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Business New Construction Service
PY5 Evaluation Report

Final

Energy Efficiency / Demand Response Plan:
ComEd Plan Year 5
Nicor Gas Plan Year 2
(6/1/2012-5/31/2013)

Presented to
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E. Executive Summary

This report presents a summary of the findings and results from the Impact and Process Evaluation of the EPY5/GPY2 [1] Business New Construction Program.

E.1. Program Savings

Table E-1 summarizes the gross and net electricity and gas savings from the Business New Construction Program by utility.

Table E-1. EPY5/GPY2 Program Results by Channel and Measure

Utility	Metric	Ex Ante Gross Savings	Evaluation-Adjusted Gross Savings	Verified Net Savings	Gross Realization Rate†	NTGR‡
ComEd	MWh	34,929	34,138	22,190	0.98	0.65
	MW	7.2	7.3	4.8	1.02	0.65
Nicor Gas	Therms with interactive effects	183,088	218,374	113,554	1.19	0.52
	Therms without interactive effects	255,509	265,503	138,062	1.04	0.52

Source: Utility tracking data and Navigant analysis.
† *Based on a combination of evaluation research findings and deemed values*
‡ *A deemed value.*

As shown below, the program achieved both gas and electric gross savings goals. . The Nicor Gas goals below reflect the original gross targets filed in the Energy Efficiency Plan in 2011; the program did not realize the revised savings targets established in the GPY2 contract.

Table E-2. New Construction Service Program Results Compared to EPY5/GPY2 Goals

Savings Estimates	Gross MWh (ComEd)	Gross Therms (Nicor)
Plan Target	26,000[a]	248,000[b]
Ex Ante Gross Savings for EPY5/GPY2	34,929	255,509*
Evaluation-Adjusted Gross Savings	34,138	265,503*
Evaluation Net Savings	22,190	138,062*

a=gross savings as reported by implementation team during June 18, 2013 telephone interview.
b=gross savings filed in the 2011Nicor Gas Energy Efficiency Plan, "Nicor PY2 Goals for Navigant.xlsx"
**This value does not include interactive therm penalties. When therm penalties are included, Nicor Gas ex post savings are 218,374 gross therms and 113,554 net therms.*

[1] The EPY5 (for ComEd) and GPY2 (for Nicor Gas) program year began June 1, 2012 and ended May 31, 2013.

E.2. Impact Estimate Parameters

In the course of estimating verified gross and net savings, the evaluation used a variety of parameters in its calculations. Some of those parameters were deemed for this program year and others were adjusted based on evaluation research. The key parameters used in the analysis are shown in the following table.

Table E-3. Impact Estimate Parameters

Gross Savings Input Parameters	Data Source	Deemed or Evaluated?
Program Model Inputs	Program supplied building models	Evaluated
Evaluated Model Inputs	Desk reviews of project documentation	Evaluated
Evaluation Model Results	Systems template; eQuest/DOE2.2, IEC, TRACE700	Evaluated
Realization Rate – Electric Systems Track Projects	ComEd SAG filing[2]	Deemed
Realization Rate – All Other Projects	Program savings and evaluated savings	Evaluated
NTG – Electric and Gas	SAG agreement[3]	Deemed

E.3. Participation Information

The program had 111 projects in EPY5/GPY2, consisting of 41 ComEd-only projects and 70 projects completed as ComEd and Nicor Gas joint projects. Of these 70 joint projects, 28 had therm savings eligible for incentives paid by Nicor Gas. In EPY5/GPY2, the program transitioned from three incentive tracks (Systems, Comprehensive, and Small Building) toward a single performance-based, Comprehensive Track model which eliminates the remaining tracks previously offered. The change to a single track only affects new projects initiated in EPY5/GPY2 or later. Thus, in EPY6/GPY3 and beyond, the program is likely have an increasing number of Comprehensive Track projects and decreasing projects in the other tracks. Since New Construction projects often take longer than one program year to complete, more than half of the projects initiated in past years and completed in EPY5/GPY2 were Systems Track, as shown in the table below. Additionally, one project was completed in EPY5/GPY2 through the Small Buildings track.

[2] PY5 Deemed Evaluation Parameters Final.xls

[3] ComEd EPY5-PY6 Proposal Comparisons with SAG.xls and Nicor_Gas_NTG_Results_and_Application_GPY1-3.pdf, which are to be found on the IL SAG web site here: http://ilsag.info/net-to-gross-framework.html.

Table E-4. EPY5/GPY2 Primary Participation Detail

Project Description	Comprehensive†	Systems	Small Buildings	Total
ComEd Only	20	21	0	41
Joint without Therm Savings	20	21	1	42
Joint with Therm Savings	11	15	0	26
Joint with Only Therm Savings	0	2	0	2
Total	51	59	1	111

Source: Program tracking database.
† Includes projects listed as "comprehensive" (42), "comprehensive – xsheet" (8), and "systems and comprehensive" (1).

E.4. Conclusions and Recommendations

The following provides insight into key program findings and recommendations

Program Savings Goals Attainment

Finding 1. In EPY5/GPY2, ComEd achieved evaluation-adjusted gross energy savings of 34,138 MWh, exceeding its target of 26,000 gross MWh.[4] Nicor Gas achieved evaluation-adjusted gross savings of 265,503 therms, but fell short of its goal of 168,000 net therms, achieving savings of 138,062 net therms.[5] This was primarily because the agreed upon NTG was lower than the planning value.

Gross Realization Rates

Finding 2. The gross realization rate for therms savings is 104%, while the realization rates for kWh and kW savings are 98% and 102%, respectively. Engineering review of a sample of projects revealed that most energy savings modeling and calculations are reasonable and meet program guidelines. However, a few issues repeat across multiple projects, including low assumed balance temperatures for ventilation measures, using a building-wide lighting power density instead of LPD for each space type, and not including the interactive effects of lighting waste heat.

Recommendation. Calculating savings according to the program guidelines will result in higher ex ante estimates and realization rates closer to 100% for future projects.

Program Participation

Finding 7. Participation increased from 50 projects in EPY4/GPY1 to 111 projects in EPY5/GPY2. Systems Track projects represented more than half the projects completed in EPY5/GPY2, but the program has shifted to a single, Comprehensive Track model for all projects initiated in EPY5/GPY2 and after.

[4] ComEd MWh goal and results are evaluation-adjusted gross savings.
[5] Not including interactive therm penalties from joint projects. When these penalties are included, the verified Nicor Gas savings are 113,554 net therms.

Process Evaluation

Finding 8. Attaining gas goals continues to be a challenge, as the gas side of the program has not had as long to mature and grow. However, program staff are actively working to increase gas savings in several ways such as researching new construction trends in the Nicor Gas service territory and mining past participation data to target sectors with high gas savings potential, as well as investigating new gas measures.

Recommendation. In addition to focusing on past participant data mining, also target previously untapped sectors with large gas loads. For example, the large hot water loads in the hospitality and food service sectors may be a potential source of savings.

Finding 9. The program has worked to improve its screening of projects for potential free-riders in several ways, including limiting participation to projects earlier in the design process and discussing large projects with the evaluation team in advance.

Recommendation. In addition to continuing these efforts and moving forward with the "real-time" self-report net-to-gross pilot for EPY6/GPY3, plan to use market research to capture outside spillover now that the program is maturing.

1. Introduction

1.1 Program Description

The Business New Construction Service 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 the non-residential market. The program is jointly offered by Commonwealth Edison (ComEd) and Nicor Gas. The ComEd program has been operating since June 1, 2009. Nicor Gas joined the program to offer natural gas rebates in June 2011.

The Energy Center of Wisconsin (ECW) implements the program for both ComEd and Nicor Gas. ECW reaches out to design professionals and customers at the beginning of the design process to engage them in the program as early as possible. Prior to EPY5/GPY2, the program offered incentives through three tracks: Systems, Comprehensive, and Small Buildings. In EPY5/GPY2 (June 2012 to May 2013), the program transitioned toward a single performance-based, Comprehensive track model which eliminates the remaining tracks previously offered. The Comprehensive track offers customers with building facilities greater than 20,000 square feet incentives for whole-building electric and therm savings. The change to a single track only affects new projects initiated in EPY5/GPY2 or later. Future program years for electric and gas are likely to see more Comprehensive Track projects and fewer projects from the Systems and Small Buildings Tracks. Since New Construction projects typically take longer than one program year to complete, more than half of all projects completed in EPY5/GPY2 were Systems Track projects initiated in past years. Additionally, one project was completed in EPY5/GPY2 through the Small Buildings track which contained lighting and day-lighting requirements for buildings under 20,000 square feet.

1.2 Evaluation Objectives

As described in our evaluation plan, the evaluation of the New Construction Service for EPY5/GPY2 seeks to answer several questions related to the program's energy savings impacts and the process for implementing the program.

1.2.1 Impact Questions

The impact research questions for both utilities are as follows:

1. What are the verified and research findings gross energy and demand savings induced by the program?
2. What are the verified net impacts from the program using SAG-approved NTG ratios?
3. Did the program meet its energy and demand savings goals? If not, why not?
4. Are the assumptions and calculations for the Systems Track projects in compliance with the statewide TRM, where applicable? If not, what changes will be required?

1.2.2 Process Questions

The following process research questions were undertaken during EPY5/GPY2:

1. What design or implementation changes occurred in EPY5/GPY2?
2. What challenges did the program face in EPY5/GPY2 and how did the program respond to them?
3. How can the program increase natural gas savings and participation? What barriers exist and how can the program overcome them?

2. Evaluation Approach

This evaluation of the Business New Construction Service is on the fifth year of program operation for ComEd and the second year for Nicor Gas. Our process evaluation was primarily based upon a review of program materials and interviews with the program manager and implementation contractors. The impact evaluation involved reviews of building plans, engineering files (including building models), and program tracking data for a sample of projects. Data collection and analyses are described in more detail below.

2.1 Primary Data Collection

2.1.1 Overview of Data Collection Activities

Table 2-1 summarizes the primary data sources that the team used to answer impact and process questions for both the ComEd and Nicor Gas evaluations.

Table 2-1. Core Data Collection Activities

N	What	Who	Target Completes	Completes Achieved	When
1	In-Depth Telephone Interviews	Program Managers, Implementation Contractors	2	2	May 2013
2	Engineering File Review	Participants	30	30	September – October 2013

2.1.2 Additional Research

Table 2-2 summarizes additional resources that were reviewed to further inform the impact and process evaluation questions.

Table 2-2. Additional Resources

Reference Source	Author	Application	Gross Impacts	Process
Program Tracking Database	Program Implementer	Impact and Process Evaluations	X	
Email Correspondence	Program Implementer	Impact Evaluation	X	
Building Plans	Program Implementer	Impact Evaluation	X	
Program Marketing and Outreach Materials	Program Implementer	Process Evaluation		X
Illinois Technical Reference Manual	Vermont Energy Investment Corporation	Impact Evaluation: Gross Savings Estimates (Systems Track Only)	X	
International Energy Conservation Code 2009	International Code Council	Impact Evaluation: Baseline Determination	X	
International Energy Conservation Code 2012	International Code Council	Impact Evaluation: Baseline Determination	X	

2.1.3 Verified Savings Parameters

Verified Gross and Net Savings (e.g., energy, demand and coincident peak demand) resulting from the PY5 Business New Construction Service were calculated using whole-building energy models to represent energy consumption for a baseline design scenario and for a projected design scenario. 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 uses the date of the application to determine which version of the IECC is the most appropriate to use as baseline: IECC 2009 is the baseline for all projects accepted on or before December 31, 2012, and IECC 2012 is the baseline for all projects accepted after that date. All EPY5/GPY2 projects we reviewed used IECC 2009 code.

The following table presents the parameters that were used in the verified gross and net savings calculations and indicates which were examined through evaluation activities and which were deemed.

Table 2-3. Verified Savings Parameter Data Sources

Gross Savings Input Parameters	Data Source	Deemed or Evaluated?
Program Model Inputs	Program supplied building models	Evaluated
Evaluated Model Inputs	Desk reviews of project documentation	Evaluated
Evaluation Model Results	Systems template; eQuest/DOE2.2, IEC, TRACE700	Evaluated
Realization Rate – Electric Systems Track Projects	ComEd SAG filing[6]	Deemed
Realization Rate – All Other Projects	Program savings and evaluated savings	Evaluated
NTG – Electric and Gas	SAG agreement[7]	Deemed

2.2 Impact Evaluation Methods

The impact evaluation focused on 111 completed projects. Forty-one of these projects were completed as ComEd-only projects and 70 projects were completed as joint ComEd/Nicor Gas projects. Of the 70 joint projects, 28 had therm savings eligible for incentives paid by Nicor Gas. The remaining projects did not claim any gas savings. Table 2-4 shows the numbers of ComEd and Nicor Gas projects for which each utility claims savings among the 111 projects.

Table 2-4. Completed ComEd EPY5 Projects and Nicor Gas GPY2 Projects

Project Description	Savings Claims by ComEd PY5	Savings Claims by Nicor Gas PY2	Number of Completed Projects
ComEd Only	Yes	No	41
Joint - with Therm Savings	Yes†	Yes	28
Joint - without Therm Savings	Yes	No	42
Total	-	-	111

† Two joint projects have only therm savings. Source: Program tracking data

Impact findings throughout this report are broken-out by fuel type so that each utility only claims the savings paid for by its own incentives. Two different realization rates were used in in this evaluation. The evaluation team developed gross realization rates (RR) from a sample of EPY5/GPY2 ComEd/Nicor Gas Comprehensive Track projects and a sample of Nicor Gas Systems Track projects.

[6] PY5 Deemed Evaluation Parameters Final.xls

[7] ComEd EPY5-PY6 Proposal Comparisons with SAG.xls and Nicor_Gas_NTG_Results_and_Application_GPY1-3.pdf, which are to be found on the IL SAG web site here: http://ilsag.info/net-to-gross-framework.html.

For Systems Track projects, the evaluation team used a deemed RR parameter to estimate PY5 electric savings. Table 2-5 shows the number of projects receiving each utility's incentives and the numbers included in the impact evaluation analysis.

Table 2-5. Completed ComEd EPY5 Projects and Nicor Gas GPY2 Projects

Project Description	Number of Projects in the Population			Number of Projects Evaluated		
	Comprehensive†	Systems‡	Total	Comprehensive	Systems	Total
Received ComEd incentives only	40	43	83	15	0	15
Received both ComEd and Nicor Gas incentives	11	15	26	8	6	14
Received Nicor Gas incentives only	0	2	2	0	1	1
Total	51	60	111	23	7	30

† Includes projects listed a "comprehensive", "comprehensive-xsheet", and "systems and comprehensive."
‡ Includes one joint Small Business track project that was not sampled.
Source: Program tracking data.

The evaluation team conducted a rigorous impact evaluation including engineering analysis and building energy modeling for the 30 sampled projects.[8] We did not perform on-site M&V visits to verify the installation of equipment or to collect detailed project or building information because on-site visits were recently conducted in EPY4/GPY1 and this evaluation revealed that the information included in project documentation as well as the program's own verification process were sufficient.

Our sample ensured that Nicor Gas projects were well represented in order to develop realization rates for both Systems and Comprehensive Track projects. For joint Nicor Gas and ComEd projects, the evaluation team collected information on gas measures along with data for electric measures. More than half (15 of 28) of Nicor Gas joint projects with therm savings were selected as part of this sample, representing 75% of reported therm savings.
The evaluation team used different combinations of inputs for the net-to-gross ratio (NTGR) and RR, depending on the utility and the project track (System or Comprehensive). These inputs are shown in Table 2-6.

[8] Of the 30 sampled projects, the 23 Comprehensive Track projects were used to develop the electric and gas Comprehensive Track realization rates. The seven sampled Systems Track projects were only used to develop the gas Systems Track realization rate. Although we performed engineering analysis on the electric savings of the Systems Track projects, the associated RR was not used in developing the electric savings for Systems Track projects. Rather, the deemed RR was used.

Table 2-6. Realization Rate and NTGR Values by Track and Utility

Utility	Systems Track Savings Inputs (Deemed or Research)	Comprehensive Track Savings Inputs (Deemed or Research)
ComEd		
NTG	Deemed 0.65	Deemed 0.65
RR	Deemed 0.997	Research (20 of 51 projects reviewed)
Nicor Gas		
NTG	Deemed 0.52	Deemed 0.52
RR	Research (7 of 17 projects reviewed)	Research (8 of 11 projects reviewed)

Source: Navigant analysis

We used deemed RR parameters from the PY3 evaluation to estimate PY5 electric savings from Systems Track projects. Since the realization rate was not deemed for Comprehensive Track projects or Gas Systems Track projects, the team used evaluation research values for these parameters. To obtain overall RR values, regardless of utility, we combined results across program tracks within each population. We used deemed NTGR values for both gas and electric projects (e.g., gas NTGR from PY4 and electric NTGR from PY3)[9].

2.2.1 Adjusted Gross Program Savings Analysis Approach

For Comprehensive Track projects, the engineering analysis used existing computer models to: 1) adjust the model inputs to match the as-built conditions determined through New Construction Service's project files; and 2) determine impacts by comparing two simulations representing the current building and the baseline building.

The evaluation team also reviewed gas Systems Track measures to determine whether compliance with the statewide TRM was required, and where required, identified the changes necessary to meet TRM compliance. The evaluation team documented how the deemed measures differ from Nicor Gas' existing planning or ex ante tracking estimates and provided guidance as to how these differences will impact Nicor Gas' programs.

When not using deemed values from the TRM, the baseline for both Comprehensive and Systems Track projects is the appropriate Illinois Energy Conservation Code for Commercial Buildings (*to be distinguished from the IECC, the International Energy Conservation Code)*. The evaluation team used the date of the construction permit to determine which version of the Illinois Energy Conservation Code, which specifically references the IECC. This is the most appropriate to use as baseline. All EPY5/GPY2 projects we reviewed using the IECC 2009 code.[10]

[9] Deemed NTGR values are provided in Section 2.2.2 Net Program Savings Analysis Approach.
[10] Senate Bill 3724, signed by the Governor on August 17, 2012, amends the effective date of the 2012 IECC to January 1, 2013. Administrative Rules to adopt the 2012 IECC with amendments were approved by the Joint Committee on Administrative Rules on December 11, 2012.

The evaluation team also calculated interactive savings associated with Comprehensive Track projects for each utility. This analysis attributes interactive savings and penalties from each fuel type to the utility associated with the measure creating the interactive effects. We included all interactive effects for projects that the program database indicated are joint projects (i.e., the project receives natural gas service from Nicor Gas and electric service from ComEd, but may or may not have received a Nicor Gas incentive).

2.2.2 Net Program Savings Analysis Approach

To calculate verified net savings, the evaluation team used deemed NTGRs to obtain verified net savings for all EPY5/GPY2 projects. These values are based on the EPY3 evaluation for ComEd and the GPY1 values for Nicor Gas as agreed through a consensus process within the SAG.[11]

Table 2-7. Verified Net Savings Parameters

Utility	Overall NTGR
ComEd (MW and MWh)	0.65
Nicor Gas (therms)	0.52

Source: EPY3 evaluation for ComEd, GPY1 evaluation for Nicor

2.2.3 Process Evaluation

Given program maturity and historically high participant satisfaction, the EPY5/GPY2 process evaluation was limited to activities that provided information on participant characteristics, program implementation changes, and program challenges, particularly for the newer Nicor Gas program offerings.

2.2.4 Program Manager Interviews

The team conducted interviews with program management to collect information on EPY5/GPY2 program implementation change and challenges for both ComEd and Nicor Gas.

2.2.5 Review of Program Materials

The evaluation team reviewed new program documents such as the updated program operations manual to improve understanding of new approaches for EPY5/GPY2.

[11] ComEd PY5-PY6 Proposal Comparisons with SAG.xls, which is to be found on the IL SAG web site here: http://ilsag.info/net-to-gross-framework.html.

3. Gross Impact Evaluation

Participants completed more than one hundred projects in the Business New Construction Service program in EPY5/GPY2. An engineering desk review of a sample of these projects found realization rates for Comprehensive Track projects of 0.91 for kWh and 0.97 for kW. The evaluation team found realization rates of 1.19 with interactive effects and 1.44 without for therm savings for Nicor Gas Systems Track and Comprehensive Track projects.

3.1 Tracking System Review

ECW's reporting and tracking system meets many aspects of national best practices. The program tracks detailed information on all projects at all stages and also records all program outreach. ECW and ComEd have transitioned to using the new Frontier database for all active project tracking data. Frontier also has the ability to send and receive data to and from the CiviCRM project outreach system once a project has been submitted. Table 3-1 and Table 3-2 summarize the status of the evaluation team's EPY4/GPY1 recommendations. The team would like to re-emphasize the following findings and recommendations for EPY5/GPY2:

Finding. The evaluation team observed that while ECW required large projects to be inspected if they were not randomly selected, the same protocol of randomly selecting 50% of projects for inspection remained in place for EPY5/GPY2. The implementation team indicated that a new system could be developed if the program grows to the point where the current system is too inefficient.

- **Recommendation.** Consider developing a new and more efficient verification sampling system now so that it is already in place by the time the program is too large for the current approach.

Finding. The evaluation team had fewer difficulties identifying the correct project files in EPY5/GPY2. However, in one instance, a final modeling file could not be located due to an employee leaving the company, indicating that the program could benefit from a more organized or centralized file storage system so that key data is not misplaced.

- **Recommendation.** Continue to improve the organization of project-specific files in a centralized location. This will reduce the chance of lost or misplaced files and make it easier to fulfill evaluation data requests.

Table 3-1. Quality Assurance and Verification Recommendations

EPY4/GPY1 Recommendation	Status of Implementation
The evaluation team recommends revising inspection protocols to allow smaller projects to automatically be inspected through document review while requiring larger projects to be physically inspected. This will cut costs for small, simple projects and ensure that large and complex projects receive greater attention.	The evaluation team observed that while ECW required large projects to be inspected if they were not randomly selected, the same protocol of randomly selecting 50% of projects for inspection remained in place for EPY5/GPY2.
We also recommend revising protocols to consider using performance verification for large and complex projects where the uncertainty of savings is high. This would give ECW the opportunity to tie project simulation models to actual consumption data and improve *ex ante* estimates. While cost prohibitive for the majority of projects, this method could be justified for select projects. As the energy code becomes more stringent and building owners pursue newer and more complicated technologies this will become an important tool.	ECW does not plan to permanently implement performance verification for large projects due to the high cost of implementation. The implementation team may consider the approach on a case-by-case basis.
The team recommends formalizing a naming convention and designated location for final savings calculations files. If changes are made to a project's calculations after verification, a new file should be saved to highlight these changes.	The evaluation team had fewer difficulties identifying the correct project files in EPY5/GPY2. However, in one instance a final modeling file could not be located due to an employee leaving the company, indicating that the program could benefit from a more organized or centralized file storage system. ECW is implementing this for EPY6/GPY3.

Table 3-2. Data Tracking System and Reporting Recommendations

EPY4/GPY1 Recommendation	Status of Implementation
We recommend adding the following information to the tracking system for all projects:	
1. Measure or end-use level data. We understand the program's effort to consider holistic savings as much as possible. However, we feel that at least indicating which measures or end uses saw efficiency improvements in the project would give users more insight into a project "at a glance."	This recommendation has been implemented.
2. Cost data. Incremental cost is very difficult to estimate for new construction programs. Because ECW works very closely with design firms on many projects, they have a unique opportunity to seek out more accurate incremental cost estimates as projects go through the design process and make decisions about which measures to include. We recommend exploring this opportunity to improve incremental cost estimates and if successful, tracking incremental cost data at the project or measure level.	The implementation team provided documentation for the current estimated incremental cost per square foot used by the program.
3. Interactive savings. While interactive effects do not always affect rebates, they are important for benefit-cost analysis and should be tracked whenever they are calculated.	ECW has added a field to Frontier for interactive therm and kWh savings.
We recommend investing in documentation of the new Frontier and CiviCRM tracking systems, including a data dictionary which defines tracking system fields and the links between them.	The program operations manual contains a list of the fields in Frontier, but does not provide a full data dictionary.

3.2 Program Volumetric Findings

The number of projects in the Business New Construction Service more than doubled from EPY4/GPY1 to EPY5/GPY2, increasing from 50 to 111. In addition, the number of joint electric and gas projects increased significantly over the previous program year. While the number of ComEd only projects increased from 30 to 41, the number of joint projects increased from 20 to 70. Table 3-3 presents the number of projects by utility and program track.

Table 3-3. ComEd PY5 and Nicor Gas PY2 Volumetric Findings Detail

Project Description	Comprehensive*	Systems	Small Buildings	Total
ComEd Only	20	21	0	41
Joint without Therm Savings	20	21	1	42
Joint with Therm Savings	11	15	0	26
Joint with Only Therm Savings	0	2	0	2
Total	51	59	1	111

Source: Program tracking database.
**Includes projects listed as "comprehensive" (42), "comprehensive – xsheet" (8), and "systems and comprehensive" (1).*

3.3 Gross Program Impact Parameter Estimates

The evaluation team used deemed realization rate values for electric Systems Track projects, but developed researched realization rates for electric Comprehensive Track projects and both Systems and Comprehensive Track gas projects.[12] One Small Business Track project went through the program in EPY5 and the electric Systems Track realization rate was used for this project. For those projects where research occurred, the gross impact engineering review included several adjustments to the program level algorithms and assumptions. While only energy (kWh and therm) savings are necessary for reporting, the program does track peak coincident demand (kW) savings since ComEd includes this program within their bid to PJM. Summary tables (see Table 7-1 and Table 7-2) in the Appendix shows the gross ex ante gross savings and evaluation-adjusted gross savings by project, including individual project realization rates, for the sampled projects.

3.3.1 Systems Track Projects

The evaluation team reviewed seven Systems Track gas projects. In the course of this review, we found the following issue across multiple projects.

Finding: The calculations for demand controlled ventilation (DCV) and energy recovery ventilation (ERV) include a minimum economizer operation temperature. For all five applicable projects, this value is set to 35°F, indicating that the units are not in heating mode until below that temperature. Although economizers may operate to this temperature, many buildings can still see DCV and ERV savings at higher temperatures since some zones may be in heating mode even while the economizer is operating for others. This value is relatively low, especially for buildings with moderate internal gains common to the program, such as offices and warehouses. Additionally, this issue applies to one Comprehensive Track project that used the Systems Track template as the energy savings calculation method.

- **Recommendation:** The program should consider using a more reasonable assumption for the maximum outdoor temperature below which DCV and ERV savings may occur. For many buildings this will be between 55-60°F, though this is dependent on internal gains

[12] Deemed realization rates were based on ComEd's SAG filing (PY5 Deemed Evaluation Parameters Final.xls)

and should be determined on a project-specific basis. If a building has an abnormal balance temperature that requires a lower set-point, this should be clearly documented.

3.3.2 Comprehensive Track Projects

The evaluation team assessed 23 Comprehensive Track projects. Of these, 19 projects utilized a building simulation model to determine the savings and 4 used the Systems Track template to calculate savings. For the building simulation projects, the evaluation team reviewed the models to ensure consistency with all provided documentation. This included reviewing the shell characteristics, lighting power densities, and operating schedules.

Finding: Some projects only use a total lighting kW value, instead breaking out kW by fixture wattage and space type. As a result, the ex ante lighting savings of four projects are based on a single lighting power density for the entire building. IECC 2009 requires that lighting power density be calculated based on space type. The ex post savings for one project in particular were significantly reduced from the ex ante savings because the assumed building lighting power density was much greater than allowed when the building was broken out by space type.

- **Recommendation:** Including only a total kW value makes review of the project more difficult and errors can be difficult to trace. The program should consider increasing the granularity for which lighting kW is input.
- **Recommendation:** To meet IECC 2009 requirements, lighting power density should be calculated by space type.

Finding: The lighting projects, as well as some other measure types, were not completed using the TRM methodology. In general, the savings for projects were increased when converted to the TRM methodology due to the inclusion of interactive effects.

- **Recommendation:** The program should use the TRM methods when appropriate.

Finding: Two major renovation projects used existing parameters (e.g., the existing exterior wall construction) as the baseline for savings calculations. Renovations that expose the interior of the wall are required by law to bring the wall construction to code. In one case, the evaluation team's review of the project documentation indicated that keeping the existing wall was appropriate. For the second project, we determined that the level of interior demolition necessitated using code as the baseline.

- **Recommendation:** Major retrofit projects that use existing parameters as baseline (such as shell) that are less than current code minimum should be reviewed to ensure reasonableness and documented accordingly. Specifically, we encourage using code minimums in all cases where the renovations are significant and the exterior walls are likely to be exposed.

Finding: Two projects used baseline equipment inconsistent with ASHRAE 90.1 Appendix G. The evaluation team changed the equipment specifications in the evaluation-adjusted model to use the appropriate baseline.

- **Recommendation:** We recommend that the implementation team describe any deviations from ASHRAE 90.1 Appendix G in the project's supporting documentation.

3.4 Development of the Realization Rate

The evaluation team conducted engineering analysis and building energy modeling for the 30 sampled projects.[13] This sample size also ensured that Nicor Gas projects were well represented in order to develop a realization rate for both systems and comprehensive track projects.

The evaluation team used deemed RR parameters from the EPY3 evaluation to estimate EPY5 electric savings from Systems Track projects. Since there are not deemed RR values for Comprehensive Track projects or gas Systems Track projects, the team used evaluation research values for these parameters. To obtain overall RR values, regardless of track, we combined results across tracks within each utility. The deemed and research realization rates are shown in Table 3-4

Table 3-4. Realization Rate by Track and Utility

Utility	Systems Track	Comprehensive Track
ComEd (MWh)	0.997 (deemed)†	0.97
ComEd (MW)	0.997 (deemed)†	1.03
Nicor Gas (Therms with interactive effects)	1.19	1.19
Nicor Gas (Therms without interactive effects)	1.04	1.04

Source: Navigant analysis
† ComEd filing

3.5 Verified Gross Program Impact Results

In EPY5/GPY2, there were 111 total projects for which incentives were paid out and ex ante savings reported. The breakdown of projects includes 59 Systems Track projects, 51 Comprehensive Track projects, and 1 Small Business Track project. The evaluation team assessed 30 projects, 23 that were Systems Track projects and 7 that were Comprehensive Track projects.

Combining the deemed electric RR for Systems Track and Small Business Track (0.997) and the research Comprehensive Track RRs for electric energy savings (0.97) and electric demand (1.03), the overall program gross realization rate for electric energy savings is 0.98 and for demand savings is 1.02. The gross realization rate for natural gas energy is 1.04 without interactive effects and 1.19 with interactive effects. The point estimates were applied back to the population to obtain the evaluation-adjusted gross savings shown in Table 3-5.

[13] Of the 30 sampled projects, the 23 Comprehensive Track projects were used to develop the electric and gas Comprehensive Track realization rates. The seven sampled Systems Track projects were only used to develop the gas Systems Track realization rate. Although we performed engineering analysis on the electric savings of the Systems Track projects, the associated RR was not used in developing the electric savings for Systems Track projects. Rather, the deemed RR was used.

The resulting total program verified gross savings is 34,138 MWh, 7.3 MW, and 265,503 therms (without interactive effects) as shown in the following table. The verified gross savings meet 90/10 confidence or better for MWh, MW, and therms.[14]

Table 3-5. ComEd EPY5 and Nicor Gas GPY2 Verified Gross Impact Savings Estimates

Utility	Metric	Ex Ante Gross Savings	Gross Realization Rate	Evaluation- Adjusted Gross Savings
ComEd	MWh	34,929	0.98	34,138
	MW	7.2	1.02	7.3
Nicor Gas	Therms with interactive effects	183,088	1.19	218,374
	Terms without interactive effects	255,509	1.04	265,503

Source: Evaluation Team analysis.

[14] Therm savings that exclude interactive effects meet the 10% relative precision threshold. Therm savings including interactive effects have a relative precision of 18% and do not meet this threshold.

4. Net Impact Evaluation

The deemed NTGR values of 0.65 for electricity and 0.52 for gas were agreed to by stakeholders in discussions in the SAG (Table 4-1).[15] The electricity NTG value is from the PY3 evaluation. The gas NTG value was derived from the evaluation results on the electric program in PY4.

Table 4-1. Deemed NTGR Values for ComEd EPY5 and Nicor Gas GPY2

Utility	Overall NTGR
ComEd (MW and MWh)	0.65
Nicor Gas (therms)	0.52

Source: SAG Agreement.

Using these deemed values, the evaluation team calculated verified net savings of 22,190 MWh, 4.8 MW, and 138,062 therms (excluding interactive therm penalties) as shown in table below. The savings estimates are statistically significant at the 90/10 level for both electric and gas savings.[16]

Table 4-2. ComEd EPY5 and Nicor Gas GPY2 Verified Gross Impact Savings Estimates

Utility	Metric	Evaluation -Adjusted Gross Savings	NTGR	Evaluation Net Savings
ComEd	MWh	34,138	0.65	22,190
	MW	7.3	0.65	4.8
Nicor Gas	Therms without interactive therm penalties	265,503	0.52	138,062
	Therms with interactive therm penalties	218,374	0.52	113,554

Source: Evaluation Team analysis.

[15] Document provided by Nicor Gas and ComEd to the SAG summarizing the SAG consensus NTGR. Distributed in the SAG Meeting on August 5-6, 2013, which is to be found on the IL SAG web site here: http://ilsag.info/net-to-gross-framework.html.
ComEd PY5-PY6 Proposal Comparisons with SAG.xls
Nicor_Gas_NTG_Results_and_Application_GPY1-3.pdf.

[16] Gas savings excluding interactive effects are statistically significant at this level but gas savings including interactive effects are not.

5. Process Evaluation

The process evaluation for EPY5/GPY2 was limited to interviews with program staff and a review of updated program materials, including the operations manual. The evaluation team drew the following findings from the limited process evaluation in EPY5/GPY2:

1. The program has transitioned smoothly to new leadership and an all-comprehensive program incentive structure for projects started in EPY5/GPY2 and after.
2. The program continues to exceed electric savings goals, evidence that previous years' marketing and outreach have paid off.
3. The program has identified several barriers to reaching natural gas savings targets:
    a. The program has had to incorporate gas into the existing electric program, which was already well-established.
    b. Many high-savings projects are *not* located in Nicor Gas service territory.
    c. Long-lead times for new construction projects means that projects that are nearing completion had already decided on gas measure options prior to working with the program (e.g., building shell). This should become less of an issue in the future because the program is actively engaging with projects earlier in the design process and building the pipeline of projects for future years.
4. For these reasons, attaining gas goals continues to be a challenge, as the gas side of the program has not had as long to mature and grow. However, program staff are actively working to increase gas savings in several ways:
    a. Increasing promotion of gas incentives in marketing materials and approach.
    b. Researching opportunities for large gas projects through targeted marketing.
    c. Investigating measures such as high-efficiency gas rooftop units which can be specified later in the design process.

The following sections provide additional detail on the two activities of the EPY5/GPY2 process evaluation.

5.1 Program Staff Interviews

The team conducted interviews with program staff from ECW, ComEd and Nicor Gas. All reported that the program continues to operate smoothly. This year, the main challenge has been finding sufficient natural gas savings to meet program goals. The program also shifted to incenting all projects on a comprehensive per kWh and per therm basis. Staff reported that this transition has taken place smoothly and mostly as an internal change with no significant objections or complaints coming from program participants. Program staff also highlighted their efforts to target specific sectors of the commercial and industrial market based on previous projects' typical building square footage and energy savings density. This technique has been very successful in meeting electric savings goals. It has also demonstrated that some sectors that have good electric potential have less potential within Nicor Gas service territory.

The program has made the following additional implementation changes:

- Completed the shift to ComEd's Frontier database for enrolled projects and CiviCRM system for tracking marketing outreach.
- Modified its marketing approach to target combination gas and electric projects.
- A new program manager has taken over leading the implementation team at ECW.

5.2 Program Materials Review

The updated program operations manual described the program's targeted marketing approach. The program uses the following criteria to determine which building sectors to target:

- Which buildings are most likely to achieve significant savings over IECC 2012?
- Which buildings are most likely to be completed within the Program Year timeframe?
- Which buildings will provide Program Year savings? Which will provide savings within and 18-month period?
- Which building types are seeing the most new construction activity in the Northern Illinois and Chicago area?

Using these criteria, the program has identified healthcare facilities, colleges and universities, warehouses, industrial/manufacturing facilities, and multifamily buildings as project types to target.

The operations manual also describes the screening process that ECW uses to try to limit the acceptance of free-riders.

6. Conclusions and Recommendations

This section summarizes the key impact and process findings and recommendations.

The Business New Construction Service more than doubled the number of participating projects in EPY5/GPY2 from the previous year, increasing from 50 projects in EPY4/GPY1 to 111 in EPY5/GPY2. While ComEd met its program year savings target, Nicor Gas fell short.

Program Savings Goals Attainment

Finding 1. In EPY5/GPY2, ComEd achieved evaluation-adjusted gross energy savings of 34,138 MWh, exceeding its target of 26,000 gross MWh.[17] Nicor Gas achieved evaluation-adjusted gross savings of 265,503 therms, but fell short of its goal of 168,000 net therms, achieving savings of 138,062 net therms.[18] This was primarily because the agreed upon NTG was lower than the planning value.

Recommendation. The program should continue to target projects with both gas and electric savings and target sectors with high levels of gas use and potential savings.

Gross Realization Rates

Finding 2. The gross realization rate for therms savings is 104%, while the realization rates for kWh and kW savings are 98% and 102%, respectively. Engineering review of a sample of projects revealed that most energy savings modeling and calculations are reasonable and meet program guidelines. However, a few issues repeat across multiple projects as a result of not following program guidelines.

Recommendation. Calculating savings according to the program guidelines will result in electric and gas realization rates closer to 100% for future projects.

Finding 3. The calculations for demand controlled ventilation (DCV) and energy recovery ventilation (ERV) include a minimum economizer operation temperature indicating that the units are not in heating mode until below that temperature. Although economizers may operate to this temperature, many buildings can still see DCV and ERV savings at higher temperatures. For all five applicable projects, this temperature is set to a relatively low value (35°F) for buildings with moderate internal gains common to the program.

Recommendation. The program should consider using a more reasonable assumption for the maximum outdoor temperature below which DCV and ERV savings may occur. For many buildings this will be between 55-60°F, though this is dependent on internal gains and should be determined on a project-specific basis. If a building has an abnormal balance temperature that requires a lower set-point, this should be clearly documented.

Finding 4. Some projects only use a total lighting kW value, instead breaking out kW by fixture wattage and space type. As a result, the ex ante lighting savings are based on a

[17] ComEd MWh goal and results are evaluation-adjusted gross savings.

[18] Including interactive therm penalties from joint projects. When these penalties are removed, the verified Nicor Gas savings are 137,441 net therms.

single lighting power density for the entire building instead of for each space type, per IECC 2009 requirements. The ex post savings for one project in particular were significantly reduced from the ex ante savings because the assumed building lighting power density was much greater than allowed when the building was broken out by space type.

Recommendation. Including only a total kW value makes review of the project more difficult and errors can be difficult to trace. The program should consider increasing the granularity for which lighting kW is input.

Recommendation. To meet IECC 2009 requirements, lighting power density should be calculated by space type.

Finding 5. Two major renovation projects used existing parameters (e.g., the existing exterior wall construction) as the baseline for savings calculations. Renovations that expose the interior of the wall are required by law to bring the wall construction to code. In one case, the evaluation team's review of the project documentation indicated that keeping the existing wall was appropriate. For the second project, we determined that the level of interior demolition necessitated using code as the baseline.

Recommendation. Major retrofit projects that use existing parameters as baseline (such as shell) that are less than current code minimum should be reviewed to ensure reasonableness and documented accordingly. Specifically, we encourage using code minimums in all cases where the renovations are significant and the exterior walls are likely to be exposed.

Finding 6. Two projects used baseline equipment inconsistent with ASHRAE 90.1 Appendix G. The evaluation team changed the equipment specifications in the evaluation-adjusted model to use the appropriate baseline.

Recommendation. We recommend that the implementation team describe any deviations from ASHRAE 90.1 Appendix G in the project's supporting documentation.

Program Participation

Finding 7. Participation increased from 50 projects in EPY4/GPY1 to 111 projects in EPY5/GPY2. Systems Track projects represented more than half of the projects completed in EPY5/GPY2, but the program has shifted to a single, Comprehensive Track model for all projects initiated in EPY5/GPY2 and after.

Process Evaluation

Finding 8. Attaining gas goals continues to be a challenge, as the gas side of the program has not had as long to mature and grow. However, program staff are actively working to increase gas savings in several ways such as researching new construction trends in the Nicor Gas service territory and mining past participation data to target sectors with high savings potential, as well as investigating new gas measures.

Recommendation. In addition to focusing on past participant data mining, also target previously untapped sectors with large gas loads. For example, the large hot water loads in the hospitality and food service sectors may be a potential source of savings.

Finding 9. The program has worked to improve its screening of projects for potential free-riders in several ways, including limiting participation to projects earlier in the design process and discussing large projects with the evaluation team in advance.

Recommendation. In addition to continuing these efforts and moving forward with the "real-time" self-report net-to-gross pilot for EPY6/GPY3, plan to use market research to capture outside spillover now that the program is maturing.

Finding 10. The evaluation team observed that while ECW required large projects to be inspected if they were not randomly selected, the same protocol of randomly selecting 50% of projects for inspection remained in place for EPY5/GPY2. The implementation team indicated that a new system could be developed if the program grows to the point where the current system is too inefficient.

Recommendation. Consider developing a new and more efficient verification sampling system now so that it is already in place by the time the program is too large for the current approach.

7. Appendix

7.1 Glossary

High Level Concepts

Program Year

- EPY1, EPY2, etc. Electric Program Year where EPY1 is June 1, 2008 through May 31, 2009, EPY2 is June 1, 2009 through May 31, 2010, etc.
- GPY1, GPY2, etc. Gas Program Year where GPY1 is June 1, 2011 through May 31, 2012, GPY2 is June 1, 2012 through May 31, 2013.

There are two main tracks for reporting impact evaluation results, called Verified Savings and Impact Evaluation Research Findings.

Verified Savings composed of

- Verified Gross Energy Savings
- Verified Gross Demand Savings
- Verified Net Energy Savings
- Verified Net Demand Savings

These are savings using deemed savings parameters when available and after evaluation adjustments to those parameters that are subject to retrospective adjustment for the purposes of measuring savings that will be compared to the utility's goals. Parameters that are subject to retrospective adjustment will vary by program but typically will include the quantity of measures installed. In EPY5/GPY2 the Illinois TRM was in effect and was the source of most deemed parameters. Some of ComEd's deemed parameters were defined in its filing with the ICC but the TRM takes precedence when parameters were in both documents.
Application: When a program has deemed parameters then the Verified Savings are to be placed in the body of the report. When it does not (e.g., Business Custom, Retrocommissioning), the evaluated impact results will be the Impact Evaluation Research Findings.

Impact Evaluation Research Findings composed of

- Research Findings Gross Energy Savings
- Research Findings Gross Demand Savings
- Research Findings Net Energy Savings
- Research Findings Net Demand Savings

These are savings reflecting evaluation adjustments to any of the savings parameters (when supported by research) regardless of whether the parameter is deemed for the verified savings analysis. Parameters that are adjusted will vary by program and depend on the specifics of the research that was performed during the evaluation effort.
Application: When a program has deemed parameters then the Impact Evaluation Research Findings are to be placed in an appendix. That Appendix (or group of appendices) should be labeled Impact Evaluation Research Findings and designated as "ER" for short. When a program does not have deemed parameters (e.g., Business Custom, Retrocommissioning), the Research Findings are to be in the body of the report as the only impact findings. (However, impact findings may be summarized in the body of the report and more detailed findings put in an appendix to make the body of the report more concise.)

Program-Level Savings Estimates Terms

N	Term Category	Term to Be Used in Reports‡	Application†	Definition	Otherwise Known As (terms formerly used for this concept)§
1	Gross Savings	Ex-ante gross savings	Verification and Research	Savings as recorded by the program tracking system, unadjusted by realization rates, free ridership, or spillover.	Tracking system gross
2	Gross Savings	Verified gross savings	Verification	Gross program savings after applying adjustments based on evaluation findings for only those items subject to verification review for the Verification Savings analysis	Ex post gross, Evaluation adjusted gross
3	Gross Savings	Verified gross realization rate	Verification	Verified gross / tracking system gross	Realization rate
4	Gross Savings	Research Findings gross savings	Research	Gross program savings after applying adjustments based on all evaluation findings	Evaluation-adjusted ex post gross savings
5	Gross Savings	Research Findings gross realization rate	Research	Research findings gross / ex-ante gross	Realization rate
6	Gross Savings	Evaluation-Adjusted gross savings	Non-Deemed	Gross program savings after applying adjustments based on all evaluation findings	Evaluation-adjusted ex post gross savings
7	Gross Savings	Gross realization rate	Non-Deemed	Evaluation-Adjusted gross / ex-ante gross	Realization rate
1	Net Savings	Net-to-Gross Ratio (NTGR)	Verification and Research	1 – Free Ridership + Spillover	NTG, Attribution
2	Net Savings	Verified net savings	Verification	Verified gross savings times NTGR	Ex post net
3	Net Savings	Research Findings net savings	Research	Research findings gross savings times research NTGR	Ex post net
4	Net Savings	Evaluation Net Savings	Non-Deemed	Evaluation-Adjusted gross savings times NTGR	Ex post net
5	Net Savings	Ex-ante net savings	Verification and Research	Savings as recorded by the program tracking system, after adjusting for realization rates, free ridership, or spillover and any other factors the program may choose to use.	Program-reported net savings

‡ "Energy" and "Demand" may be inserted in the phrase to differentiate between energy (kWh, Therms) and demand (kW) savings.

† **Verification** = Verified Savings; **Research** = Impact Evaluation Research Findings; **Non-Deemed** = impact findings for programs without deemed parameters. We anticipate that any one report will either have the first two terms or the third term, but never all three.

§ Terms in this column are not mutually exclusive and thus can cause confusion. As a result, they should not be used in the reports (unless they appear in the "Terms to be Used in Reports" column).

Individual Values and Subscript Nomenclature

The calculations that compose the larger categories defined above are typically composed of individual parameter values and savings calculation results. Definitions for use in those components, particularly within tables, are as follows:

Deemed Value – a value that has been assumed to be representative of the average condition of an input parameter and documented in the Illinois TRM or ComEd's approved deemed values. Values that are based upon a deemed measure shall use the superscript "D" (e.g., delta watts^{D}, HOU-Residential^{D}).

Non-Deemed Value – a value that has not been assumed to be representative of the average condition of an input parameter and has not been documented in the Illinois TRM or ComEd's approved deemed values. Values that are based upon a non-deemed, researched measure or value shall use the superscript "E" for "evaluated" (e.g., delta watts^{E}, HOU-Residential^{E}).

Default Value – when an input to a prescriptive saving algorithm may take on a range of values, an average value may be provided as well. This value is considered the default input to the algorithm, and should be used when the other alternatives listed for the measure are not applicable. This is designated with the superscript "DV" as in X^{DV} (meaning "Default Value").

Adjusted Value – when a deemed value is available and the utility uses some other value and the evaluation subsequently adjusts this value. This is designated with the superscript "AV" as in X^{AV}

Glossary Incorporated From the TRM

Below is the full Glossary section from the TRM Policy Document as of October 31, 2012[19].

Evaluation: Evaluation is an applied inquiry process for collecting and synthesizing evidence that culminates in conclusions about the state of affairs, accomplishments, value, merit, worth, significance, or quality of a program, product, person, policy, proposal, or plan. Impact evaluation in the energy efficiency arena is an investigation process to determine energy or demand impacts achieved through the program activities, encompassing, but not limited to: *savings verification*, *measure level research*, and *program level research*. Additionally, evaluation may occur outside of the bounds of this TRM structure to assess the design and implementation of the program.

Synonym: **Evaluation, Measurement and Verification (EM&V)**

> **Measure Level Research**: An evaluation process that takes a deeper look into measure level savings achieved through program activities driven by the goal of providing Illinois-specific research to facilitate updating measure specific TRM input values or algorithms. The focus of this process will primarily be driven by measures with high savings within Program Administrator portfolios, measures with high uncertainty in TRM input values or algorithms (typically informed by previous savings verification activities or program level research), or measures where the TRM is lacking Illinois-specific, current or relevant data.

[19] IL-TRM_Policy_Document_10-31-12_Final.docx

Program Level Research: An evaluation process that takes an alternate look into achieved program level savings across multiple measures. This type of research may or may not be specific enough to inform future TRM updates because it is done at the program level rather than measure level. An example of such research would be a program billing analysis.

Savings Verification: An evaluation process that independently verifies program savings achieved through prescriptive measures. This process verifies that the TRM was applied correctly and consistently by the program being investigated, that the measure level inputs to the algorithm were correct, and that the quantity of measures claimed through the program are correct and in place and operating. The results of savings verification may be expressed as a program savings realization rate (verified ex post savings / ex ante savings). Savings verification may also result in recommendations for further evaluation research and/or field (metering) studies to increase the accuracy of the TRM savings estimate going forward.

Measure Type: Measures are categorized into two subcategories: custom and prescriptive.

Custom: Custom measures are not covered by the TRM and a Program Administrator's savings estimates are subject to retrospective evaluation risk (retroactive adjustments to savings based on evaluation findings). Custom measures refer to undefined measures that are site specific and not offered through energy efficiency programs in a prescriptive way with standardized rebates. Custom measures are often processed through a Program Administrator's business custom energy efficiency program. Because any efficiency technology can apply, savings calculations are generally dependent on site-specific conditions.

Prescriptive: The TRM is intended to define all prescriptive measures. Prescriptive measures refer to measures offered through a standard offering within programs. The TRM establishes energy savings algorithm and inputs that are defined within the TRM and may not be changed by the Program Administrator, except as indicated within the TRM. Two main subcategories of prescriptive measures included in the TRM:

Fully Deemed: Measures whose savings are expressed on a per unit basis in the TRM and are not subject to change or choice by the Program Administrator.

Partially Deemed: Measures whose energy savings algorithms are deemed in the TRM, with input values that may be selected to some degree by the Program Administrator, typically based on a customer-specific input.

In addition, a third category is allowed as a deviation from the prescriptive TRM in certain circumstances, as indicated in Section 3.2:

Customized basis: Measures where a prescriptive algorithm exists in the TRM but a Program Administrator chooses to use a customized basis in lieu of the partially or fully deemed inputs. These measures reflect more customized, site-specific calculations (e.g., through a simulation model) to estimate savings, consistent with Section 3.2.

7.2 Detailed Impact Research Findings and Approaches

7.2.1 Gross Impact Results

The research gross program savings for sampled projects are presented in Table 7-1 and Table 7-2 below. Realization rates below 100% indicate that energy savings were adjusted downward; those above 100% indicate that the energy savings were adjusted upward; and, those equal to 100% indicate that no changes were made.

Table 7-1. Research Gross Savings for Sampled Comprehensive Track Projects

Project ID	Ex Ante kW	Ex Post kW	Realiza-ation Rate (kW)	Ex Ante kWh	Ex Post kWh	Realiza-tion Rate (kWh)	Ex Ante therms	Ex Post therms	Realiza-tion Rate (therms)	Findings
81	136.0	136.0	100%	324,706	324,706	100%	-	-	N/A	• No changes were made to the ex ante savings estimates. Review of the models found them to be consistent with the supplied building plans. It should be noted that the savings for the conversion to a primary-only pumping system are allowed for this project because this deviates from the original project specifications, which specified a primary/secondary pumping configuration.
105	132.7	133.0	100%	272,478	272,478	100%	-	-	N/A	• No changes were made to the ex ante savings based on review of the models.
109	1.0	1.4	140%	5,374	9,637	179%	-	-	N/A	• Review of the model showed that ex ante lighting analysis claimed a reduction from 1.0W/sq. ft. to 0.9 W/sq ft. However, the installed lighting was approximately 0.8 W/sq ft. The savings were increased accordingly.
112	290.0	290.0	100%	869,444	869,444	100%	-	-	N/A	• The original model was completed in IES. Review of the inputs for the model were found to be consistent with code compliance and as-built drawings. Therefore, no changes were made.
115	147.0	147.0	100%	259,529	259,529	100%	3,254	3,254	100%	• Both the input values for the energy models and the setup of rooms, systems, plants, schedules and controls were evaluated and appear to be reasonable. The custom library data for each model was missing, however, preventing us from running the models through the calculation process. However, given the review of the model's inputs and setup, no changes to the ex ante savings appear necessary.

Project ID	Ex Ante kW	Ex Post kW	Realiza-ation Rate (kW)	Ex Ante kWh	Ex Post kWh	Realiza-tion Rate (kWh)	Ex Ante therms	Ex Post therms	Realiza-tion Rate (therms)	Findings
122	257.6	383.0	149%	2,764,761	2,898,348	105%	-	-	N/A	• The ex ante verification claims a baseline energy consumption of 4,781,662 kWh and 732.3 kW. We reviewed the ex ante energy model and found it to be reasonable, therefore the calculated energy model, as it was given to us was used for ex post analysis. However, when the ex ante model was calculated in a newer version of Trane Trace (as-is with no alternations made), the resulting baseline energy consumption was 4,845,222 kWh and 711.8 kW. The different assumptions of the two versions of the models results in different ex post savings values.
131	34.0	12.7	37%	107,225	39,133	36%	-	-	N/A	• Using the quantity and wattage of the interior lights specified in the building drawings, the full-load demand of the interior lights was found to be 74.8 kW, slightly less than the 75.1 kW specified in the implementer-verified savings analysis. • The baseline average weighted LPD, based on the space types in the facility, was calculated to be 1.03 W/sq ft. This is less than the LPD of 1.3 used in the implementer-verified savings analysis and results in a decrease in savings. • The waste heat factors for energy and demand specified in the TRM are used to determine the interactive effect savings for this project. Interactive effects are not accounted for in the implementer-verified savings analysis, but are included in the evaluated savings, increasing the savings for the project.
148	91.0	87.0	96%	328,293	118,150	36%	-	-	N/A	• The baseline and proposed cases were modeled correctly, but many input values in the baseline model do not match the proposed model. It appears that windows accounted for 32% of all exterior wall areas in the baseline model, which was not the case in the proposed model. We changed both the baseline model and the ex-post model to have matching input values.
160	152.0	151.7	100%	417,851	417,851	100%	-	-	N/A	• No changes were made to the ex ante savings.

Project ID	Ex Ante kW	Ex Post kW	Realiza-ation Rate (kW)	Ex Ante kWh	Ex Post kWh	Realiza-tion Rate (kWh)	Ex Ante therms	Ex Post therms	Realiza-tion Rate (therms)	Findings
164	100.0	127.0	127%	278,864	328,157	118%	12,354	2,902	23%	• Incentives for high performance windows were claimed based on a thermal resistance U-factor of 0.45 and a solar heat gain coefficient (SHGC) of 0.19. The ex ante model used a U-factor of 0.3 and SHCG of 0.34. Therefore the ex post analysis adjusted the model to reflect the claimed values. • The Trane Trace models included gas fired unit heaters as gas fired units with an efficiency of 100%. The design drawings and invoices show that the unit heaters are hydronic units served by the hot water boiler system. The standard efficiency for hydronic unit heaters is 80%. The baseline and ex post models were changed to reflect this.
165	112.0	96.9	86%	593,549	600,591	101%	-	-	N/A	• The savings for this project were originally completed in eQuest. However, the ex post analysis was completed outside of eQuest for the lighting savings due to several inconsistencies in the original models. Specifically, the model did not reflect the correct lighting power density based on the supplied plans, nor was it consistent with the plans with respect to building area. However, these corrections nearly cancel out to result in only a 1% change in savings. • No change was made the HVAC savings. The installed chillers do not serve this building but instead serve the building next door. No changes could be made.
175	54.0	61.0	113%	94,082	104,821	111%	10,226	12,958	127%	• We revised the ex ante model based on the supplied project documentation. Specifically, the baseline wall type and R-value was changed. The original model was based on steel-frame construction but the building is R-22 concrete so the model was re-run using code-minimum for mass walls. • The lighting power density was revised slightly downward based on the supplied plans. • Interactive effects resulted in penalties of 2,403 therms, 1 kW, and 4,653 kWh. These effects were not included in the ex post savings values.
219	254.0	253.9	100%	256,068	256,068	100%	-	-	N/A	• No changes were made based on review of the model and provided documentation.

Project ID	Ex Ante kW	Ex Post kW	Realiza-ation Rate (kW)	Ex Ante kWh	Ex Post kWh	Realiza-tion Rate (kWh)	Ex Ante therms	Ex Post therms	Realiza-tion Rate (therms)	Findings
224	160.0	160.0	100%	1,280,850	1,275,831	100%	10,159	10,159	100%	• Incentives for roof insulation were claimed based on a reduction in thermal resistance U-factor from 0.048 to 0.035. The ex ante model used U-factor of 0.04 for measures 3 and 4 and the claimed U-factor of 0.035 for measures 5, 6, and 7. The ex post analysis adjusted the model to reflect the claimed values. • Documents show that the lighting power density has been reduced in the parking garage from a baseline of 0.3 W/sq to a designed 0.11 W/sq ft. Field verification shows that the LPD has been reduced further to 0.1 W/sf. However, the proposed ex ante model reflects an LPD of 0.0967 W/sq ft. The ex post analysis adjusted the model to reflect the claimed values.
234	243.0	169.6	70%	1,625,016	1,099,559	68%	2,878	24,597	855%	• No models were provided for this project, therefore the inputs were reviewed for reasonableness. No changes were made to any of the measures with the exception of the lighting power density savings. According to the supplied documentation, the LPD savings were established using a base case LPD of 1.3 W/sf. However, more than 90% of the facility is warehouse space, which should have an allowable LPD of 0.8 W/sq ft. Changing this reduces the LPD savings by 40%. • Interactive effects result in a penalty of 13,252 therms. However, this was not included in the ex post savings value.
253	17.0	21.0	124%	127,944	117,365	92%	-	-	N/A	• The building is existing. It is unclear what mechanical systems existed before this design. The baseline used in modeling does not appear to match ASHRAE 90.1. PTACs with DX cooling and HW boilers are required as a baseline for residential buildings per ASHRAE 90.1. However, the ex ante baseline is acceptable as there is an existing central steam and chiller plant. • Baseline airflows and occupancy densities were higher than code in many cases. • All models did not account for roof areas. It appears this happened because "floor multipliers" were used in the models. Infiltration was also removed from interior rooms.

Project ID	Ex Ante kW	Ex Post kW	Realiza-ation Rate (kW)	Ex Ante kWh	Ex Post kWh	Realiza-tion Rate (kWh)	Ex Ante therms	Ex Post therms	Realiza-tion Rate (therms)	Findings
289	119.0	126.0	106%	249,410	264,733	106%	21,214	20,829	98%	• The baseline and ex ante model were found to be reasonable with one exception. Energy Measure #7 involves using condensing boilers, hot water temperature reset controls, and a constant speed primary with variable speed secondary pumping. The ex ante verification report confirms this measure has been installed but the energy model excludes the savings related to the variable speed pumping systems. The ex post analysis adjusted the energy model to include these savings.

Project ID	Ex Ante kW	Ex Post kW	Realiza-ation Rate (kW)	Ex Ante kWh	Ex Post kWh	Realiza-tion Rate (kWh)	Ex Ante therms	Ex Post therms	Realiza-tion Rate (therms)	Findings
290	95.0	223.5	235%	628,440	792,400	126%	2,138	8,487	397%	• The interior lights specified in the building drawings were counted and the LPD was found to be greater than the base case of 1.3 W/sq ft. specified in Table 505.5.2 in IECC 2009. Because of this, there are no LPD savings for this project. The implementer-verified savings analysis does not indicate which fixtures were included in the total lighting demand of 125 kW specified in the savings workbook, but it is suspected that some of the lights were not included because they are considered "task lighting." None of the lights throughout the facility, including the task lighting, were found to meet any of the exception qualifications listed in section 505.5.1 in IECC, so all of the interior lighting was included in the as-built LPD calculations. Review of the lighting detail drawings found that the LPD in the process area (where the task lighting is located) is approximately 1.3 W/sq ft., which is the code-maximum. However, the LPD in the tooling and CNC machining area is approximately 2.45 W/sq ft., which is the main reason the weighted average LPD of the facility was found to be greater than the baseline LPD of 1.3 W/sq ft. • The lights controlled by occupancy sensors were counted in the building drawings and the methodology outlined in section 4.5.5 of the TRM was used to determine savings. The documentation of this project does not specify how the savings were determined. The methodology outlined in the TRM included the use of waste heat factors to account for interactive effect savings. • For the calculation of DCV and ERV savings, we increased the minimum economizer temperature from 35°F to 60°F, as this is a more reasonable value. • In the savings calculations for the ERV, the average exhaust air temperature is set to 70°F, which is the heating set-point temperature specified in the savings calculations for DCV.

Project ID	Ex Ante kW	Ex Post kW	Realiza-ation Rate (kW)	Ex Ante kWh	Ex Post kWh	Realiza-tion Rate (kWh)	Ex Ante therms	Ex Post therms	Realiza-tion Rate (therms)	Findings
295	777.0	776.8	100%	4,706,222	4,704,908	100%	-	-	N/A	• The original model includes some fan savings due to the lighting replacement projects. However, the warehouse fans are constant volume. The savings are due to the auto-sizing within eQuest changing the fan size. The ex post savings removes the resizing savings, resulting in a very small reduction in savings.
349	24.0	14.0	58%	254,541	116,372	46%	2,148	903	42%	• The original model used the existing exterior wall construction (12" block, R-value of 1.28). This value appears excessively low for the existing wall construction (including all building materials), however, this could not be determined. Based on the level of interior demolition, it appears that the baseline should be a code compliant mass wall. • Interactive effects result in a penalty of 414 therms. However, this penalty is not included in the ex post savings value.
351	206.0	205.0	100%	529,758	529,754	100%	18,517	15,443	83%	• The original model assumed a 99% efficient heating system. The units are direct fired make-up air units. While it is correct that 100% of the heat is put into the space, only 92% of the heat is useful sensible heat. The remaining 8% is the difference between the higher and lower heating values of natural gas and is tied up in water vapor. • Interactive effects results in a penalty of 1,293 therms. However, this penalty is not included in the ex post savings value.
386	414.0	292.6	71%	1,657,919	1,691,391	102%	-	-	N/A	• The lighting power density savings were calculated according to the TRM method. The total lighting wattage was confirmed using the quantity of fixtures as found in the project invoices. Interactive effects were not included. The demand savings for lighting was reduced because exterior lighting is not expected to operate during the demand window.
389	24.0	26.1	109%	212,060	214,371	101%	-	-	N/A	• The skylight daylight savings were adjusted to account for the site verification reported W/sq ft. as indicated in the project documentation. The wattage claimed was 0.22 W/sq ft., however the site reported W/sq ft. was listed as 0.28 W/sq ft., so this value was used to calculate savings.

Source: Program tracking data and evaluation analysis

Table 7-2. Research Gross Savings for Sampled Systems Track Projects

Project ID	Ex Ante kW	Ex Post kW	Realiza-tion Rate	Ex Ante kWh	Ex Post kWh	Reali za-tion Rate	Ex Ante therms	Ex Post therms	Reali za-tion Rate	Findings
46	20.9	11.2	54%	64,295	33,355	52%	16,109	12,732	79%	• The full-load power of the interior lights based on the counts and quantities from the building drawings were found to be higher than the demand specified in the ex ante calculations. The energy savings were recalculated using the full load kW using the hours of use from the ex ante calculations. • The waste heat factors for energy and demand for "Retail" specified in the TRM are used to determine the interactive effect savings for the reduced LPD. Because interactive effects are not taken into account in the implementation-verified savings analysis, including them results in increased savings. • The equations for kWh and kW savings in the TRM are used to calculate savings for the installation of high efficiency air conditioners. From IECC 2009, the minimum efficiency for 20 ton units is 10.0 EER and the EFLH is 819. From the project documentation, the efficiency of the installed unit is 11.5 EER. • The project documentation showed that the HVAC units were large enough and had enough design CFM of outdoor air that energy recovery would be required. However, the customer installed both a more effective energy recovery unit and demand controlled ventilation. Therefore, savings for the energy recovery were reduced, but savings for DCV were added. The overall gas savings for this project were reduced by approximately 25%.

Project ID	Ex Ante kW	Ex Post kW	Realiza-tion Rate	Ex Ante kWh	Ex Post kWh	Reali za-tion Rate	Ex Ante therms	Ex Post therms	Reali za-tion Rate	Findings
151	11.6	13.7	118%	65,780	83,003	126%	16,798	12,341	73%	• The quantities of interior lights were updated in the savings workbook to reflect the quantities found in the building drawings. Based on this change, the full-load demand of the interior lights increased from 90.008 kW found in the ex ante calculations to 91.702 kW. We recalculated the lighting energy savings based on this updated full-load kW using hours of use specified in the ex ante calculations. • The interactive effects for the interior lights was determined using the energy and demand waste heat factors and coincidence factors specified in the TRM. • The mechanical drawings for the building specify the minimum outdoor air for the building to be 20,300 CFM. We used this value in the savings workbook to determine the gas energy savings resulting from the installation of demand-controlled ventilation. The value previously used was 46,690 CFM, but the source of this value could not be determined. • We changed the economizer temperature set-point from 35°F to 60°F, which is a more reasonable heating changeover temperature. • The heating efficiency of the RTUs was found to be 80.9% per the mechanical detail drawings, so we updated the heating system efficiency to this value.

Project ID	Ex Ante kW	Ex Post kW	Realiza-tion Rate	Ex Ante kWh	Ex Post kWh	Reali za-tion Rate	Ex Ante therms	Ex Post therms	Reali za-tion Rate	Findings
237	20.0	6.0	30%	196,180	45,427	23%	192	555	289%	• The implementer-verified list of lights yields no savings for reduced LPD, as the lights were found to have an LPD of approximately equal to the code-maximum for retail buildings (1.5 W/sq ft.). However, in the review of the lighting detail drawings, the cooler lights and wall wash lights are not counted because they do not contribute to space lighting. Using only the lights found in the building drawings that contribute to space lighting, the LPD is approximately 1.38 W/sq ft., resulting in savings compared to the code maximum. The waste heat factors for energy and demand are used to calculate the savings due to reduced LPD as outlined in the TRM. • The mechanical drawings for the building indicate that there are two units that bring in outside air that also have CO2 sensors installed for demand-controlled ventilation. The minimum outside air CFM of these units totals 535 CFM, which is consistent with the savings workbook. We increased the minimum economizer temperature from 35°F to 60°F, as this is a more reasonable value. The occupied heating temperature setpoints specified in the mechanical drawings is 67°F, so the savings workbook was updated with this value (originally 70°F). Also, because the store is open 24/7, the operating schedule for the RTUs in the savings workbook was updated to reflect continuous occupied mode operation.

Project ID	Ex Ante kW	Ex Post kW	Realiza-tion Rate	Ex Ante kWh	Ex Post kWh	Reali za-tion Rate	Ex Ante therms	Ex Post therms	Reali za-tion Rate	Findings
238	-	-	N/A	-	-	N/A	455	624	137%	• The baseline window U-factor was changed from 0.45 to 0.55. The original value specified was for curtainwall/storefront, which is not the correct classification for the windows involved in this project. Per review of the architectural drawings, metal framing with thermal break is an appropriate classification, for which the maximum U-factor is 0.55. With the increased baseline U-factor, the other windows installed at the facility also qualified for savings, as there are 174 sq ft. of windows with U-factors of 0.45. The savings for these windows is determined in the same manner as the savings for the windows with a U-factor of 0.29 and is added to the total savings for the windows. • The project documentation specifies that there are 680 sq ft. of windows with U-factors of 0.29. The window area was changed from 681 to 680. • The efficiency of the heating system was found to be 80.87% from the mechanical drawings included in the project documentation. This change also affects the roof insulation savings.

Project ID	Ex Ante kW	Ex Post kW	Realiza-tion Rate	Ex Ante kWh	Ex Post kWh	Reali za-tion Rate	Ex Ante therms	Ex Post therms	Reali za-tion Rate	Findings
297	109.0	166.6	153%	1,013,685	1,256,970	124%	951	1,061	112%	• Waste heat adjustment factors for energy and demand are used to calculate interactive effect savings for reduced LPD. No adjustment factors were used in the implementer-verified savings analysis to account for interactive effects. Accounting for these results in savings. • The mechanical drawings for the building indicate that there are two units that bring in outside air that also have CO2 sensors installed for demand-controlled ventilation. The minimum outside air CFM of these units totals 535 CFM, which is consistent with the savings workbook. We increased the minimum economizer temperature from 35°F to 60°F, as this is a more reasonable value. Because the store is open 24/7, the operating schedule for the RTUs in the savings workbook was updated to reflect continuous occupied mode operation. The increase in the minimum economizer temperature causes savings to be calculated for more hours of the year, as savings are calculated for hours when the outdoor air temperature is below 60°F rather than below 35°F. • The TRM specifies a deemed savings value of 451 therms for the installation of infrared heaters. The savings for the installation of infrared heaters was changed to this value.

Project ID	Ex Ante kW	Ex Post kW	Realiza-tion Rate	Ex Ante kWh	Ex Post kWh	Reali za-tion Rate	Ex Ante therms	Ex Post therms	Reali za-tion Rate	Findings
R	44.0	18.9	43%	439,537	92,331	21%	601	1,027	171%	• The interior lights specified in the building drawings for the main area of the store were counted and were used in the provided lighting workbook to determine the LPD savings. To account for interactive effect savings, the waste heat factors specified in the TRM are used. Building lighting detail drawings were only provided for the main area of the store and not for offices or other areas of the building. The area of the space for which detail drawings were provided is the square footage used in the savings calculations, which is less than the total building area originally specified in the savings calculations. The LPD savings in the remainder of store (for which no drawings were received) is assumed to be equal to the savings in the main store area. • The store is open from 7:00 a.m. – 8:30 p.m. Monday through Saturday and 10:00 a.m. – 6:00 p.m. on Sundays. This total of 4,641 hours per year is not consistent with the continuous operation assumed for the lights in the implementer-verified savings analysis. We changed the hours of operation of the lights to 4,719 per year, which is the annual fixture operating hours specified in the TRM for "Retail/Service." • The ex post savings are significantly less because the implementer-verified savings analysis used the lighting in just the main store area with the square footage of the entire facility, resulting in a low inaccurate LPD for the facility. • Waste heat factors for energy and demand and a coincidence factor of 0.83 are used to determine the interactive effect savings for this project, which results in increased savings. • The mechanical drawings for the building indicate that there are five units that bring in outside air that also have CO2 sensors installed for demand-controlled ventilation. The minimum outside air CFM of these units totals 1,670 CFM, which is consistent with the savings workbook. We increased the minimum economizer temperature from 35°F to 60°F, as this is a more reasonable value.

Project ID	Ex Ante kW	Ex Post kW	Realiza-tion Rate	Ex Ante kWh	Ex Post kWh	Reali za-tion Rate	Ex Ante therms	Ex Post therms	Reali za-tion Rate	Findings
R	15.0	28.5	190%	74,517	121,481	163%	29,378	45,558	155%	• The interior lights specified in the building drawings for the main area of the store were counted and used in the provided lighting workbook to determine the LPD savings. To account for interactive effect savings, the waste heat factors specified in the TRM as is the appropriate coincidence factor. The implementer-verified total lighting demand is 125.859 kW, whereas the total lighting demand found from the lighting detail drawings is 121.548 kW. The lesser full-load demand results in greater savings, as do the use of the energy and demand waste heat factors. • In the savings workbook, the minimum economizer temperature was increased from 35°F to 60°F, as this is a more reasonable value. • The energy recovery ventilation sensible effectiveness was changed from 56% to 55.4%, which is the effectiveness stated in the product literature included in the project documentation.

Source: Program tracking data and evaluation analysis