Guidehouse
Outwit Complexity

# RetroCommissioning Program Impact Evaluation Report

## Energy Efficiency Plan: Program Year 2022 (1/1/2022-12/31/2022)

**Prepared for:**

**Nicor Gas Company**

**FINAL**

**May 1, 2023**

**Prepared by:**


Roger Hill
INCA Energy Efficiency

Sagar Phalke
Guidehouse




**guidehouse.com**

**Submitted to:**

Nicor Gas Company
1844 Ferry Road
Naperville, IL 60563

**Submitted by:**

Guidehouse
150 N. Riverside Plaza, Suite 2100
Chicago, IL 60606

**Contact:**

Ed Balbis
Partner
561.644.9407
**ebalbis@guidehouse.com**

Stu Slote
Director
802.526.5113
**stu.slote@guidehouse.com**

Laura Agapay-Read
Associate Director
312.583.4178
**laura.agapay.read@guidehouse.com**

Charles Ampong
Associate Director
608.446.3172
**charles.ampong@guidehouse.com**

# Table of Contents



# List of Tables, Figures, and Equations

# 1. Introduction

This report presents the results of the impact evaluation of the Nicor Gas 2022 RetroCommissioning program and a summary of the energy impacts for the total program and broken out by relevant measure and program structure details. The appendices present the impact analysis methodology, detailed engineering desk review results, and Illinois total resource cost (TRC) inputs. Program year 2022 covers January 1, 2022 through December 31, 2022.

The 2022 RetroCommissioning program is offered jointly to customers served by ComEd, Nicor Gas, Peoples Gas, and North Shore Gas. This report presents results of the impact evaluation for Nicor Gas.

# 2. Program Description

The RetroCommissioning program has been part of ComEd's Energy Efficiency program portfolio since 2007. In 2010, ComEd began coordinating the program with the 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 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. As the implementation contractor, Resource Innovations 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 its own funds implementing study recommendations with a simple payback of 18 months or less. Formerly, the program consisted of four tracks: (1) traditional RetroCommissioning (RCx), (2) Monitoring-Based RetroCommissioning (MBCx), (3) RCxpress, and (4) RCx Building Tune-Up (Tune-up). Starting 2021, ComEd and Resource Innovations restructured the program, merging RCx, RCxpress, and Tune-up into a single offering: RetroCommissioning Flex (RCx Flex). Most projects that completed in 2022 are part of this new offering.

- **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 and are submitted based on EESP monitoring since the prior submitted savings.

- **RCx** projects typically require more than one year to complete and result in a single comprehensive deliverable.

- **RCxpress** engagements generally last 8 to 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.
- Starting CY2021, the **RCx Flex** track merges the RCx, RCxpress, and Tune-Up tracks into a single offering.

The program had four participants in 2022 and completed four projects[1] as Table 2-1 shows.

**Table 2-1. 2022 Volumetric Findings Detail**

| Participation | Total |
|---|---|
| Participants* | 4 |
| Installed Projects † | 4 |

* Participants are defined as unique Business Name
† Installed Projects are defined as unique Vendor Project ID
*Source: Nicor Gas tracking data and Guidehouse evaluation team analysis.*

# 3. Program Savings Detail

Table 3-1 summarizes the energy savings the RetroCommissioning program achieved in 2022.

**Table 3-1. 2022 Annual Energy Savings Summary**

| Program Path | Ex Ante Gross Savings (therms) | Verified Gross RR* | Verified Gross Savings (therms) | NTG† | Verified Net Savings (therms) |
|---|---|---|---|---|---|
| All Other Tracks | 208,156 | 77% | 159,922 | 0.98 | 156,723 |
| **Total or Weighted Average** | **208,156** | **77%** | **159,922** | **0.98** | **156,723** |

* Realization Rate (RR) is the ratio of verified gross savings to ex ante gross savings, based on evaluation research findings.
† Net-to-Gross (NTG): A deemed value. Available on the Stakeholders Advisory Group (SAG) web site: **https://www.ilsag.info/evaluator-ntg-recommendations-for-2022/**.
*Source: Guidehouse evaluation team analysis.*

# 4. 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. 1.1.1.1Appendix A provides more information about sampled project-level (bundle-level for MBCx) savings.

[1] MBCx participants can submit multiple bundles at different times during the year. Each MBCx bundle submitted in CY2022 is counted as one project for impact evaluation sampling purposes.

# 5. Impact Analysis Findings and Recommendations

## 5.1 Findings and Recommendations

**Finding 1**. The evaluation team observed that custom calculators were used for measures (e.g., the optimum start for air handling units measure in project 22-0012) that could have used the standard calculator template. The standard calculator template reviewed by the evaluation team is locked against unintended changes and uses simplified savings estimates and verification. Custom calculators are comparatively more prone to errors, are difficult to review and may introduce errors like mis-mapped equations, erroneous inputs, or inappropriate weighting of parameters.

> **Recommendation 1.** Encourage the use of standard calculator template where possible. If custom calculations are used, particularly when a project uses standard calculators for some measures but not others, provide additional information and reasoning for not using the standard calculators as part of the project documentation.

**Finding 2**. Several custom savings estimates are based on assumptions, unreliable 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. Examples include:

- The use of spot measurements of difficult-to-measure parameters rather than using BAS trend data or installing data loggers
- The use of variable frequency drive (VFD) speed and assumed loading without calibration when instantaneous power is available on VFDs
- Calculation of heat load savings in one equation (baseline minus proposed) rather than separately to verify the heat flows are in the same direction

> **Recommendation 2.** Emphasize the priority of measured data for measure verification. Install data loggers for power and temperature if BAS trends have gaps and it is safe to do so, especially for critical data such as equipment loading and temperatures.

**Finding 3**. The evaluation team observed multiple input errors in the standard calculators and reporting. Some examples of the errors include incorrect motor horsepower, inconsistent heating and cooling limits, incorrect economizer limits, and incorrect reporting of energy or implementation costs as energy savings.

> **Recommendation 3.** Enhance quality control procedures to reduce these errors.

**Finding 4**. For some of the sampled projects, the measures had insufficient trend data or insufficient data points in the monitoring period, especially for the extreme temperature bins. Sparse data points for temperature bins reduce confidence in the results, introduce bias in the extrapolation if these data points are outliers, and do not meet industry standard impact evaluation protocols.

**Recommendation 4.** Extrapolation of binned trend data should require a minimum of five data points in each bin, especially if the data points are at the high or low end of the monitored parameters.

**Finding 5**. Through onsite inspections and phone interviews with building operators, the evaluation team observed that some retrocommissioning measures were deemed too aggressive by the operating engineers and undone to meet occupant comfort or other system setpoints. Examples of these measures include reduced morning warm-up duration, chiller pump optimization recommendations, and certain resets for chilled water temperature and condenser water temperature.

**Recommendation 5.** Time should be allowed post implementation for facility operators to adjust to the measures for continued feasibility before the program finalizes the estimated project savings. If the recommended changes are identified to be too aggressive and compromise system operation or occupant comfort, the EESPs should readjust the measures before finalizing project savings. The additional time post implementation will allow the EESPs to find compromised solutions for implemented measures rather than the facility operators entirely undoing the measure.

**Finding 6**. For project ID 19-0153, the savings calculations had adjustment factors to account for the effects of the COVID-19 pandemic on facility operations. The evaluation team determined that these adjustments were not required for this project as operations had returned to normal, a new normal has been implemented, or systems were never truly affected by the pandemic.

**Recommendation 6.** Only apply adjustment factors to account for the effect of the COVID-19 pandemic if the system operation at the facility is verified to be affected by the pandemic. If an adjustment factor is applied, include additional information in the project documentation to support the adjustment.

**Finding 7**. For three sampled projects, the calculation did not use the most appropriate weather station based on proximity.

**Recommendation 7.** Increase training on the availability of additional weather stations in the new version of the standard calculator template and ensure uniform use of proximal datasets.

# Appendix A. Impact Analysis Methodology

## A.1 Ex Ante Estimates

EESPs estimated ex ante energy 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)[2] for proximal locations to estimate weather-normalized savings.

## A.2 Evaluation Methods

The evaluation team used a stratified random sampling approach to select the gross impact sample. In 2022, the evaluation team reviewed 37 projects[3] (46% of the total) and 332,639 therms (38% of the total claimed). The team sorted projects based on the component track, presence or absence of therms savings, and the level of ex ante kWh savings, and then placed the projects into eight strata. Within each stratum, the team selected a random sample of projects for analysis.

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.

For a nested sample of projects (selected from projects sampled for engineering review), Guidehouse performed onsite inspections to determine whether implemented measures were still operating as described in project documentation (set points, affected equipment, hours of operation, etc.). For projects not selected for an onsite inspection, evaluators supplemented desk reviews with phone interviews with building operators and reviewed some BAS via remote connection or teleconferencing.

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.

[2] TMY3 were produced by the National Renewable Energy Laboratory'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.

[3] The evaluation team reviewed 38 individual sample points because the team randomly selected multiple bundles for one MBCx project in CY2022.

Table A-1 provides a profile of the gross impact measurement and verification sample for the RetroCommissioning program compared to the population.

**Table A-1. Profile of Gross Impact Sample (All Projects)**

| Population Summary | | | | Sample Summary | | |
|---|---|---|---|---|---|---|
| Program | Sampling Strata | Number of Projects (N) | Ex Ante Gross Savings (therms) | n | Ex Ante Gross Savings (therms) | Sampled % of Population (% therms) |
| RetroCommissioning | MBCx | 39 | 0 | 14 | 0 | N/A |
| | MBCx – Gas | 22 | 708,267 | 6 | 223,188 | 32% |
| | Large | 3 | 0 | 3 | 0 | N/A |
| | Large – Gas | 5 | 82,273 | 4 | 67,090 | 82% |
| | Medium | 8 | 0 | 6 | 0 | N/A |
| | Medium – Gas | 9 | 56,787 | 5 | 42,361 | 75% |
| | Small | 6 | 0 | 0 | 0 | N/A |
| | Small – Gas | 6 | 19,769 | 0 | 0 | 0% |
| **Total or Weighted Average** | | **98** | **867,096** | **38** | **332,639** | **38%** |

Note: The population and the sample summary represent all projects completed in CY2022 as per the ComEd tracking data, collaborated with the Nicor Gas data. Here we shown the gas sample disposition.

*Source: Guidehouse evaluation team analysis.*

### A.2.1 Savings Rollup

There are two basic statistical methods for combining individual gross RRs from the sample projects into an estimate of verified gross therms savings for the population when using stratified random sampling: separate and combined ratio estimation.[4] In the case of a separate ratio estimator, a separate gross therms savings RR is calculated for each stratum and then combined. In the case of a combined ratio estimator, the evaluation completes a single gross therms savings realization rate calculation without first calculating separate gross RRs by stratum.

The evaluation team used the separate ratio estimation technique to estimate verified gross impacts for the program. The separate ratio estimation technique follows the steps outlined in the California Evaluation Framework,[5] which identifies best practices in program evaluation. The team matched these steps to the stratified random sampling method it used to create the sample for the component.

[4] A full discussion and comparison of separate vs. combined ratio estimation can be found in *Sampling Techniques* (Cochran, 1977), pp. 164-169.

[5] Tec Market Works, *The California Evaluation Framework*, prepared for the California Energy Commission, June 2004, available at **http://www.calmac.org**.

# Appendix B. Impact Analysis Detailed Results

Table B-1 provides the ex ante and verified gas savings for each stratum.

**Table B-1. Gas Savings by Strata (All Projects)**

| Strata | Sample Size | Ex Ante Gross Savings (therms) | Verified Gross RR* | Verified Gross Savings (therms) | NTG† | Verified Net Savings (therms) |
|---|---|---|---|---|---|---|
| MBCx – Gas | 6 | 223,188 | 77% | 171,471 | 0.98 | 168,042 |
| Large – Gas | 4 | 67,090 | 105% | 70,767 | 0.98 | 69,352 |
| Medium – Gas | 5 | 42,361 | 100% | 42,177 | 0.98 | 41,333 |
| **Total or Weighted Average** | **38** | **332,639** | **86%** | **284,415** | **0.98** | **278,727** |

* RR is the ratio of verified gross savings to ex ante gross savings, based on evaluation research findings.
† Net-to-Gross (NTG): A deemed value. Available on the SAG web site: **https://www.ilsag.info/evaluator-ntg-recommendations-for-2022/**.

*Source: Guidehouse evaluation team analysis.*

Table B-2 shows the strata classification and ex ante and verified gas savings for all projects claimed by Nicor Gas in 2022.

**Table B-2. Gas Savings by Project (Nicor Gas Projects Only)**

| Project ID | Strata | Ex Ante Gross Savings (therms) | Verified Gross RR* | Verified Gross Savings (therms) | NTG† | Verified Net Savings (therms) |
|---|---|---|---|---|---|---|
| 20-0027 | MBCx - Gas | 128,205 | 77% | 98,497 | 0.98 | 96,527 |
| 21-0036 | MBCx - Gas | 32,098 | 77% | 24,660 | 0.98 | 24,167 |
| 20-0071‡ | MBCx - Gas | 25,001 | 77% | 19,208 | 0.98 | 18,824 |
| 20-0036 | MBCx - Gas | 22,852 | 77% | 17,557 | 0.98 | 17,206 |
| **Total or Weighted Average** | | **208,156** | **77%** | **159,922** | **0.98** | **156,724** |

* Realization Rate (RR) is the ratio of verified gross savings to ex ante gross savings, based on evaluation research findings.
† Net-to-Gross (NTG): A deemed value. Available on the SAG website: **https://www.ilsag.info/evaluator-ntg-recommendations-for-2022/**.
‡The MBCx project 20-0071 submitted two bundles (Bundle #1 and Bundle #2) at different times during the year. Only MBCx Bundle #1 was sampled for impact evaluation. As a result of this, the savings for this project in Table B-3 do not match the total savings for this project in Table B-2.

*Source: Guidehouse evaluation team analysis.*

Table B-3 details the verified gas savings and realization rates of all sampled gas projects.

### Table B-3. Gas Savings by Project (All Sampled Projects)

| Project ID | Strata | Ex Ante Gross Savings (therms) | Verified Gross RR* | Verified Gross Savings (therms) | NTG† | Verified Net Savings (therms) |
|---|---|---|---|---|---|---|
| 20-0027 | MBCx - Gas | 128,205 | 70% | 89,744 | 0.98 | 87,949 |
| 15-108 | MBCx - Gas | 46,167 | 96% | 44,498 | 0.98 | 43,609 |
| 21-0051 | Large - Gas | 38,635 | 72% | 27,792 | 0.98 | 27,236 |
| 21-0036 | MBCx - Gas | 32,098 | 80% | 25,534 | 0.98 | 25,023 |
| 19-0017 | Medium - Gas | 20,777 | 103% | 21,416 | 0.98 | 20,988 |
| 20-0032 | Large - Gas | 13,218 | 196% | 25,919 | 0.98 | 25,401 |
| 21-0019 | Medium - Gas | 11,070 | 100% | 11,070 | 0.98 | 10,849 |
| 21-0050 | Large - Gas | 10,993 | 117% | 12,812 | 0.98 | 12,556 |
| 20-0071 | MBCx - Gas | 8,038 | 74% | 5,941 | 0.98 | 5,822 |
| 22-0010 | MBCx - Gas | 7,049 | 58% | 4,123 | 0.98 | 4,040 |
| 19-0137 | Medium - Gas | 4,376 | 99% | 4,345 | 0.98 | 4,258 |
| 21-0031 | Large - Gas | 4,244 | 100% | 4,244 | 0.98 | 4,159 |
| 18-032 | Medium - Gas | 3,388 | 77% | 2,596 | 0.98 | 2,544 |
| 20-0077 | Medium - Gas | 2,750 | 100% | 2,750 | 0.98 | 2,695 |
| 19-0119 | MBCx - Gas | 1,631 | 100% | 1,631 | 0.98 | 1,598 |

Note: MBCx participants can submit multiple bundles at different times during the year. Each MBCx bundle submitted in CY2022 was counted as one project for impact evaluation sampling purposes.
* RR is the ratio of verified gross savings to ex ante gross savings, based on evaluation research findings.
† Net-to-Gross (NTG): A deemed value. Available on the SAG website: **https://www.ilsag.info/evaluator-ntg-recommendations-for-2022/**.

*Source: Guidehouse evaluation team analysis.*

# Appendix C. Program-Specific Inputs for the Illinois TRC

Table C-1 shows the TRC cost-effectiveness analysis inputs available at the time of producing this impact evaluation report. Currently, 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. Guidehouse will include annual and lifetime water savings and greenhouse gas reductions in the end of year summary report.

**Table C-1. Verified Cost-Effectiveness Inputs**

| Program Path | Savings Category | Units | Quantity | Effective Useful Life | Ex Ante Gross Savings (therms) | Verified Gross Savings (therms) | Verified Net Savings (therms) |
|---|---|---|---|---|---|---|---|
| All Other Tracks | All Other Tracks | Projects | 4 | 8.6 | 208,156 | 159,922 | 156,723 |
| **Total or Weighted Average** | | | **4** | **8.6** | **208,156** | **159,922** | **156,723** |

*Source: Nicor Gas tracking data and Guidehouse evaluation team analysis.*