Business Energy Efficiency Rebate Program

GPY4 Evaluation Report

Energy Efficiency Plan: Gas Plan Year 4 (6/1/2014-5/31/2015)

FINAL

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Nicor Gas Company

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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 Nicor Gas program year four (GPY4)[1] Business Energy Efficiency Rebate (BEER) Program. Through the BEER Program, business customers receive incentives for installing new, highly efficient space heating, water heating, pipe insulation and commercial kitchen equipment covered by the program, as well as rebates for other prescriptive cost effective equipment and services to improve the energy efficiency of existing equipment. The program target market is business customers using 60,000 therms or more per year, with reliance on wholesale and retail trade allies and business trade associations to assist in the marketing of the program to Nicor Gas' end-use customers. In addition to previously offered program measures, the GPY4 program measure mix included direct install measures such as bathroom and kitchen faucet aerators, pre-rinse sprayers and low flow showerheads. The BEER Program is implemented by CLEAResult.

The GPY4 evaluation involved verifying gross savings and calculating verified net impact savings using the Net-to-Gross (NTG) ratio approved through the Illinois Stakeholder Advisory Group (SAG) consensus process for GPY4.[2] The majority of the savings from the measures installed in GPY4 are derived from deemed values and algorithms contained in the Illinois Technical Reference Manual (TRM).[3] Navigant interviewed program staff and the implementation contractor staff to verify information about the tracking system.

In fall of 2014, Navigant conducted GPY4 NTG and process evaluation research on 44 customers and 20 trade allies that participated in the GPY3 BEER Program. The results of this research were used to inform the NTG values deemed for GPY5, and provided feedback on a limited number of process questions. The GPY4 evaluation also included a steam trap study that involved using previous program year data and updating algorithm assumptions with Illinois-specific data available from rebate applications and steam trap audit reports to confirm applicability of updates to the Illinois steam trap market. The results were summarized in memos to Nicor Gas, and copies are attached in the Appendix of this report.

E.1. Program Savings

The following two tables summarize the total program savings and program savings by measure. Table E-1 shows the GPY4 BEER Program achieved verified net energy savings of 3,823,275 therms.

[1] The GPY4 program year began June 1, 2014 and ended May 31, 2015.
[2] http://ilsagfiles.org/SAG_files/NTG/2015_NTG_Meetings/Final_2015_Documents/Nicor_Gas_NTG_Summary_GPY1-5_2015-03-01_Final.pdf
[3] Illinois Statewide Technical Reference Manual for Energy Efficiency Version 3.0, available at: http://www.ilsag.info/technical-reference-manual.html

Table E-1. GPY4 Program Results

Savings Category	Nicor Gas
Ex Ante Gross Savings[4] (Therms)	4,607,856
Verified Gross Realization Rate (RR)	1.00 ‡
Verified Gross Savings (Therms)	4,606,355
Net to Gross Ratio (NTGR)	0.83 †
Verified Net Savings (Therms)	3,823,275

Source: Utility tracking data and Navigant analysis.
‡ Based on evaluation research findings
† Source:
http://ilsagfiles.org/SAG_files/NTG/2015_NTG_Meetings/Final_2015_Documents/Nicor_Gas_NTG_Summary_GPY1-5_2015-03-01_Final.pdf

Table E-2 summarizes the ex-ante gross savings, verified gross savings, and verified net savings for the GPY4 BEER Program by measure. Steam traps continued to make the largest impact of the program savings, contributing 94 percent of the GPY4 verified net savings. Space heating, kitchen equipment and other equipment including the direct install measures contributed the remaining six percent of the verified net savings.

[4] From Program Tracking System

Table E-2. GPY4 Program Results by Measure

	Research Category	Ex Ante Gross Savings (Therms)	Verified Gross Realization Rate‡	Verified Gross Savings (Therms)	NTGR †	Verified Net Savings (Therms)
Direct Install Measures	Faucet Aerator	2,007	1.00	2,007	0.83	1,666
	Showerhead	4,317	1.00	4,317	0.83	3,583
	Pre-Rinse Spray Valve	183	1.00	183	0.83	152
Subtotal		*6,507*	*1.00*	*6,507*	*0.83*	*5,401*
Prescriptive Incentives Measures	Boiler Tune Up, Heating	22,352	1.00	22,352	0.83	18,552
	Boiler Tune Up, Process	115,369	1.00	115,369	0.83	95,756
	Efficient Boiler	32,856	1.00	32,770	0.83	27,199
	Efficient Furnace	3,667	1.00	3,667	0.83	3,044
	Pool Covers	15,369	0.88	13,550	0.83	11,247
	Ozone Laundry	3,686	1.00	3,687	0.83	3,060
	Pipe Insulation	26,017	1.00	26,017	0.83	21,594
	Steam Trap	4,326,166	1.00	4,326,173	0.83	3,590,723
	Convection Oven	1,224	1.00	1,224	0.83	1,016
	Fryer	30,756	1.00	30,756	0.83	25,527
	Griddle	298	1.00	298	0.83	247
	Infrared Charbroiler	661	1.00	661	0.83	549
	Infrared Heaters	10,373	1.00	10,373	0.83	8,610
	Infrared Upright Broiler	1,089	1.00	1,089	0.83	904
	Programmable Thermostat	4,077	1.02	4,164	0.83	3,456
	Rack Oven	6,192	1.00	6,192	0.83	5,139
	Storage Water Heater	1,197	1.26	1,506	0.83	1,250
Subtotal		*4,601,349*	*1.00*	*4,599,848*	*0.83*	*3,817,874*
Total		4,607,856	1.00	4,606,355	0.83	3,823,275

Source: Program tracking data and Navigant analysis.
‡ Based on evaluation research findings.
† Source:
http://ilsagfiles.org/SAG_files/NTG/2015_NTG_Meetings/Final_2015_Documents/Nicor_Gas_NTG_Summary_GPY1-5_2015-03-01_Final.pdf

E.2. Impact Estimate Parameters

Table E-3 shows the key parameters used in the GPY4 impact analysis. Navigant used impact parameters as defined by the Illinois Technical Reference Manual (TRM v3.0) to evaluate the savings for

most program measures. Navigant evaluated and verified custom savings input parameters used by CLEAResult including steam traps hours of use, and custom efficiency values used to estimate ex ante savings for space heating and kitchen equipment. For the calculation of net savings, Navigant used a NTGR deemed by the Stakeholder Advisory Group (SAG) for Nicor Gas GPY4 BEER Program savings. This report provides further overview of impact parameters in Section 2.2.

Table E-3. Impact Estimate Parameters

Parameter	Data Source	Deemed or Evaluated?
Net to Gross Ratio	SAG Document †	Deemed
Verified Gross Realization Rate	Program Tracking Data, Illinois TRM (v3.0) or custom evaluation	Evaluated
Space Heating and Kitchen Equipment Efficiency Inputs	Nicor Gas custom values	Deemed
Steam Trap HOU Values	Nicor Gas custom values	Evaluated

Source: Navigant analysis
† Deemed values. Source: http://ilsagfiles.org/SAG_files/NTG/2015_NTG_Meetings/Final_2015_Documents/Nicor_Gas_NTG_Summary_GPY1-5_2015-03-01_Final.pdf

E.3. Participation Information

Table E-4 provides an overview of GPY4 participation. The BEER Program had 166 total participants, including 13 customers who received no-cost direct install products or services, and 153 participants who received prescriptive incentives. A total of 355 projects were completed through the GPY4 program, including the installation of 3,180 measures.

Table E-4. GPY4 Primary Participation Detail

Participation	Direct Install	Prescriptive Incentive	Program Total
Participants[5]	13	153	166
Completed Projects	22	333	355
Installed Measures[6]	675	2,505	3,180

Source: Program tracking data and Navigant analysis.

[5] Participants are defined based on the project site address and number of accounts.
[6] For evaluation reporting purpose, if a measure quantity is reported in the tracking system in linear feet, MBH, or square feet, Navigant treated each row entry of such measure as one measure quantity in this table.

E.4. Finding and Recommendations

This section summarizes the key findings and recommendations.

Program Savings Achievement

Finding 1. Navigant verified net savings of 3,823,275 therms for the GPY4 BEER Program, based on the SAG approved NTG ratio of 0.83. The verified net savings is 135 percent of the program net savings goal of 2,825,000 therms.[7] Steam trap measures continued to account for the highest portion of program savings, contributing 94 percent of the GPY4 verified net savings. Space heating, kitchen equipment and other equipment including the direct install measures contributed the remaining six percent of the verified net savings.

Gross Realization Rates

Finding 2. Navigant calculated an overall gross savings realization rate of 100 percent for the BEER Program, based on verified gross savings of 4,606,355 therms compared with the ex ante 4,607,856 therms. Navigant's analysis determined that custom inputs were applied to programmable thermostats, pipe insulation, steam traps, boilers, and furnace measures. Our verification showed that for some measures (e.g. Fryers) Nicor Gas defaulted to the TRM deemed savings for all instances although actual custom data was collected. We emphasize that according to the TRM ***"A Program Administrator can choose to count savings for a TRM measure on a customized basis using actual or on-site parameter values. However, for the duration of a program year, once a measure savings calculation path is chosen—either on a customized or a prescriptive basis within a particular program—all instances of the measure within that program must be treated consistently".***[8] This provision calls for a consistent approach from Nicor Gas in the estimation of the BEER program measure savings.

Recommendation 1. Nicor Gas should notify the TRM Technical Advisory Committee (TAC) and evaluators prior to the start of each program year on instances where custom inputs are collected to replace TRM deemed inputs for measure savings estimation. In the case for GPY4, the custom hours of use values collected for industrial steam traps would need the TAC notification, although Navigant verified the values on a custom, retrospective basis. We also emphasize that, for consistency, when custom inputs are available, even when lowering the savings compared with the deemed TRM value, the custom input be applied to the ex ante savings. The same is true when the custom input increases the savings compared with the deemed value. Following these steps will reduce the potential for an unexpected retrospective savings verification adjustment.

Finding 3. Navigant determined that most of the GPY4 measures had a gross realization rate of 100 percent after reviewing the TRM deemed inputs and verified the custom input parameters. The realization rate for storage water heaters was adjusted to 126 percent. The realization rate for pool covers was lowered to 88 percent using the TRM approved savings adjustment factors for indoor and outdoor pool covers. Programmable thermostats had a 102 percent gross realization rate. Other measures including efficient boilers and steam traps had verified savings with minor adjustments or rounding difference compare to the ex ante, but with 100 percent realization rate. The reasons for adjustments are discussed in Section 3.

[7] Nicor Gas Energy Efficiency Plan, June 2014 - May 2017

[8] http://ilsagfiles.org/SAG_files/Technical_Reference_Manual/Policy%20Document%20for%20IL%20TRM%2010-25-12.pdf)

Recommendation 2. Nicor Gas should update the ex-ante savings calculations for commercial pool covers to use TRM approved savings factors for indoor and outdoor spaces.

Recommendation 3. Nicor Gas should ensure that the description of program measures in the tracking system are consistent with deemed and custom input parameters used to generate measure savings.

Tracking System Review

Finding 4. Navigant's preliminary savings verification effort calculated low realization rates for pipe insulation measures, boilers, furnace, fryers, and steam traps. Navigant's review of the BEER Program tracking database revealed that in many instances the measure savings input parameters did not produce the claimed savings in the tracking system. When we reported this as a preliminary finding, CLEAResult informed us that when provided in the application, custom inputs were used to determine savings – otherwise TRM values were applied. We found that projects that used custom inputs to determine the ex ante savings value did not include the custom input in the tracking data. Although Navigant was aware from past evaluations that CLEAResult uses custom inputs, it was not clear from the tracking data which measures were affected in GPY4. Follow up supplemental data with lookup values provided by CLEAResult enabled Navigant to verify the full claimed savings for some measures and adjust the savings for others. Navigant's verification approach was that when the ex ante savings calculation contained custom inputs, our analysis considered[9] those provided by CLEAResult; when not provided, we defaulted to the TRM values.

Recommendation 4. Nicor Gas should consider updating the tracking system to accommodate the supplemental data lookup custom input variables collected from customer applications. The supplemental custom data should be provided together with the tracking database submitted for evaluation verification. This could minimize the extra time and cost involved in repeating the savings verification process and delays in the evaluation reporting deadlines.

Finding 5. Nicor Gas uses a default heating capacity of 104,000 Btu/hr as an input variable for heating equipment when estimating savings for programmable thermostats. The savings calculation uses a custom savings factor instead of deemed TRM values based on building type and location. The verified savings increased after reviewing the project details and supplemental data. We acknowledge that savings assumptions and methodology for programmable thermostats have changed in the subsequent TRM versions, and that Nicor Gas is making the necessary changes to the measure savings assumption and tracking.

Program Participation

Finding 6. The GPY4 BEER Program resulted in participation of 166 participants, including 13 customers who had direct install products or services, and 153 participants who received prescriptive incentives. A total of 355 projects were completed through the GPY4 program, involving the installation of 3,180 rebate measures. The program paid $602,152 in incentives, which is about $0.13 per gross therm.

[9] Navigant's retrospective verification of custom inputs was not constrained to using values provided on the application form or supplemental program tracking data provided by Nicor Gas.

1. INTRODUCTION

1.1 Program Description

Through the BEER Program, business customers receive incentives for installing new, highly efficient space heating, water heating, pipe insulation and commercial kitchen equipment covered by the program, as well as rebates for other prescriptive cost effective equipment and services to improve the energy efficiency of existing equipment. The program target market is business customers using 60,000 therms or more per year, with reliance on wholesale and retail trade allies and business trade associations to assist in the marketing of the program to Nicor Gas' end-use customers. In addition to previously offered program measures, the GPY4 program measure mix included direct install measures such as bathroom and kitchen faucet aerators, pre-rinse sprayers and low flow showerheads. The BEER Program is implemented by CLEAResult. During GPY4, program tracking data showed that 166 business customers participated in the BEER Program and installed 3,180 rebate measures.

1.2 Evaluation Objectives

This evaluation of the BEER Program covers the fourth full-scale year of program operation (June 1, 2014 through May 31, 2015). As planned, the Nicor Gas BEER Program year four (GPY4) evaluation primarily focused on the following key research topics for GPY4:

Impact Research:

1. What is the program's verified gross savings?
2. What is the program's verified net savings?
3. What updates are recommended for the Illinois Technical Reference Manual (TRM)?

Process Research:

Customers and trade allies were interviewed to answer questions related to their overall satisfaction with the program and how the program can be improved, their awareness of the Nicor Gas on-bill financing option, customer participation in the on-bill financing option, and how the financing option can be improved. Analyses of the satisfaction and awareness responses are summarized in a memo presented to Nicor Gas and shown in the Appendix of this report.

The remaining GPY4 process evaluation activities for the BEER Program were limited to interviews with program staff and the implementation contractor staff to verify information about the tracking system.

2. EVALUATION APPROACH

The GPY4 evaluation involved verifying gross savings and calculating verified net impact savings using the deemed Net-to-Gross Ratio (NTGR) ratio approved through the Illinois SAG for GPY4.[10] The majority of the savings from the measures installed in GPY4 are derived from deemed values and algorithms contained in the Illinois Technical Reference Manual (TRM).[11]

In fall of 2014, Navigant conducted GPY4 NTG and process evaluation interviews with 44 customers and 20 trade allies that participated in the GPY3 BEER Program. The results of this research were used to inform the NTG values deemed for GPY5, and provided feedback on a limited number of process questions. The GPY4 evaluation also included a steam trap study that involved using previous program year data and updating algorithm assumptions with Illinois-specific data available from rebate applications and steam trap audit reports. Navigant interviewed program staff and the implementation contractor staff to verify information about the tracking system.

2.1 Overview of Data Collection Activities

The core data collection activities included a tracking system review and an engineering analysis as shown in the table below.

Table 2-1. Data Collection Activities

What	Who	Target Completes	Completes Achieved	When
Telephone Interviews	GPY3 Participating Customers	44	44	Fall 2014
Telephone Interviews	Trade Allies	20	20	Fall 2014
In Depth Interviews	PM/IC	2	2	May 2015
Tracking System & Engineering Review	GPY4 Projects using IL-TRM or through research	All	All	April-June 2016
Project File Reviews	GPY4 Projects with custom inputs	All	All	April-June 2016

Source: Navigant analysis

[10] http://ilsagfiles.org/SAG_files/NTG/2015_NTG_Meetings/Final_2015_Documents/Nicor_Gas_NTG_Summary_GPY1-5_2015-03-01_Final.pdf

[11] Illinois Statewide Technical Reference Manual for Energy Efficiency Version 3.0, available at: http://www.ilsag.info/technical-reference-manual.html

2.2 Verified Savings Parameters

Table 2-2 below presents the sources for parameters that were used in verified gross savings analysis indicating which were examined through GPY4 evaluation research and which were deemed.

Table 2-2 Verified Gross and Net Savings Parameters

Measure	Input Parameter Source	Deemed or Evaluated?
NTGR	SAG Agreement†	Deemed
Gross Realization Rate	Tracking data and evaluation research	Evaluated
Faucet Aerator	Illinois TRM, v3.0, section 4.3.2‡	Deemed
Showerhead	Illinois TRM, v3.0, section 4.3.3‡	Deemed
Pre-Rinse Spray Valve	Illinois TRM, v3.0, section 4.2.11‡	Deemed
Boiler Tune Up, Heating	Illinois TRM, v3.0, section 4.4.2‡	Deemed
Boiler Tune Up, Process	Illinois TRM, v3.0, section 4.4.3‡	Deemed
Boiler Cutout/Reset Control	Illinois TRM, v3.0, section 4.4.4‡	Deemed
High Efficiency Boiler	Illinois TRM, v3.0, section 4.4.10‡ & custom input	Evaluated
High Efficiency Furnace	Illinois TRM, v3.0, section 4.4.11‡ & custom input	Evaluated
Commercial Pool Covers	Illinois TRM, v3.0, section 4.3.4‡	Deemed
Ozone Laundry	Illinois TRM, v3.0, section 4.3.6‡	Deemed
Pipe Insulation	Illinois TRM, v3.0, section 4.4.14‡	Deemed
Steam Traps	Illinois TRM, v3.0, section 4.4.16‡ & custom input	Evaluated
Commercial Kitchen – Fryer/Convection Oven	Illinois TRM, v3.0, section 4.2‡ & custom input	Deemed
Commercial Kitchen – Griddle/Broilers/Rack Oven	Illinois TRM, v3.0, section 4.2‡	Deemed
Infrared Heaters	Illinois TRM, v3.0, section 4.4.12‡	Deemed
Programmable Thermostat	Illinois TRM, v3.0, section 4.4.18‡	Deemed
Storage Water Heater	Illinois TRM, v3.0, section 4.3.1‡	Deemed

Source: Navigant analysis

† http://ilsagfiles.org/SAG_files/NTG/2015_NTG_Meetings/Final_2015_Documents/Nicor_Gas_NTG_Summary_GPY1-5_2015-03-01_Final.pdf

‡ Illinois Statewide Technical Reference Manual for Energy Efficiency Version 3.0, available at: http://www.ilsag.info/technical-reference-manual.html

2.3 Verified Gross Program Savings Analysis Approach

Navigant used the Illinois TRM Version 3.0 methodology to calculate verified gross savings for measures with deemed savings. The Illinois TRM allows for some custom values to be used in the algorithms as well. CLEAResult used custom input variables collected from customer applications alongside TRM deemed inputs to estimate ex ante savings for some measures. Navigant reviewed the custom assumptions in the tracking database and supplemental data provided by CLEAResult to verify the reasonableness of the custom inputs. To estimate verified gross savings, Navigant multiplied measure quantities from the program tracking system data times the verified per unit savings value.

2.4 Verified Net Program Savings Analysis Approach

Verified net energy savings were calculated by multiplying the verified gross savings estimates by a NTGR. For GPY4, the evaluation team used a NTGR value that was deemed.

2.5 Process Evaluation and Other Research

As part of the fall 2014 BEER Program net-to-gross research, participating customers and trade allies were asked through computer assisted telephone interviews (CATI) to answer questions related to their overall satisfaction with the program and how the program can be improved. Navigant conducted GPY4 NTG and process evaluation research on 44 GPY3 customers and 20 trade allies that participated in the BEER Program. The results of this research were used to inform the NTG values deemed for GPY5, and provided feedback on a limited number of process questions. The results were summarized in memos to Nicor Gas, and copies are attached in the Appendix of this report. The remaining GPY4 process evaluation activities for the BEER Program were limited to a review of the program materials and conducted an interview with program staff and the implementation contractor staff to verify information about the tracking system.

The GPY4 evaluation also included a steam trap study that involved using previous program year data and updating algorithm assumptions with Illinois-specific data available from rebate applications and steam trap audit reports to confirm applicability of updates to the Illinois steam trap market. The assumptions that relied on out-of-territory data included operating hours, average boiler efficiency, operating pressure, and the “Enbridge 50% adjustment factor” to maximum theoretical steam flow. The results were summarized in a memo to Nicor Gas, and a copy is attached in the Appendix of this report.

3. GROSS IMPACT EVALUATION

Navigant performed a verification of the BEER Program tracking database to determine the correctness and reasonableness of the data gathered and required to calculate program savings from rebated measures installed through the program. Navigant used measure quantities, program tracking data and supplemental data of equipment specifications supplied by Nicor Gas as inputs to Illinois TRM algorithms to determine verified gross savings. Navigant estimated that the GPY4 BEER Program achieved verified gross savings of 4,606,355 therms and a 100 percent verified gross realization rate.

3.1 Tracking System Review

The purpose of the tracking system review was to ensure the system gathers the required data to correctly calculate program savings. Nicor Gas and CLEAResult delivered tracking data in April 2016. Navigant's initial analysis of the tracking data savings assumptions revealed that several of the input parameters did not produce the claimed savings for some measures. Nicor Gas provided supplemental data upon request from Navigant to back up the assumptions behind the ex ante savings to resolve the discrepancies. These delays affected the GPY4 evaluation reporting timeline relative to the original evaluation plan.

From Navigant's initial review, it appeared that CLEAResult used custom inputs for some measures and projects and deemed for others. CLEAResult explained that when provided in the application, custom inputs were used to determine savings, otherwise TRM values were applied. However, Navigant found that in many instances, projects that used a custom input to determine the ex ante savings value did not include the custom input in the tracking data or even when available the custom input did not produce the claimed savings. Measures with custom inputs were programmable thermostats, pipe insulation, steam traps, convection ovens, boilers, furnaces and fryers. Navigant's savings verification approach was that when the program tracking data contained custom inputs, our analysis considered those; when not provided, we defaulted to the TRM values unless Nicor Gas provided supplemental custom input data to support the ex ante savings calculation.

Considering the bolded portion of the Illinois TRM Policy Document below, verification requires a review of the program tracking data, with the custom inputs included, to ensure a consistent application of the provided custom input. "Consistent application" indicates that when ex ante savings will be calculated on a custom basis, and custom inputs are available, the custom input is used to calculate the ex ante savings even when lowering the savings compared with the deemed TRM value. The same is true for when the custom input increases the savings compared with the deemed value.

> A Program Administrator can choose to count savings for a TRM measure on a customized basis using actual or on-site parameter values. **However, for the duration of a program year, once a measure savings calculation path is chosen—either on a customized or a prescriptive basis within a particular program—all instances of the measure within that program must be treated consistently.** Also, prior to treating a TRM measure as a customized measure in a particular program, the Program Administrator will notify the TRM Technical Advisory Committee (TAC), and the treatment of the measure as a customized versus a prescriptively deemed measure will be discussed during the TRM Update Process. The Program Administrator is at risk for retroactive evaluation adjustments to savings in this case. Evaluators are not prohibited from

using the Commission-approved TRM when evaluating a TRM measure that a Program Administrator has chosen to implement as a customized measure.[12]

From Navigant's discussion with Nicor Gas and CLEAResult, it does not appear the TAC was notified when Nicor Gas decided to use custom hours for industrial steam trap savings. Notification of using custom inputs to calculate ex ante savings should be given to the TAC and evaluators prior to the start of each program year. Nicor Gas has indicated that data issues found in the GPY4 evaluation have been resolved in subsequent program year files. Navigant will verify this is the case in the GPY5 evaluation.

Other measure specific findings from the tracking system review are provided below.

1. Nicor Gas used custom boiler efficiency values and TRM deemed hours of use (HOU) values to calculate savings for commercial and dry cleaner steam trap measures. For industrial steam traps of various sizes, Nicor Gas used custom HOU values. These custom HOU values were not provided in the tracking database but upon further request we received supplemental data from Nicor Gas. Navigant verified that the custom HOU values were reasonable. The average custom HOU input for the industrial steam traps was 7,842 hours compared with the TRM deemed value of 7,752 hours. Navigant verified the ex-ante savings calculations resulting in a 100 percent gross realization rate for all steam traps.
2. Nicor Gas used the correct base gallons per minute (GPM_base), 2.67 gpm prescribed by the Illinois TRM for *direct installed* units, as the input in the TRM showerhead energy savings algorithm to report ex ante savings. The tracking database reported an incorrect input value of 2.50 gpm. Navigant applied the correct TRM value for the verified savings calculation (Nicor claimed savings for 1.5 gpm and 2.0 gpm efficient showerheads) and the measure achieved a 100 percent realization rate.
3. The tracking database showed 1.0 operating hours per day as an input value for savings estimates for pre-rinse spray valve. Using this operating hours value and the TRM algorithm produced savings that were double the ex ante savings for the measure. Nicor Gas explained that the intended HOU value was 0.5 hours, corresponding to TRM v3.0 operating hours per day for small, quick-service restaurants. Navigant made the necessary adjustment and verified a 100 percent gross realization rate for the measure.
4. Post installation efficiency values for boilers and furnaces reported in the tracking system were used to calculate the verified savings. In some cases, these values did not produce the claimed savings, leading to savings adjustment for two boiler projects (PRJ-357148 and PRJ-400046). The impact of the adjustments on verified savings was minor, resulting in 100 percent gross realization rate for both boiler and furnace measures.
5. Navigant did not adjust the savings for efficient boilers and furnaces and space heating boiler tune-ups for unknown building types, even though TRM v3.0 contains an error in the algorithm input for heating EFLH. The unknown building type uses the simple average of known building types for EFLH, and the average value should be 1,163 hours, not 1,119 hours, for climate zone two. Navigant applied the TRM value of 1,119 hours and calculated 100 percent realization rate

[12] Source: http://ilsagfiles.org/SAG_files/Technical_Reference_Manual/Policy%20Document%20for%20IL%20TRM%2010-25-12.pdf

for the measures. If 1,163 hours were used for unknown building types, the impact would be a minor increase in verified savings, but the realization rate would still round to 100 percent.

6. Nicor Gas used incorrect TRM savings adjustment factors for commercial pool covers to calculate savings for indoor and outdoor pool covers, resulting in the measure gross realization rate of 88 percent. The deemed savings factor for indoor pool cover should be 2.61 but it was interchanged with 1.01, a value deemed for outdoor pool covers.
7. The gross savings for storage water heaters was verified with a 126 percent realization rate. Navigant verified the model description, thermal efficiency and other specifications of the water heaters installed through the program and determined that the water heaters are high efficiency storage water heater (>88% TE). This measure should have a deemed savings of 251 therms. The ex ante savings calculation assumes three of the six water heaters installed were standard water heaters and thus estimated148 therms per unit savings, although the measure description shows they are high efficiency water heaters.
8. Navigant identified two programmable thermostat projects (PRJ-399542 and PRJ-400538) that Nicor Gas did not claim savings. Navigant agrees the verified savings should be zero. Our review of the tracking database indicates these measures were most likely installed in an unheated or uncooled garage space, and therefore will not produce energy savings according to the TRM. We also found that Nicor Gas uses a default heating capacity of 104,000 Btu/hr as an input variable for heating equipment when estimating savings for programmable thermostats instead of using actual heating capacities of existing or new heating equipment. Navigant used a TRM v3.0 deemed savings factors based on reported building type and location to estimate programmable thermostat savings. The ex ante used a custom default value for all building types and locations which we found to be inconsistent with the TRM. The adjustments increased the verified savings for the measure to a 102 percent verified gross realization rate. We acknowledge that savings methodology and assumptions for programmable thermostats have changed in the subsequent TRM versions, and that Nicor Gas is making the necessary changes to the measure savings assumption and tracking.

3.2 Program Volumetric Findings

Table 3-1 provides a breakdown of the GPY4 participants by program category. The BEER Program had 166 total participants, including 13 customers who received no-cost direct install products or services, and 153 participants who received prescriptive incentives. A total of 355 projects were completed through the GPY4 program, involving installation of 3,180 rebate measures. The program offered incentives in the amount of $602,152, which is about $0.13 per gross therm.

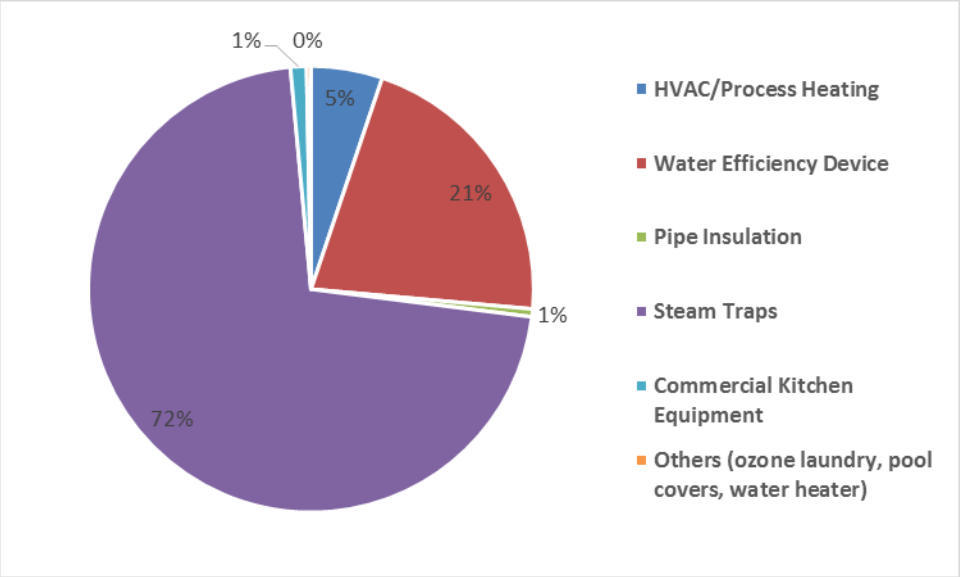
Table 3-1 GPY4 Primary Participation Detail

Participation	Direct Install	Prescriptive Incentive	Program Total
Participants[13]	13	153	166
Completed Projects	22	333	355
Installed Measures[14]	675	2,505	3,180
Incentives ($)	-	-	602,152

Source: Program tracking data and Navigant analysis.

Figure 3-1 depicts the GPY4 volumetric measure counts by end-use category. Steam trap replacements accounted for 72 percent of the measure count followed by the direct install water efficiency measures with 21 percent and the space and process heating equipment with 5 percent. Table 3-2 provides a breakdown of the GPY4 participants by program rebate units.

Figure 3-1. GPY4 BEER Program Measure End-use Category (Number of Measures)



Source: Program tracking data and Navigant analysis.

[13] Participants are defined based on the project site address and number of accounts.
[14] For evaluation reporting purpose, if a measure quantity is reported in the tracking system in linear feet, MBH, or square feet, Navigant treated each row entry of such measure as one measure quantity in this table.

Table 3-2. GPY4 BEER Program Installed Measures by Rebate Unit

Measure Category	Unit of Rebate	Ex Ante Quantity	Verified Quantity
Faucet Aerator	unit	335	335
Showerhead	unit	337	337
Pre-Rinse Spray Valve	unit	3	3
Boiler Tune Up, Heating	unit	27	27
Boiler Tune Up, Process	unit	25	25
Efficient Boiler	unit	21	21
Efficient Furnace	unit	24	24
Pool Covers	Sq.ft	7,960	7,960
Ozone Laundry	unit	1	1
Pipe Insulation	Ln.ft	7,209	7,209
Steam Traps	unit	2,275	2,275
Convection Oven	unit	2	2
Fryer	unit	28	28
Griddle	unit	2	2
Infrared Charbroiler	unit	1	1
Infrared Heaters	unit	23	23
Infrared Upright Broiler	unit	1	1
Programmable Thermostat	unit	45	45
Rack Oven	unit	3	3
Storage Water Heater	unit	6	6

Source: Program tracking data and Navigant analysis.

3.3 Gross Program Impact Parameter Estimates

Navigant verified the ex ante savings using the assumptions and algorithms specified in the TRM v3.0 or through engineering analysis for non-deemed measures and custom inputs. Table 3-3 summarizes the input parameters and unit of savings used to estimate program verified gross savings.

Table 3-3 Verified Gross Savings Parameters

Input Parameter	Value	Unit	Deemed or Evaluated?
Verified Gross Realization Rate	1.00		Evaluated
Faucet Aerator	5.99	therms/unit	Deemed
Showerhead	21.64 for 1.5 gpm 12.40 for 2.0 gpm	therms/unit	Deemed
Pre-Rinse Spray Valve	61.14	therms/unit	Deemed
Boiler Tune Up, Heating	Vary. Acceptable as is	therms/unit	Deemed
Boiler Tune Up, Process	Vary. Acceptable as is	therms/unit	Deemed
Efficient Boiler	Vary. Acceptable with minor adjustment for two projects using custom input	therms/unit	Evaluated
Efficient Furnace	Vary. Acceptable as is	therms/unit	Evaluated
Pool Covers	2.61 for indoor, 1.01 for outdoor	therms/Sq.ft	Deemed
Ozone Laundry	30.72	therms/lb-capacity	Deemed
Pipe Insulation	Vary. Acceptable as is	therms/Ln.ft	Evaluated
Steam Trap	Vary. Acceptable with minor adjustment to unit savings due to rounding difference	therms/unit	Evaluated
Convection Oven	306	therms/unit	Deemed
Fryer	505 for standard fryer (E>50%) 578 for large vat	therms/unit	Deemed Evaluated
Griddle	149	therms/unit	Deemed
Infrared Charbroiler	661	therms/unit	Deemed
Infrared Heaters	451	therms/unit	Deemed
Infrared Upright Broiler	1,089	therms/unit	Deemed
Programmable Thermostat	Vary. Acceptable with adjustment for savings factors based on building type and location	therms/unit	Deemed
Rack Oven	2,064	therms/unit	Deemed
Storage Water Heater	251 for >88% TE, 166 for EF>67%	therms/unit	Deemed

Source: Navigant analysis

3.4 Development of the Verified Gross Realization Rate

Navigant determined the verified gross realization rates by comparing the ex ante gross savings with the verified gross savings. The overall program verified gross realization rate is 100 percent. Results by measure are summarized in Table 3-4 below. Steam trap measures contributed 94 percent of the GPY4

verified gross savings, the HVAC and process application measures contributed 4 percent, and the remaining measures contributed 2 percent.

Table 3-4. Verified Gross Savings by Measure

Measure End-use	Measure	Ex Ante Gross Savings (Therms)	Verified Gross Realization Rate‡	Verified Gross Savings (Therms)
Direct Install Water Efficiency	Faucet Aerator	2,007	1.00	2,007
	Showerhead	4,317	1.00	4,317
	Pre-Rinse Spray Valve	183	1.00	183
HVAC/Process Heating	Boiler Tune Up, Heating	22,352	1.00	22,352
	Boiler Tune Up, Process	115,369	1.00	115,369
	Efficient Boiler	32,856	1.00	32,770
	Efficient Furnace	3,667	1.00	3,667
	Infrared Heaters	10,373	1.00	10,373
	Programmable Thermostat	4,077	1.02	4,164
Commercial Kitchen Equipment	Convection Oven	1,224	1.00	1,224
	Fryer	30,756	1.00	30,756
	Griddle	298	1.00	298
	Infrared Charbroiler	661	1.00	661
	Infrared Upright Broiler	1,089	1.00	1,089
	Rack Oven	6,192	1.00	6,192
Pipe Insulation	Pipe Insulation	26,017	1.00	26,017
Steam Trap	Steam Trap	4,326,166	1.00	4,326,173
Other	Pool Covers	15,369	0.88	13,550
	Ozone Laundry	3,686	1.00	3,687
	Storage Water Heater	1,197	1.26	1,506
	Total	4,607,856	1.00	4,606,355

Source: Program tracking data and Navigant analysis.
‡ Based on evaluation research findings.

A detailed breakdown of the realization rates of the steam trap savings is provided in Table 3-5. As mentioned above, Navigant verified the reasonableness of the custom hours used to calculate the ex ante savings. The average HOU for the industrial steam traps was 7,842 compare with the TRM deemed value 7,752 hours. Navigant accepted the ex-ante savings calculations with minor adjustment to the commercial dry cleaner calculation, and determined a 100 percent gross realization rate for steam trap measure.

Table 3-5. GPY4 Steam Traps Savings Estimates

C&I Measures	Ex Ante Gross Savings (Therms)	Verified Gross Realization Rate‡	Verified Gross Savings (Therms)
Commercial Dry Cleaners	7,980	100%	7,987
Commercial Heating	83,291	100%	83,291
Industrial High Pressure ≤125 <7175 psig	1,955,284	100%	1,955,284
Industrial High Pressure ≤175 <250 psig	108,137	100%	108,137
Industrial High Pressure ≥250 psig	1,045,162	100%	1,045,162
Industrial Medium Pressure ≥15 <30 psig	156,068	100%	156,068
Industrial Medium Pressure ≥30 <75 psig	227,871	100%	227,871
Industrial Medium Pressure ≥75 <125 psig	742,374	100%	742,374
Total	4,326,166	100%	4,326,173

Source: Program tracking data and Navigant analysis.

3.5 Verified Gross Program Impact Results

As shown in Table 3-6 below, the savings adjustments did not greatly affect the verified savings, but resulted in realization rate of 1.00 at the program level. The difference between the ex ante gross savings and the verified gross savings is 1,501 therms. Direct install measures accounted for approximately 6,507 therms. The resulting total program verified gross savings is 4,606,355 therms.

Table 3-6. GPY4 Verified Gross Impact Savings Estimates

	Research Category	Ex Ante Gross Savings (Therms)	Verified Gross Realization Rate‡	Verified Gross Savings (Therms)
Direct Install Measures	Faucet Aerator	2,007	1.00	2,007
	Showerhead	4,317	1.00	4,317
	Pre-Rinse Spray Valve	183	1.00	183
Subtotal		*6,507*	*1.00*	*6,507*
Prescriptive Incentives Measures	Boiler Tune Up, Heating	22,352	1.00	22,352
	Boiler Tune Up, Process	115,369	1.00	115,369
	Efficient Boiler	32,856	1.00	32,770
	Efficient Furnace	3,667	1.00	3,667
	Pool Covers	15,369	0.88	13,550
	Ozone Laundry	3,686	1.00	3,687
	Pipe Insulation	26,017	1.00	26,017
	Steam Trap	4,326,166	1.00	4,326,173
	Convection Oven	1,224	1.00	1,224
	Fryer	30,756	1.00	30,756
	Griddle	298	1.00	298
	Infrared Charbroiler	661	1.00	661
	Infrared Heaters	10,373	1.00	10,373
	Infrared Upright Broiler	1,089	1.00	1,089
	Programmable Thermostat	4,077	1.02	4,164
	Rack Oven	6,192	1.00	6,192
	Storage Water Heater	1,197	1.26	1,506
Subtotal		*4,601,349*	*1.00*	*4,599,848*
Total		4,607,856	1.00	4,606,355

Source: Program tracking data and Navigant analysis.

4. NET IMPACT EVALUATION

For GPY4, Navigant used an Illinois SAG approved deemed NTG value of 0.83 to calculate net savings for Nicor Gas BEER Program. To calculate the verified net savings, Navigant applied the NTG ratio to the verified gross savings. Table 4-1 presents the program net savings.

Table 4-1. GPY4 Verified Net Impact Savings Estimates

	Energy Savings (Therms)
Verified Gross Savings	4,606,355
Net-to-Gross Ratio	0.83†
Verified Net Savings	3,823,275

Source: Utility tracking data and Navigant analysis.
† Deemed value. Source:
http://ilsagfiles.org/SAG_files/NTG/2015_NTG_Meetings/Final_2015_Documents/Nicor_Gas_NTG_Summary_GPY1-5_2015-03-01_Final.pdf

5. PROCESS EVALUATION

The GPY4 process evaluation activities for the BEER Program were limited to interviews with program staff and the implementation contractor staff to verify information about the tracking system.

As part of the fall 2014 BEER Program net-to-gross research, participant customers and trade allies were asked through computer assisted telephone interviews (CATI) to answer questions related to their overall satisfaction with the program and how the program can be improved. Customers and trade allies were also asked of their awareness of the Nicor Gas on-bill financing option, customer participation in the on-bill financing option, and how the financing option can be improved. Analyses of the satisfaction and awareness responses are summarized in a memo presented to Nicor Gas and shown in Appendix of this report.

6. FINDINGS AND RECOMMENDATIONS

This section summarizes the key findings and recommendations.

Program Savings Achievement

Finding 1. Navigant verified net savings of 3,823,275 therms for the GPY4 BEER Program, based on the SAG approved NTG ratio of 0.83. The verified net savings is 135 percent of the program net savings goal of 2,825,000 therms.[15] Steam trap measures continued to account for the highest portion of program savings, contributing 94 percent of the GPY4 verified net savings. Space heating, kitchen equipment and other equipment including the direct install measures contributed the remaining six percent of the verified net savings.

Gross Realization Rates

Finding 2. Navigant calculated an overall gross savings realization rate of 100 percent for the BEER Program, based on verified gross savings of 4,606,355 therms compared with the ex ante 4,607,856 therms. Navigant's analysis determined that custom inputs were applied to programmable thermostats, pipe insulation, steam traps, boilers, and furnace measures. Our verification showed that for some measures (e.g. Fryers) Nicor Gas defaulted to the TRM deemed savings for all instances although actual custom data was collected. We emphasize that according to the TRM ***"A Program Administrator can choose to count savings for a TRM measure on a customized basis using actual or on-site parameter values. However, for the duration of a program year, once a measure savings calculation path is chosen—either on a customized or a prescriptive basis within a particular program—all instances of the measure within that program must be treated consistently".***[16] This provision calls for a consistent approach from Nicor Gas in the estimation of the BEER program measure savings.

Recommendation 1. Nicor Gas should notify the TRM Technical Advisory Committee (TAC) and evaluators prior to the start of each program year on instances where custom inputs are collected to replace TRM deemed inputs for measure savings estimation. In the case for GPY4, the custom hours of use values collected for industrial steam traps would need the TAC notification, although Navigant verified the values on a custom, retrospective basis. We also emphasize that, for consistency, when custom inputs are available, even when lowering the savings compared with the deemed TRM value, the custom input be applied to the ex ante savings. The same is true when the custom input increases the savings compared with the deemed value. Following these steps will reduce the potential for an unexpected retrospective savings verification adjustment.

Finding 3. Navigant determined that most of the GPY4 measures had a gross realization rate of 100 percent after reviewing the TRM deemed inputs and verified the custom input parameters. The realization rate for storage water heaters was adjusted to 126 percent. The realization rate for pool covers was lowered to 88 percent using the TRM approved savings adjustment factors for indoor and outdoor pool covers. Programmable thermostats had a 102 percent gross realization rate. Other measures including efficient boilers and steam traps had verified savings with minor adjustments or rounding difference compare to the ex ante, but with 100 percent realization rate. The reasons for adjustments are discussed in Section 3.

[15] Nicor Gas Energy Efficiency Plan, June 2014 - May 2017

[16] http://ilsagfiles.org/SAG_files/Technical_Reference_Manual/Policy%20Document%20for%20IL%20TRM%2010-25-12.pdf)

Recommendation 2. Nicor Gas should update the ex-ante savings calculations for commercial pool covers to use TRM approved savings factors for indoor and outdoor spaces.

Recommendation 3. Nicor Gas should ensure that the description of program measures in the tracking system are consistent with deemed and custom input parameters used to generate measure savings.

Tracking System Review

Finding 4. Navigant's preliminary savings verification effort calculated low realization rates for pipe insulation measures, boilers, furnace, fryers, and steam traps. Navigant's review of the BEER Program tracking database revealed that in many instances the measure savings input parameters did not produce the claimed savings in the tracking system. When we reported this as a preliminary finding, CLEAResult informed us that when provided in the application, custom inputs were used to determine savings – otherwise TRM values were applied. We found that projects that used custom inputs to determine the ex ante savings value did not include the custom input in the tracking data. Although Navigant was aware from past evaluations that CLEAResult uses custom inputs, it was not clear from the tracking data which measures were affected in GPY4. Follow up supplemental data with lookup values provided by CLEAResult enabled Navigant to verify the full claimed savings for some measures and adjust the savings for others. Navigant's verification approach was that when the ex ante savings calculation contained custom inputs, our analysis considered[17] those provided by CLEAResult; when not provided, we defaulted to the TRM values.

Recommendation 4. Nicor Gas should consider updating the tracking system to accommodate the supplemental data lookup custom input variables collected from customer applications. The supplemental custom data should be provided together with the tracking database submitted for evaluation verification. This could minimize the extra time and cost involved in repeating the savings verification process and delays in the evaluation reporting deadlines.

Finding 5. Nicor Gas uses a default heating capacity of 104,000 Btu/hr as an input variable for heating equipment when estimating savings for programmable thermostats. The savings calculation uses a custom savings factor instead of deemed TRM values based on building type and location. The verified savings increased after reviewing the project details and supplemental data. We acknowledge that savings methodology for programmable thermostats has changed in the subsequent TRM versions. Nicor Gas has indicated the necessary changes to the measure savings assumption and tracking has been implemented, and Navigant will verify this is the case in the GPY5 evaluation.

Program Participation

Finding 6. The GPY4 BEER Program resulted in participation of 166 participants, including 13 customers who had direct install products or services, and 153 participants who received prescriptive incentives. A total of 355 projects were completed through the GPY4 program, involving the installation of 3,180 rebate measures. The program paid $602,152 in incentives, which is about $0.13 per gross therm.

[17] Navigant's retrospective verification of custom inputs was not constrained to using values provided on the application form or supplemental program tracking data provided by Nicor Gas.

7. APPENDIX

7.1 Fall 2014 BEER Program NTG Results Final

To: Jim Jerozal, John Madziarczyk, Hammad Chaudhry, Ed Kriz, Nicor Gas; Scott Dimetrosky, Apex Analytics; Ted Weaver, Frist Tracks Consulting; Jennifer Morris, David Brightwell, ICC Staff

From: Nick Beaman, Charles Ampong, Navigant

CC: Randy Gunn, Charley Budd, Kevin Grabner, Laura Agapay-Read, Navigant

Date: January 7, 2015

Re: Fall 2014 Net-to-Gross Ratio Estimate for use in GPY5 for the Nicor Gas Business Energy Efficiency Rebate (BEER) Program

This memo presents results from Navigant's fall 2014 evaluation activities that are relevant to our January 7, 2015 delivery of net-to-gross values to be applied in GPY5 for the Business Energy Efficiency Rebate (BEER) program. Navigant will provide additional results from our fall 2014 evaluation activities in a separate memo in January 2015. Navigant will provide complete process evaluation results and gross impact results for GPY4 in the fall of 2015.

NET-TO-GROSS RATIO ESTIMATE

Table 7-1 shows free ridership and participating trade ally spillover results from Navigant's fall 2014 evaluation as well as non-participating trade ally spillover results from Navigant's GPY2 evaluation of the BEER program. Navigant estimates a NTG ratio of 0.68 to be applied in GPY5 for the BEER program. The fall 2014 results are based on GPY3 population of projects and participant customers and participant

trade allies self-reported responses from telephone interviews in fall 2014, as outlined in Navigant's fall 2014 evaluation plan for the Nicor Gas BEER program.[18]

Table 7-1. Program Net-to-Gross Ratio and Components

Parameter	Value	90/10 Significance	Data Source
Participating Customer Free-Ridership (FR)	0.35	Yes	Fall 2014 Telephone Surveys of GPY3 participating customers
Participating Trade Ally Spillover (PSO)	0.01	-	Fall 2014 Telephone Surveys of GPY3 participating trade allies
NTGR = 1-FR + PSO	0.66	Yes	
Confidence and Precision (90/10)	±9%	Yes	
Non-Participating Trade Ally Spillover from GPY2 (NPSO)	0.02	-	GPY2 Telephone Surveys of non-participating trade allies
NTGR (incl. GPY2 TA NPSO) = 1 – FR + PSO + NPSO	**0.68**	**Yes**	

Source: Evaluation Analysis

Business Energy Efficiency Rebate (BEER) Program

The Nicor Gas BEER program provides incentives to Nicor Gas customers to increase the market share of new, highly efficient space heating, water heating, and commercial kitchen equipment as well as cost-effective improvement and additions to existing equipment. Participants must purchase and install equipment covered by the program. A rebate form must be filled out and submitted within 90 days of installation. Customers may receive a rebate without pre-approval for participation.

The GPY3 BEER Program reported net savings of 9,286,363 therms, which is 150 percent more than the program's filed net savings goal of 3,718,644 therms[19]. Steam traps continue to be a very significant factor in the savings contributing close to 83 percent of the gross savings. The BEER Program's GPY4 planned net savings is 2,825,000[20] therms.

DATA COLLECTION FOR NET TO GROSS ESTIMATES

Process question respondents were those who answered the net-to-gross research questions that were the primary purpose for the survey. A stratified sample of 50 participating customers was drawn from the BEER program tracking database population of 990 customers for the participant net-to-gross and process research. A sample of 21 participating trade allies was drawn from a population of 317 participating trade allies for the trade ally spillover and process research. A total of 44 participating customer interviews and

[18] Email attachment *Nicor Gas Fall 2014 BEER and Kits Eval Plan 2014 10 24 Final* from Laura Agapay-Read.
[19] Nicor Rider 30 4rd Quarterly Report PY3 ICC Filing, Order Docket 10-0562.
[20] *Nicor Gas Energy Efficiency Plan June 2014 – May 2017*, Revised Plan Filed Pursuant to Order Docket 13-0549, May 30, 2014.

20 trade ally participant interviews were completed that provided process results. Table 7-2 below summarizes Navigant's fall 2014 primary data sources to estimate the net-to-gross ratio for the program.

Table 7-2. Primary Data Sources

Method	Subject	Target Completes[21]	Actual Completes	Completed	Confidence Precision
Telephone Survey	GPY3 Program Participants	≤50	44	December 22, 2014	90/10
Telephone Survey	GPY3 Participant Trade Allies	≤21	20	December 22, 2014	

Source: Navigant Consulting Analysis

METHODOLOGY

Navigant used the standard self-report method for the Net-to-Gross Ratio (NTGR) analysis. The standard self-report method asks questions of the participating customers and the trade allies to determine what may have occurred in the absence of the program and the presence of any spillover installations.

The net-to-gross analysis algorithm used was:

> ***Net-to-Gross =1- Participating Customer Free Ridership Score + Participating Trade Ally Spillover + Non-Participating Trade Ally Spillover***[22]

Free Ridership

The participating customer free ridership method calculates participant free-ridership using data collected during participant telephone interviews covering three scoring items: 1) Timing and Selection Score[23] (reflects the influence of the most important of various program and program-related elements in the customer's decision to select a specific program measure in GPY3); 2) Program Influence Score (captures the perceived importance of the program whether rebate, recommendation, or other program intervention); and 3) No-Program Score (captures the likelihood of various actions the customer might have taken at this time and in the future if the program had not been available).

[21] After reviewing the population of projects installed in GPY3, Navigant revised the evaluation plan targeted sample size from 68 to 50 participating customers and from 40 to 21 participating trade allies to achieve 90/10 confidence level and precision.

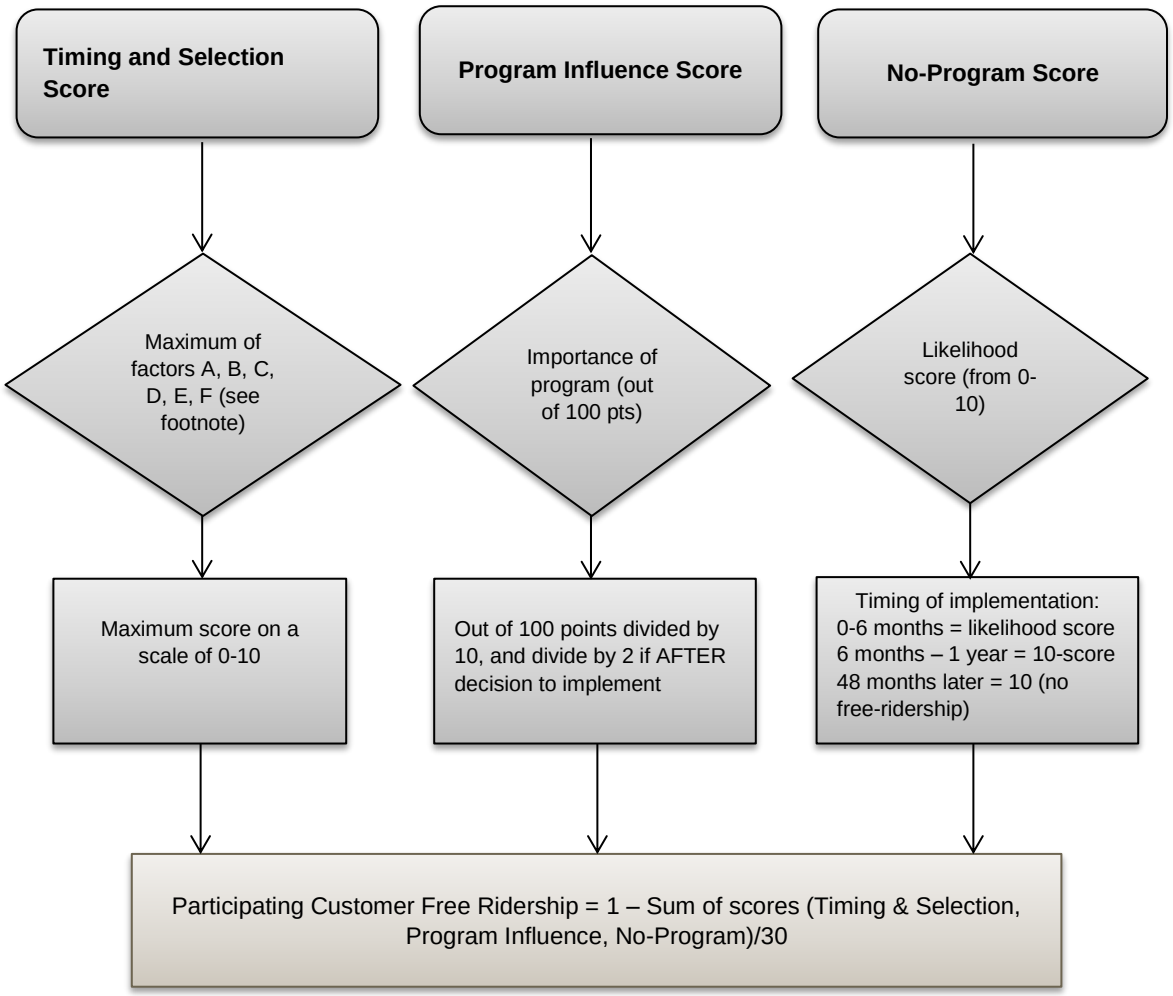
[22] Navigant did not conduct trade ally free ridership and participating customer spillover research for the fall 2014 NTG study as initially indicated in the evaluation plan. Similar studies in the past (documented in the GPY2 evaluation report) did not provide reliable results for the trade ally free ridership and participant customer spillover was almost zero. Instead, Navigant considered the inclusion of the non-participating trade ally spillover findings from the GPY2 NTG study.

[23] Timing and Selection score on a scale of 0-10 takes the maximum of the following factors: A. Availability of the program incentive; B. Vendor Score (when triggered by customer and interviewed); C. Recommendation from a Nicor Gas program representative; D. Information from utility or program marketing materials; E. Endorsement or recommendation by Nicor Gas account manager; F. Other factors (recorded verbatim).

Based on the free-ridership methodology presented in Figure 2, the algorithm for determining participating customer free ridership score is shown below.

Participating Customer Free Ridership = 1 - Average [(Timing & Selection Score + Program Influence Score + No Program Influence Score)]

Figure 2. Participant Free-Ridership Algorithm



In a Standard Rigor Free-Ridership Assessment, program influence through vendor or a contractor is incorporated into the Timing and Selection score, if a follow-up interview has been triggered by the customer, and where the customer had not already assigned a maximum program influence score to one of the other program components. The purpose of this additional component is to assess the influence of the program on vendors for programs that are vendor-driven, where the utility has specific outreach and assistance efforts targeting vendors.

The Vendor Score is the maximum (on a scale of 0 to 10) of the following factors where 10 is associated with no free-ridership due to program influence:

1. [Score= response, on scale of 0 to 10] On a scale of 0 to 10 where 0 is not at all important and 10 is extremely, how important was the program, including incentives as well as program services and information, in influencing your decision to recommend that <customer> install the energy efficiency measure at this time?

2. [Score= 10 minus the response, on a scale from 0 to 10] And using a 0 to 10 likelihood scale where 0 is not at all likely and 10 is extremely likely, if the program, including incentives as well as program services and information, had not been available, what is the likelihood that you would have recommended this specific <measure> to <customer>?

Spillover

The existence of participating trade ally spillover was examined using survey self-report data. The trade allies and other contractors were asked about their total sales. This number was used to weight the trade ally responses to calculate an overall increase in the sales of program qualified measures. For participating trade allies, their total sales were compared to the program sales, to calculate an estimated savings from the additional measures installed outside of the program. Trade ally spillover was calculated using the following algorithm:

> ***Trade Ally Estimated Spillover = (Sales of qualifying equipment that does not receive an incentive from Nicor Gas) * Program Influence Score***

NTGR Sampling Approach

The participating customer free ridership sample of 50 customers targeting a 90/10 level of confidence and relative precision for program-level NTG was drawn from the BEER program tracking database population of 2,641 projects (from 990 customers). Projects were stratified at tracking record level using the population ex ante gross therms savings. Strata were defined by project size, based on ex-ante gross energy savings boundaries that placed about one-third of program-level savings into large, medium and small stratum. Stratum one sample is comprised of 14 projects, stratum 2 of 18 projects, and stratum 3 of 18 projects.

The participating trade ally spillover research involved a telephone survey of 21 trade allies from a population of 317 participating trade allies.

In an effort to facilitate survey efforts and ensure a timely completion, Navigant conducted both the participant and trade ally surveys concurrently. To encourage trade allies to participate in the survey, Navigant offered a chance to win a $1,000 gift card as an incentive to participate. Additionally, Navigant worked with the implementation contractor in coordinating the survey effort to increase participation through advance letters to a sample of trade allies. Navigant attempted to contact all trade allies noted by the customer as being highly influential (a rating of 7 or higher) during the customer free ridership

survey to confirm and incorporate the customer score for the trade ally or to investigate further spillover effects.

RESULTS

From the analysis of the 44 participating customer interview responses, Navigant estimated program participant average free ridership of 0.35 at ±9 percent overall relative precision at 90 percent confidence level. Nine influential trade allies were identified with the highest score among the participant free ridership responses. These trade allies were called back and two completed additional interviews confirming their influence in the customers' decision to implement the measures. The customer scores for the trade allies were incorporated in the timing and selection scoring. Navigant decided not to call back the other seven influential trade allies after determining that even assigning the maximum score from the trade allies in the timing and selection scoring will produce minimal impact or will not change the weighted NTG results since most of the trade ally customers were smaller projects in terms of savings.

From the sample of 20 completed trade allies spillover responses Navigant identified four trade allies with spillover savings and determined the program could achieve 1 percent more net savings from the spillover projects (PSO).

The estimated BEER program net to gross ratio based on the fall 2014 research is 0.66 as presented in Table 7-3. In GPY2, Navigant conducted interviews with both participating and non-participating trade allies for potential spillover quantification. Navigant estimated non-participating trade ally spillover of 2 percent and participating trade ally spillover of 0.2 percent. Navigant determined that the program could apply the non-participating trade ally spillover from GPY2 in addition to the GPY3 NTG results of 0.66 to produce an overall NTG of 0.68 to be applied for the BEER program in GPY5.[24]

[24] Nicor Gas GPY2 Business EE Rebate Eval 2014-05-08 Final.pdf (pages 51-52)

Table 7-3. Net-to-Gross Estimate Parameters

Parameter	Sample Size	Value	90/10 Significance
Participating Customer Free Ridership (FR)	44	0.35	Yes
Participating Trade Ally Spillover (PSO)	20	0.01	-
NTGR = 1-FR + PSO		0.66	Yes
Precision @ 90% Confidence Level)		± 9%	
Non-Participating Trade Ally Spillover from GPY2 (NPSO)	31	0.02	-
NTGR (incl. GPY2 TA NPSO)= 1-FR + PSO + NPSO		**0.68**	**Yes**

Source: Evaluation Team analysis.

Navigant also examined free ridership among customers at the measure end-use level, categorized into steam traps, HVAC heating equipment and others (including pipe insulation, kitchen equipment, pool covers, etc.). Table 7-4 shows the measure level NTG findings.

Table 7-4. Net-to-Gross Estimates by Measure Type

Measure	Sample Size	Unweighted NTG	90/10 Significance
HVAC Space Heating (incl. T-Stat)	19	0.53	No
Steam Trap	20	0.72	No
Other (incl. pipe insulation, pool cover, kitchen equipment, etc.)	5	0.57	No

Source: Evaluation Team analysis.

Free ridership is less among customers with steam traps with unweighted NTG of 0.72 compared to other customers. This analysis is not statistically significant as the program level NTG sampling approach was based on project size but not on measure type.

7.2 Fall 2014 BEER Program Process Survey Results

To: Jim Jerozal, John Madziarczyk, Hammad Chaudhry, Ed Kriz, Bridgid Lutz, Nicor Gas; Scott Dimetrosky, Apex Analytics; Ted Weaver, First Tracks Consulting; Jennifer Morris, David Brightwell, ICC Staff

From: Charles Ampong, Nick Beaman, Navigant

CC: Randy Gunn, Charley Budd, Kevin Grabner, Laura Agapay-Read, Navigant

Date: July 17, 2015

Re: Fall 2014 Process Survey Results for the Nicor Gas Business Energy Efficiency Rebate (BEER) Program, *Revised Draft*

This memo presents Navigant's process research findings and recommendations drawn from participating customer and trade ally responses gathered as part of the fall 2014 net-to-gross research with GPY3 participants conducted for the GPY4 Business Energy Efficiency Rebate (BEER) Program. This memo provides feedback on the process findings to inform GPY5 planning rather than presenting the results at the end of the GPY4 evaluation reporting period. A copy of this memo will be included in the Appendix of the GPY4 BEER Program evaluation report when it is completed at the end of 2015.

GPY4 BEER Program Early Process Research Results

As part of the fall 2014 BEER Program net-to-gross research, participant customers and trade allies were asked through computer assisted telephone interviews (CATI) to answer questions related to their overall satisfaction with the program and how the program can be improved. Customers and trade allies were also asked of their awareness of the Nicor Gas on-bill financing option, customer participation in the on-bill financing option, and how the financing option can be improved. Analyses of the satisfaction and awareness responses are summarized in Table 7-5.

Table 7-5. BEER Program Process Satisfaction and Awareness Results

	Respondents	Percent	Evaluation Comments
Customer Satisfaction Score (0-10 scale), n = 44			
8-10 (most satisfied)	40	90%	Overall participant satisfaction with the program is strong. We found that 24 of 44 filled out an application on their own and 16 indicated applications clearly explain program requirements and how to participate. Participants also provided their views on how to improve the program. Details are presented in Table 3.
6-7	2	5%	
3-5 (less satisfied)	2	5%	
Customer Awareness of On-Bill Financing, n = 44			
Yes	2	5%	Only 4 of 44 respondents were aware and learned of the on-bill financing option before participation, but they chose not to use it. Reasons include availability of funds for projects, and lack of details on the option. Only 4 of 40 of those not aware of the financing option would consider changing their program participation, depending on how much it would cost to pay back, or if fairly priced and divided within a year's payment, or maybe a year later due to perceived expense of the financing option.
Somewhat	2	5%	
No	40	90%	
Trade Ally Satisfaction Score (0-10 scale), n = 20			
8-10 (most satisfied)	11	55%	Those Trade Allies most satisfied cited these reasons: program staff readiness to respond to questions and openness to communication enables successful project completion for customers; convenience of application process and turnaround for customers getting the rebate is pretty reasonable; and satisfied with incentive limit for customers especially steam traps (easiness to figure out incentive calculation). Those less satisfied cited time delay in receiving rebate checks and complexity in paperwork. One commenter felt that Nicor Gas did not communicate the initial opt-out for companies with mature energy programs very well.
6-7	6	30%	
3-5 (less satisfied)	3	15%	
Trade Ally Awareness of On-Bill Financing, n = 20			
Yes	10	50%	Trade allies who are aware of the financing option have never used it and therefore couldn't comment on improving the option. They are just aware but do not know the specifics, or they do not use financing option because of their business nature.
No	10	50%	

Source: Evaluation analysis of participant and trade ally process surveys conducted in fall 2014 of GPY3 participants.

Data Collection and Survey Methodology

Table 7-6 summarizes the primary data sources for the participant surveys. Process question respondents were those who answered the net-to-gross research questions that were the primary purpose for the survey. A stratified sample of 50 participating customers was drawn from the BEER program tracking

database population of 990 customers for the participant net-to-gross and process research. A sample of 21 participating trade allies was drawn from a population of 317 participating trade allies for the trade ally spillover and process research. A total of 44 participating customer interviews and 20 trade ally participant interviews were completed that provided process results.

Table 7-6. Primary Data Sources

Method	Subject	Targeted Completions	Actual Completions	Completed
Telephone Survey	GPY3 Program Participants	≤50	44	December 22, 2014
Telephone Survey	GPY3 Participant Trade Allies	≤21	20	December 22, 2014

Source: Navigant Analysis of tracking data

1. The process battery asked participants and trade allies to rank their experience or satisfaction with the program in general on a scale from 0 to 10, where 10 is a high rating and 0 is a low rating. Participating customers and trade allies were also given the chance to provide their perspective on what changes could be made to improve the BEER Program. An additional set of questions asked participants about their awareness and participation in the Nicor Gas on-bill financing option and how it can be improved.

2. Trade allies were also asked about their familiarity with the BEER Program, if there are any measures or customer groups they would recommend for additional Nicor Gas incentives, and if there are other things CLEAResult can do to make things easier for them to market the program to their customers.

Customer Participant Perspective on Program Improvement

Table 7-7 summarizes the customer participants' responses on program improvement. The participants' perspectives have been grouped into themes of suggestions for easy reference. The issues raised in the open-ended responses, sometimes specific complaints, do not represent statistically significant sample results. Further research would be needed to determine whether the responses were one-off experiences or a common occurrence.

Table 7-7. Participating Customer Perspective on Program Improvement

Respondents (n=25)	Theme	Customer Participant Perspective on Program Improvement (Drawn from Open-Ended Responses)
4	Incentive Amount	Maintain and possibly expand the incentive which included the higher rebate rates for steam trap replacement. The bonus incentives did spur customers to complete the project. Provide advanced notice of window to opt out of program.
8	Rebate Awareness and Processing	Publicize better and ensure more open communication and further knowledge beforehand that program rebates exist, to avoid project delays. It would be nice if Nicor sent an email out saying rebates are available (people have to look for those kinds of rebates instead of having them presented). Include property management in the rebate process instead of dealing only with corporate. More timely turnaround of the rebate from Nicor once projects are completed and submitted. Problems with the checks, rebated check process could have been better; Make sure check is going to correct person. It will be great if there is longer eligibility period to get rebates than 3 months. Periodic communication from whoever is administrating the rebate program, if anything changes or more programs out there. Maybe more face-to-face visits.
7	Paperwork Challenges	Streamline the application process to ensure paperwork is a little easier; the forms are difficult to fill out although very convenient after understanding the sections. Ensure call support staff are very knowledgeable about the program to help fill out forms. Improve the instructions in the application. The documents that needed to be sent were not clearly stated in the application, hence it got sent back with an accompanied letter that had specific instructions that if it came with the original instructions would not have been a problem in the first place.
2	Trade Ally Involvement	Improve communication between contractor and program staff. Misunderstanding and back and forth on equipment specifications (e.g. furnace model number and serial number) for program qualification could delay projects.
3	Online Application	Suggestions are mixed, quotes include: Redesign website to make it more user friendly, the website was a little confusing, it was difficult to figure out what information goes where (average lay person will have no clue what BTU is). Full online application is cumbersome and does not help large customers who process several rebates yearly (submitting a spreadsheet like we previously did). If there was an online application process that would allow uploading of files that would be better than manually doing so.
1	Suggestion for other programs	Nicor Gas could improve its programs, if it offers incentives to optimize process steam burners and boilers for peak performance, because there are lots of boilers that aren't running at peak efficiency, and if they were, a lot of natural gas could be saved.

Source: Evaluation analysis of participant analysis on program improvement.

Note: Not all 44 participants provided their perspective on improvements. We presented findings drawn from the 25 participants that responded to the question for suggestions for program improvement.

Participating Trade Ally Perspective on Program Improvement

Of the 20 respondents to the participant trade ally survey, 13 (65%) said they were very familiar with the BEER Program, when asked to rank their familiarity on a scale of 0-10 with 10 being highest. Two respondents gave moderate answers, while 5 others gave low ratings.

When respondents were asked to provide their view on potential markets and measures, some suggested that the program should consider expanding to schools, churches, food pantries, hospitals, and nonprofit nursing homes. On measures, one respondent suggested incentives should be provided for instrumentation calibration to increase total boiler efficiency in addition to tuning.

Table 7-8 provides additional perspectives from trade allies on how the BEER Program can be improved. The issues raised in the open-ended responses, sometimes specific complaints, do not represent statistically significant sample results. Further research would be needed to determine whether the responses were one-off experiences or a common occurrence.

Table 7-8. Participating Trade Ally Perspective on Program Improvement

Respondents (n=20)	Theme	Trade Ally Perspective on Program Improvement (Drawn from Open-Ended Responses)
5	Rebate Amount and Processing	Quicker turnaround times for processing rebates and responding to general items. Increase the incentive dollar amount across the board, different incentives for different things. If people aren't going after a particular one, find out why and maybe increase it. Help with the energy savings calculation and proposal ideas.
4	Paperwork and Online Challenges	Streamlining the paperwork process, they are too cumbersome. Automating in apps and online -- paperwork is currently overly detailed for the amount of benefit received. The preliminary and final applications are same document and just requires redundancy. Website could be more user friendly, It would have been much easier to use program search engine to find information (spent a lot time finding the landlord forms, it was in fine print and you really had to search for it).
2	Trade Ally Involvement	If Nicor had a team that would go in and do all that work, provide that service -- go in and evaluate the cost and energy savings of a particular idea, then decide what the rebate would be. That's a lot of work for contractors to do with no guarantee to get paid for that. Get trade allies involved in studies on qualified measures (this would go a long way towards Nicor's success).
5	Outreach and Marketing	Shared marketing material has been generally slow to release (prepare to release programs before Nicor starts advertising about them). When changes are made -- to give 3-4 weeks' notice instead of making them retroactive. For example, Nicor will change the rebate amount and say it takes effect next week and will last 3 weeks. We should have that notice a month in advance. Program administrators should know their program better. It is not good to receive a green light to pursue certain programs for clients only to find out they wouldn't qualify (after dealing with 2 or 3 separate people from Nicor)-- there's so many people involved in rebate processing at Nicor, and information gets lost and there's lots of duplication on our end. Providing more information for businesses who are skeptical by either providing better authorization documents, a number or hotline for a customer to call, and also either a FAQ or some resource for a business that installs the equipment -- if the equipment breaks down or they have some complication with it. Availability of some materials that could be sent to a business that would help the business inventory their gas-using equipment so that they could be aware of all the rebates available for when they need to replace equipment or when they're purchasing new equipment.
4	Other Suggestions	There are some real old boilers out there that are running a lot lower than what they use as a baseline. It would benefit the customer a lot more if they go on what the boiler is actually running than using the baseline. Program should create more of a path for customers, so rather than approaching a business one time for this spray valve and establishing a completely new relationship, the program would be improved if there would be a succession of products that would be offered to the business over a span of time.

Source: Evaluation analysis of participant analysis on program improvement.

Table 7-9 provides overall evaluation summary of the findings and recommendations to improve the BEER program processes.

Table 7-9. Summary of Findings and Recommendations

	Findings		Recommendations
1	**On Bill Financing**. Awareness of the On-Bill Financing option was very low among customers (9% aware) and low among trade allies (50% aware). Those customers and trade allies that were aware cited lack of knowledge of the details for not using the financing option or that financing was not needed to implement the project. A small percentage of unaware customers (10%, 4 of 40) would have consider financing.	→	The PM/IC should consider reviewing the marketing and outreach approach for the financing option to raise awareness. To improve response to the financing option, there is a need to broaden awareness, because it appears a relatively small proportion of the customer population are prospects. For those customers interested in financing, easy access to the details of the offer are needed. Consider inviting trade allies to educational workshops focused on "the details" of the offer so that they can provide the information potential customers need at the key point in the sales cycle. The trade allies attending the workshop should be self-selected to those most likely to benefit from a financing option, and may serve as an informal focus group to improve the offer.
2	**Communications**. Customers and trade allies raised a number of problems and suggestions involving communications with program staff and program communications in general. Both raised the need for more information and earlier outreach of when rebates are available or changing, and changing program requirements.	→	Consider providing more advanced notice of changes to program rebate amounts, qualifications, and program requirements. Consider increasing the frequency of communications with customers through email and face-to-face. Consider usability testing and improvements to the web site, and possibly adding an app that customers and trade allies can use to receive frequent updates.
3	**Application Process**. Customers and trade allies continue to identify challenges in completing the application process although the program has over the years sought to make this process simpler. Both would like the application process streamlined and offered suggestions, and both requested quicker processing of rebates for completed projects.	→	Ensure that stipulated timeframes for rebate processing are adhered to maintain confidence in customers and trade allies, to minimize possible project delays. The program should consider adding a mechanism to make it easier for previous participant customers and trade allies to submit applications for new measures without going through a new application process.
4	**Program Expansion**. Customers and trade allies suggest expanding target markets to include other businesses (e.g. schools, churches, food pantries), or incentivizing other measures such as instrumentation calibration in addition to boiler tuning. Some trade allies suggested Nicor Gas provide technical assistance for doing energy calculations and identifying measures – services offered in PY4. One trade ally suggested creating a path for the customers to travel, so rather than approaching a business one time for a measure and establishing a new relationship, there would be a succession of products that would be offered to the business over a span of time.	→	Nicor Gas and CLEAResult should consider whether technical assistance offerings require more publicity, and whether more emphasis could be placed on encouraging customers to contact trade allies after an assessment. Consider offers that encourage customers to implement multiple measures over a span of time.

Source: Navigant research

7.3 TRM Version 4.0 Steam Trap Measure Review

To: Jim Jerozal, John Madziarczyk, Hammad Chaudhry, Ed Kriz, Bridgid Lutz, Nicor Gas; Scott Dimetrosky, Apex Analytics; Ted Weaver, First Tracks Consulting; Jennifer Morris, David Brightwell, ICC Staff

From: Navigant C&I Evaluation Team: Nick Beaman, Kuldeep Moore, Charles Ampong, Kevin Grabner

CC: Randy Gunn, Charley Budd, Laura Agapay-Read, Navigant

Date: October 30, 2015

Re: Review of the 'Steam Trap Replacement or Repair' Measure from Illinois TRM Version 4.0 and Recommendations for Updating Deemed Values Based on Nicor Gas Program Tracking Data

This memo presents Navigant's review of the 'Steam Trap Replacement or Repair' measure from the Illinois Technical Reference Manual Version 4.0 (TRM Version 4.0)[25]. Navigant worked with Nicor Gas and CLEAResult staff to review GPY1 through GPY4 tracking data from the Nicor Gas Business Energy Efficiency Rebate Program for this measure to assess whether the tracking data could support revisions to key operating parameters of the steam trap savings algorithm. This memo summarizes our findings and recommendations to improve transparency of the TRM calculations and to update the deemed input assumptions effective in TRM Version 5.0. Pending a review of this memo by Nicor Gas, CLEAResult, and ICC staff, Navigant will prepare a work paper of recommended changes to the steam trap measure and submit it to the Technical Advisory Committee reviewing changes for Version 5.0 of the Illinois TRM.

Eligibility

Eligibility for the steam trap measure is defined in TRM Version 4.0 and we found the definition to be reasonable. The TRM states that "Customers must have leaking traps to qualify for rebates. However, if a commercial customer opts to replace all traps without inspection, rebates and the savings are discounted to take into consideration the fact that some traps are being replaced that have not yet failed." No specific leak rate is required. Maximum pressure for this measure is 300 psig.[26]

Savings for commercial full replacement projects are adjusted by the percentage of traps found to be leaking on average from the studies listed as a references in the TRM. This is reasonable in the absence of actual data from individual sites which are probably performing full replacements in order to avoid the time and expense of a full survey.

[25] Referenced as Attachment 1.
[26] Pressure, pounds per square inch gauge (psig) or absolute (psia).

Engineering Algorithm

The TRM uses following algorithm to calculate therm savings for steam trap measures:

$$\Delta therm = \left[S * \left({}^{H_v}/_{B}\right) * Hours * A * L\right]/100{,}000$$

Where,

S = Maximum theoretical steam loss per trap (lbs./hour/trap)

Hv = Heat of vaporization of steam (Btu/lb)

B = Boiler efficiency
= custom,
If unknown:
= 80.7% for steam boilers, except multifamily low-pressure
= 64.8% for multifamily low-pressure steam boilers

Hours = Annual operating hours of steam plant

A = Adjustment factor
= 50%
This factor is to account for reducing the maximum theoretical steam flow (S) to the average steam flow (the Enbridge factor).

L = Leaking & blow-through
L is 1.0 when applied to the replacement of an individual leaking trap. If a number of steam traps are replaced and the system has not been audited, the leaking and blow-through is applied to reflect the assumed percentage of steam traps that were actually leaking and need to be replaced. A custom value can be utilized if supported by an evaluation.

Overall, the energy savings algorithm is sound and is well-referenced. Navigant performed a literature review of various work papers regarding steam traps and the above algorithm is standard practice within the industry. This algorithm is reasonable to estimate the natural gas savings from the steam trap replacement measures.

Algorithm Input Review

The TRM algorithm for steam trap energy savings is sourced from the steam traps work paper "C5 Steam Traps - Nicor FINAL 10.27.11". This work paper was prepared by Resource Solutions Group which is now a part of the CLEAResult group. Thus, the reference in the Illinois TRM Version 4.0 mentions "CLEAResult "Steam Traps Revision #1" dated August 2011". Here onwards, Navigant will refer to this work paper as the "Work Paper #1".[27]

Below, Navigant has provided review and recommendations for the input parameters of the steam trap algorithm.

[27] See Attachment 2 for this work paper.

S (Maximum Theoretical Steam Loss / Trap)

Table 7-10 below provides the deemed values for the maximum theoretical steam loss per trap (lbs./hour/trap), or variable S, provided in the TRM.

Table 7-10. Maximum Theoretical Steam Loss per Trap from TRM Version 4.0

Steam System	Average Steam Loss (lbs/hr/trap)
Commercial Dry Cleaners	38.1
Commercial Heating (including Multifamily) LPS	13.8
Industrial Low Pressure, <15 psig	13.8
Industrial Medium Pressure > 15 psig < 30 psig	12.7
Industrial Medium Pressure >= 30 < 75 psig	19
Industrial High Pressure >= 75 < 125 psig	67.9
Industrial High Pressure >= 125 < 175 psig	105.8
Industrial High Pressure >= 175 < 250 psig	143.7
Industrial High Pressure >= 250	200.5

Source: TRM Version 4.0

The Work Paper #1 referenced in the TRM does not contain Table 7-10, and it is not clear in either the TRM or the work paper what inputs were used to derive the TRM values for industrial medium and high pressure steam traps. Navigant worked with the CLEAResult team who developed the steam trap measure assumptions. The CLEAResult team provided an updated version - *Work Paper Steam Traps Revision #2*,[28] - which provides details about the deemed values used in the TRM Version 4.0.

The Work Paper #1 outlines Napier's equation to estimate the steam loss through the trap as follows:

$$\textit{Flow Rate} = (\textit{Discharge Coefficient}) \times (\textit{Orifice Area}) \times (\textit{Inlet Pressure} + 14.7) / 70$$ [29]

From the literature review, Navigant found that this is a reasonable equation to estimate the maximum theoretical flow rate through a failed steam trap. Using the equation above, we were able to reproduce the values in Table 7-10 for commercial dry cleaners, commercial heating, and industrial low pressure steam traps.

The Work Paper #2 estimates theoretical steam loss through an orifice using a variant of the Napier formula:

Steam Flow (lb/hr) = 24.24 x Pa x D^2 (Maximum theoretical steam flow)
Steam Flow (lb/hr) = 24.24 x Pa x D^2 x CBFF (average steam flow)

[28] See Attachment 3. We refer to this work paper as "Work Paper #2".
[29] Eugene A. Avallone, Theodore Baumeister, Ali Sade, Marks' Standard Handbook for Mechanical Engineers, 11th Edition.

Where:
Pa = Pgauge + Patm
Pa = Absolute Pressure, psia
Pgauge = Gauge Pressure, psig
Patm = Atmospheric Pressure, psi = 14.696 psi
D = Diameter of Orifice, in.
CBFF = Condensate Blockage Flow Factor. Although not shown in the Work Paper #2 algorithm, a note was added in the Work Paper #2: "NOTE: In addition to Enbridge factor, an additional condensate blockage factor of 50% was used in Table 5 above to calculate steam loss in Lbs/hr". Navigant shows this term in the algorithm for clarity, and we labeled it CBFF.

From the literature review, Navigant found that this variant is also a reasonable equation to estimate the flow rate through a failed steam trap. Using the equation above, we were able to reproduce the values in Table 7-10 for medium and high pressure industrial steam traps using input parameters from Table 5 in Work Paper #2. We have reproduced the input parameters in Table 7-11 below, which summarizes the inputs and deemed values for industrial steam systems greater than 15 pounds per square inch gauge (psig). Orifice areas used for each steam pressure categories are also shown in Table 7-11.

The key variables in the average steam flow equation of Work Paper #2 are the inlet pressure (psig), the orifice diameter, and the adjustment factor from theoretical to actual flow. The TRM input values for these variables were drawn from the attached reference documents. Nicor Gas program tracking data was available to estimate average inlet pressures for a given pressure range, but the orifice areas and adjustment factor rely upon reference documents. The orifice diameter is a key parameter in the steam flow estimate, but we do not have Illinois program data to assess whether a revision to the TRM should be considered.

CLEAResult explained that the condensate blockage flow factor was intended to address medium and high pressure float and thermostatic style traps where additional blockage is possible in addition to the Enbridge Factor. Further investigation may be needed to determine if this factor should apply to commercial heating and low pressure traps.

Table 7-11. Revised Table of Annual Gas Savings[30]

Parameters	Industrial Medium Pressure		Industrial High Pressure			
	15 psig	30 psig	75psig	125 psig	175 psig	250 psig
Heat of vaporization (Btu/lb)	945	928	894	868	846	820
Average installed boiler efficiency	80%	80%	80%	80%	80%	80%
Boiler energy to replace lost steam (Btu of gas/lb of steam)	1,189	1,160	1117.5	1,085	1,057.5	1,025
Annual operating hours	7,752	7,752	7,752	7.752	7,752	7.752
Industry average of leaking & blow-thru steam traps	16%	16%	16%	16%	16%	16%
Orifice Diameter	.1875	.1875	.25	.25	.25	.25
% Flow Factor	.5	.5	.5	.5	.5	.5
Average steam loss (lb/hr per trap)	12.7	19	67.9	105.8	143.7	200.5
Average annual steam loss (lb/yr per trap)	98,450.4	147,228	526,360.8	820,162	1,113,962	1,554,276
Annual gas savings (therms /year per trap)	1,158	1,712	5,886	8,899	11,780	15,931
Enbridge Leakage Factor 50%	**579**	**856**	**2,943**	**4,450**	**5,890**	**7,966**

Source: Work Paper Steam Traps Revision #2

[30] Table 5, Addendum, Attachment 3

H_v (Heat of vaporization of steam)

The CLEAResult work paper uses a standard steam table to obtain the heat of vaporization. Table 7-12 provides a summary of the heat of vaporization value, H_v, provided in the TRM.

Table 7-12. Heat of Vaporization of the Steam from TRM Version 4.0

Steam System	Heat of Vaporization (Btu/lb)
Commercial Dry Cleaners	890
Commercial Heating (including Multifamily) LPS	951
Industrial Low Pressure, <15 psig	951
Industrial Medium Pressure > 15 psig < 30 psig	945
Steam Trap, Industrial Medium Pressure >= 30 < 75 psig	928
Steam Trap, Industrial High Pressure >= 75 < 125 psig	894
Steam Trap, Industrial High Pressure >= 125 < 175 psig	868
Steam Trap, Industrial High Pressure >= 175 < 250 psig	846
Steam Trap, Industrial High Pressure >= 250	820

Source: TRM Version 4.0

B (Boiler efficiency)

The TRM Version 4.0 has following values for the boiler efficiency:

B = Boiler efficiency
= custom, if unknown:
= 80.7% for steam boilers, except multifamily low-pressure
= 64.8% for multifamily low-pressure steam boilers

Navigant reviewed the estimated average values suggested and they are reasonable and well-referenced by extensive studies conducted previously.

Hours (Annual operating hours of steam plant)

Table 7-13 provides a summary of the current deemed values for steam trap annual operating hours provided in TRM Version 4.0.

Table 7-13. Annual Operating Hours from TRM Version 4.0

Steam System	Zone (where applicable)	Hours/Yr
Commercial Dry Cleaners	n/a	2,425
Industrial Low Pressure, <15 psig		7,752
Industrial Medium Pressure > 15 psig < 30 psig		7,752
Industrial Medium Pressure >= 30 < 75 psig		7,752
Industrial High Pressure >= 75 < 125 psig		7,752
Industrial High Pressure >= 125 < 175 psig		7,752
Industrial High Pressure >= 175 < 250 psig		7,752
Industrial High Pressure >= 250 psig		7,752
Commercial Heating (including Multifamily) LPS	1 (Rockford)	4,272
	2 (Chicago O'Hare)	4,029
	3 (Springfield)	3,406
	4 (Belleville)	2,515
	5 (Marion)	2,546

Source: TRM Version 4.0

The deemed annual operating hours for industrial steam traps presented in the CLEAResult Work Papers were based on reasonable engineering judgement, without supporting research provided: "the basis for annual operating hours is a steam plant that nominally operates 24 hour per day, 7 days per week, but it is depressurized 6 weeks per year." Commercial space heating annual operating hours for steam traps in TRM Version 4.0 are based on HDD55. [31] Current steam trap hours do not reflect recent updates to equivalent annual full load hours and new steam system configurations in TRM Version 4.0 for other measures. For example, steam trap operating hours in TRM Version 4.0 are inconsistent with operating hours for commercial steam pipe insulation.

The pipe insulation measure allows input of actual operating hours if known. For steam traps, TRM Version 4.0 does not specify that if the actual operating hours value is available, it should be used in the calculations instead of the deemed values provided in the TRM steam trap table. Navigant recommends that the actual hours of use option should be specified in the TRM for industrial steam trap measures, and considered for commercial non-space-heating applications as well.[32]

[31] HDD55 are the heating degree days at 55° F temperature. When the outdoor air temperature is below 55° F, HDD for the particular day is calculated as the difference between 55° F and the average outdoor temperature for that particular day. Example: For a particular location, if the average daily temperature on January 1st is 40° F then HDD55 for January 1st for that location is "55° F - 40° F" i.e. 15.

[32] A complete and detailed set of recommendations is provided in a "Findings and Recommendations" section below.

A (Adjustment factor)

The adjustment factor accounts for reduction in the maximum theoretical steam flow (S) to the average steam flow (the Enbridge factor). Enbridge recommended an adjustment factor of 50% to steam trap energy savings estimates to account for the fact that the actual leak rate in almost all the cases is less than the maximum theoretical leak rate. Based on the review of the CLEAResult work paper and primary documents, Navigant believes that this is a reasonable assumption.

L (Leaking & blow-through)

The leaking and blow-through parameter, L, is defined as follows in the TRM:

> "L is 1.0 when applied to the replacement of an individual leaking trap. If a number of steam traps are replaced and the system has not been audited, the leaking and blow-thru is applied to reflect the assumed percentage of steam traps that were actually leaking and need to be replaced. A custom value can be utilized if a supported by an evaluation."

Deemed values for the leaking and blow-through factor are presented below in Table 7-14.

Table 7-14. Deemed Values for Leaking and Blow-thru Factor from TRM Version 4.0

Steam System	%
Custom	Custom
Commercial Dry Cleaners	27%
Industrial Low Pressure <= 15 psig	16%
Industrial Medium and High Pressure > 15 psig	16%
Commercial Heating (including Multifamily) LPS	27%

Source: TRM Version 4.0

After the review of the "Enbridge Steam Trap Survey" and related source documents Navigant believes that these values are reasonable.

Nicor Gas Program Tracking Data Review

Nicor Gas provided two sets of program tracking data for this study.

1. Navigant received the custom input values for steam trap measures collected during program implementation by Nicor Gas for GPY1 through GPY4. For each steam trap project, the data provided measure savings description, operating pressure, installation Zip code, business building type, program year, and annual operating hours. For GPY4, the inputs also had boiler efficiency values per site. The anonymized data is provided in Attachment 4.
2. Navigant also received data from the program tracking system for steam trap measures that included therm savings and steam trap quantities for GPY1 to GPY3 as well measure name and site location. The anonymized data is provided in Attachment 5.

These custom inputs were analyzed and compared with the comparable deemed values in TRM Version 4.0. The purpose of the analysis was to determine whether custom input data from Nicor Gas program tracking data could provide the basis for recommending an update to the steam trap measure in TRM Version 5.0.

Findings and Recommendations

Overall, Navigant finds that the algorithms used to calculate the energy savings from the steam trap replacement measure in TRM Version 4.0 are reasonable. Our review of Nicor Gas program tracking data suggests these data should be considered for updating TRM Version 4.0 inputs. Following are Navigant's recommendations for updating the Steam Trap measure of TRM Version 4.0.

Recommendation 1: Further Investigate whether the Condensate Blockage Flow Factor Should Apply to Commercial Heating and Low Pressure Steam Traps

The condensate blockage flow factor was intended to address medium and high pressure float and thermostatic style traps where additional blockage is possible in addition to the Enbridge Factor. Further investigation may be needed to determine if this factor should apply to commercial heating and low pressure traps.

Recommendation 2: Make the TRM Algorithm More Transparent

Although Navigant found that the algorithm provided to calculate therm savings was reasonable, adding clarifying statements and secondary equations to the TRM will increase the transparency of the savings algorithms. Navigant recommends adding a brief explanation to the steam trap measure in the TRM to help users understand:

- How the steam pressure is used to calculate maximum theoretical steam loss using Napier's equation and assumed orifice diameters,
- How the theoretical steam flow is adjusted to an "actual" steam flow, and
- How the steam pressure is used to calculate the heat of vaporization using the steam table.

These additional explanations would make the energy saving algorithm more transparent. Something similar to Table 7-11 above can be added in the TRM to show the transition of the pressure values to the steam loss and heat of vaporization.

Recommendation 3: Allow Actual Steam Pressure to be used in the TRM algorithm for Industrial Steam Traps at Pressures above 250 psig

The TRM eligibility requirement for steam traps sets a maximum pressure of 300 psig. The Nicor Gas data indicated some large industrial steam systems operate at pressures higher than 300 psig. Navigant recommends that the TRM allow actual "custom" steam pressure, if known, to be used with the TRM algorithm at pressures above 250 psig. This will be facilitated by adding the algorithm for maximum theoretical steam loss discussed in Recommendation 2.

Recommendation 4: Use the Custom or Default Boiler Efficiency

The TRM recommends that an actual "custom" boiler efficiency value should be used in the calculations if known, and the TRM Version 4.0 deemed boiler efficiency values used if the actual efficiency is not known. CLEAResult explained to Navigant that the program defaulted to recording the deemed boiler efficiency of 80 percent if the program was not able obtain a custom boiler efficiency value from the participant. As part of our review of GPY4 custom input data collected by Nicor Gas,[33] Navigant found that few projects in the GPY4 population had custom boiler efficiency values. The data did not provide the basis for recommending a change to the TRM Version 4.0 deemed default values. Using an actual boiler efficiency value will result in more accurate gas savings estimates, but the deemed defaults are reasonable alternatives.

Navigant recommends no changes to the TRM Version 4.0 boiler efficiency approach (custom if known, default if not) or deemed boiler efficiencies based on our review of Nicor Gas program tracking data. The TRM allows a custom value to be used when a variable in a measure formula can be replaced by a verifiable and documented value. The TRM does not define the documentation required to substantiate a custom boiler efficiency, but boiler efficiency test results or boiler technical specifications from the manufacturer are acceptable for evaluation verification. If documentation is not available, the deemed default value should be used.

Recommendation 5: Update Values for Deemed Average Pressure and Annual Operating Hours

Navigant reviewed the custom inputs from program tracking data provided by Nicor Gas for GPY1 to GPY3[34]. Table 7-15 shows how the actual values of the average operating pressure and annual operating hours compare with the deemed values from the TRM Version 4.0.

Table 7-15. Custom Inputs for GPY1-GPY3 vs. Deemed Values from TRM Version 4.0

Steam System	Custom Inputs from Nicor Gas Program Tracking Data			Deemed Values from TRM Version 4.0	
	Project Count	Average Pressure (psig)	Average Annual Operating Hours	Average Pressure (psig)	Operating Hours / Year
Steam Trap, Industrial Medium Pressure >= 15 < 30 psig	135	16	8,631	15	7,752
Steam Trap, Industrial Medium Pressure >= 30 < 75 psig	186	47	8,284	30	7,752
Steam Trap, Industrial High Pressure >= 75 < 125 psig	270	101	8,100	75	7,752
Steam Trap, Industrial High Pressure >= 125 < 175 psig	181	146	8,346	125	7,752
Steam Trap, Industrial High Pressure >= 175 < 250 psig	37	202	7,788	175	7,752
Steam Trap, Industrial High Pressure >= 250 psig	19	334	8,746	250	7,752
Total Project Count / Overall Averages	828		8,282		7,752

Source: Navigant analysis of Nicor Gas data and TRM Version 4.0

[33] See Attachment 4.
[34] See Attachment 4.

The deemed values from TRM Version 4.0 for industrial medium and high pressure categories are derived from the lower value of the measure description range of pressures. Table 7-15 shows that the program tracking data for GPY1 to GPY3 has a sufficient number of data points to consider updating the deemed values with a value that falls between the low and the high end of the range. The average values are simple averages of project level data with the number of data points shown in the Project Count column of Table 7-15. We did not weight the pressures by steam trap quantities or therm savings. It is not certain whether other weighting approaches would be more representative of future participants

The operating hours in TRM Version 4.0 are based on a (reasonable) engineering assumption that is not sourced to field research. The annual hours of operation recorded by Nicor Gas represent data gathered from Illinois program participants, and Illinois data is generally preferred for the TRM.

Navigant believes that the actual pressure and annual operating hours values provided in the Nicor Gas custom inputs data for the industrial steam trap replacement measures (> 15 psig pressure) is more representative of the Illinois population than the current deemed values in Illinois TRM Version 4.0. Thus, Navigant recommends updating the deemed average pressure and annual operating hour values for the steam trap measure in the Illinois TRM as follows:

Table 7-16. Recommended Changes to the Deemed TRM Version 4.0 Values

Steam System	Current Deemed Values		Recommended Deemed Values	
	Average Pressure (psig)	Operating Hours / Year	Average Pressure (psig)	Operating Hours / Year
Steam Trap, Medium Pressure >= 15 < 30 psig	15	7,752	16	8,631
Steam Trap, Medium Pressure >= 30 < 75 psig	30	7,752	47	8,284
Steam Trap, High Pressure >= 75 < 125 psig	75	7,752	101	8,100
Steam Trap, High Pressure >= 125 < 175 psig	125	7,752	146	8,346
Steam Trap, High Pressure >= 175 < 250 psig	175	7,752	202	7,788
Steam Trap, High Pressure >= 250 psig	250	7,752	263 or Custom if Known	8,746
Steam Trap, All Medium and High Pressures		7,752		8,282

Source: Navigant analysis of Nicor Gas data and TRM Version 4.0

It would be reasonable to use the overall average of 8,282 annual operating hours for all industrial applications, replacing 7,752 hours. The recommended average pressure and operating hours should be applied to medium and high pressure steam process loads (non-space heating) for industrial and non-industrial facilities. For steam traps operating at 250 psig and above, we chose to base the default operating pressure on the average for projects sites in the range of 250 psig to 300 psig, because 15 of the 19 projects fell in that range, and the other four were well outside that range (600 psig). Over 300 psig, the calculation should be based on custom operating pressure values.

Navigant also recommends that the commercial heating annual operating hours in the steam trap measure be revised to be consistent with updated values in TRM Version 4.0 presented in measure 4.4.14 Pipe Insulation.

Recommendation 6: Update Deemed Values that are Dependent on Average Pressure, if the Changes in Recommendation 5 are Adopted

Navigant's proposed changes in the average pressure values will change the deemed values for 'Average Steam Loss' and 'Heat of Vaporization' for the industrial steam system categories (>15 psig) as these variables are functions of average pressure value.

Recommendation 7: Define Acceptable Options for Choosing an Annual Operating Hours Value in the TRM Energy Savings Calculation

The TRM does not specify that if the actual operating hours value is available and documented, it may be used in the calculations instead of the deemed values provided in the TRM. Navigant recommends that the steam trap measure in TRM Version 4.0 be updated to be consistent with the Pipe Insulation measure 4.4.14 that allows actual or default operating hours.