



# Combined Utility RetroCommissioning Impact Evaluation Report

Energy Efficiency/Demand Response Plan:  
Program Year 2021 (CY2021)  
(1/1/2021-12/31/2021)

Prepared for:

ComEd  
Nicor Gas  
Peoples Gas  
North Shore Gas

**FINAL**

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## 1. Introduction

The CY2021 RetroCommissioning Program is offered jointly to customers served by ComEd, Nicor Gas, Peoples Gas, and North Shore Gas. This report presents results for all utilities.

This report 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) analysis inputs. CY2021 covers January 1, 2021 through December 31, 2021.

## 2. Program Description

The RetroCommissioning Program has been part of ComEd's Energy Efficiency Program since 2007. In 2010, ComEd began coordinating the program with gas utilities that also serve ComEd customers. ComEd manages and funds the program, and the gas utilities have the option to share the program costs and savings with ComEd on a project-by-project basis. The overlapping gas territories include Nicor Gas, Peoples Gas, and North Shore Gas.

The RetroCommissioning Program helps commercial and industrial customers below 10 MW improve the energy performance of their facilities through the systematic analysis of existing building systems. Program-qualified energy efficiency service providers (EESPs) recruit participants, conduct energy studies and recommend energy-saving measures to implement. EESPs are required to verify implemented projects and measures before the project is considered complete. Resource Innovations is the implementation contractor (IC) and verifies, tracks, and reports savings for the coordinating utilities.

Generally, the program pays 100% for a detailed study, contingent on a participant's commitment to spend a defined amount of their own money implementing study recommendations having a simple payback of 18 months or less. Formerly, the program consisted of four tracks<sup>1</sup>: traditional retrocommissioning (RCx), monitoring-based retrocommissioning (MBCx), RCxpress, and RCx Building Tune-Up (Tune-up). ComEd and Resource Innovations restructured the program in CY2021, merging RCx, RCxpress, and Tune-up into one offering: RetroCommissioning Flex. Most projects that completed in CY2021 are part of the legacy lineup.

- **RCx** projects typically require more than 1 year to complete and result in a single comprehensive deliverable.
- **RCxpress** engagements generally last 8-16 months and typically have a more limited scope than RCx.
- The **Tune-up** track focuses on the most common RCx measures in smaller commercial buildings and grocery stores and results in a briefer deliverable on a faster timeline.
- **MBCx** projects are supported by a multiyear agreement between the building owner and the EESP. This approach identifies, analyzes, implements, and verifies multiple bundles of measures on a rolling basis with the EESP monitoring building automation system (BAS) data periodically using integrated, program-installed software to document ongoing savings. Measure savings are counted toward program goals in the calendar year they are submitted based on EESP monitoring since the prior submitted savings.

The program reported 104 projects<sup>2</sup> in CY2021, a decrease of 11 projects compared to CY2020. In CY2021, the RetroCommissioning Program implemented measures with electric and gas savings as Table 2-1, Figure 2-2, and Figure 2-3 show.

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<sup>1</sup> An additional track, Virtual Retro-Commissioning (VCx), is offered under the RetroCommissioning Program umbrella both among the legacy and restructured lineup. VCx participant targets and recruiting and program delivery are significantly different from the program tracks discussed here. VCx impacts are evaluated and reported separately.

<sup>2</sup> MBCx participants can submit multiple bundles at different times during the year. Each MBCx bundle submitted in CY2021 is counted as one project for impact evaluation sampling purposes.

**Table 2-1. Volumetric Findings Detail by Utility**

Participation	Electric Only	Nicor Gas	Peoples Gas	North Shore Gas	Total
Projects with service*	26	30	40	8	104
Projects with savings†	27	30	39	8	104
Electric only measures	66	45	93	8	212
Gas only measures	0	4	11	1	16
Combination electric and gas	0	34	47	8	89
Total measures‡	66	83	151	17	317
Measures/project (service)	2.5	2.8	3.8	2.1	3.0

\* As noted by the IC as having gas accounts. Electric only service are all projects that did not identify a gas company in the tracking system.

† Projects without gas savings are included in electric only, even when the participant was served by one of the gas companies.

‡ All projects with gas service and savings also have CY2021 electric service and savings, except one project (18-524) where the implemented measures only produced gas savings.

Source: ComEd tracking data and evaluation team analysis

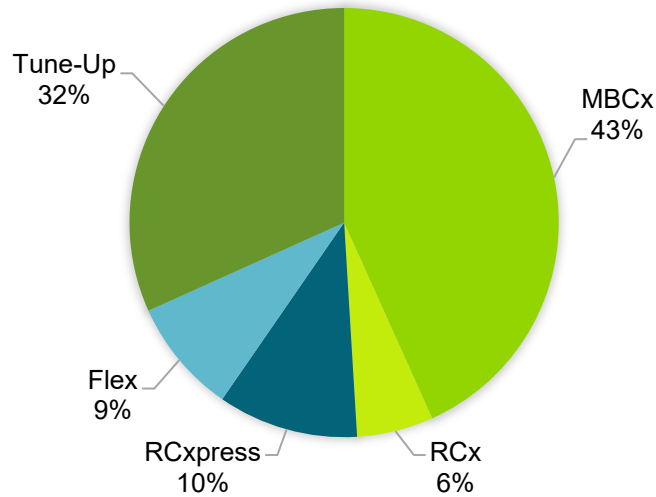
Table 2-2 and Figure 2-1 show the tracks included in the program and the distribution of projects by track.

**Table 2-2. CY2021 Volumetric Findings Detail by Track**

Participation	MBCx	RCx	RCxpress	Flex	Tune-Up	Total
Projects	45	6	11	9	33	104
Electric only measures	79	24	27	16	66	212
Gas only measures	9	1	1	0	5	16
Combination electric & gas	37	7	12	3	30	89
Total measures	125	32	40	19	101	317
Measures/project	2.8	5.3	3.6	2.1	3.1	3.0

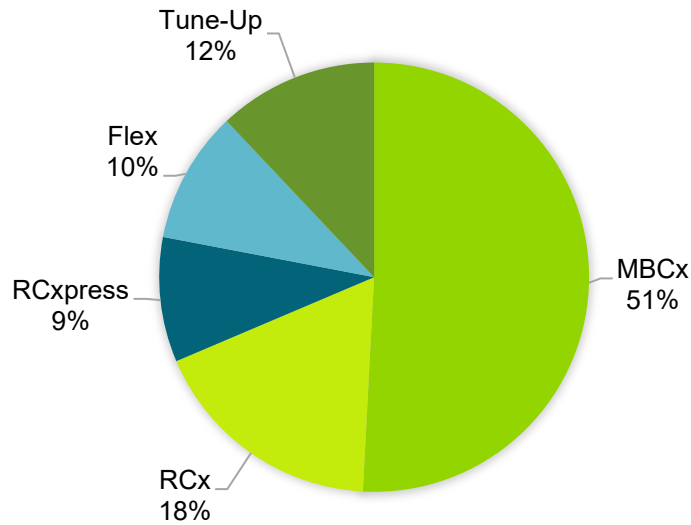
Source: ComEd tracking data and evaluation team analysis

**Figure 2-1. Distribution of Projects Completed by Track**



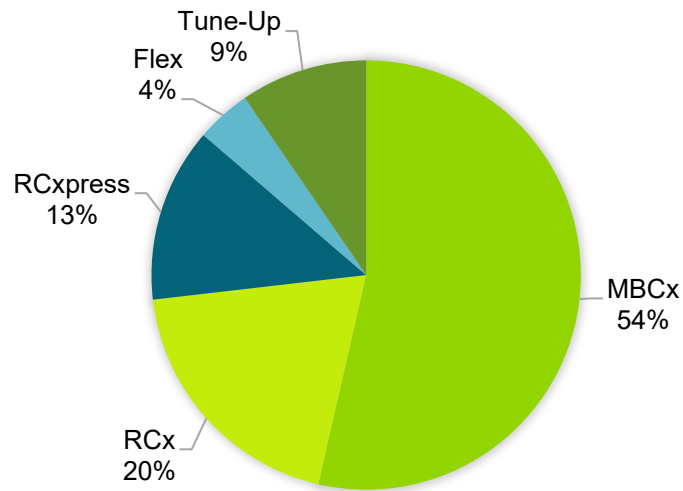
Source: ComEd tracking data and evaluation team analysis

**Figure 2-2. Distribution of Electric kWh Saved (Ex Ante Gross) by Track**



Source: ComEd tracking data and evaluation team analysis

**Figure 2-3. Distribution of Natural Gas Therms Saved (Ex Ante Gross) by Track**



Source: ComEd tracking data and evaluation team analysis



### 3. Program Savings Detail

Table 3-1 summarizes the incremental energy and demand savings the RetroCommissioning Program achieved in CY2021. The gas savings are only those that ComEd may be able to claim, which excludes savings the gas utilities claim, either via joint or non-joint programs.<sup>3</sup>

**Table 3-1. Total Annual Incremental Electric Savings**

Savings Category	Units	Ex Ante Gross Savings	Program Gross Realization Rate	Verified Gross Savings	Program Net-to-Gross Ratio (NTG)	CY2019 Net Carryover Savings	CY2020 Net Carryover Savings	Verified Net Savings
Electric Energy Savings - Direct	kWh	25,781,470	0.91	23,364,353	0.94	N/A	N/A	21,962,492
Electric Energy Savings - Converted from Gas <sup>‡</sup>	kWh	2,475,698	0.81	2,009,874	0.94	N/A	N/A	1,889,281
Total Electric Energy Savings	kWh	28,257,168	0.90	25,374,227	0.94	N/A	N/A	23,851,773
Summer Peak <sup>§</sup> Demand Savings	kW	1,965	1.04	2,041	0.94	N/A	N/A	1,919

N/A = not applicable (refers to a piece of data that cannot be produced or does not apply).

<sup>‡</sup> Gas savings are converted to kilowatt-hours (kWh) by multiplying therms by 29.31 (which is based on 100,000 Btu/therm and 3,412 Btu/kWh). The evaluation will determine which gas savings will be converted to kWh and counted toward ComEd's electric savings goal while producing the portfolio-wide Summary Report. According to Section 8-103B(b-25) of the Illinois Public Utilities Act, "In no event shall more than 10% of each year's applicable annual incremental goal as defined in paragraph (7) of subsection (g) of this Section be met through savings of fuels other than electricity."

<sup>§</sup> The coincident summer peak period is defined as 1:00-5:00 p.m. Central Prevailing Time on non-holiday weekdays, June through August.

The "Verified Net Savings" in row one (Electric Energy Savings – Direct) includes primary kWh savings as a result of measure implementation. It does not include carryover savings, secondary kWh savings from wastewater treatment or electric heating penalties as they don't apply to this program.

Source: ComEd tracking data and evaluation team analysis

Table 3-2 shows overall gas savings claimed by the gas utilities. The gas companies claimed a majority of the gas savings realized through the program.

**Table 3-2. CY2021 Total Annual Incremental Therm Savings**

Savings Category	Nicor Gas (Therms)	Peoples Gas (Therms)	North Shore Gas (Therms)
<b>Natural Gas*</b>			
Ex Ante Gross Savings	386,109	425,668	34,667
Program Gross Realization Rate	0.81	0.81	0.81
Verified Gross Savings	313,459	345,575	28,144
Program Net-to-Gross Ratio (NTG)	0.94	0.94	0.94
Verified Net Savings	294,652	324,840	26,455

\* Natural gas savings with electric interactive effects removed. Ex ante gross savings are based on final project files provided by ComEd and the IC.

Source: ComEd, Nicor Gas, Peoples Gas, and North Shore Gas tracking data and evaluation team analysis

<sup>3</sup> The evaluation team will determine which gas savings will be counted toward goal while producing the portfolio-wide Summary Report.

## 4. Cumulative Persisting Annual Savings

Table 4-1 to Table 4-3 and Figure 4-1 show the total verified gross savings for the RetroCommissioning Program and the cumulative persisting annual savings (CPAS) for the measures installed in CY2021. The electric CPAS across all measures installed in 2021 is shown in Table 4-1. The CY2021 gas contribution to CPAS (converted to equivalent electricity) is shown in Table 4-2. The combined savings are shown in Table 4-3. The historic rows in each table are the CPAS contribution back to CY2018. The Program Total Electric CPAS and the Program Total Gas CPAS are the sum of the CY2021 contribution and the historic contribution. Figure 4-1 shows the savings across the effective useful life (EUL) of the measures.

**Table 4-1. Cumulative Persisting Annual Savings – Electric**

End Use Type	Research Category	EUL	CY2021 Verified Gross Savings (kWh)	NTG*	Lifetime Net Savings (kWh)†	Verified Net kWh Savings								
						2018	2019	2020	2021	2022	2023	2024	2025	2026
RetroCommissioning	Tune-up	7.5	2,812,360	0.94	19,827,140				2,643,619	2,643,619	2,643,619	2,643,619	2,643,619	2,643,619
RetroCommissioning	All other tracks	8.6	20,551,993	0.94	166,142,308				19,318,873	19,318,873	19,318,873	19,318,873	19,318,873	19,318,873
<b>CY2021 Program Total Electric Contribution to CPAS</b>									21,962,492	21,962,492	21,962,492	21,962,492	21,962,492	21,962,492
<b>Historic Program Total Electric Contribution to CPAS‡</b>						34,519,759	66,202,042	93,043,004	93,043,004	93,043,004	93,043,004	93,043,004	75,783,125	58,523,245
<b>Program Total Electric CPAS</b>						34,519,759	66,202,042	93,043,004	115,005,496	115,005,496	115,005,496	115,005,496	97,745,616	80,485,737
<b>CY2021 Program Incremental Expiring Electric Savings§</b>									-	-	-	-	-	-
<b>Historic Program Incremental Expiring Electric Savings</b>									-	-	-	-	17,259,880	17,259,880
<b>Program Total Incremental Expiring Electric Savings</b>									-	-	-	-	17,259,880	17,259,880

End Use Type	Research Category	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
RetroCommissioning	Tune-up	2,643,619	1,321,809										
RetroCommissioning	All other tracks	19,318,873	19,318,873	11,591,324									
<b>CY2021 Program Total Electric Contribution to CPAS</b>		21,962,492	20,640,682	11,591,324									
<b>Historic Program Total Electric Contribution to CPAS‡</b>		40,464,344	11,541,614										
<b>Program Total Electric CPAS</b>		62,426,836	32,182,296	11,591,324									
<b>CY2021 Program Incremental Expiring Electric Savings§</b>		-	1,321,809	9,049,359	11,591,324								
<b>Historic Program Incremental Expiring Electric Savings</b>		18,058,901	28,922,730	11,541,614									
<b>Program Total Incremental Expiring Electric Savings</b>		18,058,901	30,244,539	20,590,972	11,591,324								

Note: The green highlighted cell shows program total first-year electric savings. The gray cells are blank, indicating values irrelevant to the CY2021 contribution to CPAS.

\* A deemed value. Source: Illinois SAG website: <https://www.ilsag.info/evaluator-ntg-recommendations-for-2021>.

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

‡ Historic savings go back to CY2018.

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

Source: Evaluation team analysis

**Table 4-2. Cumulative Persisting Annual Savings – Natural Gas, ComEd**

End Use Type	Research Category	EUL	CY2021 Verified Gross Savings (Therms)	NTG*	Lifetime Net Savings (Therms)†	Verified Net Therms Savings								
						2018	2019	2020	2021	2022	2023	2024	2025	2026
RetroCommissioning	Tune-up	7.5	5,466	0.94	38,536				5,138	5,138	5,138	5,138	5,138	5,138
RetroCommissioning	All other tracks	8.6	63,107	0.94	510,156				59,320	59,320	59,320	59,320	59,320	59,320
<b>CY2021 Program Total Gas Contribution to CPAS (Therms)</b>			<b>68,573</b>		<b>548,692</b>				<b>64,459</b>	<b>64,459</b>	<b>64,459</b>	<b>64,459</b>	<b>64,459</b>	<b>64,459</b>
<b>CY2021 Program Total Gas Contribution to CPAS (kWh Equivalent)‡</b>									<b>1,889,281</b>	<b>1,889,281</b>	<b>1,889,281</b>	<b>1,889,281</b>	<b>1,889,281</b>	<b>1,889,281</b>
<b>Historic Program Total Gas Contribution to CPAS (kWh Equivalent)§</b>						<b>2,907,030</b>	<b>3,986,674</b>	<b>7,278,229</b>	<b>7,278,229</b>	<b>7,278,229</b>	<b>7,278,229</b>	<b>7,278,229</b>	<b>5,824,714</b>	<b>4,371,200</b>
<b>Program Total Gas CPAS (kWh Equivalent)</b>						<b>2,907,030</b>	<b>3,986,674</b>	<b>7,278,229</b>	<b>9,167,511</b>	<b>9,167,511</b>	<b>9,167,511</b>	<b>9,167,511</b>	<b>7,713,996</b>	<b>6,260,481</b>
<b>CY2021 Program Incremental Expiring Gas Savings (Therms)</b>														
<b>CY2021 Program Incremental Expiring Gas Savings (kWh Equivalent)  </b>														
<b>Historic Program Incremental Expiring Gas Savings (kWh Equivalent)</b>													<b>1,453,515</b>	<b>1,453,515</b>
<b>Program Total Incremental Expiring Gas Savings (kWh Equivalent)</b>													<b>1,453,515</b>	<b>1,453,515</b>

End Use Type	Research Category	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
RetroCommissioning	Tune-up	5,138	2,569										
RetroCommissioning	All other tracks	59,320	59,320	35,592									
<b>CY2021 Program Total Gas Contribution to CPAS (Therms)</b>		<b>64,459</b>	<b>61,890</b>	<b>35,592</b>									
<b>CY2021 Program Total Gas Contribution to CPAS (kWh Equivalent)‡</b>		<b>1,889,281</b>	<b>1,813,982</b>	<b>1,043,209</b>									
<b>Historic Program Total Gas Contribution to CPAS (kWh Equivalent)§</b>		<b>3,507,484</b>	<b>1,974,933</b>										
<b>Program Total Gas CPAS (kWh Equivalent)</b>		<b>5,396,766</b>	<b>3,788,915</b>	<b>1,043,209</b>									
<b>CY2021 Program Incremental Expiring Gas Savings (Therms)</b>			<b>2,569</b>	<b>26,297</b>	<b>35,592</b>								
<b>CY2021 Program Incremental Expiring Gas Savings (kWh Equivalent)  </b>			<b>75,300</b>	<b>770,773</b>	<b>1,043,209</b>								
<b>Historic Program Incremental Expiring Gas Savings (kWh Equivalent)</b>		<b>863,715</b>	<b>1,532,551</b>	<b>1,974,933</b>									
<b>Program Total Incremental Expiring Gas Savings (kWh Equivalent)</b>		<b>863,715</b>	<b>1,607,851</b>	<b>2,745,706</b>	<b>1,043,209</b>								

Note: The green highlighted cell shows program total first-year gas savings in kWh equivalents. The gray cells are blank, indicating no values or do not contribute to calculating CPAS in CY2021.

\* A deemed value. Source: Illinois SAG website: <https://www.ilsag.info/evaluator-ntg-recommendations-for-2021>.

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

‡ kWh equivalent savings are calculated by multiplying therm savings by 29.31.

§ Historic savings go back to CY2018.

|| Incremental expiring savings are equal to CPAS Yn-1 - CPAS Yn.

Source: Evaluation team analysis

**Table 4-3. Cumulative Persisting Annual Savings – Total**

End Use Type	Research Category	EUL	CY2021 Verified			Verified Net kWh Savings (Including Those Converted from Gas Savings)									
			Gross Savings (kWh)	NTG* Savings (kWh)†	Lifetime Net Savings (kWh)‡	2018	2019	2020	2021	2022	2023	2024	2025	2026	
RetroCommissioning	Tune-up	7.5	2,972,572	0.94	20,956,636				2,794,218	2,794,218	2,794,218	2,794,218	2,794,218	2,794,218	2,794,218
RetroCommissioning	All other tracks	8.6	22,401,654	0.94	181,094,974				21,057,555	21,057,555	21,057,555	21,057,555	21,057,555	21,057,555	21,057,555
<b>CY2021 Program Total Contribution to CPAS</b>			<b>25,374,227</b>	<b>202,051,610</b>					<b>23,851,773</b>	<b>23,851,773</b>	<b>23,851,773</b>	<b>23,851,773</b>	<b>23,851,773</b>	<b>23,851,773</b>	<b>23,851,773</b>
<b>Historic Program Total Contribution to CPAS‡</b>						<b>37,426,789</b>	<b>70,188,716</b>	<b>100,321,234</b>	<b>100,321,234</b>	<b>100,321,234</b>	<b>100,321,234</b>	<b>100,321,234</b>	<b>81,607,839</b>	<b>62,894,444</b>	
<b>Program Total CPAS</b>						<b>37,426,789</b>	<b>70,188,716</b>	<b>100,321,234</b>	<b>124,173,007</b>	<b>124,173,007</b>	<b>124,173,007</b>	<b>124,173,007</b>	<b>105,459,612</b>	<b>86,746,218</b>	
<b>CY2021 Program Incremental Expiring Savings§</b>															
<b>Historic Program Incremental Expiring Savings</b>														<b>18,713,395</b>	<b>18,713,395</b>
<b>Program Total Incremental Expiring Savings</b>														<b>18,713,395</b>	<b>18,713,395</b>
End Use Type	Research Category		2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	
RetroCommissioning	Tune-up		2,794,218	1,397,109											
RetroCommissioning	All other tracks		21,057,555	21,057,555	12,634,533										
<b>CY2021 Program Total Contribution to CPAS</b>			<b>23,851,773</b>	<b>22,454,664</b>	<b>12,634,533</b>	-	-	-	-	-	-	-	-	-	
<b>Historic Program Total Contribution to CPAS‡</b>			<b>43,971,828</b>	<b>13,516,547</b>	-	-	-	-	-	-	-	-	-	-	
<b>Program Total CPAS</b>			<b>67,823,602</b>	<b>35,971,211</b>	<b>12,634,533</b>	-	-	-	-	-	-	-	-	-	
<b>CY2021 Program Incremental Expiring Savings§</b>			-	<b>1,397,109</b>	<b>9,820,131</b>	<b>12,634,533</b>	-	-	-	-	-	-	-	-	
<b>Historic Program Incremental Expiring Savings</b>			<b>18,922,616</b>	<b>30,455,281</b>	<b>13,516,547</b>	-	-	-	-	-	-	-	-	-	
<b>Program Total Incremental Expiring Savings</b>			<b>18,922,616</b>	<b>31,852,390</b>	<b>23,336,678</b>	<b>12,634,533</b>	-	-	-	-	-	-	-	-	

Note: The green highlighted cell shows program total first-year electric savings (including direct electric savings and those converted from gas). The gray cells are blank, indicating no values or do not contribute to calculating CPAS in CY2021.

\* A deemed value. Source: Illinois SAG website: <https://www.ilsag.info/evaluator-ntg-recommendations-for-2021>.

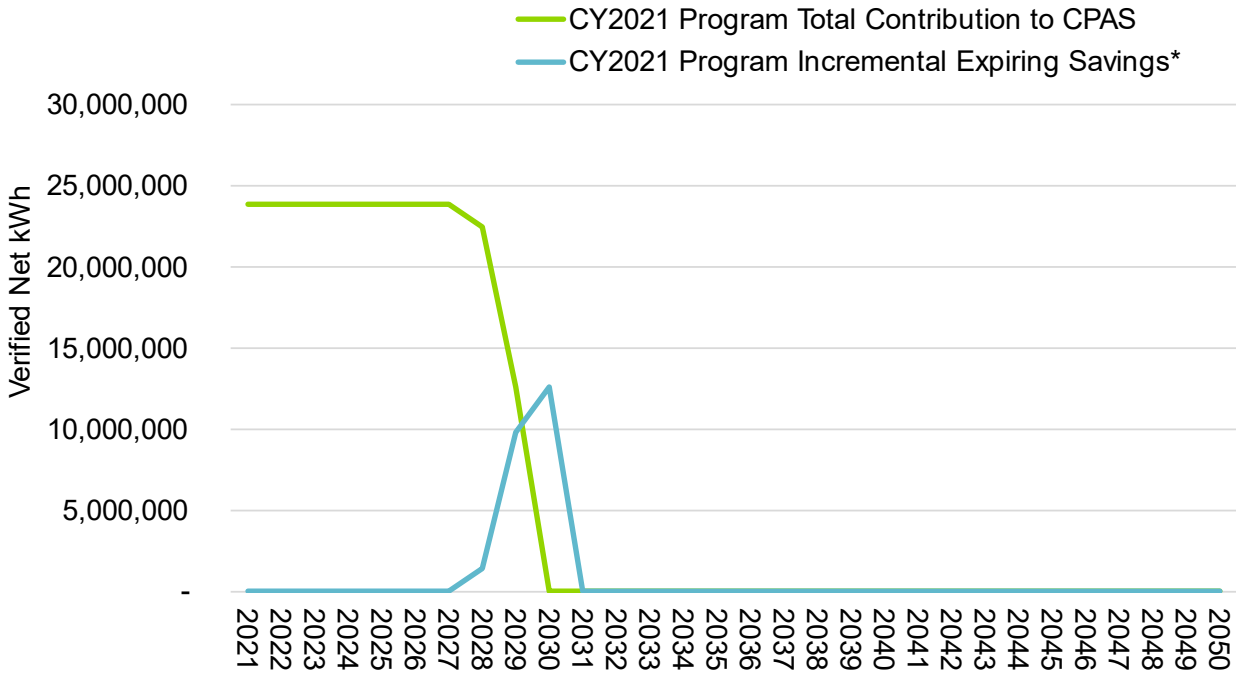
† Lifetime savings are the sum of CPAS savings through the EUL.

‡ 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  $Y_n$ .

Source: Evaluation team analysis

## **5. Program Savings by Measure**

The RetroCommissioning Program does not claim savings by measure, so this report does not present measure-level savings. Evaluation-verified savings for the program are based on a random sample of projects and reported at the project level. Appendix B provides more information about sampled project-level (bundle-level for MBCx) savings.

## 6. Impact Analysis Findings and Recommendations

Based on the CY2021 impact evaluation, the evaluation team developed the following findings and recommendations to help ComEd avoid future impact evaluation risk and improve program cost-effectiveness.

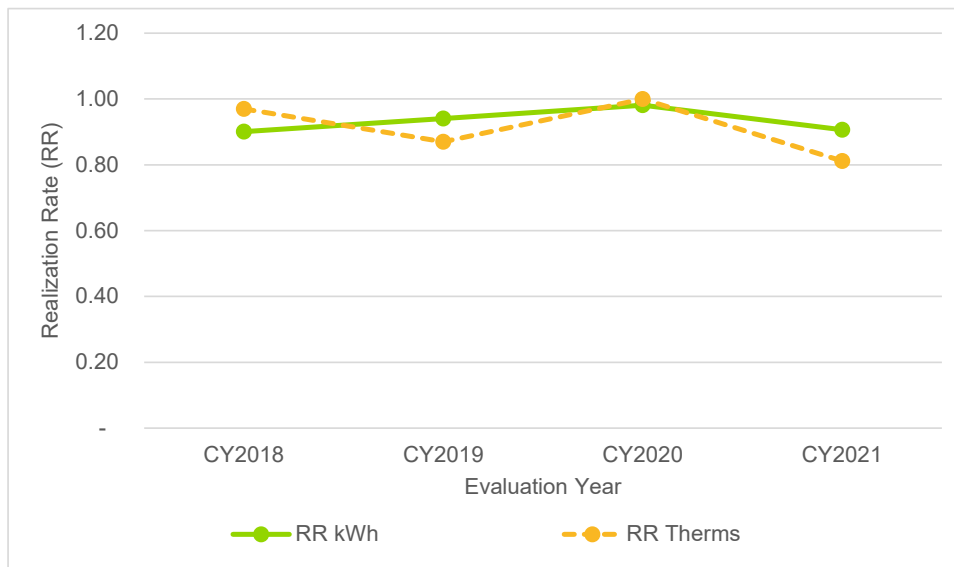
In general, the evaluation team did not find systemic concerns resulting in large adjustments to project-level ex ante gross savings. Rather, the team found small errors in calculated savings due to the following:

- Methodological issues including lack of supporting data (e.g., lack of seasonally relevant data to support seasonal savings for some measures).
- Incorrect assumptions for key inputs to savings algorithms (e.g., the program assumed an air-cooled chiller efficiency where the measure involved a water-cooled chiller).
- Differences in operational settings as installed compared to in the ex ante project file (e.g., the evaluation team found hours of use or HVAC system setpoint changes different than those documented in the file).

In some cases, additional data available to evaluators due to the passage of time was not available to the program for the ex ante calculation, which led to revised verified savings estimates. See Appendix B for more detail on project-level findings.

The CY2021 program-level realization rate for electricity savings is 0.91. The overall gas savings realization rate is 0.81. Realization rates for recent years are shown in Figure 6-1. CY2021 realization rates for kWh and therms are relatively lower than recent years, but do not indicate a trend, at this point.

**Figure 6-1. Realization Rates for Recent Years**



Source: ComEd tracking data and evaluation team analysis



The recommendations in the following sections generally apply to both electric and gas savings estimates, except where specific electric measures are referenced. Detailed findings specific to individual electric and gas projects are provided in Appendix B.

## 6.1 Findings Pertaining to Ex Ante Savings Methodology and Ex Ante Verification

**Finding 1.** Several custom savings estimates are based on assumptions, out-of-context spot measurements, or easy-to-acquire proxy measurements when more accurate or project-specific data should be used to satisfy industry standard practice impact calculation protocols. The frequency of these practices seems to be increasing. Examples include:

- The use of assumed equipment loading when measured or nameplate data are available.
- The use of variable frequency drive (VFD) speed and assumed loading without calibration when instantaneous power is available on VFDs.
- A crucial temperature in a dynamic system was measured a handful of times and assumed constant for all conditions of operation.
- Setback savings for internal spaces used a TRM algorithm for whole-building setbacks, which is not appropriate for setbacks only affecting internal spaces.

**Recommendation 1.** Emphasize the priority of measured data for RetroCommissioning verification. Install data loggers for power and temperature if BAS trends have gaps and it is safe to do so, especially for critical data like equipment loading and temperatures.

**Finding 2.** The structure of the monitoring-based program offering (MBCx) allows different bundles of measures to be submitted and verified with years of intervening time. Sometimes the subsequent measures affect the identical or overlapping systems and conditions of preceding measures, creating the potential to double count savings. Because the systems are monitored, sub-optimal operation can be quickly identified and corrected, but when this overlap of measures occurs, the initial measure and incentive preempts any claim for additional savings. Accounting for savings otherwise would open the program up to gaming the incentives.

**Recommendation 2.** Scrutinize later bundles of measures to ensure there is no concern about double counting savings from prior bundles. If helpful, ComEd can present case-by-case examples to evaluators for preliminary review, prior to granting a project savings and incentives.

**Finding 3.** Discharge air temperature (DAT) reset measures are not always documented adequately. While DAT trends are included with the analysis, the mixed air temperature (MAT) trends are not always provided. This data is required to determine if the measure is effective.

**Recommendation 3.** Document MAT controls and trend pre- and post-implementation for several weeks during conditions the reset is effective to improve the accuracy of program savings estimates.

**Finding 4.** Many measures have seasonal savings. Ex ante savings for some projects were based on data collected during the offseason (e.g., chiller optimization verified in October and

November). Sparse data during the offseason reduces confidence in the results and does not meet industry standard impact evaluation protocols.

**Recommendation 4.** Verify savings for the season in which the measure saves the most energy. This will reduce uncertainty in the ex ante savings estimate and satisfy industry standard practice for verifying energy impacts. Data spanning the full operating range of a measure is preferred.

**Finding 5.** Savings estimates frequently employ large and complex custom spreadsheets. These tools are susceptible to minor errors from time to time that can result in small or large changes to the realization rates. These errors include mis-mapped equations, erroneous inputs, or inappropriate weighting of parameters. None of the identified errors are systemic or endemic, but they do contribute to non-1.0 realization rates

**Recommendation 5.** Enhance quality control for the program. Calculate baseline and proposed operation independently to identify potential calculation or implementation errors. Encourage the use of program-standard calculation spreadsheets that have already undergone extensive review and are locked against spurious changes.

**Finding 6.** Revenue meter and interval data is frequently used to estimate savings or to confirm or adjust engineering savings estimates. Exceptional building operation during the COVID-19 pandemic means that this data will be less useful for the next couple years; however, the ComEd billing data interface typically holds 2 years of data. The IC has been downloading this data for all projects with completed applications.

**Recommendation 6.** Include the file of downloaded electrical interval data with the project files provided to evaluators, even if there is not an immediate use for the data.

**Finding 7.** Recommendations for and installation of high efficiency filters in air handling units have increased in frequency in the past several years. This measure has high implementation costs (7% of program participant implementation costs) while only delivering 2% of savings coupled with an aggregate simple payback of 1 year and a 1-year measure life. Furthermore, the fan energy savings estimates are based solely on manufacturer specifications with no opportunity for the evaluator to measure savings post-retrofit after the old filter media and frame have been removed. Savings estimates do not account for the various types of HVAC systems (e.g., variable air volume, constant air volume) and fan control sequence of operations that could affect the magnitude of savings realized for this measure. The program does not require any documentation demonstrating savings were realized for this measure, such as pre- and post-measure fan speeds or fan power measurements, variable air volume (VAV) box damper position trend data, or air balancing reports. The current implementation approach does not meet industry standard practice for verifying measure impacts.

**Recommendation 7.** Apply a higher level of rigor when approving this measure. Require fan power monitoring (return and supply speed and power) for at least two filter change cycles in the baseline and 3 months post-installation to establish actual savings. Consider proscribing this measure in the future.

**Finding 8.** The reach of the program has expanded outside the Chicago metropolitan area, yet the primary weather data used for weather-dependent measures still relies largely on Chicago area weather stations, partly due to embedded restrictions with program-standard calculators.

**Recommendation 8.** Provide guidance to EESPs to ensure uniform use of proximal datasets, perhaps by county.

**Finding 9.** The evaluation team found that some measures as installed used different operational input values (e.g., hours of use, temperature setpoints) than used in the ex ante calculators and supporting documentation.

**Recommendation 9.** Encourage EESPs to update ex ante calculations prior to finalizing the project to ensure the ex ante operational assumptions are still correct and the project savings are accurate.

## Appendix A. Impact Analysis Methodology

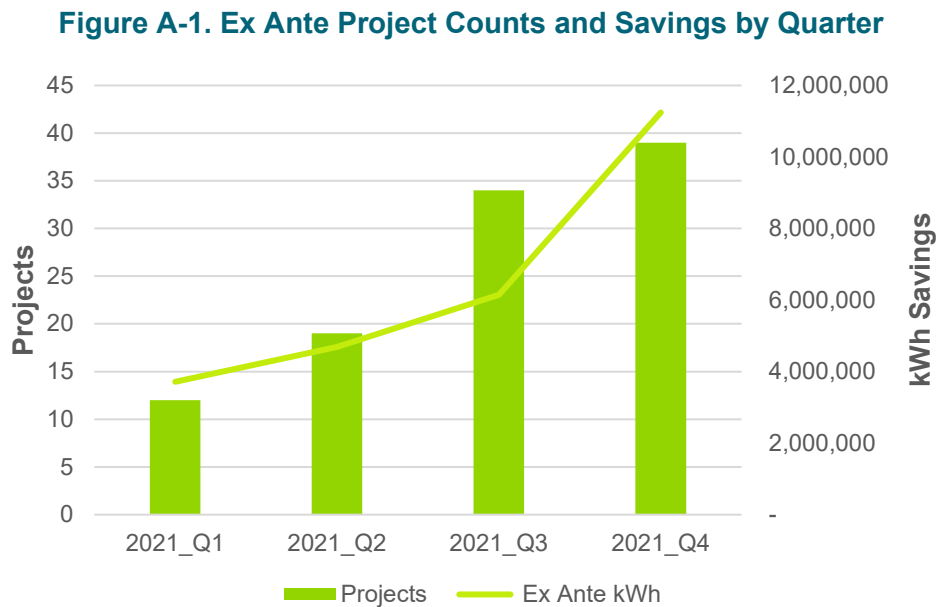
### A.1 Ex Ante Estimates

EESPs estimated ex ante energy and demand savings with custom algorithms, frequently using hourly weather data and time-series trend data applied in engineering relationships of energy, temperature, and mass transfer. Alternatively, when data supported the method, EESPs determined savings by regressions of utility-metered energy use versus outdoor temperature and other independent variables. When energy efficiency measures had a climate-related component, service providers used standard weather datasets (typical meteorological year 3, or TMY3)<sup>4</sup> for proximal locations to estimate weather-normalized savings.

The program only reports electric demand savings with respect to the summer peak. Some measures have demand savings tied to time of day. Other measures have demand savings that are weather-dependent. For the ComEd service territory, PJM determined the weighted temperature-humidity index zonal weather standard value is 81.6.

### A.2 Evaluation Methods

The impact evaluation consists of a review of a representative sample of projects. Due to the number of projects and the compressed schedule between program year-end and reporting, the evaluation team began project reviews in waves, roughly quarterly starting with the first quarter of 2021, including a mid-quarter sample between the third and fourth quarter. Figure A-1 shows the distribution of IC project completions by quarter.



Source: ComEd tracking data and evaluation team analysis

<sup>4</sup> Typical Meteorological Year, version 3, were produced by the National Renewable Energy Laboratory’s (NREL’s) Electric and Systems Center under the Solar Resource Characterization Project, which is funded and monitored by the US Department of Energy’s Energy Efficiency and Renewable Energy Office. Source data for all 239 TMY3 locations draw on data from 1991 through 2005.

In CY2021, the evaluation team reviewed 38 projects<sup>5</sup> (39% of the total), 10,131 MWh (39% of claimed), and almost 402,000 therms (43% of claimed).

Under normal circumstances, the evaluation team would conduct an engineering desk review and onsite verification for a large subset of sampled projects. Due to COVID-19 protocols, the team conducted onsite inspections at only eight of the largest-saving projects, among the 42 projects<sup>6</sup> sampled for the impact evaluation. Instead of additional onsite inspections, evaluators supplemented desk reviews with more phone interviews with building operators and reviewed some BAS via remote connection or teleconferencing.

The evaluation team reviewed each sampled project and its measures individually to validate the savings, usually using the same methods as the ex ante estimate. Savings calculation reviews ensured the savings estimates were accurately modeled, used consistent inputs, and included reasonable assumptions, as required. In some cases, the team acquired additional trend data or interval meter data to verify savings with more data and data concurrent with expected savings (e.g., winter data for winter measures). In most cases, the impact evaluation involved analysis of time-series trend and measured data both pre- and post-implementation. In all cases, the evaluation team normalized savings estimates to TMY weather data to minimize the effects of atypical weather variation.

In cases where the evaluation team's verified inputs were inconsistent with EESP reported data, such as setpoints or operational hours, the team re-estimated savings with available data, additional data requested from the participant or EESP, or program guideline inputs.

The evaluation team rolled up the verified savings for sampled projects to the population level according to the sampling protocol to obtain program gross realization rate impact parameter estimates for electric energy, electric demand, and natural gas energy savings. The evaluation team applied deemed net-to-gross (NTG) ratios to verified gross savings results to arrive at net researched impacts.

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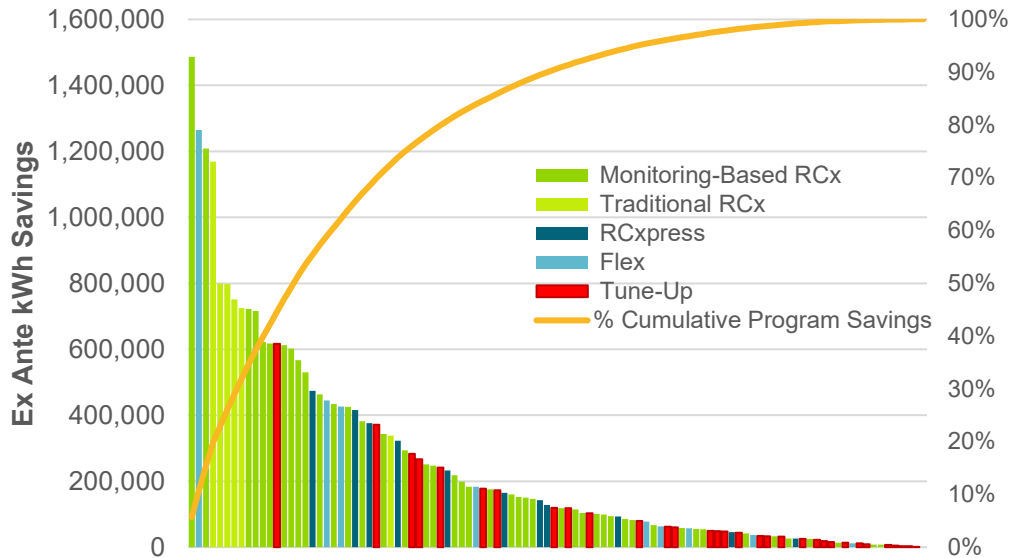
<sup>5</sup> The evaluation team reviewed 42 individual sample points because the team randomly selected multiple bundles per MBCx project in CY2021.

<sup>6</sup> Among the 38 unique project numbers, several MBCx projects were sampled for multiple bundles, so there are 42 sample points.

## Appendix B. Impact Findings Detailed Results

Figure B-1 shows the breakdown of electric savings in the RetroCommissioning Program by project and track. As expected, larger projects are generally in the MBCx and Traditional RCx tracks. For electricity, ex ante project savings ranged from over 1,486,000 kWh to 0 kWh, with the seven largest projects making up slightly more than one-quarter of program savings and 31 projects (30% of the total) covering more than 75% of electric energy savings.

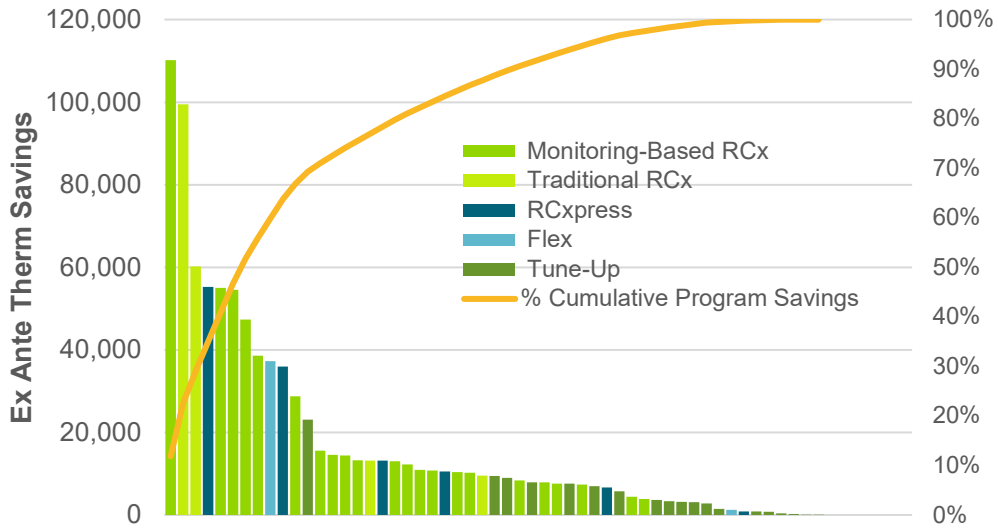
**Figure B-1. CY2021 Ex Ante Electric Energy Savings by Track and Project**



Source: Evaluation team analysis

Figure B-2 shows ex ante gas savings by project and track for the 53 participants with gas savings. As with electric savings, larger projects are generally in the RCx and MBCx tracks. For natural gas, ex ante savings per project ranged from 110,000 therms to 11 therms annually, with the seven largest projects making up one-half of program savings and the 16 largest accounting for more than 75% of program savings.

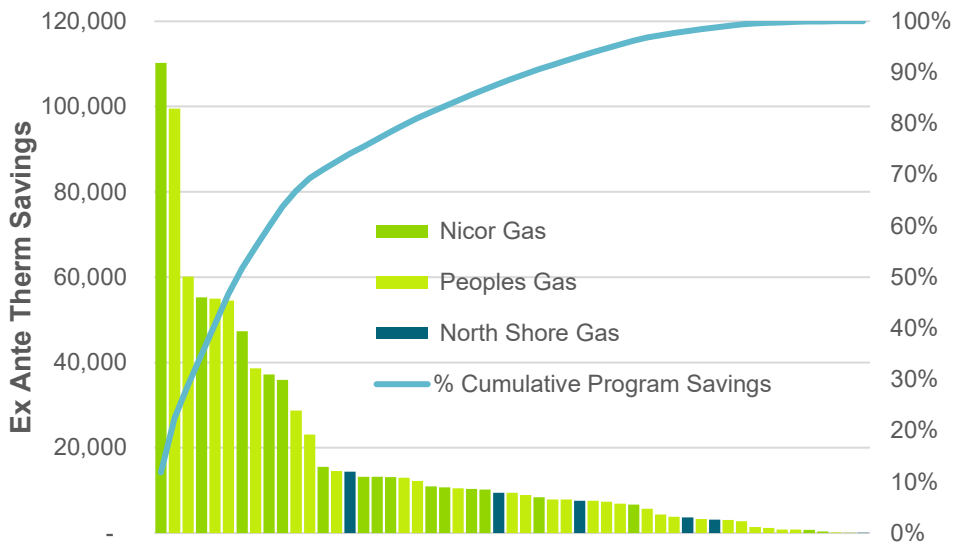
**Figure B-2. CY2021 Gas Energy Savings by Track and Project**



Source: Evaluation team analysis

Figure B-3 shows ex ante gas savings by utility.

**Figure B-3. CY2021 Gas Energy Savings by Utility and Project**



Source: Evaluation team analysis

Table B-1 details the realization rates of all sampled projects.

**Table B-1. Project-Level Realization Rates**

Project number	Track	Gas Company	RR kWh	RR kW	RR Therms	Notes
21-0002-B1	Flex	Peoples Gas	1.00		1.00	
21-0021-B1	Flex	Electric Only	0.94			A set-back savings calculation did not use the full set of trend data.
16-104-B6	MBCx	North Shore Gas	1.00	0.98	1.00	
17-117-B5	MBCx	Electric Only	0.59	1.00		A savings estimate claimed savings from reduced night-time ventilation when a prior MBCx measure already claimed to fix night-time overventilation.
18-115-B4	MBCx	Electric Only	0.95			An implemented measure saves reheat in the perimeter zones, but the savings estimate includes energy use in the core zones in error.
18-116-B1	MBCx	Peoples Gas	0.90		0.97	Estimates were based on VFD rated HP rather than the installed motor nameplate HP.
18-117-B2	MBCx	Electric Only	0.96			
19-0030-B7	MBCx	Peoples Gas	1.00		1.00	
19-0030-B8	MBCx	Peoples Gas	1.00	1.00	1.00	
19-0062-B2	MBCx	Peoples Gas	1.00			
19-0129-B2	MBCx	Peoples Gas	0.74			One measure savings estimate incorrectly averaged pump speed across all operating ranges to estimate power. Another estimate did not account for increased pumping in the winter months that are apparent in trend data.
19-0153-B1	MBCx	Electric Only	0.72			The savings estimate applied an unsubstantiated adjustment for the effects of Covid-19 on operations and did not normalize for weather.
20-0027-B2	MBCx	Nicor Gas	1.00		1.00	
20-0027-B3	MBCx	Nicor Gas	1.00		1.00	
20-0036-B2	MBCx	Nicor Gas	1.71		1.09	Additional post-installation trend data were used to refine savings estimates.
20-0036-B4	MBCx	Nicor Gas	0.93			Additional post-installation trend data were used to refine savings estimates.
20-0065-B1	MBCx	Nicor Gas	0.73			The savings calculation improperly summed heating and cooling savings.
20-0074-B1	MBCx	Peoples Gas	0.67	0.92		The savings calculation was corrected to match trended hours of operation and added a load factor for the fan motors.
20-0074-B2	MBCx	Peoples Gas	0.96			An un-documented factor used for low-speed VFD power. Evaluators defaulted to TRM methods, instead.
19-0080	RCx	Peoples Gas	0.94		0.27	The engineering methods used to estimate outdoor air ventilation were incorrect.
19-0081	RCx	Electric Only	0.97			
20-0015	RCx	Electric Only	0.96	0.65		Additional data acquired via site visit and supplemental trend data were used to correct pumping and fan power estimates.
18-041	RCxpress	Nicor Gas	1.04	1.00	0.48	A savings estimate double-counted a portion of the building heating load.
18-054	RCxpress	Nicor Gas	1.01	1.04	1.24	Hours of operation changed to match post-installation trends.

Source: Evaluation team analysis



**Table B-2. Project-Level Realization Rates Continued**

Project number	Track	Gas Company	RR kWh	RR kW	RR Therms	Notes
19-0146	RCxpress	Peoples Gas	1.06	0.99	1.00	Some savings estimates were missing some motor HP values.
19-0150	RCxpress	Nicor Gas	0.85		0.66	Estimated savings incorrectly included daytime hours when a measure only affects night operations. A calculation for heat-recovery improvement overstates system efficiency and latent cooling capability. There was an error in the model for one measure.
19-0165	RCxpress	Peoples Gas	1.00		1.02	
20-0009	RCxpress	Peoples Gas	1.00	1.00		
20-0011	RCxpress	Peoples Gas	1.00	1.00		
20-0031	RCxpress	Electric Only	0.99	1.00		
18-531	Tune-Up	Peoples Gas	0.98	1.07	1.00	
18-537	Tune-Up	Peoples Gas	1.83			Per conversation with the operating engineer, the affected chiller is far less efficient than assumed in the estimate.
18-541	Tune-Up	Peoples Gas	0.99	1.00	0.90	A small change to a small ventilation measure resulted in a 0.90 RR.
19-0042	Tune-Up	Electric Only	0.29	1.00		The savings estimate did not account for reduced hours of operation due to occupancy control.
19-0043	Tune-Up	Electric Only	0.78	0.96		The savings estimate did not account for reduced hours of operation due to occupancy control.
19-0044	Tune-Up	Nicor Gas	0.21			Savings for server room set-back measure inappropriately used a residential rule-of-thumb.
19-0097	Tune-Up	Nicor Gas	1.00			
19-0113	Tune-Up	Peoples Gas	1.00		1.00	
19-0147	Tune-Up	Peoples Gas	0.92		1.06	Savings were included for an area where the measure was not implemented, and a setpoint in a calculation was updated per data in the report.
19-0148	Tune-Up	Nicor Gas	0.99		0.99	
20-0019	Tune-Up	Electric Only	0.62	1.00		A heating setpoint in the calculation was incorrect, according to photos in the files.
20-0069	Tune-Up	Peoples Gas	1.00	1.00	1.00	

Source: Evaluation team analysis

## Appendix C. Total Resource Cost Detail

Table C-1 through Table C-4 show the TRC cost-effectiveness analysis inputs available at the time of finalizing this impact evaluation report. These tables do not include additional required cost data (e.g., measure costs, program-level incentives, and non-incentive costs). ComEd will provide this data to the evaluation team later.

**Table C-1. Total Resource Cost Savings Summary - ComEd**

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 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)
RetroCommissioning	Tune-up	Each	42	7.5	No	2,812,360	294	5,466	0	0	0	0.94	0.94	0.94	2,643,619	276	5,138	0	0	0
RetroCommissioning	All other tracks	Each	62	8.6	No	20,551,993	1,747	63,107	0	0	0	0.94	0.94	0.94	19,318,873	1,642	59,320	0	0	0
<b>Total</b>				<b>8.5</b>		<b>23,364,353</b>	<b>2,041</b>	<b>68,573</b>	<b>0</b>	<b>0</b>	<b>0</b>				<b>21,962,492</b>	<b>1,919</b>	<b>64,459</b>	<b>0</b>	<b>0</b>	<b>0</b>

\* 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: Evaluation team analysis of tracking data

**Table C-2. Total Resource Cost Savings Summary – Nicor Gas**

End Use Type	Research Category	Units	Quantity	EUL (years)*	ER Flag†	Ex Ante Savings (Therms)	Gross Verified Savings (Therms)	NTG‡	Verified Net Savings (Therms)
RetroCommissioning	Tune-up	Each	4	7.5	No	1,101	894	0.94	840
RetroCommissioning	All other tracks	Each	15	8.6	No	385,008	312,565	0.94	293,811
<b>Total</b>			<b>19</b>	<b>8.6</b>		<b>386,109</b>	<b>313,459</b>		<b>294,652</b>

\* The total of the EUL column is the WAML and is calculated as the sum product of EUL and measure savings divided by total program savings.

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

‡ A deemed value. Source: Illinois SAG website: <https://www.ilsag.info/evaluator-ntg-recommendations-for-2021>.

Source: Evaluation analysis of tracking data

**Table C-3. Total Resource Cost Savings Summary – Peoples Gas**

End Use Type	Research Category	Units	Quantity	EUL (years)*	ER Flag†	Ex Ante Gross Savings (Therms)	Verified Gross Savings (Therms)	NTG‡	Verified Net Savings (Therms)
RetroCommissioning	Tune-up	Each	15	7.5	No	78,020	63,340	0.94	59,539
RetroCommissioning	All other tracks	Each	17	8.6	No	347,648	282,235	0.94	265,301
			<b>32</b>	<b>8.4</b>		<b>425,668</b>	<b>345,575</b>		<b>324,840</b>

\* The total of the EUL column is the WAML and is calculated as the sum product of EUL and measure savings divided by total program savings.

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

‡ A deemed value. Source: Illinois SAG website: <https://www.ilsag.info/evaluator-ntg-recommendations-for-2021>.

Source: Evaluation team analysis of tracking data

**Table C-4. Total Resource Cost Savings Summary – North Shore Gas**

End Use Type	Research Category	Units	Quantity	EUL (years)*	ER Flag†	Ex Ante Gross Savings (Therms)	Verified Gross Savings (Therms)	NTG‡	Verified Net Savings (Therms)
RetroCommissioning	Tune-up	Each	2	7.5	No	3,171	2,574	0.94	2,420
RetroCommissioning	All other tracks	Each	4	8.6	No	31,496	25,570	0.94	24,036
			<b>6</b>	<b>8.5</b>		<b>34,667</b>	<b>28,144</b>		<b>26,455</b>

\* The total of the EUL column is the WAML and is calculated as the sum product of EUL and measure savings divided by total program savings.

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

‡ A deemed value. Source: Illinois SAG website: <https://www.ilsag.info/evaluator-ntg-recommendations-for-2021>.

Source: Evaluation team analysis of tracking data