NAVIGANT

Coordinated Utility Non-Residential New Construction Impact Evaluation Report

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

Presented to
ComEd
Nicor Gas
Peoples Gas
North Shore Gas

FINAL

April 26, 2019

Prepared by:

Jake Millette
Jayden Wilson
Opinion Dynamics

Ryan Kroll
Michaels Energy

Itron

Opinion Dynamics

MichaelsEnergy

www.navigant.com

Coordinated Utility Non-Residential New Construction Impact Evaluation Report

Submitted to:

ComEd
Three Lincoln Centre
Oakbrook Terrace, IL 60181

Nicor Gas Company
1844 Ferry Road
Naperville, IL 60563

Peoples Gas and North Shore Gas
200 East Randolph Street
Chicago, IL 60601

Submitted by:

Navigant Consulting, Inc.
150 N. Riverside Plaza, Suite 2100
Chicago, IL 60606

Contact:

Randy Gunn, Managing Director
312.583.5714
Randy.Gunn@Navigant.com

Jeff Erickson, Director
608.497.2322
Jeff.Erickson@Navigant.com

Rob Neumann, Assoc. Director
312-583-2176
Rob.Neumann@Navigant.com

Kevin Grabner, Associate Director
608.497.2323
Kevin.Grabner@Navigant.com

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

NAVIGANT

Coordinated Utility Non-Residential New Construction Impact Evaluation Report

1. Introduction

This report presents the results of the impact evaluation of the Coordinated Utility Non-Residential New Construction (New Construction) Program implemented for ComEd, Nicor Gas, and Peoples Gas and North Shore Gas Companies. CY2018 covers January 1, 2018 through December 31, 2018.

The report presents a summary of the energy and demand impacts for the overall program and broken out by utility. The appendix presents the impact analysis methodology and lists project-specific impact analysis findings and results.

2. Program Description

The New Construction Program aims to capture immediate and long-term energy efficiency opportunities that are available during the design and construction of new buildings, additions and renovations in non-residential and multi-family buildings in ComEd's service area. Nicor Gas, Peoples Gas and North Shore Gas each purchase therm savings from the program on a "dollars per therm" payment model on a project-by-project basis. Slipstream (formerly Seventhwave) implements the program by reaching out to design professionals, commercial real estate developers, and customers at the beginning of the design process. The New Construction Program coordinates with Nicor Gas, Peoples Gas, and North Shore Gas where their service areas overlap with ComEd's service area. The implementation team provides technical assistance in building designs to reduce energy use beyond what is required by existing building codes and standards. The program served 75 projects in CY2018 as shown in Table 2-1.

Table 2-1. CY2018 Volumetric Findings Detail

Project Description	Count of Projects
ComEd Only	9
ComEd and Nicor Gas	33
ComEd and Peoples Gas	28
ComEd and North Shore Gas	5
Total	75

Source: ComEd tracking data and Navigant team analysis.

In CY2018, the program also accepted applications from public sector buildings. A total of four public sector buildings participated in this program year. Three of these projects were in the Nicor Gas territory and one was in the North Shore Gas territory.

3. Program Savings Detail

Table 3-1 summarizes the incremental energy and demand savings the New Construction Program achieved by ComEd in CY2018. The gas savings in this table are only those that the gas utilities are not claiming because they are associated with projects which entered the program before the gas utilities began funding the program, and therefore will eventually disappear when all projects have been completed. These therm savings may be available for ComEd to claim. Table 3-2 shows the gas savings

claimed by the gas utilities.[1] Total net verified savings for CY2018 is 22,239,823 kWh and 981,763 kWh from gas savings converted to electricity for a total of 23,221,586 kWh.[2]

Table 3-1. CY2018 Total Annual Incremental Electric Savings

Savings Category	Energy Savings (kWh)	Demand Savings (kW)	Summer Peak Demand Savings (kW)
Electricity			
Ex Ante Gross Savings	40,732,277	8,821	6,825
Program Gross Realization Rate	0.91	0.81	0.85
Verified Gross Savings	37,066,372	7,145	5,802
Program Net-to-Gross Ratio (NTG)	0.60	0.60	0.60
Verified Net Savings	22,239,823	4,287	3,481
Converted from Gas*			
Ex Ante Gross Savings	1,517,877	NA	NA
Program Gross Realization Rate	0.84	NA	NA
Verified Gross Savings	1,275,017	NA	NA
Program Net-to-Gross Ratio (NTG)	0.77	NA	NA
Verified Net Savings	981,763	NA	NA
Total Electric Plus Gas			
Ex Ante Gross Savings	42,250,154	8,821	6,825
Program Gross Realization Rate	0.91	0.81	0.85
Verified Gross Savings	38,341,389	7,145	5,802
Program Net-to-Gross Ratio (NTG)	0.61	0.60	0.60
Verified Net Savings	23,221,586	4,287	3,481

* Gas savings converted to kWh by multiplying therms * 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."
NA = Not applicable
Note: The coincident Summer Peak period is defined as 1:00-5:00 PM Central Prevailing Time on non-holiday weekdays, June through August.
Source: ComEd tracking data and Navigant team analysis.

[1] The gas realization rate is less than 100% in part due to penalties from the window-to-wall ratio (WWR) of some projects not meeting code. Nicor Gas believes that this issue may not apply to projects in their service territory to the same extent as projects in other gas companies' territories due to differences in building stock. At their request, the evaluation team calculated that the gas realization rate (across all gas companies) would be 93% if no WWR penalties were included.
[2] Unless noted, the results in this report exclude penalties from cross-fuel interactive effects (e.g., gas heating penalty from electric lighting measures).

Table 3-2. CY2018 Total Annual Incremental Therm Savings

Savings Category	Nicor Gas	Peoples Gas	North Shore Gas
Natural Gas*			
Ex Ante Gross Savings	365,382	471,363	9,906
Program Gross Realization Rate	0.84	0.84	0.84
Verified Gross Savings	306,921	395,945	8,321
Program Net-to-Gross Ratio (NTG)	0.77	0.77	0.77
Verified Net Savings	236,329	304,878	6,407

* Natural gas savings with electric interactive effects removed.
Source: ComEd, Nicor Gas, Peoples Gas, and North Shore Gas tracking data and Navigant team analysis.

4. Cumulative Persisting Annual Savings

The total ex ante gross savings for the New Construction Program and the cumulative persisting annual savings (CPAS) for the projects completed in CY2018 are shown in the following tables and figure. The total electric-only CPAS across all projects completed in 2018 is 22,239,823 kWh net savings. The offering also achieved 33,496 therms able to be claimed by ComEd or 981,763 kWh net CPAS equivalent[3]. Adding the savings converted from gas savings to the electric savings produces a total of 23,221,586 kWh of total net CPAS savings.

[3] The conversion factor from gas to electric is mandated by rule: 1 therm = 100,000 Btu. 1 kWh = 3,412 Btu. 1 therm = 100,000/3412 = 29.31 kWh equivalent.

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

Utility	Research Category	EUL	CY2018 Verified Gross Savings	NTG*	Lifetime Net Savings†	Verified Net kWh Savings 2018	2019	2020	2021	2022	2023	2024	2025	2026
ComEd	kWh removing interactive effects	17.4	37,066,372	0.60	386,972,924	22,239,823	22,239,823	22,239,823	22,239,823	22,239,823	22,239,823	22,239,823	22,239,823	22,239,823
CY2018 Program Total Electric CPAS			37,066,372		386,972,924	22,239,823	22,239,823	22,239,823	22,239,823	22,239,823	22,239,823	22,239,823	22,239,823	22,239,823
CY2018 Program Expiring Electric Savings‡							-	-	-	-	-	-	-	-

Utility	Research Category	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
ComEd	kWh removing interactive effects	22,239,823	22,239,823	22,239,823	22,239,823	22,239,823	22,239,823	22,239,823	22,239,823	8,895,929			
CY2018 Program Total Electric CPAS		22,239,823	22,239,823	22,239,823	22,239,823	22,239,823	22,239,823	22,239,823	22,239,823	8,895,929	-	-	-
CY2018 Program Expiring Electric Savings‡		-	-	-	-	-	-	-	-	13,343,894	22,239,823	22,239,823	22,239,823

Utility	Research Category	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
ComEd	kWh removing interactive effects												
CY2018 Program Total Electric CPAS		-	-	-	-	-	-	-	-	-	-	-	-
CY2018 Program Expiring Electric Savings‡		22,239,823	22,239,823	22,239,823	22,239,823	22,239,823	22,239,823	22,239,823	22,239,823	22,239,823	22,239,823	22,239,823	22,239,823

Note: The green highlighted cell shows program total first year electric savings.

* A deemed value. Source: ComEd_NTG_History_and_PY10_Recommendations_2017-03-01.xlsx, which is to be found on the IL SAG web site here: http://ilsag.info/net-to-gross-framework.html.

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

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

Source: Navigant analysis

Table 4-2. Cumulative Persisting Annual Savings (CPAS) – Gas

Utility	Research Category	EUL	CY2018 Verified Gross Savings (Therms)	NTG*	Lifetime Net Savings†	Verified Net Therms Savings 2018	2019	2020	2021	2022	2023	2024	2025	2026
ComEd	Therms removing interactive effects	20.6	43,501.1	0.77	582,827	33,496	33,496	33,496	33,496	33,496	33,496	33,496	33,496	33,496
CY2018 Program Total Gas CPAS (Therms)			43501.08		582,827	33,496	33,496	33,496	33,496	33,496	33,496	33,496	33,496	33,496
CY2018 Program Total Gas CPAS (kWh Equivalent)‡					17,082,673	981,763	981,763	981,763	981,763	981,763	981,763	981,763	981,763	981,763
CY2018 Program Expiring Gas Savings (Therms)§							-	-	-	-	-	-	-	-
CY2018 Program Expiring Gas Savings (kWh Equivalent)‡§							-	-	-	-	-	-	-	-

Utility	Research Category	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
ComEd	Therms removing interactive effects	33,496	33,496	33,496	33,496	33,496	33,496	33,496	33,496	13,398			
CY2018 Program Total Gas CPAS (Therms)		33,496	33,496	33,496	33,496	33,496	33,496	33,496	33,496	13,398	-	-	-
CY2018 Program Total Gas CPAS (kWh Equivalent)‡		981,763	981,763	981,763	981,763	981,763	981,763	981,763	981,763	392,705	-	-	-
CY2018 Program Expiring Gas Savings (Therms)§		-	-	-	-	-	-	-	-	20,097	33,496	33,496	33,496
CY2018 Program Expiring Gas Savings (kWh Equivalent)‡§		-	-	-	-	-	-	-	-	589,058	981,763	981,763	981,763

Utility	Research Category	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
ComEd	Therms removing interactive effects												
CY2018 Program Total Gas CPAS (Therms)		-	-	-	-	-	-	-	-	-	-	-	-
CY2018 Program Total Gas CPAS (kWh Equivalent)‡		-	-	-	-	-	-	-	-	-	-	-	-
CY2018 Program Expiring Gas Savings (Therms)§		33,496	33,496	33,496	33,496	33,496	33,496	33,496	33,496	33,496	33,496	33,496	33,496
CY2018 Program Expiring Gas Savings (kWh Equivalent)‡§		981,763	981,763	981,763	981,763	981,763	981,763	981,763	981,763	981,763	981,763	981,763	981,763

Note: The green highlighted cell shows program total first year gas savings in kWh equivalents.

* A deemed value. Source: ComEd_NTG_History_and_PY10_Recommendations_2017-03-01.xlsx, which is to be found on the IL SAG web site here: http://ilsag.info/net-to-gross-framework.html.

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

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

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

Source: Navigant analysis

Table 4-3. Cumulative Persisting Annual Savings (CPAS) – Total

Utility	Research Category	EUL	CY2018 Verified Gross Savings	NTG*	Lifetime Net Savings†	Verified Net kWh Savings (Including Those Converted from Gas Savings) 2018	2019	2020	2021	2022	2023	2024	2025	2026
ComEd	kWh removing interactive effects	17.4	37,066,372.1	0.60	386,972,924	22,239,823	22,239,823	22,239,823	22,239,823	22,239,823	22,239,823	22,239,823	22,239,823	22,239,823
ComEd	Therms removing interactive effects (kWh Equivalent)	20.6	1,275,017	0.77	17,082,673	981,763	981,763	981,763	981,763	981,763	981,763	981,763	981,763	981,763
CY2018 Program Total CPAS			38,341,389		404,055,598	23,221,586	23,221,586	23,221,586	23,221,586	23,221,586	23,221,586	23,221,586	23,221,586	23,221,586
CY2018 Program Expiring Savings‡							-	-	-	-	-	-	-	-

Utility	Research Category	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
ComEd	kWh removing interactive effects	22,239,823	22,239,823	22,239,823	22,239,823	22,239,823	22,239,823	22,239,823	22,239,823	8,895,929	-	-	-
ComEd	Therms removing interactive effects (kWh Equivalent)	981,763	981,763	981,763	981,763	981,763	981,763	981,763	981,763	392,705	-	-	-
CY2018 Program Total CPAS		23,221,586	23,221,586	23,221,586	23,221,586	23,221,586	23,221,586	23,221,586	23,221,586	9,288,634	-	-	-
CY2018 Program Expiring Savings‡		-	-	-	-	-	-	-	-	13,932,952	23,221,586	23,221,586	23,221,586

Utility	Research Category	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
ComEd	kWh removing interactive effects	-	-	-	-	-	-	-	-	-	-	-	-
ComEd	Therms removing interactive effects (kWh Equivalent)	-	-	-	-	-	-	-	-	-	-	-	-
CY2018 Program Total CPAS		-	-	-	-	-	-	-	-	-	-	-	-
CY2018 Program Expiring Savings‡		23,221,586	23,221,586	23,221,586	23,221,586	23,221,586	23,221,586	23,221,586	23,221,586	23,221,586	23,221,586	23,221,586	23,221,586

Note: The green highlighted cell shows program total first year electric savings (including direct electric savings and those converted from gas).

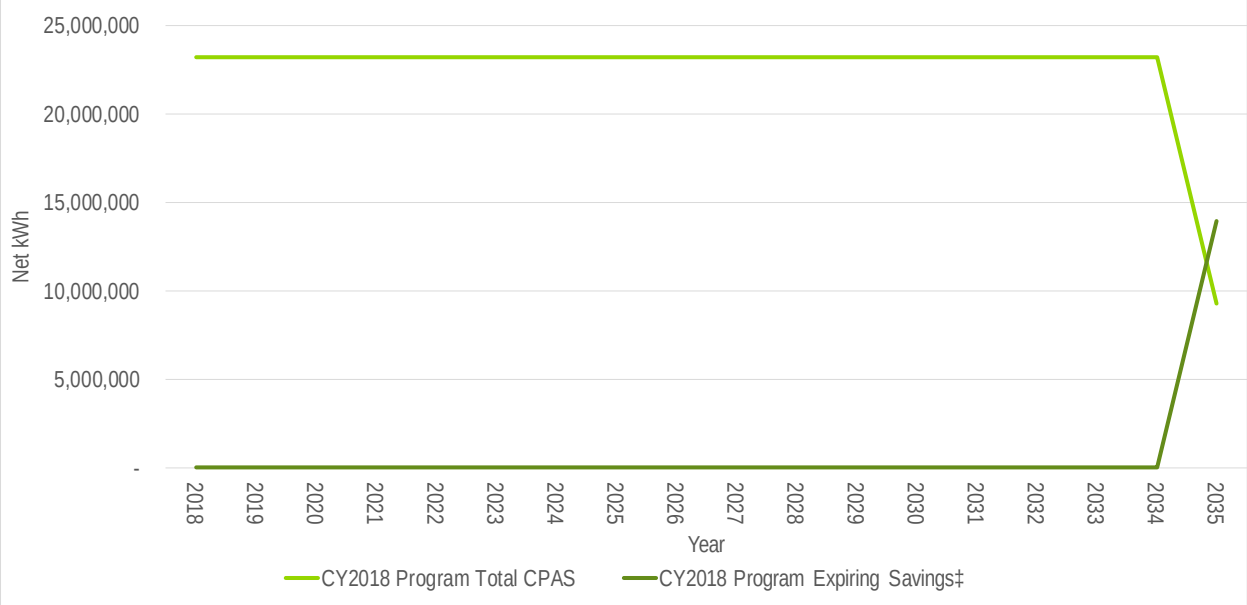
* A deemed value. Source: ComEd_NTG_History_and_PY10_Recommendations_2017-03-01.xlsx, which is to be found on the IL SAG web site here: http://ilsag.info/net-to-gross-framework.html.

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

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

Source: Navigant analysis

Figure 4-1. Cumulative Persisting Annual Savings



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

5. Program Savings by Measure

The New Construction Program does not track savings by measure. Program savings are estimated through participant-specific whole building energy analyses, discussed further in Section 6 below.

6. Impact Analysis Findings and Recommendations

6.1 Impact Parameter Estimates

Participants completed 75 projects through the New Construction Program in CY2018, of which 30 were selected though a stratified sampling approach to be included in the engineering desk review. In many cases, the desk review independently confirmed the estimation of ex ante savings and no ex post adjustments were required. However, for 19 sampled projects, we identified discrepancies in model inputs and ex ante savings calculations. The evaluation team calculated realization rates with and without interactive effects. The final realization rate was 91% for kWh with interactive effects removed and 90% for kWh including interactive effects. For kW, the final realization rate was 81% with interactive effects removed and 79% with interactive effects. For projects with gas savings, final realization rates were 84% for therms with interactive effects removed and 83% for therms with interactive effects. These realization rates were similar to past program years.

One reason for the lower realization rate is the treatment of static pressure-based controls of make-up air unit supply fans, which is an issue that has also appeared in past evaluations. For two sampled projects, the baseline and proposed equipment assumed a higher peak exhaust rate than would be required for constant volume exhaust fans. The evaluation team and implementer discussed this issue on several occasions. After reviewing the relevant codes and supporting documentation provided by the implementer, the evaluation team recognizes that the existing code is not clear on how this measure should be treated, but maintains its position that the claimed savings should be reduced in CY2018. The

evaluation team will continue to work with the implementation team to clarify how best to treat similar projects in the future.

The impact evaluation is fuel-specific: the electric impact evaluation includes a sample of 30 CY2018 projects with electric savings, while the gas impact evaluation includes a sample of 18 projects with gas savings. ComEd-only projects are those with no gas savings claimable by another utility

The evaluation team calculated verified gross and net savings for energy, demand, and coincident peak demand[4] resulting from the CY2018 New Construction Program by using participant-specific whole building energy models developed for baseline and projected design scenarios. For each participant, the design energy model estimates the annual whole building energy consumption of the proposed building based on architectural, building envelope, HVAC, lighting, and other parameters from the building design plans. The baseline energy model for a project estimates the counterfactual annual energy consumption the building would be expected to consume if it was built to meet the energy performance baseline standards. The estimated first year savings is the difference in annual electric and gas consumption between the two models. The energy performance baseline is the Illinois Energy Conservation Code for Commercial Buildings, which references and incorporates the applicable International Energy Conservation Code (IECC). This reference specifically allows for use of ASHRAE Standard 90.1 as an alternate compliance method. The program assumes the appropriate baseline based on the date that the project applied to the program. Projects that applied prior to January 1, 2013 used the IECC 2009 as the baseline, those that applied after January 1, 2013 but before May 31, 2016 used the IECC 2012, and those that applied after June 1, 2016 use IECC 2015. The evaluation team used a variety of modeling programs and methods, relying on the same software and/or methods program implementors used in estimating the ex ante models.

Table 6-1 below presents the parameters that were used in the verified gross and net savings calculations and indicates which were calculated through evaluation activities and which were deemed.

Table 6-1. Verified Savings Parameter Data Sources

Gross Savings Input Parameters	Data Source	Deemed or Evaluated?
Program Model Inputs	Program supplied building models and Savings calculation spreadsheet*	Evaluated
Evaluated Model Inputs	Desk review of project documentation	Evaluated
Evaluated Model Inputs	Illinois TRM Version 6.0†	Deemed
Evaluation Model Results	eQuest/DOE2.2, TRACE700, AutoCAD	Evaluated
Realization Rate – All Projects	Program savings and evaluated savings	Evaluated
NTG – Electric and Gas	SAG agreement‡	Deemed

* The program continues to use the System Track spreadsheet to calculate savings for simple project calculations, such as HVAC and lighting
† State of Illinois Technical Reference Manual version 6.0 from http://www.ilsag.info/technical-reference-manual.html.
‡ CY2018 deemed NTG ratios for ComEd, Nicor Gas, Peoples Gas and North Shore Gas are available on the IL SAG website here: http://ilsag.info/net-to-gross-framework.html.

Table 6-2 summarizes the incremental electric energy and demand savings the New Construction Program achieved for ComEd, as well as the therm savings achieved in this period for each gas utility. Note that the evaluation achieved the target 90/10 confidence and precision level for kWh and therm savings but did not meet it for demand savings due to the large discrepancy in ex ante and ex post savings for some large projects.

[4] The evaluation team estimated both summer and winter peak demand using PJM's peak periods.

Table 6-2. CY2018 Total Annual Incremental Electric and Gas Savings, by Utility

Utility	Metric	Ex Ante Gross Savings	Verified Gross Realization Rate	Verified Gross Savings	NTG*	Verified Net Savings	Effective Useful Life
ComEd	kWh	39,579,139	0.90	35,621,225	0.60	21,372,735	17.4
	kWh removing interactive effects	40,732,277	0.91	37,066,372	0.60	22,239,823	17.4
	Total kW	8,821	0.79	6,969	0.60	4,181	17.4
	Total kW removing interactive effects	8,821	0.81	7,145	0.60	4,287	17.4
	Summer Peak kW	6,825	0.85	5,802	0.60	3,481	17.4
	Winter Peak kW	5,333	0.90	4,800	0.60	2,880	17.4
	Therms	46,273	0.83	38,407	0.77	29,573	20.6
	Therms removing interactive effects	51,787	0.84	43,501	0.77	33,496	20.6
Nicor Gas	Therms	229,069	0.83	190,127	0.77	146,398	20.6
	Therms removing interactive effects	365,382	0.84	306,921	0.77	236,329	20.6
Peoples Gas	Therms	385,844	0.83	320,251	0.77	246,593	20.6
	Therms removing interactive effects	471,363	0.84	395,945	0.77	304,878	20.6
North Shore Gas	Therms	7,053	0.83	5,854	0.77	4,508	20.6
	Therms removing interactive effects	9,906	0.84	8,321	0.77	6,407	20.6

Source: Navigant Evaluation

The lifetime energy and demand savings are estimated by multiplying the verified savings by the effective useful life for each measure group.

6.2 Other Impact Findings and Recommendations

The evaluation team reviewed the New Construction Program tracking data for projects completed in CY2018. The program completed fewer projects (75) in CY2018 than in EPY9/GPY6, when the program completed 99 projects, but EPY9/GPY6 was 19 months long. and the program completed a similar number of projects in CY2018 to EPY8/GPY5 when the program completed 76 projects. Despite the lower number of projects, the number of projects completed with claimed gas savings remained steady, with 43 in CY2018 compared to 42 projects in EPY9/GPY6. The average verified gross electric savings per project declined in CY2018 to 475 MWh per project from 649 MWh per project in EPY9/GPY6, while the average verified gross gas savings also declined slightly to 12.005 therms per project from 12,753 therms per project in EPY9/GPY6. The decrease in savings is largely due to the decrease in building area, which dropped from an average of 270,308 square feet in EPY9/GPY6 to 216,204 in CY2018.

Similar to the previous program year, approximately three-quarters (71%) of completed projects involved organizations or representatives who worked on projects in previous program years. Projects from repeat customers were somewhat larger in terms of area than first time customers, averaging 225,240 square feet compared to 194,435 square feet. Notably, the average MWh per project was similar for repeat and first-time participants (494 MWh compared to 490 MWh) while the gas savings were roughly double for repeat participants (11,981 therms compared to 5,545 therms), and therms per square foot for repeat participants (0.05 therms per sq. ft.) is nearly twice that of first-time participants (0.03 therms per sq. ft.).

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

Finding 1. In previous years, a primary driver for lower realization rates was the treatment of baseline window-to-wall ratios (WWR). The evaluation team understands that the program shifted away from this practice in early 2016 after discussions with the evaluation team and currently attempts to account for any related penalties in the ex ante savings estimates. In the sample of CY2018 projects reviewed for this evaluation, there appeared to be several projects for which the program did not account for the WWR penalty in the original ex ante savings. The program later updated these savings in a revised data set.

Recommendation 1. The evaluation team recommends that the program continues to ensure that projects consistently follow the approaches in ASHRAE 90.1 or IECC when measuring ex ante program savings. For WWR, this includes accounting for the energy penalty for the excess window area. The evaluation team understands that the program shifted away from this practice in early 2016 after discussions with the evaluation team, but that these issues carried over from legacy projects started before the change in practice.

Finding 2. Nicor Gas believes that the WWR issue described in Finding 1 may not apply to projects in their service territory to the same extent as projects in other gas utilities due to differences in building stock.

Recommendation 2. Due to the sampling strategy used in CY2018, the evaluation team could not provide separate realization rates by gas utility because of insufficient sample sizes. The team will work with the program implementer in CY2019 to determine if the differences in measures and buildings by service territory warrant updating the sampling strategy to support utility-specific realization rates.

Finding 3 In several projects, the evaluation team found instances where savings were double counted by different measures, such as the savings from the hot gas defrost measure already counted in other measures for project 850.

Recommendation 3. The evaluation team recommends the program ensures that, where possible, savings from complementary measures are not double counted.

Finding 4. The evaluation team identified several instances where the program assumed baselines for supply or exhaust fans not consistent with the applicable mechanical code.

Recommendation 4. The evaluation team recommends the program ensures it follows the applicable mechanical code and notes the different requirements for constant and variable volume fans. In this case, the Evaluation Team recognizes that the existing code is not clear about how this measure should be treated and will work with the implementer to determine how best to treat similar projects in the future.

7. APPENDIX 1. IMPACT ANALYSIS METHODOLOGY

7.1 Engineering Methodology

The building energy models used in the engineering analysis are included in Table 6-1. The analysis included:

1) Adjusting the model inputs in the executable files to match the as-built conditions identified in our review of the New Construction Program's project files and then rerunning the model.

2) Quantifying impacts by comparing two simulations representing the projected design scenario and the baseline scenario.

The baseline scenario in the model is dictated by the appropriate Illinois Energy Conservation Code for Commercial Buildings (this is to be distinguished from the IECC, the International Energy Conservation Code). A project's ex ante savings model is based on a baseline scenario which incorporates the building codes that were in effect at the time of the project's application. Although the applicable energy codes may change by the time a project obtains a building permit, the evaluation team believes that this is rare and the program's approach of using the application date to determine the applicable building code is reasonable and justified.

The evaluation team also calculated interactive effects, where applicable, for each fuel type. Interactive effects are the resulting changes to savings that occur when the installation of one measure has a positive or negative effect on the savings for the other fuel type. Interactive effects are calculated in the model. Peak kWs are only shown with interactive effects because it is required for PJM reporting. For utilities' goals tracking, we provide the savings without the penalties from interactive effects. The implementation team calculated savings for joint projects including interactive effects; however, the evaluation team also calculated savings both with and without interactive effects for reporting purposes. *Unless noted, the results in this report exclude penalties from cross-fuel interactive effects.*

The evaluation calculated verified net energy and demand savings by multiplying the verified gross savings estimates by a net-to-gross (NTG) ratio. In CY2018, the NTG values used to calculate the net verified savings were based on past evaluation research and approved by the Stakeholder Advisory Group (SAG)[5].

7.2 Sampling Approach

As in prior years, the evaluation team selected a stratified random sample for the New Construction Program to support the engineering desk reviews. The approach focused on both electric and gas savings. The evaluation team designed the sample to provide 90/10 precision for both evaluated kWh and therm savings estimates. This approach was also designed to provide 90/10 precision at the program MBtu and kW level.

The sample frame is composed of all projects with electric or gas savings. These projects may or may not have gas savings and may or may not receive gas utility incentives. A total of 75 CY2018 projects comprised the population for this sampling approach. We divided the sample frame of all projects into three strata based on their overall project MBtu savings and randomly selected 30 projects across these strata to compose our sample. We then developed case weights to extrapolate the results to similar projects, ensuring that the engineering results are representative of the population of CY0218 participants. Table 7-1 and Table 7-2 show the sampling approach and weights for electric and gas savings.

[5] CY2018 deemed NTG ratios for ComEd, Nicor Gas, Peoples Gas and North Shore Gas are available on the IL SAG website here: http://ilsag.info/net-to-gross-framework.html.

Table 7-1. Sampling Approach for Projects with Electric Savings

Stratum	Boundaries (MWh)	Projects in Population	Projects in Sample	Stratum Weight
1	>0 – 199	31	5	6.20
2	200 – 999	33	15	2.20
3	>1,000	11	10	1.10
Total		75	30	

Table 7-2. Sampling Approach for Projects with Gas Savings

Stratum	Boundaries (Therms)	Projects in Population	Projects in Sample	Stratum Weight
1	>0 – 9,999	26	6	4.33
2	10,000 – 29,999	11	5	2.20
3	>30,000	9	7	1.29
Total		46	18	

The evaluation achieved the target 90/10 confidence and precision level for kWh and therm savings but did not meet it for demand savings due to the large discrepancy in ex ante and ex post savings in some large projects.

8. Appendix 2. Impact Analysis Detail

Table 8-1 below shows the results of the engineering desk review. Ex ante and ex post electric and gas savings and the resulting realization rate are presented for each of the 30 projects included in the sample. In addition, where applicable, the table includes a narrative describing the reasons for any discrepancies between ex ante and ex post savings. Realization rates below 100% indicate that energy savings were adjusted downwards while realization rates above 100% indicate energy savings were adjusted upwards. All energy savings include interactive effects.

Table 8-1. Researched Gross Savings for Sampled Projects

Project ID	Gas Utility Claiming Savings	Ex Ante		Ex Post		Realization Rate	
		Electric Savings (kWh/yr)	Gas Savings (therms/yr)	Electric Savings (kWh/yr)	Gas Savings (therms/yr)	Electric (kWh) Savings RR	Gas (therm) Savings RR
326	No Gas Incentive	349,573	13,958	291,971	13,958	84%	100%
The ex ante model used NPLV efficiency instead of full-load efficiency, which overestimated the savings for the chiller installation. The model was updated to better reflect the installed chiller performance curve.							
397	No Gas Incentive	962,584	0	1,099,274	0	114%	N/A
No significant adjustment was made to the model. The evaluation team adjusted the occupied heating temperatures from 72F to 70F to meet temperature dead band requirements.							
514	Nicor Gas	430,777	4,425	422,348	4,517	98%	102%
A small adjustment was made to exterior lighting savings because a portion of the building was not completed. There is also a small gas savings discrepancy of unknown origin.							
605	Nicor Gas	107,749	0	107,749	0	100%	N/A
No change							
616	No Gas Incentive	681,029	0	547,964	0	80%	N/A
The savings for this project was adjusted because of changes to the baseline model. 1) the temperature drop in the chilled and hot water loops were modified to comply with ASHRAE sections G3.1.3.8 and G3.1.3.3, respectively , 2) upon review of the mechanical drawings for the building, it was found that the installed supply fans exceed code requirements. Because of this, the savings for the reduced fan power were removed. Finally, 3) The baseline fans (distinct from the supply fans mentioned above) were installed on an existing building, and they assumed constant volume operation, when in reality there were variable pitch axial guide fans.							
629	No Gas Incentive	370,001	0	370,001	0	100%	N/A
No Change							

Project ID	Gas Utility Claiming Savings	Ex Ante		Ex Post		Realization Rate	
		Electric Savings (kWh/yr)	Gas Savings (therms/yr)	Electric Savings (kWh/yr)	Gas Savings (therms/yr)	Electric (kWh) Savings RR	Gas (therm) Savings RR
636	No Gas Incentive	901,272	30,386	299,638	2,939	33%	10%
The ex ante models received 2 significant changes. 1) the baseline building WWR was significantly more than 40%, and this was corrected in the ex post analysis, and 2) the baseline for the smart thermostat measure was changed from constant temperature to a programmable thermostat which then generated savings that are relatively consistent with the IL TRM.							
665	No Gas Incentive	1,514,377	0	1,385,272	4,347	91%	N/A
The remainder of the adjustments from floating head pressure controls were removed because no project documentation was found that indicated that this measure had been installed. The electric savings were slightly increased when the calculations for the kitchen hoods and night covers were brought in line with the IL TRM.							
685	Nicor Gas	163,636	3,217	155,584	3,224	95%	100%
The HOU of the building lighting was changed to be more consistent with the posted building schedules found online.							
688	Peoples Gas	137,483	7,668	113,720	1,987	83%	26%
The savings for this project were reduced due to WWR issues							
696	Peoples Gas	230,194	10,522	0	0	0%	0%
Upon review of the demand control ventilation for the toilet exhaust fans, it was found that the full-load airflow rate for the baseline and proposed conditions is the same, but for the baseline constant-speed fans the full-load flow rate should be lower. Based on 90.1 and the mechanical code for Chicago, constant flow exhaust for toilet rooms is 25 CFM, versus 50 CFM for variable flow. The residences have a total of approximately 220 toilet rooms, so the exhaust flow rate in the baseline was reduced by 5,000 CFM, from 16,700 to 11,700 CFM.							

Project ID	Gas Utility Claiming Savings	Ex Ante		Ex Post		Realization Rate	
		Electric Savings (kWh/yr)	Gas Savings (therms/yr)	Electric Savings (kWh/yr)	Gas Savings (therms/yr)	Electric (kWh) Savings RR	Gas (therm) Savings RR
706	Peoples Gas	840,350	11,871	738,961	11,928	88%	100%
Upon review of the claimed measures and the eQuest building model, multiple changes were deemed necessary. In the parametric run for switching from a constant primary/variable secondary chilled water system to a variable primary system, the primary pumps are removed from the model and the head pressure of the VFD pumps is reduced from 100 feet to 60 feet, but this was found to be inaccurate, as the head pressure should increase with the change in piping configuration, not decrease. It is likely that this was the intention of the parametric run as the label for the parametric run suggests the head pressure should increase. Upon review of the chilled water system configuration it was estimated that an appropriate head pressure increase for the pumps was 20 feet of head, so the chilled water pump head pressure was changed from 60 feet to 80 feet with the parametric run. For the installation of a chilled water system rather than packaged VAV units with DX Cooling, it was found that the baseline chiller efficiency is not consistent with code requirements, so the baseline chiller electric input ratio was changed from 0.2676 to 0.3568. This causes the savings for switching to a central air-cooled chiller system to decrease. Additionally, it was found that the electric input ratio for the installation of the high efficiency chiller was determined based on the IPLV rating of the chiller, not the full-load efficiency. Updating the parametric run for the installation of the high efficiency chiller causes the electric input ratio to change from 0.1806 to 0.3669. This causes the savings for the installation of a high efficiency chiller to decrease.						
711	No Gas Incentive	443,133	0	443,133	0	100%	N/A
No changes.							
759	Peoples Gas	376,926	12,374	274,278	6,385	73%	52%
Upon review of the hot water use estimates for the installed low-flow plumbing fixtures and the water use schedules specified in the models, it was found that the hot water supply temperature setpoint in the model was 110ºF, whereas the water use estimates assume a supply temperature of 135ºF. A spreadsheet detailing the expected water use reduction included with the project documentation shows that the annual use of the showerheads and faucets is expected to go from 1.441 million gallons to 1.125 million gallons, and the hot water use schedule in the model results in a baseline hot water use of 1.816 million gallons per year. The global parameter used to define the low-flow plumbing fixtures measure was updated to reflect the appropriate hot water reduction as determined from the provided spreadsheet. Based on Table 6.8.1B in ASHRAE 90.1-2010, the baseline heating mode coefficient of performance of the water source heat pumps should be 4.2, whereas in the model the baseline COP is specified to be 4.6. Changing this causes the savings for the WSHP efficiency measure to increase.						

Project ID	Gas Utility Claiming Savings	Ex Ante		Ex Post		Realization Rate	
		Electric Savings (kWh/yr)	Gas Savings (therms/yr)	Electric Savings (kWh/yr)	Gas Savings (therms/yr)	Electric (kWh) Savings RR	Gas (therm) Savings RR
Upon review of the model and drawings for the building, it was found that the airflow rate of the makeup air unit in the model is not consistent with what is specified in the drawings. The airflow rate in the model may have been de-rated to account for ventilation requirements, but for the installation of the DCV controls on the MAU the airflow rate in the model was increased to what is specified in the drawings, as the DCV will cause the airflow to throttle back from this airflow rate. Upon review of the ENERGY STAR savings calculator used to determine the savings for the clothes washers, clothes dryers, and dishwashers, it was found that several changes to the inputs for the calculator were necessary - the equipment use was changed from "commercial" to "residential", and the fuel type for water heating was changed from "electric" to "natural gas". These modifications reduce the number of times per year the appliances are each expected to be used, and eliminates the electric water heating energy savings while adding natural gas water heating savings. All other measures have been reviewed and deemed reasonable.							
768	Nicor Gas	2,767,107	0	2,742,102	0	99%	N/A
Model changes to the chillers and boilers lead to a small reduction in savings. The chiller cooling efficiency measure included parametric runs for chiller efficiencies, schedules, cooling tower control change, fan low flow ratio, electric input ratio, and chiller curves. The changes to this measure include changing the delta T from 10F to 12F, the number of cells in the cooling tower from 4 to 6 based on known installation, adding CHW reset schedules with updated supply leaving temp at drybulb low to 98F with 85F baseline, and supply leaving temp at drybulb high to 66F from baseline of 70F. The controls were changed to VFDs where installed on the cooling tower fans and chilled water pumps. Baselines were based on ASHRAE 90.1 2010 Appendix G and Section 6.5.5.							
769	Peoples Gas	101,166	0	73,973	0	73%	N/A
The ex ante model was updated for the exterior lighting measure. The original model claimed garage doors on storage units as entrances. The evaluation removed the allowance associated with these doors. However, the location was updated from Zone 2 to Zone 3. Combined, these changes reduced the exterior lighting savings from 9.1 kW to 4.0 kW.							
774	Nicor Gas	1,736,301	17,025	1,793,850	16,726	103%	98%
The exterior lighting and air compressor measures were modified, but only resulted in small changes to the claimed savings for this project.							
795	Nicor Gas	3,564,754	48,012	3,564,754	48,012	100%	100%
No change							

Project ID	Gas Utility Claiming Savings	Ex Ante		Ex Post		Realization Rate	
		Electric Savings (kWh/yr)	Gas Savings (therms/yr)	Electric Savings (kWh/yr)	Gas Savings (therms/yr)	Electric (kWh) Savings RR	Gas (therm) Savings RR
821	Nicor Gas	1,692,640	2,423	1,616,354	2,266	95%	94%
Several small changes were made to the models for this project that slightly reduced the savings. This included modifications to the wall insulation levels of the building, heating efficiencies of rooftop units and unit heaters, and cooling efficiencies for rooftop units and makeup air units. No changes were made to the custom calculations associated with this project.							
827	Peoples Gas	1,118,352	30,033	904,692	10,920	81%	36%
The ex ante model correctly accounted for WWR and some lighting control penalties when the savings were calculated. The savings for this measure were reduced because the baseline exhaust CFM was reduced by 13,000 CFM. The as-built fans assume a higher peak exhaust rate than would be required for constant volume toilet exhaust for the approximately 520 total toilet exhaust fans in the building.							
839	Peoples Gas	1,632,095	0	1,632,095	0	100%	N/A
No change							
844	Peoples Gas	647,779	57,806	411,133	58,654	63%	101%
Many issues contributed to the savings reduction for this project. The typical lighting patterns of an apartment were not represented in the model. A new lighting schedule was created for the apartments which is based on the schedule used for other high-rise apartment building projects. The schedule that was previously in place for the apartments yields annual operation of 5,166 hours, whereas the new schedule yields 854 hours per year of operation. The result is a reduction in savings. Adjustments were also made to the baseline exhaust-air flow rates. We found that the full-load airflow rate for the baseline and proposed conditions was the same, yet for the baseline constant-speed fans the full-load flow rate should be lower. Based on the mechanical code for Chicago, constant flow exhaust for toilet rooms is 25 CFM, versus 50 CFM for variable flow. The residences have a total of 600 toilet rooms, so the full-load flow rate for the DOAS system in the baseline case was reduced by 15,000 CFM (25 CFM x 600). The savings calculations for the installed ENERGY STAR® appliances were determined using deemed values taken from an ENERGY STAR® savings calculation tool. Upon review of the savings, it was found that the dishwashers are specified to be served by electric water heaters, but the model and the plans for the project indicate that the building has natural gas water heating. This change applies to only the dishwashers that were installed, and causes the electric savings to decrease but creates natural gas savings. The daytime setback that is used to model the savings for the installed smart thermostats was adjusted such that the resulting savings are in line with what is							

Project ID	Gas Utility Claiming Savings	Ex Ante		Ex Post		Realization Rate	
		Electric Savings (kWh/yr)	Gas Savings (therms/yr)	Electric Savings (kWh/yr)	Gas Savings (therms/yr)	Electric (kWh) Savings RR	Gas (therm) Savings RR
specified in the Illinois TRM for the replacement of programmable thermostats with advanced thermostats (TRM specifies 5.6% heating energy savings and 8.0% cooling energy savings). This involves a nighttime setback and reducing the hours and degrees of setback resulting from the installation of the smart thermostats.							
846	Nicor Gas	402,058	46,908	402,058	46,908	100%	100%
No change							
850	No Gas Incentive	2,641,569	0	2,596,665	0	98%	N/A
The savings for this project were updated based on additional information supplied by Slipstream. The original project included savings for hot-gas bypass instead of electric defrost for walk-in coolers. However, the original project documentation included calculations for defrost savings for the refrigerated cases. The case defrost savings are not eligible since they were included in savings for the cases already, which use the installed case kWh/day compared to federal standards.							
864	Nicor Gas	1,245,013	31,136	1,245,013	31,136	100%	100%
No change							
875	Nicor Gas	81,987	750	81,987	750	100%	100%
No change							
889	Nicor Gas	805,303	0	805,303	0	100%	N/A
No change							
919	Peoples Gas	761,722	91,183	534,667	95,662	70%	105%
The savings adjust for this project is primarily due to changes to the AHU fan power measures. This measure did not account for return fans and exhaust fans when a fan-power reduction measure was incentivized. The result is a reduction in electric savings but an increase in gas savings due to a reduction in the interactive effect penalty.							
935	North Shore Gas	2,374,816	0	2,374,816	0	100%	N/A
No change							
958	Nicor Gas	345,325	3,093	345,325	3,093	100%	100%
No change							

9. APPENDIX 3. TOTAL RESOURCE COST DETAIL

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

Table 9-1. Total Resource Cost Savings Summary

Utility	Research Category	Units	Quantity	Effective Useful Life	Verified Gross Savings (kWh)	Verified Gross Peak Demand Reduction (kW)	Verified Gross Savings Therms	Gross Heating Penalty (kWh)	Gross Heating Penalty (Therms)	NTG Ratio (kWh)	NTG Ratio (kW)	NTG Ratio (Therms)	Verified Net Savings (kWh)	Verified Net Peak Demand Reduction (kW)	Verified Net Savings Therms	Net Heating Penalty (kWh)	Net Heating Penalty (Therms)
ComEd	Electric Savings	Project	32	17.4 - Electric 20.6 - Gas	37,066,372	7,145	43,501	1,445,147	5,094	0.6	0.6	0.77	22,239,823	4,287	33,496	867,088	3,923
Nicor Gas	Gas Savings	Project	20	20.6	0	0	306,921	0	116,794	NA	NA	0.77	0	0	236,329	0	89,931
Peoples Gas	Gas Savings	Project	21	20.6	0	0	395,945	0	75,694	NA	NA	0.77	0	0	304,878	0	58,285
North Shore Gas	Gas Savings	Project	2	20.6	0	0	8,321	0	2,467	NA	NA	0.77	0	0	6,407	0	1,900

Source: ComEd tracking data and Navigant team analysis.