Guidehouse

ComEd Virtual Commissioning™ Impact Evaluation Report

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

Prepared for:

ComEd

FINAL

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1. Introduction

This report presents results from the CY2020 impact evaluation of ComEd's Virtual Commissioning™ (VCx™) Program. It summarizes the total energy and demand impacts for the program broken out by relevant measure and program structure details. 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 VCx Program is an energy efficiency pathway within the Retro-Commissioning Program[1] that targets small and medium-sized businesses, including franchisees of national chains, who the program deems to have significant potential for achieving energy savings through low- or no-cost operational changes. VCx is designed and operated by Power TakeOff (PTO) and administered by Nexant. This program provides qualified ComEd business customers[2] with energy management and information system services to better manage their energy usage, identify energy savings opportunities, and achieve energy savings through low- or no-cost energy-saving operational changes or adjustments.[3] The program was formerly known as the Energy Advisor Monitoring-based Commissioning program and is listed under that name in the spreadsheet documenting the CY2020 net-to-gross (NTG) values.[4] The program follows a step-by-step process to:

- Identify customers with significant potential for low- or no-cost energy savings
- Work with customers to understand their energy usage and identify savings opportunities
- Enroll customers in the VCx Program
- Monitor customer progress throughout their participation in the program

All contacts between ComEd customers and VCx Program staff are remote, and all operational changes implemented through the program are performed by the participants or their employees or contractors. Energy savings actions taken by each participant are documented as part of the program, and the resulting energy savings claimed for each action are estimated by PTO using a regression analysis of the participant's pre- and post-enrollment energy usage data.

The program had 124 participants in CY2020.

[1] Although the VCx Program falls within the Retro-Commissioning Program, it is evaluated separately due to differences in implementation and the evaluation methodology.

[2] To qualify, a participant must be a ComEd business customer with at least 1 year of 30-minute interval smart ("AMI") meter data available prior to program engagement.

[3] Recommended actions may include but are not limited to adjusting HVAC and lighting schedules to match occupancy, adjusting thermostat setbacks, and managing equipment startup and shutdown schedules.

[4] See https://www.ilsag.info/ntg_2020.

3. Program Savings Detail

Table 3-1 summarizes the incremental energy and demand savings the VCx Program achieved in CY2020. This evaluation did not assess gas savings.

Table 3-1. CY2020 Total Annual Incremental Electric Savings

Savings Category	Energy Savings (kWh)	Summer Peak* Demand Savings (kW)
Electricity		
Ex Ante Gross Savings	18,509,660	NA
Program Gross Realization Rate	1.00	NA
Verified Gross Savings	18,548,812	1,673
Program Net-to-Gross Ratio (NTG)	1.00	1.00
Verified Net Savings	18,548,812	1,673
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	18,509,660	NA
Program Gross Realization Rate	1.00	NA
Verified Gross Savings	18,548,812	1,673
Program Net-to-Gross Ratio (NTG)	1.00	1.00
Verified Net Savings	18,548,812	1,673

NA = not applicable (refers to a piece of data that cannot be produced or does not apply)
*The coincident summer peak period is defined as 1:00 p.m.-5:00 p.m. Central Prevailing Time on non-holiday weekdays, June through August.
† The program did not report, and the evaluation did not document, gas savings.
Source: ComEd tracking data and evaluation team analysis

4. Cumulative Persisting Annual Savings

Table 4-1 shows the total verified gross savings for the VCx Program and the cumulative persisting annual savings (CPAS) for the program in CY2020. Figure 4-1 shows the savings across the useful life of the measures. The electric CPAS in 2020 is 18,548,812 kWh (Table 4-1). Guidehouse did not evaluate gas savings for this program; as such, electric CPAS is equivalent to total CPAS. The historic rows in the table are the CPAS contribution back to CY2018. The Program Total Electric CPAS row is the sum of the CY2020 contribution and the historic contribution.

Table 4-1. Cumulative Persisting Annual Savings (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
Other	VCx	7.3	18,548,812	1.00	135,406,324			18,548,812	18,548,812	18,548,812	18,548,812	18,548,812	18,548,812	18,548,812
CY2020 Program Total Electric Contribution to CPAS			18,548,812		135,406,324			18,548,812	18,548,812	18,548,812	18,548,812	18,548,812	18,548,812	18,548,812
Historic Program Total Electric Contribution to CPAS‡						8,148,664	22,571,439	22,571,439	22,571,439	22,571,439	14,422,775	14,422,775	14,422,775	14,422,775
Program Total Electric CPAS						8,148,664	22,571,439	41,120,251	41,120,251	41,120,251	32,971,587	32,971,587	32,971,587	32,971,587
CY2020 Program Incremental Expiring Electric Savings§									-	-	-	-	-	-
Historic Program Incremental Expiring Electric Savings‡§								-	-	-	8,148,664	-	-	-
Program Total Incremental Expiring Electric Savings§								-	-	-	8,148,664	-	-	-

End Use Type	Research Category	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Other	VCx	5,564,643	-	-	-	-	-	-	-	-	-	-	-
CY2020 Program Total Electric Contribution to CPAS		5,564,643	-	-	-	-	-	-	-	-	-	-	-
Historic Program Total Electric Contribution to CPAS‡		14,422,775	8,653,665										
Program Total Electric CPAS		19,987,419	8,653,665	-	-	-	-	-	-	-	-	-	-
CY2020 Program Incremental Expiring Electric Savings§		12,984,168	5,564,643	-	-	-	-	-	-	-	-	-	-
Historic Program Incremental Expiring Electric Savings‡§		-	5,769,110	8,653,665	-	-	-	-	-	-	-	-	-
Program Total Incremental Expiring Electric Savings§		12,984,168	11,333,754	8,653,665	-	-	-	-	-	-	-	-	-

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.

* A deemed value. Source found on the Illinois Stakeholder Advisory Group (SAG) website: https://www.ilsag.info/ntg_2020.

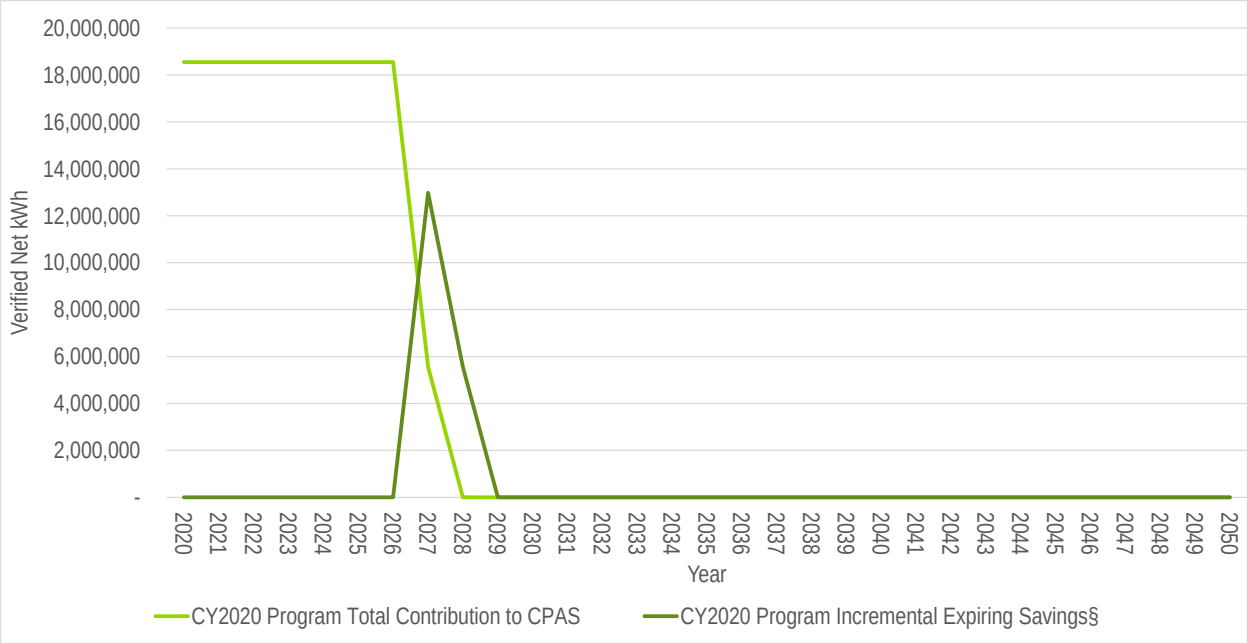
† Lifetime savings are the sum of CPAS savings through the effective useful life (EUL).

‡ Historic savings go back to CY2018.

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

Source: Evaluation team analysis

Figure 4-1. Cumulative Persisting Annual Savings



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

Source: Evaluation team analysis

5. Program Savings by Measure

This program has only one measure, so measure-level results are the same as the program-level results discussed in section 3.

6. Impact Analysis Findings and Recommendations

6.1 Impact Parameter Estimates

The VCx 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 listed below.

Finding 1. The CY2020 savings calculations were complicated by the need to make baseline adjustments to correct for the effects of COVID-19 for some participants. Not all baseline adjustments in the model summary file matched those in the detailed site workbooks. In a few cases the adjustment dates were incorrect and required manual corrections to obtain the correct results.

Recommendation 1. Guidehouse recommends that PTO ensure that all relevant baseline adjustments are included in the tracking summary file with correct start and stop dates. Baseline adjustments that start and end prior to the baseline year, and those that are unverified and not included in PTO's model, can be omitted.

Finding 2. Some customers' model specifications were unclear and/or included mutually exclusive terms. This did not affect the realization rate, but hindered detailed investigation of specific sites.

Recommendation 2. Guidehouse recommends that PTO provide model specifications for each site with defined terms in the included README documentation, as well as notes on any deviations.

Finding 3. It wasn't clear how PTO handled Daylight Savings Time (DST) in the customer AMI data. The DST start and end dates all had 24 hourly intervals, but there was no indication of how the switch from standard time to DST or vice versa was achieved. In the U.S. DST always ends at 2:00 a.m. local time and clocks are set back to 1:00 a.m., so that day has 25 hours; when we transition from standard time to DST in the spring, clocks are set forward so that day has 23 hours. Guidehouse included all 24 intervals for each DST start and end date in the analysis.

Recommendation 3. Guidehouse recommends providing information documenting the adjustments done to the AMI data, such as how DST was handled.

Finding 4. The AMI data contained a field labeled INTERVAL_END_TIME indexing the hourly time intervals, which had a range of 0 to 23 inclusive. "End" (or "hour ending") time, by convention, represents time intervals by the time-stamp at the *end* of each interval, and thus has a range of 1 to 24, whereas "start" (or "hour starting") time represents intervals by the start of each period, and thus ranges from 0 to 23. Guidehouse assumed the intervals were hour starting and conducted the analysis accordingly.

Recommendation 4. Guidehouse recommends reconciling the hour start/hour end convention with AMI field names.

Finding 5. While the hourly model contains coefficients sufficient to capture the separate program effects of weekday and weekend hours, the daily model only contains a single change coefficient (cf. Equations A-1 and A-2), which means it is unable to accommodate differing program impacts on weekdays versus weekends.

Recommendation 5. Guidehouse recommends adjusting the specification of the daily model to allow for separate weekday and weekend change terms. We will revise our evaluation plan for CY2021 to illustrate how to do this.

Appendix A. Impact Analysis Methodology

Guidehouse measured the VCx Program's annualized energy savings by developing baseline hourly energy usage models for each CY2020 program participant calibrated to their year of pre-enrollment hourly AMI usage data and available post-enrollment usage data using a regression model of the form shown in Equation A-1. In addition to AMI data, the evaluation team used degree-day data derived from local weather data supplied by PTO for this purpose.[5] CY2020 gross program savings comprises the sum of the individual participants' gross annualized savings.

Equation A-1. VCx Hourly Load Model

$$E_{t,d} = \sum_{h=1}^{24} \alpha_h HOD_{h,t} + \sum_{h=1}^{24} \beta_h HOD_{h,t} * Weekend_d + \sum_{m=1}^{12} \sum_{h=1}^{24} \beta_{m,h} HOD_{h,t} * Month_{t,m} +$$

$$\gamma_L CDH_{t,d} + \gamma_Q CDH_{t,d}^2 + \delta_L HDH_{t,d} + \delta_Q HDH_{t,d}^2 +$$

$$Change_{t,d} \left(\sum_{h=1}^{24} \theta_h HOD_h + \sum_{h=1}^{24} \varphi_h HOD_h * Weekend_d \right) + \varepsilon_t$$

where:

- t, d, m and h index the hour of day, day of week, month of year, and hour, respectively
- $E_{t,d}$ is the customer's energy consumption at hour t of day d
- The $HOD_{h,t}$ comprise a set of 24 binary hour-of-day indicators, which equal 1 if t falls in the hth hour of the day, and 0 otherwise
- $Weekend_d$ is a binary indicator that equals 1 if d is a weekend or holiday weekday, and 0 otherwise
- The $Month_{t,m}$ comprise a set of 12 month-of-year indicators, which equals 1 if t falls in month m, and 0 otherwise
- $CDH_{t,d}$ are the cooling degree hours during hour t of day d
- $HDH_{t,d}$ are the heating degree hours during hour t of day d
- $Change_{t,d}$ is a binary indicator that equals 1 if t falls after the date of the agreed-upon change(s), and 0 otherwise
- The α_h, β_h, $\beta_{m,h}$, γ_L, γ_Q, δ_L, δ_Q, θ and φ coefficients are unknown parameters to be estimated
- $\varepsilon_{t,d}$ is an hourly mean-zero disturbance term

Fitting this model to the available data in the baseline and reporting periods for a given participant using regression analysis yields a customer-specific set of coefficients that represent

[5] ZIP code-level weather data from The Weather Company was provided by PTO.

the effects of the program-induced operational changes net of hour of day, day-type, month of year, and weather.

In cases where a participant's model fails to meet the model fitness criteria (discussed in section A.1 below), the program may instead use a daily version of the model shown in Equation A-1, fitted to daily rollups of the customer's hourly usage and weather data, as Equation A-2 shows.

Equation A-2. VCx Daily Load Model

$$E_d = \alpha Weekend_d + \sum_{m=1}^{12} \beta_{d,m} Month_m + \gamma_L CDD_d + \gamma_Q CDD_d^2 + \delta_L HDD_d + \delta_Q HDD_d^2 + \theta Change_d + \varepsilon_d$$

where:

- E_d is the customer's energy consumption during day d
- CDD_d are the cooling degree days during day d
- HDD_d are the heating degree days during day d
- ε_d is a daily mean-zero disturbance term

All other definitions are the same as in Equation A-1. If the customer's daily load model meets all three fitness criteria, savings are calculated using this model.

A.1 Model Fitness Criteria

The VCx Program periodically re-estimates the selected model for each participant site as post-change observations accumulate until it meets the following criteria:

Model Fitness Criteria

- Normalized mean bias error (NMBE) < 0.5%
- Coefficient of Variation (CV) of the root mean square error (RMSE) < 25%
- Savings uncertainty < 0.5 at 68% confidence

where NMBE and CV(RMSE) are defined following normal industry practice, and savings uncertainty is defined for a given customer as the ratio of the standard error of the customer's estimated annualized savings to the magnitude of the annualized savings.[6] In calculating the standard errors, the program used a Newey-West estimator of the model covariance matrix[7] that is restricted to the coefficients in the model that interact with the change coefficients (the θs and φs); this has the effect of focusing the uncertainty measure on the change coefficients on which the energy savings calculation is based. The Newey-West covariance matrix is robust to

[6] For descriptions of these criteria, see ASHRAE Guideline 14, Measurement of Energy and Demand Savings (https://www.techstreet.com/mss/products/preview/1888937) and the International Performance Measurement and Verification Protocol: Concepts and Options for Determining Energy and Water Savings, Volume I, EVO-10000-1.2012 (http://www.eeperformance.org/uploads/8/6/5/0/8650231/ipmvp_volume_i__2012.pdf).

[7] Newey, Whitney K and Kenneth D. West, (1987). "A Simple, Positive Semi-definite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix." *Econometrica* 55 (3): 703–708 (https://www.nber.org/system/files/working_papers/t0055/t0055.pdf).

certain common departures from the assumptions underlying the standard linear regression model, namely heteroskedasticity and autocorrelated residuals.[8] For these reasons, Guidehouse approves of this approach. A t-test of the null hypothesis that the uncertainty value is greater than or equal to 0.5 is then performed, and the third criterion is met if the null hypothesis is rejected at the 68% confidence level or better.

A.2 Savings Calculation

Guidehouse used the set of individual change coefficients obtained from fitting each customer's regression model to their hourly usage and weather data to derive their annualized program savings. How this works depended on whether the hourly model (Equation A-1) or the daily model (Equation A-2) was used.[9]

In the case of the hourly model, the customer had 48 change coefficients, representing the average program savings the customer realized in each hour of the day by day-type (weekday vs. weekend). These were aggregated up to yearly values by summing each hourly change coefficient over the two day-types and then multiplying the resulting value by the number of days in CY2020 of that day type. This produced a weekday and weekend total, which were then added together for a final yearly total. In the case of the daily model, the single change coefficient represented the average program savings the customer realized per day. This value was multiplied by the number of calendar days in CY2020 to obtain the customer's annualized program savings.

A.3 Treatment of Non-Routine Events

The savings estimation method outlined in the previous section may be susceptible to bias if the data used to fit the pre-post model include periods when one or more non-routine events (NREs) occurs that affect customer usage. NREs can result in savings estimates that are either higher or lower than appropriate depending on whether the NRE occurs during the baseline period, the implementation period, the reporting period, or a combination. Guidehouse understands that the program generally followed the International Performance Measurement and Verification Protocol (IPMVP) guidance on handling NREs[10] to the extent feasible, which generally takes one of three possible approaches:

- Omitting the data from the period(s) affected by the NRE
- Redefining the baseline model by adding variables that identify and control for the impact of the NRE
- Estimating the impact on program savings of the NRE and applying a non-routine adjustment (NRA) to offset that impact of the NRE

Guidehouse generally recommends using the first approach as long as the number of affected observations is small enough to permit robust estimation of the baseline (i.e., pre-change) usage, post-change usage or, if relevant, both. Most common NREs that typically affect the

[8] While heteroskedasticity and autocorrelation do not cause bias in the regression estimates of the model coefficients themselves, they can bias the estimated variance-covariance values, and thus the standard error of the normalized energy savings. See, e.g., William H. Greene, *Econometric Analysis*.

[9] Note that regardless of which model was used, the resulting savings is weather-normalized.

[10] IPMVP Application Guide on Non-Routine Events & Adjustments. EVO 10400-1:2020, October 2020 (https://evo-world.org/images/denisdocuments/NRE_TOC.pdf).

measured program savings of VCx participants include temporary overrides of the schedule and setback changes adopted through the program (e.g., to accommodate maintenance or repair work), special events (e.g., holidays, sales, school closures), and participation in other energy efficiency programs; these common NREs have been dealt with using the first method in the past.

The COVID-19 pandemic pushed these methods to the fore in Illinois because VCx participants saw their normal business operations affected by the pandemic—either by being entirely shut down or experiencing significantly attenuated operations for an extended period. Given the open-ended, uncertain nature of the pandemic, omitting data was not a practical option in all such cases. The program decided on the approach to use based on the timing and duration of the COVID-19 NRE.

In cases where the pandemic effects occurred during the baseline period and normal operations eventually resumed, the program excluded the impacted period and, where necessary, extended the baseline period backward to compensate for the excluded time using data from the prior year.[11]

If the COVID-19 NRE occurred during the period when the VCx changes were being implemented and ended prior to the start of the reporting period, the IPMVP guidance recommends delaying the reporting period until the NRE has ended. PTO's plan[12] indicates that if a permanent NRE began during this period (e.g., if operations changed permanently as a result of the pandemic, or a major change to the site's electric load was added such as a new ventilation schedule or significant new HVAC equipment), they withdrew the project from consideration.

If the COVID-19 NRE occurred during the reporting period, PTO followed the IPMVP guidance, which involved omitting data or redefining the baseline by adding variables or extending the reporting period.

[11] VCx M&V Plan, Op. Cit. Section 4.1.1.

[12] VCx M&V Plan, Op. Cit., Section 4.1.2.

Appendix B. Detailed Customer-Level Results

Table B-1. CY2020 Verified Savings by Customer

VCx ID	PTO Model Resolution	Guidehouse Model Resolution	Verified Savings (kWh)	Verified Savings %	Ex Ante Savings (kWh)	Relization Rate
0061Q00000qd2poQAA	Hourly	Hourly	183,031	29.3%	146,297	1.25
0061Q00000odI74QAE	Hourly	Hourly	50,672	24.1%	47,492	1.07
0061Q00000od1oPQAQ	Hourly	Hourly	13,843	4.5%	13,094	1.06
0061Q00000mttKtQAI	Daily	Hourly	269,914	16.0%	258,506	1.04
0061Q00000mCWDFQA4	Hourly	Hourly	51,223	8.1%	49,234	1.04
0061Q00000oeZ3bQAE	Hourly	Hourly	39,656	10.7%	38,548	1.03
0061Q00000obXiQQAU	Daily	Daily	188,143	25.3%	183,966	1.02
0061Q00000oeuDVQAY	Hourly	Hourly	127,170	18.5%	124,637	1.02
0063600000i5qeYAAQ	Hourly	Hourly	28,640	10.0%	28,200	1.02
0061Q00000r7GmcQAE	Daily	Hourly	136,891	23.4%	134,810	1.02
0061Q00000odKQXQA2	Hourly	Hourly	38,446	3.9%	37,876	1.02
0061Q00000oeZ2sQAE	Hourly	Hourly	83,739	6.3%	82,610	1.01
0061Q00000oeZ4tQAE	Daily	Hourly	251,090	27.6%	248,151	1.01
0061Q00000oevhrQAA	Hourly	Hourly	64,572	13.9%	63,818	1.01
0061Q00000kQadkQAC	Hourly	Hourly	2,767	3.2%	2,736	1.01
0061Q00000od7UTQAY	Daily	Hourly	49,005	53.5%	48,519	1.01
0063600000fuotsAAA	Hourly	Hourly	9,870	10.2%	9,773	1.01
0061Q00000kQafLQAS	Hourly	Hourly	11,810	9.5%	11,695	1.01
0061Q00000oepPkQAI	Hourly	Hourly	125,891	15.1%	124,704	1.01
0061Q00000kQadiQAC	Hourly	Hourly	8,476	7.9%	8,398	1.01
0061Q00000r704NQAQ	Hourly	Hourly	1,255,632	7.9%	1,244,645	1.01
0061Q00000r7FfkQAE	Hourly	Hourly	29,119	15.5%	28,874	1.01
0061Q00000odJzDQAU	Hourly	Hourly	49,541	8.9%	49,129	1.01
0061Q00000r7ioCQAQ	Hourly	Hourly	403,711	20.3%	400,749	1.01
0061Q00000odUToQAM	Daily	Daily	28,948	11.3%	28,738	1.01
0061Q00000kQadsQAC	Hourly	Hourly	12,484	12.5%	12,402	1.01
0061Q00000r8ZHTQA2	Hourly	Hourly	167,825	15.1%	166,724	1.01
0061Q00000r8qEAQAY	Hourly	Hourly	484,902	34.3%	481,788	1.01
0061Q00000obSXlQA2	Hourly	Hourly	31,575	6.1%	31,379	1.01
0061Q00000mCx0WQAS	Hourly	Hourly	69,497	23.2%	69,095	1.01
0061Q00000tTXFPQA4	Hourly	Hourly	449,183	28.2%	446,764	1.01
0063600000fusDsAAI	Hourly	Hourly	34,390	5.8%	34,207	1.01
0063600000i5GLrAAM	Hourly	Hourly	116,062	28.2%	115,454	1.01
0061Q00000odI0nQAE	Hourly	Hourly	74,445	26.2%	74,067	1.01

VCx ID	PTO Model Resolution	Guidehouse Model Resolution	Verified Savings (kWh)	Verified Savings %	Ex Ante Savings (kWh)	Relization Rate
0063600000fuotpAAA	Hourly	Hourly	10,653	11.9%	10,601	1.00
0061Q00000r9sqhQAA	Hourly	Hourly	457,947	9.8%	455,751	1.00
0061Q00000r7jAwQAI	Hourly	Hourly	163,617	19.2%	162,835	1.00
0061Q00000mDC5bQAG	Hourly	Hourly	419,819	37.2%	417,897	1.00
0061Q00000ocay9QAA	Hourly	Hourly	244,632	15.3%	243,533	1.00
0061Q00000kQaeMQAS	Hourly	Hourly	16,750	15.4%	16,675	1.00
0061Q00000kQafCQAS	Hourly	Hourly	56,793	15.1%	56,539	1.00
0063600000g4SheAAE	Hourly	Hourly	65,246	25.3%	64,959	1.00
0061Q00000mCWEBQA4	Hourly	Hourly	78,674	10.7%	78,335	1.00
0061Q00000rlquoQAA	Hourly	Hourly	691,984	20.3%	689,067	1.00
0063600000i5GK2AAM	Hourly	Hourly	79,076	17.7%	78,752	1.00
0061Q00000r8tFlQAI	Hourly	Hourly	128,230	47.4%	127,705	1.00
0061Q00000oeZ2JQAU	Hourly	Hourly	73,744	15.7%	73,466	1.00
0061Q00000kQaf7QAC	Hourly	Hourly	13,868	5.3%	13,816	1.00
0063600000g4SVwAAM	Hourly	Hourly	73,842	24.0%	73,581	1.00
0061Q00000oepGiQAI	Hourly	Hourly	12,541	8.0%	12,497	1.00
0063600000i5GL0AAM	Hourly	Hourly	136,028	35.6%	135,555	1.00
0061Q00000oeLkLQAU	Hourly	Hourly	185,509	14.7%	184,946	1.00
0061Q00000oc7lpQAA	Hourly	Hourly	86,065	21.6%	85,806	1.00
0061Q00000mttKqQAI	Hourly	Hourly	676,435	25.6%	674,401	1.00
0063600000g4SWMAA2	Hourly	Hourly	52,296	23.6%	52,142	1.00
0061Q00000odK1iQAE	Hourly	Hourly	132,527	22.2%	132,152	1.00
0061Q00000mttLoQAI	Hourly	Hourly	150,401	14.8%	149,980	1.00
0063600000i5GNyAAM	Hourly	Hourly	639,912	38.5%	638,183	1.00
0063600000i5DcUAAU	Hourly	Hourly	20,380	4.5%	20,326	1.00
0061Q00000oeNstQAE	Hourly	Hourly	163,499	31.5%	163,082	1.00
0061Q00000ofUhmQAE	Hourly	Hourly	120,725	40.1%	120,432	1.00
0063600000i5GJnAAM	Hourly	Hourly	110,121	30.5%	109,860	1.00
0061Q00000mCWG0QAO	Hourly	Hourly	97,760	20.5%	97,528	1.00
0061Q00000oc59jQAA	Hourly	Hourly	67,208	15.6%	67,055	1.00
0061Q00000mCWDTQA4	Hourly	Hourly	347,310	30.9%	346,578	1.00
0063600000g4SbNAAU	Daily	Daily	24,034	12.0%	23,984	1.00
0061Q00000oeNsdQAE	Hourly	Hourly	168,247	33.7%	167,933	1.00
0061Q00000mGqlXQAS	Hourly	Hourly	90,395	24.9%	90,240	1.00

VCx ID	PTO Model Resolution	Guidehouse Model Resolution	Verified Savings (kWh)	Verified Savings %	Ex Ante Savings (kWh)	Relization Rate
0061Q00000mCWDLQA4	Hourly	Hourly	202,336	37.7%	202,017	1.00
0061Q00000oeZ3vQAE	Hourly	Hourly	151,932	15.9%	151,710	1.00
0063600000i5GJzAAM	Hourly	Hourly	88,947	20.8%	88,831	1.00
0061Q00000ocA1gQAE	Hourly	Hourly	122,397	15.9%	122,251	1.00
0061Q00000mGqIaQAC	Hourly	Hourly	110,439	33.1%	110,342	1.00
0061Q00000mCWF5QAO	Hourly	Hourly	522,350	19.6%	522,170	1.00
0061Q00000r9QJwQAM	Hourly	Hourly	149,095	13.6%	149,128	1.00
0063600000fusDZAAY	Hourly	Hourly	99,783	15.1%	99,813	1.00
0061Q00000kQafDQAS	Hourly	Hourly	22,471	8.2%	22,478	1.00
0061Q00000mttKvQAI	Hourly	Hourly	386,078	23.1%	386,236	1.00
0061Q00000mCWDKQA4	Hourly	Hourly	68,378	11.2%	68,407	1.00
0061Q00000oemZSQAY	Hourly	Hourly	123,944	25.2%	124,011	1.00
0061Q00000obwVhQAI	Hourly	Hourly	1,252,358	31.8%	1,253,102	1.00
0061Q00000ocOChQAM	Hourly	Hourly	280,454	18.5%	280,631	1.00
0061Q00000obTwuQAE	Daily	Daily	12,863	17.8%	12,880	1.00
0063600000fuotlAAA	Daily	Hourly	32,905	12.2%	32,949	1.00
0061Q00000mttN5QAI	Daily	Hourly	87,440	29.2%	87,583	1.00
0061Q00000r9mw9QAA	Daily	Hourly	291,283	43.4%	291,774	1.00
0061Q00000r704XQAQ	Daily	Daily	8,716	13.3%	8,731	1.00
0061Q00000oevjjQAA	Hourly	Hourly	10,949	20.2%	10,970	1.00
0061Q00000mttNUQAY	Hourly	Hourly	60,502	24.8%	60,626	1.00
0063600000fusDhAAI	Hourly	Hourly	142,609	13.2%	142,926	1.00
0061Q00000odSG8QAM	Hourly	Hourly	28,883	16.9%	28,953	1.00
0061Q00000r7enkQAA	Hourly	Hourly	32,498	13.2%	32,582	1.00
0061Q00000mCWEVQA4	Hourly	Hourly	73,350	16.2%	73,549	1.00
0061Q00000oexpJQAQ	Hourly	Hourly	21,892	24.0%	21,964	1.00
0061Q00000r6ZguQAE	Hourly	Hourly	37,462	14.1%	37,594	1.00
0061Q00000r704aQAA	Hourly	Hourly	517,952	10.2%	520,236	1.00
0061Q00000oc6UJQAY	Hourly	Hourly	186,995	24.8%	187,890	1.00
0061Q00000mCWFSQA4	Hourly	Hourly	27,328	12.6%	27,472	0.99
0061Q00000oexp9QAA	Hourly	Hourly	9,283	7.9%	9,333	0.99
0061Q00000odUuGQAU	Hourly	Hourly	447,960	21.9%	450,742	0.99
0061Q00000oertiQAA	Hourly	Hourly	27,073	21.4%	27,257	0.99
0061Q00000oeZ1GQAU	Hourly	Hourly	100,487	20.2%	101,206	0.99

VCx ID	PTO Model Resolution	Guidehouse Model Resolution	Verified Savings (kWh)	Verified Savings %	Ex Ante Savings (kWh)	Relization Rate
0061Q00000mCWFeQAO	Hourly	Hourly	414,499	15.6%	417,865	0.99
0061Q00000oeRTKQA2	Hourly	Hourly	78,572	12.7%	79,294	0.99
0063600000i5qdYAAQ	Daily	Daily	99,032	36.7%	99,995	0.99
0063600000fuzeTAAQ	Hourly	Hourly	25,115	5.2%	25,405	0.99
0063600000fuzg4AAA	Hourly	Hourly	18,463	9.8%	18,686	0.99
0061Q00000oepEcQAI	Daily	Daily	11,380	14.4%	11,519	0.99
0063600000i5GKaAAM	Hourly	Hourly	12,673	4.3%	12,848	0.99
0061Q00000kQafPQAS	Hourly	Hourly	38,206	18.1%	38,755	0.99
0061Q00000oexhoQAA	Hourly	Hourly	19,392	16.5%	19,712	0.98
0063600000i5GIsAAM	Hourly	Hourly	7,805	2.3%	7,944	0.98
0061Q00000kQafBQAS	Hourly	Hourly	252,734	25.7%	258,816	0.98
0061Q00000r7hZzQAI	Hourly	Hourly	78,914	14.1%	80,863	0.98
0061Q00000oemZRQAY	Hourly	Hourly	28,788	9.5%	29,608	0.97
0063600000g4SexAAE	Daily	Hourly	57,770	2.7%	59,526	0.97
0061Q00000r7Gn2QAE	Hourly	Hourly	25,359	12.6%	26,176	0.97
0061Q00000od0IRQAY	Hourly	Hourly	520,064	32.1%	537,550	0.97
0061Q00000ocQ3TQAU	Daily	Daily	57,078	13.4%	59,004	0.97
0061Q00000odUKhQAM	Hourly	Hourly	15,588	11.1%	16,523	0.94
0061Q00000oepPQQAY	Hourly	Hourly	35,972	4.0%	38,168	0.94
0061Q00000obtkFQAQ	Hourly	Hourly	139,099	22.0%	149,618	0.93
0061Q00000r704WQAQ	Hourly	Hourly	14,762	8.3%	16,825	0.88
0061Q00000mttKyQAI	Hourly	Hourly	59,724	3.0%	73,348	0.81
Total			**18,548,812**		**18,509,660**	**1.00**

Source: Evaluation team analysis

Appendix C. Data and Data Cleaning Details

Guidehouse performed several data cleaning steps prior to modeling. Table C-1 shows details about the AMI data, the data cleaning process, and attrition at each cleaning step.

Table C-1. AMI Data Attrition

Step	Customer Count	Observation Count	Customers Removed	Observations Removed	%Customers Removed	%Observations Removed
0 - Raw AMI Data	124	4,486,240				
1 - Only Meters in Tracking & AMI Data	124	4,486,240	-	-	0%	0%
2 - Aggregate to Hourly	124	4,486,240	-	-	0%	0%
3 - Date Range of Interest	124	2,076,309	-	2,409,931	0%	54%
4 - Remove Incomplete Days	124	2,075,232	-	1,077	0%	0%
5 - Customers With Full Year of Pre-Period Data	124	2,075,232	-	-	0%	0%

Source: Evaluation team analysis

where:

0 – Raw AMI Data	This represents the data as received.
1 – Only Meters in Tracking & AMI Data	Guidehouse confirmed all customers had both tracking and AMI data.
2 – Aggregate to Hourly	Guidehouse confirmed all AMI observations were hourly.
3 – Date Range of Interest	Guidehouse removed AMI data outside the specified pre-period and reporting period ranges.
4 – Remove Incomplete Days	Guidehouse removed customer days without a complete set of hourly intervals.
5 – Customers With Full Year of Pre-Period Data	Guidehouse confirmed all customers had a full year of AMI data prior to the PTO change.

Appendix D. Total Resource Cost Detail

Table D-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) is not included in this table and will be provided to the evaluation team later.

Table D-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)
Other	VCx	Projects	124	7.3	No	18,548,812	1,673	NA	NA	NA	NA	1.00	1.00	NA	18,548,812	1,673	NA	NA	NA	NA
	Total			NA		18,548,812	1,673	NA	NA	NA	NA	1.00	1.00	NA	18,548,812	1,673	NA	NA	NA	NA

NA = not applicable (refers to a piece of data that cannot be produced or does not apply)
Note: To avoid double counting, the verified gross kWh and net kWh used in the TRC analysis exclude secondary energy savings from water reduction measures.
*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.
† Early replacement (ER) measures are flagged as YES; otherwise a NO is indicated in the column.
Source: ComEd tracking data and evaluation team analysis