293	110,371	67,050	34,643	15,086		
Behavioral	Wave 4	5.0	NA	NA	3,916,428			1,578,056	1,136,200	690,242	356,625	155,304		
Behavioral	Wave 5	5.0	NA	NA	1,591,435			641,241	461,694	280,479	144,914	63,108		
Behavioral	Wave 6	5.0	NA	NA	15,215,452			6,130,801	4,414,176	2,681,612	1,385,500	603,363		
Behavioral	Wave 7 Low	5.0	NA	NA	27,806,399			11,204,103	8,066,954	4,900,675	2,532,015	1,102,652		
Behavioral	Wave 7 High	5.0	NA	NA	58,308,651			23,494,453	16,916,006	10,276,474	5,309,511	2,312,207		
Behavioral	Wave 8	5.0	NA	NA	3,830,382			1,543,386	1,111,238	675,077	348,790	151,892		
Behavioral	Wave 9	5.0	NA	NA	12,838,099			5,172,888	3,724,479	2,262,621	1,169,021	509,090		
Behavioral	Wave 10	5.0	NA	NA	5,378,427			2,167,143	1,560,343	947,908	489,753	213,279		
Behavioral	Wave 11	5.0	NA	NA	5,406,385			2,178,409	1,568,454	952,836	492,299	214,388		
Behavioral	Wave 12	5.0	NA	NA	3,756,213			1,513,501	1,089,720	662,005	342,036	148,951		
Behavioral	Wave 13	5.0	NA	NA	41,325,316			16,651,315	11,988,947	7,283,285	3,763,031	1,638,739		
Behavioral	New Mover	5.0	NA	NA	8,750,763			3,525,967	2,538,696	1,542,258	796,833	347,008		
CY2020 Program Total Electric Contribution to CPAS			-		196,098,926			79,014,639	56,890,540	34,561,003	17,856,518	7,776,226	-	-
Historic Program Total Electric Contribution to CPAS‡						279,539,772	255,950,948	161,421,169	86,866,650	39,725,912	5,425,577			
Program Total Electric CPAS						279,539,772	255,950,948	240,435,808	143,757,190	74,286,915	23,282,095	7,776,226	-	-
CY2020 Program Incremental Expiring Electric Savings§									22,124,099	22,329,537	16,704,485	10,080,293	7,776,226	-
Historic Program Incremental Expiring Electric Savings‡§								94,529,779	74,554,519	47,140,738	34,300,335	5,425,577	-	-
Program Total Incremental Expiring Electric Savings§								94,529,779	96,678,618	69,470,275	51,004,820	15,505,870	7,776,226	-

Note: The green highlighted cell shows program total first year electric savings. The gray cells are blank, indicating values irrelevant to the CY2020 contribution to CPAS.
NA = Not applicable (refers to a piece of data that cannot be produced or does not apply)
* The randomized controlled trial used for this evaluation produces net savings and so the NTG ratio is not applicable. Source: is found on the Illinois SAG website: https://www.ilsag.info/ntg_2020.
† Lifetime savings are the sum of CPAS savings through the EUL.
‡ Historical savings go back to CY2018.
§ Incremental expiring savings are equal to CPAS Y_{n-1} - CPAS Y_{n}.
Source: Evaluation team analysis

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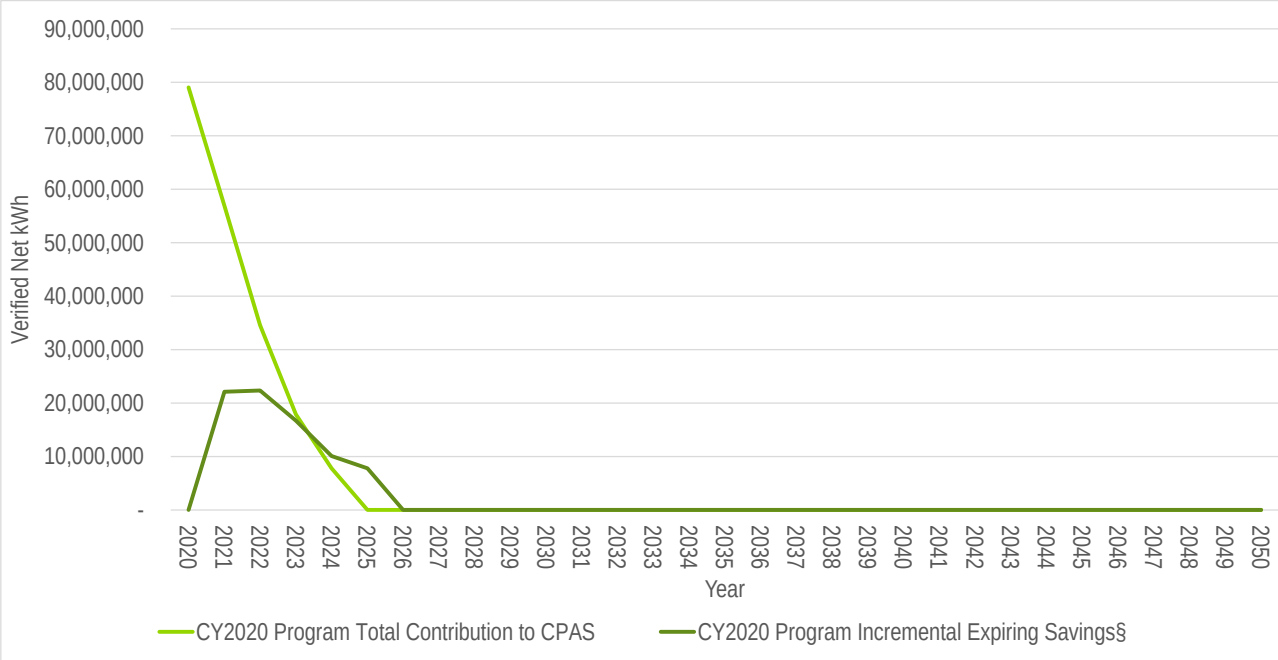
Figure 4-1. Cumulative Persisting Annual Savings



§ Expiring savings are equal to CPAS Y_{n-1} - CPAS Y_n.

Source: Evaluation team analysis

5. Program Savings by Measure

The Residential Behavior 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 Appendix B.

6. Impact Analysis Findings and Recommendations

6.1 Impact Parameter Estimates

The Residential Behavior Program does not have relevant impact parameters.

6.2 Other Impact Findings and Recommendations

The evaluation team developed several recommendations based on findings from the CY2020 evaluation.

Finding 1. CY2020 marked the third year since the CPAS framework took effect. At the same time 3 years ago, the program measure life was revised from 1 to 5 years with savings decay in the TRM associated with each year. Continuous treatment of customers required adjustment of the current year's savings for the persisting savings claimed as part of the previous years' impacts. In CY2020, the evaluation team reduced total savings by 64% to account for persisting savings from CY2018 and CY2019 interventions.

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Finding 2. The pandemic overshadowed CY2020, which led to stay at home orders, social distancing, and sustained work-from-home behaviors from March and through much of 2020. Program verified net savings in CY2020 were normalized to adjust for the effects of the pandemic using historical savings data. Alongside normalized savings, the evaluation team modeled actual savings from CY2020 to offer a point of comparison. Normalized savings were on average 2% higher than actual savings when adjusted for uplift and 6% higher when adjusted for persisting savings along with uplift. Differences in normalized and actual savings within each wave varied considerably. Should pandemic-induced behaviors persist and translate into the new normal, misalignment of persisting normalized savings with actual customer behaviors can result in steeper than warranted reductions in future years' verified savings, presenting a source of uncertainty and risk for the program. Wave-specific deeper variability between normalized and actual savings may even result in negative claimable savings for individual waves.

Recommendation 1. ComEd and the implementer should monitor future longer-term market trends and customer behaviors caused by the pandemic to assess and anticipate risk associated with savings claims.

Finding 3. The program treated population was expanded significantly in CY2020 by adding a new wave (Wave 13) of 541,551 treatment customers. With nearly 2 million customers enrolled, ComEd's program represents over two-thirds of ComEd's residential customer base. Average energy consumption of the newly enrolled Wave 13 customers is considerably lower than that of most other waves at 18.3 kWh per day. Lower energy consumption is correlated with lower energy savings, both in absolute and relative terms, which is evidenced in Wave 13 having much lower per-participant savings than most other waves (0.09 normalized kWh per day versus 0.22 for the next lowest wave). Continued treatment generally leads to an increase in savings over time.

Recommendation 2. ComEd and the implementer should continue balancing continued treatment of existing customers to deliver incremental savings under the CPAS framework, while pairing that with enrollment of new waves, focusing on higher usage customers, and further program optimization in terms of treatment frequency and optimization of high usage alerts. Another consideration is newer waves typically have higher attrition in the first year than after more treatment, which may result in a savings shortage following a persistence adjustment.

Finding 4. The statistical nature of the savings calculations for the Residential Behavior Program presents uncertainty in savings variation year-over-year within the CPAS framework and can result in negative savings and even unclaimed savings (as explained above Table 4-1), with attrition, uplift, and modeling uncertainty acting as possible contributing factors. CY2020 is the second year in a row where retrospective adjustments to the retention rates resulted in unclaimed savings.

Recommendation 3. ComEd, the implementer, and the evaluation team should continue to review the retrospective retention rates each year. If the retention rates by wave are stable for several years, we recommend changing the prospective retention rate to make it wave specific.

Finding 5. The program realization rate was 1.27, although comparing normalized savings gives a realization rate of 1.15. After discussing with the implementer, the most likely cause of the high realization rate is differences in the way the implementer calculated persistence, and particularly retrospective retention rates, compared to the evaluation team.

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Recommendation 4. The implementer and the evaluation team should work together to clarify how the implementer should calculate retrospective retention rates to most closely match the evaluation team's methods. These retention rates should be reviewed as part of the mid-year early data characterization memo to identify any discrepancies earlier in the process.

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Appendix A. Impact Analysis Methodology

A.1 Savings Methodology – Normalized Savings

Stay at home orders, social distancing, and sustained work-from-home behaviors across Illinois as a result of the coronavirus pandemic likely led to a change in usage patterns for CY2020 starting in March.[6] Notably, pandemic-related impacts may have limited the program's ability to influence energy efficiency behaviors that participants are willing and able to take. While the program RCT design should produce an unbiased estimate of program savings given the pandemic, it does not normalize the savings that occur under the pandemic. For CY2020, SAG directed evaluation teams to normalize claimable savings for pandemic-related changes across the utilities' energy efficiency programs, including the Residential Behavior Program.

The evaluation team developed a normalization approach that builds upon historical program data, is wave-specific, and incorporates available history for each wave. For each wave, the evaluation team developed per household, per day savings adjusted for current year and legacy uplift but before subtracting persisting savings from previous years. It is important to use savings estimates adjusted for uplift because suspensions in other program operations (as well as changes to the HER program's cross-promotion of other programs) likely resulted in different than normal uplift in CY2020. Using historic data to adjust for uplift ensures the use of normalized program uplift in our calculations. Additionally, we use absolute (kWh) savings rather than percentage savings as usage patterns and levels likely differed from normal in CY2020.

We developed a tiered inclusion of years of historic data to average across to develop normalized estimates based on the duration of treatment in each wave, given sufficient comparable data and to reflect the amount of ramp (or increase in savings over time with continued treatment) that had already occurred in the wave. We outline the normalization process by duration of treatment categories that follow.

A.1.1 At Least Five Years of Program History

For waves with at least 5 years of program history (starting in PY7 or earlier), the evaluation team took the average of the last 3 years' (PY9, CY2018, and CY2019) per household per day verified net savings after adjusting for both current year and legacy uplift to develop wave-specific normalized savings. This method was used for Waves 1-7.

Waves with at least a 5-year history are well-established and the evaluation team's review of historic savings found stable savings for the last 3 years of treatment for those waves. In addition, averaging savings over several years smooths out any variation in a given year.

When considering what years to average, the evaluation team found that the uplift methodology was consistent since PY7[7] and using savings before that time would not result in incomparable, year-over-year comparisons. In reviewing historic program data, we found that PY8 savings appeared to be an outlier for many waves and the last three years savings were more consistent.

[6] Phase 1 of Illinois' pandemic response began the week of March 16, 2020.

[7] The evaluation team did not calculate legacy uplift prior to PY7 and in PY7 the team still made adjustments for negative uplift which were excluded in PY8 and beyond.

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A.1.2 Four Years of Program History

For the New Mover wave, which has 4 years of program history, we took an average of the last two years' (CY2018 and CY2019) per household per day savings after adjusting for the current year and legacy uplift to create normalized savings. Using only the last 2 years avoids including the first 2 years of treatment when savings are often still ramping up.

A.1.3 Three Years of Program History

For Waves 8, 9, and 10, which have three years of program history, we used just CY2019 per household per day savings after adjusting for current year and legacy uplift to create normalized savings. Using just 1 year of data avoids the first 2 years of treatment when savings are often still ramping up.

A.1.4 Two Years of Program History

For Waves 11 and 12, which both launched in CY2018 and have 2 years of program history, we also used just CY2019 per household per day savings after adjusting for current year and legacy uplift to create normalized savings.l

Using CY2019 estimates only avoids including the first year of treatment when savings are typically ramping up but will result in a conservative estimate of year 3 savings (CY2020), because savings are likely to continue to increase from year 2 into year 3. This results in less risk associated with the overestimation of savings, including overestimating persisting savings that could result in negative savings in future years.

For these waves, the evaluation team explored the option of using a percent change in savings from year 2 to year 3 from the waves with a longer treatment history. However, the team found that the savings trajectory from year 2 to year 3 were not consistent across waves, varying from a decrease of 39% to an increase of 179%.

A.1.5 No Program History

For Wave 13, which began in CY2020 and does not have any treatment history, the evaluation team reviewed pre-period usage[8] and used first year savings for the most similar waves that started since PY9.

Wave 13 pre-period usage is 18.30 kWh per day. The most similar waves starting since PY9 are Waves 9 and 10 with pre-period usage of 23.60 kWh and 22.63 kWh per day, respectively.[9] We averaged first-year savings across those two waves and used the resulting value for Wave 13.

Table A-1 summarizes the normalized per household per day savings the team used to develop verified net savings for CY2020. To arrive at the total savings for each wave, we multiplied the per household per day savings estimates by the total number of participant days in CY2020.

[8] Evaluations both from this evaluation team and others nationwide have consistently shown that pre-period is one of the key factors driving savings.

[9] The evaluation team also considered Wave 7 Low, which had pre-period usage of 17.83 kWh per day but launched in PY7. The team compared the pre-uplift adjustment first year percentage savings of this wave (recall the post-uplift adjustment savings are not comparable pre-PY8) to Waves 9 and 10 and found the savings were similar to Wave 10.

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The savings were further adjusted for savings persistence and participant retention (see Section A.3.5).

Table A-1. Normalized Per Household Per Day Savings for CY2020

Wave	Group	Year of Treatment Start	Normalized Savings Based On	Per Household per Day Savings (kWh)
Wave 1	Continued Report (CR)	2009	Average of the most recent 3 years	0.92
Wave 1	Lapsed Report (LR)	2009		0.75
Wave 2	-	2010		0.74
Wave 4	-	2012		0.81
Wave 5	-	2013		1.04
Wave 6	-	2014		0.88
Wave 7	Low	2014		0.22
Wave 7	High	2014		0.57
New Mover Wave	-	2014	Average of the most recent 2 years	0.47
Wave 8	-	2015	CY2019 estimate	0.34
Wave 9	-	2016		0.26
Wave 10	-	2017		0.26
Wave 11	-	2018		0.53
Wave 12	-	2018		0.29
Wave 13	-	2020	Average of first year savings of Wave 9 and Wave 10 (PY9)	0.09

Source: Evaluation team analysis of historic ComEd HER Program data

A.2 Equivalency Analysis

The evaluation team performed a series of equivalency analyses to ensure the fidelity of the RCT design. In addition to ascertaining consumption equivalency between the treatment and control groups in the pre-period for the newly added wave (Wave 13), the evaluation team assessed equivalency of each wave's treatment and control group both in terms of pre-period consumption and sociodemographic characteristics. This review was conducted as the evaluation team was concerned the pandemic could exacerbate any naturally occurring differences.

A.2.1 New Wave Consumption Equivalency

To test that the new CY2020 wave (Wave 13) is 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 12 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.

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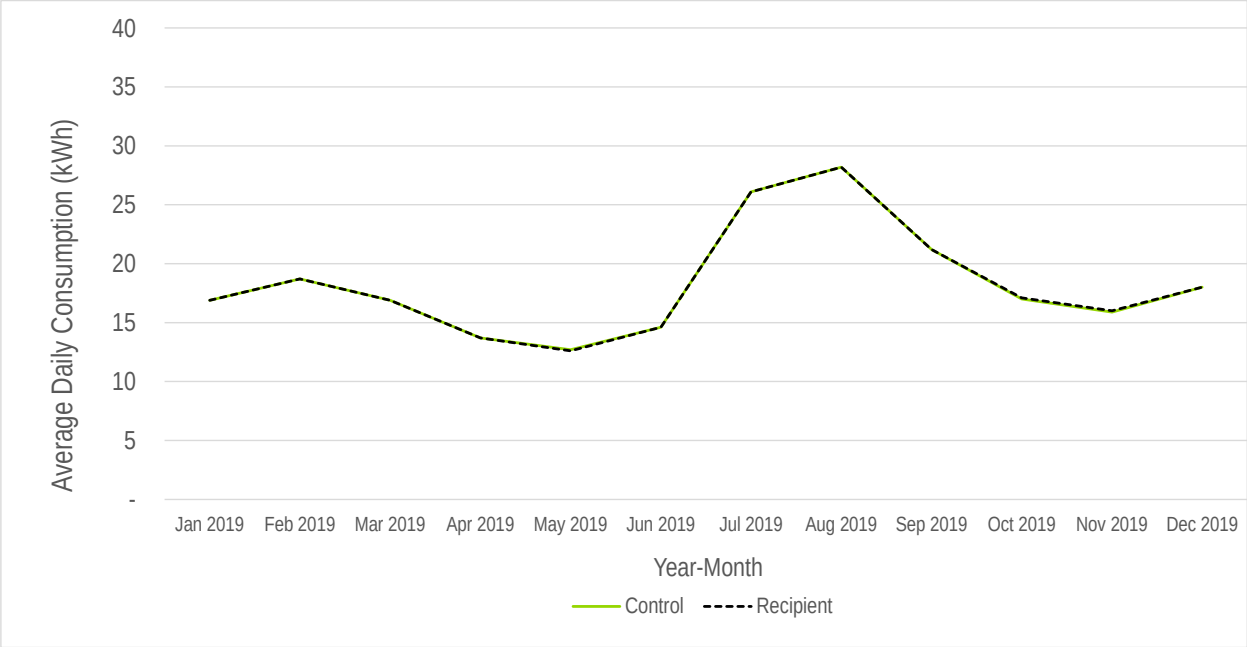
Table A-2 illustrates the control group and treatment group usage during the 12-month pre-period for Wave 13. The graph indicates what the evaluation team's statistical analysis confirmed, namely that the assignment of customers into the treatment and control groups was consistent with randomization.

Table A-2. RCT Usage Comparison for Wave 13



Source: Evaluation team analysis

A.2.2 Consumption Equivalency

As part of this analysis, the evaluation team checked equivalency of pre-treatment consumption patterns among participants in the treatment and control group active in CY2020. The team ran this analysis for each wave actively treated in CY2020. This analysis helped ensure that customer attrition over the course of 2020 did not result in an overall RCT design imbalance. The evaluation team conducted variance tests and t-tests comparing participant and control usage for each month of the pre-period. 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.

A.2.3 Equivalency of Customer Sociodemographic Composition

Different customer segments may respond to the pandemic differently. For instance, it is possible that customers of older age and with lower incomes have been disproportionately affected by the pandemic. Unbalanced composition of the treatment and control groups across such key customer characteristics can result in biased savings estimates. The evaluation team leveraged PRIZM segment data provided by ComEd to explore the balance across key available sociodemographic characteristics of active treatment and control customers to ensure that the treatment and control groups are equivalently composed. We ran this analysis for each wave actively treated in CY2020 and found a balanced and equivalent distribution of treatment

and control customers across the segments of interest. Detailed tables and graphs with equivalency analysis outputs are available upon request.

A.3 Savings Methodology – Actual Savings Modeling

This section details the methodology employed for developing custom savings estimates for CY2020. Notably, these savings were not used by the evaluation team to develop claimable savings for CY2020 but were developed for robustness purposes to allow a comparison to the normalized savings used for claimable savings and for future use when the program transitions away from using normalized savings estimates.

A.3.1 Data Cleaning

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

- Observations outside CY2020 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 0.01% of customers and 3.2% of observations,[10] evenly distributed across participants and controls. This suggests that the evaluation team's cleaning steps did not introduce non-random biases into the data.

A.3.2 Imputation of Pre-Period Data

The evaluation team found a large share of treatment and control customers in Waves 10, 11, and 12 had less than a full year of pre-period data. On average, customers in these waves had less than 10 months of pre-period billing data and only 27% of customers in Waves 10, 11, and 12 had a full year of pre-period billing data.

Incomplete (less than 12 months) pre-period data can introduce bias when modeling savings. In addition, due to the nature of the lagged dependent variable (LDV) model, participants with incomplete pre-period data are dropped from the modeling process.[11]

To account for the large number of missing pre-period observations for Waves 10, 11, and 12, the team replaced the missing data with substituted values (i.e., imputed data) representing average daily consumption for customers that have pre-period data. The evaluation team performed imputations independently for each wave, pre-period month, and customer group (treatment vs. control).

[10] The New Mover Wave dropped more observations than the other waves (9.2%) because they were more frequently missing pre-period usage.

[11] Since this model includes pre-period information as explanatory variables, if a customer is missing billing data for a certain pre-period month, then the model will drop this calendar month in the analysis period for the customer.

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A.3.3 Modeling Methodology

The evaluation team used lagged dependent variable (LDV) and linear fixed effects regression (LFER) models to estimate actual program savings.[12] Neither of these results were used for claiming savings in CY2020 as normalized savings were claimed based on the method described in Section A.1. The following sections present the specifications for each model.

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 A-1.

Equation A-1. Lagged Dependent Variable Regression Model

$$ADU_{kt} = \beta_1 Treatment_k + \sum_J \beta_2 Month_{jt} + \sum_J \beta_3 Month_{jt} \cdot ADUlag_{kt} + \varepsilon_{kt}$$

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[13]
$ADUlag_{kt}$	is household *k*'s energy use in the same calendar month of the pre-program year as the calendar month of month *t*[14]
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 β_1 is the estimate of average daily kWh energy savings due to the program.

Linear Fixed Effects Regression Model

The LFER model used by the evaluation team is one in which the 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.

[12] 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.

[13] 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.

[14] Note that the evaluation team imputed these values for some observations of Waves 10, 11, and 12 as discussed in Section 7.3.

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3. The interaction between these variables, $Treatment_k \cdot Post_t$.

Formally, the LFER model is shown in Equation A-2.

Equation A-2. Linear Fixed Effects Regression Model

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

Coefficient α_{0k} captures all household-specific effects on energy use that do not change over time, including those that are unobservable. Coefficient α_1 captures the average effect across all households of being in the post-treatment period. 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.

Weather Normalization

TRM v8.0 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 is 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 CY2020. 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 timeframe is likely different than the future expectations, given the effects of climate change. 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.

A.3.4 Account for Uplift in Other Energy Efficiency Programs

Accounting for Uplift in CY2020

The home energy reports sent to participating households include energy-savings 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 Residential Behavior treatment and control groups, the savings estimates from the regression analyses are already net of savings from other programs as this indicates the Residential Behavior Program does not increase or decrease participation in other EE programs. If the Residential Behavior 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 Residential Behavior and EE programs. For instance, if the Residential Behavior Program increases participation in other EE programs, the increase in savings may be allocated to either the Residential Behavior Program or the EE

program, but cannot be allocated to both programs simultaneously.[15] When the Residential Behavior 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 CY2020 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 CY2020 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 Residential Behavior Program is 2% for the treatment group and 1% for the control group, then the rate of uplift due to the Residential Behavior Program is 1%, as reflected in Equation A-3.

Equation A-3. DID Statistic Calculation

$$(CY2019\ treatment\ group\ participation - prePY\ treatment\ group\ participation) - (CY2019\ control\ group\ participation - prePY\ control\ group\ participation) = DID\ statistic$$

$$(5\% - 2\%) - (3\% - 1\%) = 1\%$$

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 CY2020. 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 CY2020 the evaluation team examined the uplift associated with the following EE programs:[16]

- Fridge & Freezer Recycling (FFR) Program. This program achieves energy savings through retirement and recycling of older, inefficient refrigerators, freezers, and room air conditioners. This program was only active for the first few months in CY2020 and then discontinued.

- Single-Family Illinois Home Weatherization Assistance (SF-IHWAP) Program. This program helps low income customers residing in single-family homes conserve fuel and reduce energy costs by making their homes and apartments more energy efficient. IHWAP also provides many health and safety upgrades ensuring safe and healthy homes. Weatherization services included as part of the program include

[15] 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.

[16] ComEd has other residential programs that were not included in the analysis. The Appliance Rebates, Elementary Energy Education, Lighting Discounts, Food Bank-LED Distribution, and Income Eligible 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 New Construction Programs and Residential Behavior is not possible due to the requirement that Residential Behavior participants have sufficient historical usage data.

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insulation and air sealing, HVAC and water heating equipment upgrades, and ventilation and moisture control measures.

- Multi-Family Illinois Home Weatherization Assistance (MF-IHWAP) Program. This program caters to building owners who provide housing to income-eligible residents. Improvements include a range of weatherization services.

- Single-Family Retrofits – Income Eligible (IE) 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 – IE 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 using IHWAP.

- Residential HVAC Program. This program offers incentives to residential customers to encourage customer purchases of higher efficiency HVAC equipment. In CY2020, this program also began offering rebates for the installation of ground source heat pumps.

- Manufactured Housing Retrofits Program. This program achieves energy savings by providing direct installation of low-cost efficiency measures for manufactured homes, such as LEDs, smart thermostats, faucet aerators, and advanced power strips. The program also offers air and duct sealing to improve performance of HVAC equipment.

- Multifamily Energy Savings (MESP) Program. This program provides qualifying property owners and managers with a no-cost energy assessment, incentives for energy-saving building upgrades, and incentives for energy-saving products installed throughout their building, including resident's homes

- Home Energy Assessments (HEA). 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.

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

Accounting for Legacy Uplift

The uplift adjustment methodology 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.[17] For other EE programs that include measures with multi-year measure lives; however, Residential Behavior 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 10-year measure life that was installed in PY3 would generate savings captured in the Residential Behavior Program savings not just in PY3, but in PY4 through CY2020 as well.

Consider the following example. A household receiving home energy reports through the Residential Behavior 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 Residential Behavior 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. When only relying on the uplift adjustment, FFR second year savings would be included in the PY7 Residential Behavior Program's savings, which is inconsistent with Illinois' practices of only crediting utilities with first-year EE program savings. Legacy uplift removes double counted energy savings from programs that include measures with 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,[18] from CY2020 Residential Behavior savings through the measure lives of measures from other EE programs. The legacy uplift adjustment is shown in Equation A-4.

Equation A-4. Legacy Uplift Calculation

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

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. 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 lives, 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.

The legacy uplift adjustment goes back to PY4 when the evaluation team first considered uplift for the Residential Behavior Program. In PY4, the evaluation team considered double counted savings from the Fridge Freezer Recycle Rewards (FFRR), the Central Air Conditioning Efficiency Services (CACES), 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

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

[18] Since Residential Behavior Program participations are dropped from that program when they move, other EE programs' savings are no longer captured in the Residential Behavior Program savings from that point forward.

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considered in PY6, except for the CW Program, which was discontinued. In PY7, PY8, and PY9 the evaluation team considered double counted savings for the Multi-Family Energy Savings Program (MESP), and the HEA, HVAC and Weatherization, and FFR Programs.[19] In CY2018 the evaluation team considered double counted savings for the FFR, HEA, Single Family Retrofits Program, Multi-Family Retrofits Program, HVAC, and Weatherization Programs. In CY2019 the program considered double counted savings from FFR, HEA, Multi-Family Assessments, Single Family Retrofits IE, Multi-Family Retrofits IE, HVAC, Weatherization, and Manufactured Housing Retrofits.

Due to expired program-level EULs, the evaluation team removed the FFR and CACES programs from legacy PY4 uplift in CY2020, and also removed MF Program uplift from PY5 and PY6.

A.3.5 Account for Savings Persistence and Participant Retention

Continued implementation of Residential Behavior 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 TRM v8.0. This framework assumes that savings persist over 5 years but the persistence decays in each year. The TRM recommends using the persistence factors presented in Table A-3 over the 5-year life to estimate lifetime electric energy savings for the program.

Table A-3. Residential Behavior Electric Savings Persistence Factors

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

Source: TRM v8.0, Measure 6.1.1, Volume 4

In addition to applying persistence rate factors, lifetime savings need to account for customer attrition over time due to move-outs and account closures.[20] In CY2018, the evaluation team calculated a prospective annual retention rate of 89.8% which is also applied in CY2020.[21] This is a weighted average rate across all program waves, except for the New Mover Wave[22] from 2014 through 2018. Using customers across all program waves allowed the evaluation team to

[19] Due to expiring weighted average measure life, legacy savings from the PY4 CACES Program, and the PY5 and PY6 MF Programs are no longer considered in the CY2019 legacy uplift.

[20] It is possible that some savings resulting from Residential Behavior 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 8 of the TRM therefore assumes no persisting savings upon customer move-out, though it encourages additional research on the matter.

[21] The evaluation team will update this prospective retention rate for the next plan cycle.

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

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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 5-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. The CY2018 report includes details for this approach.

A.4 Peak Demand Savings Estimation

The evaluation team calculated peak demand savings using the approach outlined in TRM v8.0 for cases where peak demand is not measured directly by the custom savings analysis.

Equation A-5. Peak Demand Savings Formula

$$\Delta kW_{T\ Adjusted} = \left(\frac{\Delta kWh_{T\ Adjusted\ Summer}}{Summer\ Hours}\right) * Peak\ Adjustment\ Factor$$

Where:

Where:

$\Delta kW_{T\ Adjusted\ Summer}$ = average adjusted electric energy savings (calculated above)
for peak summer months
= $\Delta kWh_{T\ Adjusted}$ * 0.42 * (3/5)
= $\Delta kW_{hT\ Adjusted}$ * 0.25
Where:
0.42 = summer loadshape percent for May through Sept
3/5 = proportion of May through Sept hours that fall in June, July, and Aug

summer hours = hours in June, July, and Aug
= 8,760 / 4
Where:
8,760 = Hours per year

peak adjustment factor = adjustment for peak kW over average kW for these hours
= 1.5

Appendix B. Detailed Impact Analysis Results

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.

B.1 Normalized Savings by Wave

This section disaggregates program savings according to individual waves and wave subgroups. The evaluation team developed separate normalized savings estimates for each wave and wave subgroup approach as described in Section A.1.

Table B-1. CY2020 Residential Behavior Program – Normalized Savings Results by Wave

Wave	Treatment Customer Count*	Control Customer Count*	Normalized Per Participant Per Day Savings†	Per Participant Average Days	Normalized Annualized Customer Savings, kWh‡	Normalized Net Savings, kWh	Retrospective Retention Rate (2020 to 2019)§	Savings Attributed to Prior Years||	Verified Net Savings, kWh#
Wave 1 CR	16,374	24,948	0.92	359	332	5,435,582	0.95	2,980,757	2,454,824
Wave 1 LR	5,042		0.75	361	271	1,365,051	0.95	759,791	605,260
Wave 2	1,701	1,714	0.74	357	265	450,158	0.95	296,865	153,293
Wave 4	13,028	13,090	0.81	359	291	3,795,952	0.96	2,217,896	1,578,056
Wave 5	3,950	5,164	1.04	358	370	1,462,673	0.93	821,432	641,241
Wave 6	58,694	17,747	0.88	359	315	18,502,633	0.94	12,371,832	6,130,801
Wave 7 Low	357,455	29,713	0.22	357	79	28,305,678	0.93	17,101,575	11,204,103
Wave 7 High	395,792	32,965	0.57	358	205	81,191,368	0.94	57,696,915	23,494,453
Wave 8	40,218	5,445	0.34	354	119	4,781,317	0.90	3,237,931	1,543,386
Wave 9	200,217	12,630	0.26	353	93	18,679,785	0.90	13,506,897	5,172,888
Wave 10	92,533	11,540	0.26	350	93	8,562,057	0.86	6,394,914	2,167,143
Wave 11	51,429	12,236	0.53	346	184	9,472,683	0.82	7,294,275	2,178,409
Wave 12	57,331	13,710	0.29	346	100	5,749,368	0.81	4,235,868	1,513,501
Wave 13	541,551	49,567	0.09	336	31	16,651,315	1.00	0	16,651,315
New Mover	86,855	21,665	0.47	349	165	14,300,020	0.86	10,774,053	3,525,967
Total	1,922,170	252,134	0.33	350	114	218,705,640	0.94	139,691,001	79,014,639

* These counts are for active customers at the beginning of CY2020.
† Savings values are adjusted for uplift.
‡Total savings are pro-rated for participants that closed their accounts during CY2020.
§ The retrospective retention rate reflects actual program retention for each wave from one year to the next.
|| Savings attributed to prior years are those deducted for persistence from CY2018 and CY2019 within the CPAS framework. This value is calculated by multiplying the CY2018 and CY2019 customer savings calculation per wave by the retrospective retention rate per wave by the savings decay rate for the third and second year of receiving reports, respectively (54% and 80%, respectively).
Verified Net Savings are equal to Normalized Net Savings less Savings Attributed to Prior Years.
Source: ComEd data and evaluation team analysis

B.2 Actual Savings by Wave

This section disaggregates actual program savings according to individual waves and wave subgroups. None of these results were used for claiming savings in CY2020 as normalized savings were claimed as shown in the previous section based on the method described in Section A.1.

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Table B-2 summarizes estimated program savings by participant wave. To examine the persistence of savings, the implementer terminated reports in October 2012 for 10,000 customers in Wave 1, but accidentally restarted treatment in August 2013. This report refers to these customers as the Wave 1 LR subgroup. Customers in Wave 1 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. In CY2020, the evaluation attributed savings to 1,922,170 treatment customers. The evaluation team estimated separate savings for each wave and wave subgroup using regression analysis as described in Section A.3.

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Table B-2. CY2020 Residential Behavior Program – Actual Savings 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.*	CY2020 Uplift, kWh‡	Legacy Uplift, kWh‡	CY2020 Custom Savings Calculation	Retrospective Retention Rate (2020 to 2019)§	Savings Attributed to Prior Years||	Verified Net Savings, kWh#
Wave 1 CR	16,374	24,948	2.37%	0.33%	322	45	5,194,549	725,119	17,469	501,982	4,675,098	0.95	2,980,757	1,694,341
Wave 1 LR	5,042		2.37%	0.33%	322	45	1,604,164	224,586	2,939	212,904	1,388,321	0.95	759,791	628,531
Wave 2	1,701	1,714	2.13%	1.24%	273	158	454,363	263,989	597	23,058	430,708	0.95	296,865	133,843
Wave 4	13,028	13,090	2.30%	0.38%	260	43	3,331,119	552,114	14,723	101,288	3,215,109	0.96	2,217,896	997,213
Wave 5	3,950	5,164	1.96%	0.73%	395	148	1,527,263	572,525	19,560	69,027	1,438,677	0.93	821,432	617,245
Wave 6	58,694	17,747	2.07%	0.28%	307	41	17,677,640	2,379,977	68,816	458,609	17,150,215	0.94	12,371,832	4,778,383
Wave 7 Low	357,455	29,713	1.24%	0.21%	81	14	28,273,122	4,732,841	134,798	685,536	27,452,788	0.93	17,101,575	10,351,213
Wave 7 High	395,792	32,965	2.04%	0.14%	203	14	78,894,949	5,262,834	894,026	2,908,083	75,092,841	0.94	57,696,915	17,395,926
Wave 8	40,218	5,445	0.97%	0.53%	116	63	4,542,354	2,453,261	46,566	255,113	4,240,675	0.90	3,237,931	1,002,744
Wave 9	200,217	12,630	0.95%	0.30%	83	26	16,134,524	5,025,783	560,944	1,116,893	14,456,687	0.90	13,506,897	949,791
Wave 10	92,533	11,540	1.77%	0.41%	156	37	13,820,128	3,242,285	27,227	556,408	13,236,492	0.86	6,394,914	6,841,578
Wave 11	51,429	12,236	1.52%	0.36%	196	47	9,567,533	2,281,903	37,464	364,389	9,165,681	0.82	7,294,275	1,871,406
Wave 12	57,331	13,710	1.94%	0.38%	197	38	10,671,705	2,071,047	21,170	208,032	10,442,503	0.81	4,235,868	6,206,636
Wave 13	541,551	49,567	0.53%	0.12%	38	9	18,814,019	4,363,490	148,573	0	18,665,446	1.00	0	18,665,446
New Mover	86,855	21,665	1.51%	0.37%	167	41	13,904,736	3,436,650	83,777	585,862	13,235,097	0.86	10,774,053	2,461,044
Total	1,922,170	252,134	1.28%	-	121	-	224,412,168	37,588,403	2,078,648	8,047,181	214,286,340	0.94	139,691,001	74,595,339

* These counts are for active customers at the beginning of CY2020.

† Total savings are pro-rated for participants that closed their accounts during CY2020.

‡ No adjustment was made to total savings for negative uplift, (i.e. cases where the Residential Behavior Program decreased participation in other programs).

§ The retrospective retention rate reflects actual program retention for each wave from one year to the next.

|| Savings attributed to prior years are those deducted for persistence from CY2018 and CY2019 within the CPAS framework. This value is calculated by multiplying the CY2018 and CY2019 customer savings calculation per wave by the retrospective retention rate per wave by the savings decay rate for the second year of receiving reports (80%).

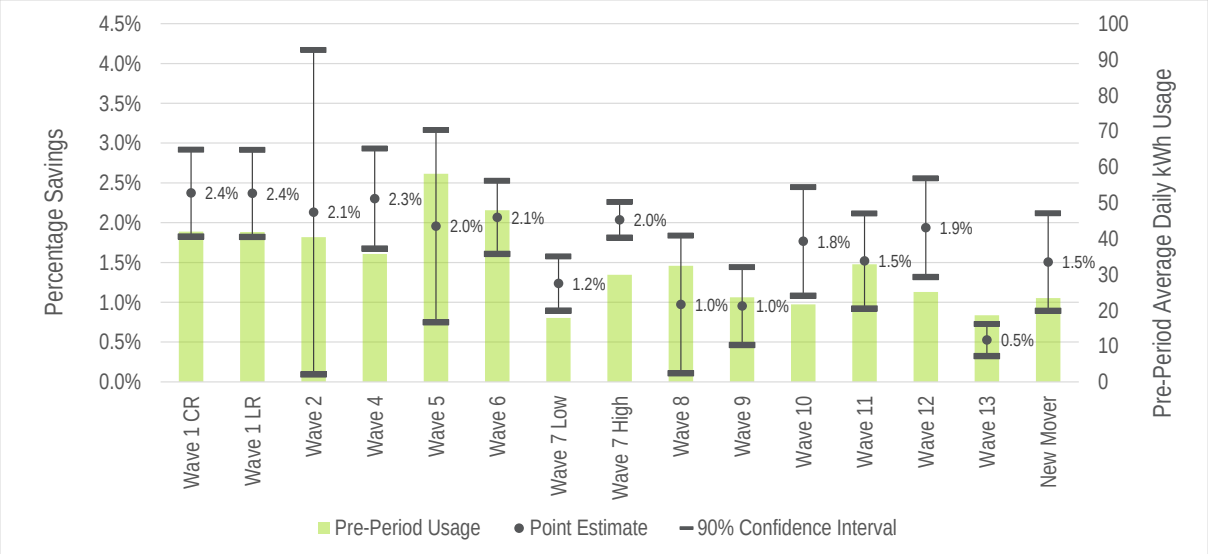
Verified Net Savings are equal to Net Savings, Prior to Uplift less CY2020 Uplift, Legacy Uplift, and Savings Attributed to Prior Years.

Source: ComEd data and evaluation team analysis

Figure B-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 has a small sample size of 1,701 participants and 1,714 controls and large confidence bounds compared to the other waves, while Wave 13 had 541,551 participants and 49,567 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 pre-period usage at 18 kWh per day, while Wave 5 had the highest at 58 kWh per day. Previous evaluations identified that higher usage is often associated with greater Residential Behavior Program savings.[23] Overlaying average pre-period daily usage with savings for each wave confirms that association. There is a positive correlation between pre-period usage and savings (0.628) indicating that energy savings increase with energy usage.

Figure B-1. Actual Savings and Pre-Period Usage by Wave

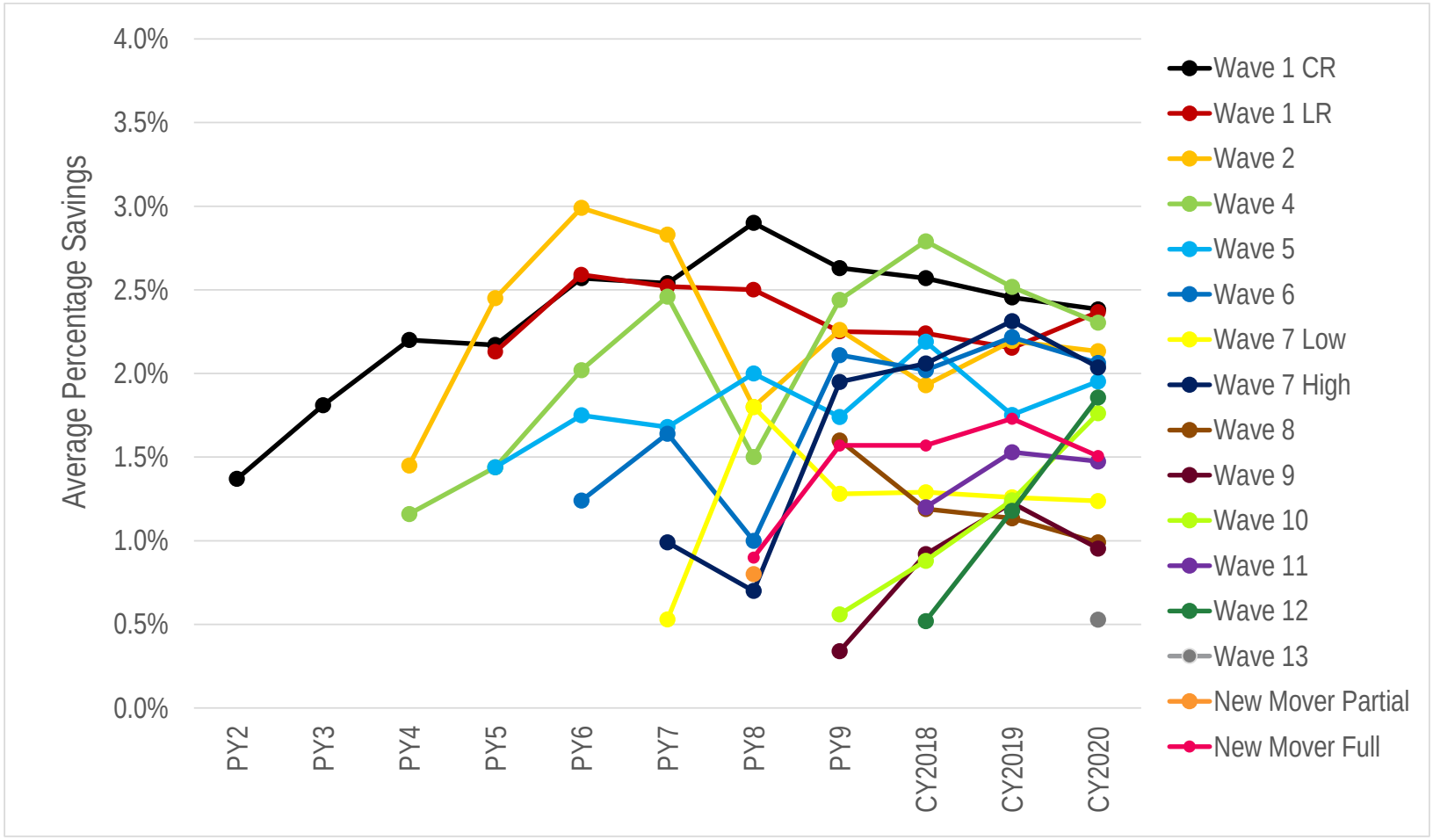


Source: ComEd data and evaluation team analysis

Figure B-2 combines CY2020 results with those from previous evaluations to show how the estimated percentage savings have changed over program years for each wave. In general, wave-specific savings show a consistent ramp-up in the first few years post-enrollment. After that savings tend to plateau, though there can be considerable fluctuation from year to year.

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

Figure B-2. Residential Behavior Program Savings over Time by Wave



Note: In PY8, the evaluation team separated the New Mover Wave separated according to customers who received reports for a full or partial year (New Mover Full and New Mover Partial, respectively). In subsequent evaluations, the evaluation team combined these two subgroups under the "New Mover Full" heading. As a result, New Mover Partial does not have a savings value after PY8.

Source: ComEd data and evaluation team analysis

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B.3 Uplift Analysis Results

This section summarizes CY2020 uplift results. These results were not used for claiming savings in CY2020 as normalized savings were claimed based on the method described in Section A.1.

The uplift of savings in other EE programs was a small proportion of the total savings: 10,125,829 kWh, or approximately 4.5%. The uplift can be broken down into uplift in CY2020 and legacy uplift from previous program years. The CY2020 uplift was 2,078,648 kWh or 0.9% of total program savings and the legacy uplift was 8,047,181 kWh or 3.6% of total program savings.[24] Double counting of savings with other ComEd EE programs does not appear to be a significant issue for the Residential Behavior Program.

B.4 Comparison of Normalized and Actual Savings

This section compares normalized and actual savings for CY2020. Table B-3 compares two sets of savings values: 1) savings adjusted for uplift but not for persisting savings and 2) savings adjusted for uplift and persisting savings. Both comparisons are useful, the first offers insight into the magnitude of difference in savings estimates, while the second offers insight into the additional difference caused by the persisting savings adjustment. As Table B-3 shows, normalized savings adjusted for uplift but not for persisting savings are overall 2% higher than equivalently adjusted actual savings. Depending on the wave, normalized savings range from 55% to 129% of actual savings. Overall, normalized savings for most of the earlier waves (Waves 1 through 9) are higher than CY2020 actual savings, whereas for most of the later waves (Waves 10 through 13) normalized savings are lower than actual. After adjusting for persisting savings, normalized savings are overall 6% higher than actual savings. There is a much larger variability in individual wave's savings, with normalized saving reaching 545% of the actual savings on the high end and 24% of the actual savings on the low end.

[24] 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 Residential Behavior analysis. This overestimate likely offsets some underestimation due to the inability to account for double counting with upstream programs not tracked at the customer level.

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Table B-3. Normalized and Actual Savings Comparison

Wave	Treatment Customer Count*	Control Customer Count*	Savings Adjusted for Uplift and Prior to Adjusting for Persisting Savings					Savings Adjusted for Uplift and Persisting Savings		
			Per Participant Per Day Savings (Normalized), kWh†	Per Participant Per Day Savings (Actual), kWh†	Total Normalized Savings, kWh	Total Actual Savings, kWh	Normalized Savings/Actual Savings	Total Normalized Savings, kWh	Total Actual Savings, kWh	Normalized Savings/Actual Savings
Wave 1 CR	16,374	24,948	0.92	0.79	5,435,582	4,675,098	116%	2,454,824	1,694,341	145%
Wave 1 LR	5,042		0.75	0.76	1,365,051	1,388,321	98%	605,260	628,531	96%
Wave 2	1,701	1,714	0.74	0.71	450,158	430,708	105%	153,293	133,843	115%
Wave 4	13,028	13,090	0.81	0.69	3,795,952	3,215,109	118%	1,578,056	997,213	158%
Wave 5	3,950	5,164	1.04	1.02	1,462,673	1,438,677	102%	641,241	617,245	104%
Wave 6	58,694	17,747	0.88	0.82	18,502,633	17,150,215	108%	6,130,801	4,778,383	128%
Wave 7 Low	357,455	29,713	0.22	0.22	28,305,678	27,452,788	103%	11,204,103	10,351,213	108%
Wave 7 High	395,792	32,965	0.57	0.53	81,191,368	75,092,841	108%	23,494,453	17,395,926	135%
Wave 8	40,218	5,445	0.34	0.30	4,781,317	4,240,675	113%	1,543,386	1,002,744	154%
Wave 9	200,217	12,630	0.26	0.20	18,679,785	14,456,687	129%	5,172,888	949,791	545%
Wave 10	92,533	11,540	0.26	0.41	8,562,057	13,236,492	65%	2,167,143	6,841,578	32%
Wave 11	51,429	12,236	0.53	0.52	9,472,683	9,165,681	103%	2,178,409	1,871,406	116%
Wave 12	57,331	13,710	0.29	0.53	5,749,368	10,442,503	55%	1,513,501	6,206,636	24%
Wave 13	541,551	49,567	0.09	0.10	16,651,315	18,665,446	89%	16,651,315	18,665,446	89%
New Mover	86,855	21,665	0.47	0.44	14,300,020	13,235,097	108%	3,525,967	2,461,044	143%
Total	1,922,170	252,134	0.33	0.32	218,705,640	214,286,340	102%	79,014,639	74,595,339	106%

* These counts are for active customers at the beginning of CY2020.

† Savings are adjusted for uplift.

Source: Evaluation team analysis

Appendix C. Total Resource Cost Detail

Table C-1 shows the TRC 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 the evaluation team later.

Table C-1. Total Resource Cost Savings Summary

End Use Type	Research Category	Units	Quantity	EUL (years)*	ER Flag†	Gross Electric Energy Savings (kWh)	Gross Peak Demand Reduction (kW)	Gross Gas Savings (Therms)	Gross Secondary Savings due to Water Reduction (kWh)	Gross Heating Penalty (kWh)	Gross Heating Penalty (Therms)	NTG (kWh)	NTG (kW)	NTG (Therms)	Net Electric Energy Savings (kWh)	Net Peak Demand Reduction (kW)	Net Gas Savings (Therms)	Net Secondary Savings due to Water Reduction (kWh)	Net Heating Penalty (kWh)	Net Heating Penalty (Therms)
Behavioral	All Waves	Household	1,922,170	5‡	No	NA	NA	NA	NA	NA	NA	NA	NA	NA	79,014,639	13,638	NA	NA	NA	NA

NA = Not applicable (refers to a piece of data that cannot be produced or does not apply)

* The total of the EUL column is the weighted average measure life (WAML), and is calculated as the sum product of EUL and measure savings divided by total program savings. Additionally, the EUL for this measure varies over time. See the CPAS table (Table 4-1).

† Early Replacement (ER) measures are flagged as YES, otherwise a NO is indicated in the column.

‡ The EUL for this measure varies over time. See the CPAS tables (Table 4-1)

Source: ComEd tracking data and evaluation team analysis

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