

Impact and Process Evaluations of Northern Illinois Retro-Commissioning Programs

*Randy Gunn and Roger Hill, Navigant Consulting, Chicago, IL
George Malek and Richard Tonielli, Commonwealth Edison, Chicago, IL*

ABSTRACT

This paper presents a comprehensive assessment of one of the largest retro-commissioning (RCx) Programs operating in the U.S. The RCx Program is jointly operated by ComEd, Nicor Gas, North Shore Gas, and People's Gas in the Chicago metropolitan area. The evaluation discussed in this paper is the fourth evaluation of this Program, and covers net and gross impacts, as well as process issues.

A particular focus of the program year (PY) 4 evaluation was net-to-gross (NTG) matters. The estimated NTG ratio had declined from 92% in PY2 to 71% in PY3, so the PY4 evaluation used a more comprehensive assessment of program attribution and attempted to attain increased survey response rates to further investigate and enhance the reliability of these results. Previous evaluations had used a self-report approach that primarily relied upon customer participants to estimate NTG ratios, and was consistent with the most rigorous NTG method used for other RCx Program evaluations. For PY4, we used the input from retro-commissioning service providers (RSPs) much more significantly to estimate NTG ratios. Navigant used a variation of the NTG approach that we use for some NYSERDA programs for this Illinois RCx Program, weighting the NTG results from customer participants and trade allies equally to determine the Program NTG ratio. Increased customer participant and RSP responses to the evaluation surveys, together with the updated NTG approach, increased the estimated NTG to slightly more than 100% for ComEd, as well as the participating gas utilities.

Introduction

The Northern Illinois Joint Utility Retro-Commissioning (RCx) Program is implemented as a joint Program by ComEd, Nicor Gas, North Shore Gas, and Peoples Gas for the first time in 2011-12, which is electric PY4 (EPY4) and gas PY1 (GPY1). Previously, ComEd conducted the Program as a single utility Program that focused on electricity conservation. Illinois Senate Bill 1918 required the state's gas investor-owned utilities (IOUs) to conduct energy efficiency programs starting on June 1, 2011. This is three years after the Illinois electric IOUs started electric energy efficiency programs through an energy efficiency performance standards (EEPS) structure, as required by the 2007 Illinois Power Agency Act.

The RCx Program was initiated by ComEd as a pilot program in the first Illinois energy efficiency program year, which ran from June 1, 2008 to May 31st, 2009¹. The Program was operated as a full scale electric energy efficiency program in the second and third program years. However, the RCx Program was still ramping up over the initial three year period, with participation increasing from four participants in Program year one (PY1) to 14 in PY2, to 34 in PY3.

The RCx Program helps commercial and industrial customers improve the performance and reduce energy consumption of their facilities through the systematic evaluation of existing building systems. In general, the Program pays for 100% of a detailed retro-commissioning study contingent

¹ The Illinois energy efficiency program years are set up to coincide with the calendar for the Pennsylvania-Jersey-Maryland (PJM) power pool.

upon a participant's commitment to spend a certain amount of their own money implementing recommendations in the study that have a payback of 18 months or less. RCx recommendations typically include low-cost or no-cost HVAC measures such as: (1) scheduling equipment with occupancy, (2) optimizing temperature setpoints and controls to operate equipment efficiently and (3) repairing worn-out or failed components² that manifest themselves as energy waste rather than affecting the ability of the whole system to maintain comfort. Measures can usually be implemented in the course of normal maintenance or through improvements to sensors or control programs with existing building automation systems (BAS).

To be eligible for the RCx Program, customers' facilities must generally be at least five years old and 150,000 square feet in size, have a peak electric demand of at least 500 kW, and not have any major systems renovation or retrofits planned for the near term. In addition, the facility should have a higher than average energy use index, measured in energy used per square foot, and the facility owner must commit to staying involved with the RCx project over its lifetime, which can last about one year in total. The Program is managed by ComEd, administered by Nexant, and program services are delivered through RCx service providers, who are independent commissioning agents.

Summary of Evaluation Results for the First Three Program Years

The electric program impact evaluation results over the first three year program years showed both consistency and variation in results. Annual evaluations have shown the "gross" realization rates were within the narrow range of 90% to 95% over the prior three years. Net-to-gross (NTG) ratios, on the other hand, varied over the three years from 80% in PY1 to 92% in PY2, and then dropped to 71% in PY3. The PY3 NTG ratio was possibly the result of a somewhat low participant evaluation survey response rate of 24%, despite the best efforts of the evaluation team to survey all of the participants.

Process evaluations were conducted in PY2 and PY3. Small numbers of participants completed evaluation surveys each year, but those who were surveyed reported high levels of satisfaction with the Program overall and major Program components. PY3 participants reported that participation barriers included the following:

- Not previously being familiar with the program;
- Legal reviews required by their organizations; and
- Mandatory measure implementation spending requirements.

The RCx service providers were also generally quite satisfied with the Program, but were concerned about a few matters. These included insufficient compensation relative to the time planning projects, redundant paperwork requirements, and delays in receiving approvals to proceed from one program phase to another.

One interesting finding from the PY3 evaluation is that customer participants and RCx service providers have different ideas about how participants became familiar with the Program. More than half of participants surveyed reported learning about the Program from a colleague, word of mouth, or the ComEd website. However, all the RCx service provider respondents reported that they were the main channel by which customers learned about the Program.

Program Year 4 Evaluation Objectives

² For example, broken damper linkages that permit introducing too much ventilation air in extreme weather conditions. Servicing or replacing the linkages so they perform as intended would be a retro-commissioning measure.

Following up on evaluations of the first three electric program years, the EPY4/GPY1 evaluations focused on two objectives, which were designed to deal with issues encountered during the electric PY3 evaluation. These included:

1. Increasing customer participation in the evaluation surveys up to about 50%, approximately double the similar result of the PY3 evaluation.
2. Conducting a more comprehensive assessment of program attribution, including incorporating the views of RCx service providers more fully into the net-to-gross ratio.

The current evaluation of the RCx Program reflects the third full-scale year³ of program operation. During EPY4/GPY1, 50 facilities participated in the RCx Program including 41 unique commercial entities. Among the 50 sites, more than 240 retro-commissioning measures (RCMs) were implemented and verified by the implementation contractor (IC). The participants were shepherded through the Program by nine different retro-commissioning service providers (RSPs).⁴

Evaluation Methods and Data Sources

Impact Evaluation Methods

Navigant examined measure-level impacts for the sample of program participants. The IC, Nexant, submitted detailed data and engineering calculations from the service providers for each measure for Navigant review. Navigant also conducted on-site inspections and verification of measure installations at 11 sites as well as reviewed operating parameters and some trend data from the summer of 2012. On-site inspections included the following tasks, as necessary or possible: interviews with operations staff, reviewing sequences of operations, testing sequences with operator over-ride inputs, observing equipment-level operations, verifying operations with recent or new trend data and spot measurements with hand-held instruments.

Navigant reviewed each implemented measure and many proposed⁵ measures at the sampled projects for accuracy and completeness. The evaluation verified that appropriate algorithms, methods, and data sets were used. During the review Navigant compared calculation parameters to assumptions and applied prescribed parameter defaults as needed when measure calculations deviated from expected norms. Measure savings were confirmed or adjusted, as needed, for each implemented measure for each participant. Navigant analyzed gross savings at the participant level, measure end-use level, and measure-type level. Aggregate savings of the individual measures comprise project gross savings.

Within each sample strata Navigant developed realization rates for electric and gas savings from the sampled projects. Stratum-specific realization rates were applied to un-sampled projects in the strata to determine overall realization rates for the Program.

Gross Program Savings Data Collection

The primary data for the impact evaluation came from the program administrator, Nexant, Inc. Among the data reviewed for the impact analysis were the following:

- Program guidelines⁶ that described expected savings estimation techniques and assumptions when site-specific data were not available;

³ A small pilot program was conducted in EPY1 with Nexant serving as RSP and program implementer

⁴ Four additional RSPs were working on projects during EPY4/GPY1 that were not completed by the end of the program year, so the savings from those projects are not included in the evaluation year reported on in this paper.

⁵ Even measures that were not implemented contain key information about facility operations, setpoints and interactive effects among energy end-uses.

⁶ Smart Ideas for Your Business Commercial Retro-Commissioning Calculation and M&V Guidelines.

- Template for standard savings calculators for common, but lower-impact measures;
- Exports from Nexant's Program tracking system in spreadsheet format including project-level and measure-level descriptions and savings; and
- Electronic versions of reports, invoices, submittals and savings calculations.

Navigant supplemented these data with on-site inspections at a sample of sites and requests for supplemental data from participants and/or RSPs, as needed, to fully understand the implemented measures.

Net Program Savings Data Collection

Net-to-Gross (NTG) research methods in EPY4/GPY1 combine participant and service provider survey results. Research for both groups uses a self-report method where participants and RSPs answer questions about the Program. The participant survey instrument asked about awareness of the measures identified and the respondent's inclination to pursue corrective actions for those measures absent the Program. The RSP survey instrument asked about the retro-commissioning market prior to and since the Program, as well as the likelihood of measure implementation without the Program and as a result of the Program. Navigant also explored spillover effects through the participant and service provider surveys.

Free-Ridership Analysis. Navigant's method examines three elements of free-ridership for participants, described as follows:

1. Program Influence considers the importance of program factors for the participants' decisions to undertake retro-commissioning at this time.
2. Timing and Selection considers when the participant learned of the program, relative to the decision to retro-commission the facility and the impetus to implement measures. Since the RSPs cannot speak to timing and selection, this element is only asked of customers.
3. No Program Score is a self-reported estimate of what measures or savings would have been implemented without the Program.

The three (or for RSPs, two) elements of free-ridership are weighted equally for estimates for participant and RSP free-ridership, respectively. Navigant subsequently calculated the overall program savings-weighted free-ridership from individual participant and RSP values to determine overall participant and RSP free-ridership. Navigant averaged the participant and RSP estimates for fuel specific Net-of-Free-rider⁷ estimates.

⁷ Net-of-Free-rider = 1 – Free-ridership

Spillover Analysis. Navigant also asked participants and RSPs about the effect the RCx Program had on the Illinois retro-commissioning market outside of the Program – or spillover. For participants, spillover might include projects at the same facility, or a facility under the same ownership or management, which implemented energy savings projects as a direct result of the RCx Program, but without receiving an incentive to do so. For RSPs, spillover consists of additional projects completed and measures implemented, through increased awareness, marketing materials or staff capacity, as a direct result of the Program. Participant and RSP spillover are considered additive, to the extent the same projects are not the basis of both estimates. This was assessed and verified as part of the evaluation activities.

Process Evaluation Methods

The Process Evaluation included in-depth interviews with key actors in the Program including ComEd, WECC (Nicor Gas) and Franklin Energy (Integrus) Program Managers; the IC (Nexant), Program-approved RSPs and telephone surveys of program participants. These interviews dealt with overarching satisfaction with the Program and details about program operations, marketing, training, and market potential for retro-commissioning services. The process evaluation also reviewed documents related to the program such as application forms, program design, implementation, training, and marketing materials.

Interviews with RSPs. The evaluation team conducted in-depth interviews with eight of the nine active PY4 RSPs. These eight RSPs implemented 47 of the 50 EPY4 projects and all GPY1 projects. Questions focused on Program awareness, Program processes, the effects of the Program on business practices, free-ridership and spillover, marketing and outreach, training, barriers to participation, and general feedback and recommendations.

Interviews with Participants. The evaluation team also completed in-depth-interviews with 25 of the 39 EPY4/GPY1 Program participants (representing 29 projects) who completed all of the program phases. Our questions focused on Program awareness, program participation, marketing and outreach, free-ridership and spillover, benefits and barriers to participation.

Evaluation Sampling

Impact Sampling

Impact sampling occurred in two stages. Since all participants were ComEd customers, we first sampled for electric program participants to ensure we had an un-biased sample. We then examined the sample with respect to the gas utilities and *supplemented* the initial sample with randomly sampled gas customers to ensure an adequate sample for each of the gas utilities and to achieve our confidence and precision targets. This resulted in over-sampling the ComEd projects. Table 1 shows the sample sizes for each utility.

Navigant used the stratified ratio estimation method for choosing the impact sample for each utility. This method is based on the anticipated realization rate, and we stratified the population based on project *ex ante* savings to ensure that our 90/10 (confidence/precision) strategy also captures a significant proportion of program savings. The ratio estimation method tends to create a sample with a near-census of the largest savings customer stratum and a balanced sample between the remaining strata to achieve the desired precision. Within each stratum Navigant selected projects randomly (error ratio = 0.4). In our final sample, the expected relative precision is 8.5% at the 90% confidence level for

electricity, and Navigant reviewed projects accounting for 69% of Program kWh and 75% of Program gas savings. Table 2 shows the population and sample data for each sample strata.

Table 1. Impact Evaluation Samples by Utility

	Program Population	Sample Required for 90/10	Final Sample Size Attained	Relative Precision at 90% Confidence
ComEd	50	22	24	8.5%
Peoples Gas	14	8	8	8.7%
North Shore Gas	1	1	1	Census
Nicor Gas	7	5	5	7.0%
Overall	50	22	24	NA

Source: Utility tracking data and Navigant analysis.

Table 2. Impact Evaluation Samples by Stratum

	Program Population	Population kWh savings	Final Sample Size Attained	Sample kWh Savings
Stratum 1	7	12,065,680	7	12,065,680
Stratum 2	14	9,849,967	9	6,197,309
Stratum 3	29	7,991,951	8	2,464,437
Total	50	29,907,598	24	20,727,426

Source: Utility tracking data and Navigant analysis.

Process Sampling

The process evaluation team attempted interviews with a census of the nine active RSPs and the 39 customer contacts⁸ in the EPY4/GPY1 Program. Statistical confidence and precision is based on the sample size relative to the population. For the process analysis, all participants were included in the sample, thus the sampling approach was a census attempt, so there is no sampling error and the error bounds are zero.

Key Impact Evaluation Findings

Table 3. and Table 4. summarize the savings from the Joint Utility RCx Program. *Ex Ante* estimates for electric savings assume a deemed Net-to-Gross (NTG) ratio of 0.916. There were 50 participants in the EPY4/GPY1 Program representing 39 unique customer decision makers.⁹ Three projects were participants in EPY3 with select measures completed and verified in EPY4/GPY1.

⁸ Two participants had multiple project sites enrolled in EPY4.

⁹ Three projects were completed at a private university and one corporation completed projects at eight properties in the ComEd service territory.

Table 3. EPY4 Evaluation Electric Savings Estimates

Research Category	Energy Savings (MWh)
Ex Ante Gross	29,908
Ex Ante Net ¹⁰	27,395
Evaluation Research Findings Gross	27,315
Evaluation Verified Net	25,021

Among the 50 participating buildings, 22 were also gas utility participants. The gas utilities did not have a deemed NTG ratio; however, they all used 0.8 as a planning assumption, and Navigant applies this ratio to estimate ex ante net savings. Since no NTG estimates were deemed for gas savings, Navigant applied the NTG ratio estimated by EPY4/GPY1 research below to GPY1 gas savings.

Table 4. GPY1 Evaluation Natural Gas Savings Estimates

Research Category	Peoples Gas Savings (therms)	North Shore Gas Savings (therms)	Nicor Gas Savings (therms)	Total Gas Savings (therms)
Ex Ante Gross	858,657	56,775	180,345	1,095,777
Ex Ante Net ¹¹	686,926	45,420	144,276	876,622
Evaluation Research Findings Gross	913,820	67,908	147,838	1,129,566
Evaluation Verified Net ¹²	927,535	68,927	150,057	1,146,519

Gross Realization Rates

The realization rate for electric energy is 91.3%, similar to the 90%-95% realization rates resulting from EPY1-EPY3 evaluations. Gas savings realization rates are 106.4%, 119.6% and 82.0%, for Peoples Gas, North Shore Gas and Nicor Gas, respectively. Divergent gas realization rates are a result of the small populations of participants and savings for the latter two utilities. The overall gas realization rate is 103%. At 90% confidence, the relative precision in the electric estimate is 3.0%, and in the gas estimate it is 7.7%

Energy savings estimates from the RSPs are generally well-supported and calculated with a high degree of rigor. Most RSPs continue to use their own estimation spreadsheets, rather than Program-provided templates for common measures. This factor complicates program implementation and

¹⁰ The program-assumed net-to-gross ratio is 0.916 for electricity savings.

¹¹ The program-assumed net-to-gross ratio is 0.8 for Nicor Gas savings, Peoples Gas and North Shore Gas for planning purposes.

¹² Natural gas verified net savings is based on EPY4/GPY1 research that found a net-to-gross ratio of 1.015 for gas and 1.038 for electric savings.

evaluation efforts as the variety of RSP methods are time-consuming to evaluate and more prone to errors.

Net-to-Gross Ratio Estimates

For the first time in the PY4 evaluation, free-ridership was explored in both participant and RSP surveys. Navigant calculated net-of free-ridership¹³ estimates for each interview and then savings-weighted participant and RSP net-of-free-ridership for the Program. Navigant tracked natural gas and electricity factors separately. The results are shown in Table 5 below.

Some participants felt they would have implemented some retro-commissioning measures absent the RCx Program and studies. Service providers with long experience in the market are highly skeptical that studies would be performed and measures implemented without the funded studies, commitments and, by extension, the Program. Most of the RSP observations, though, are based on their experience with poorly-performing buildings. Overall Program net-of-free-ridership is the average of the participant and RSP estimates. Spillover from both participants and RSPs is additive to the overall net-of-free-ridership to derive NTG. The estimate of participant spillover was less than one percent. Precision at 90% confidence in the final NTG estimate is 2.3% for electricity and 1.9% for natural gas.

Table 5. Net-of- Free-Ridership (1-FR), Spillover and NTG Estimates

	Participant		Service Provider		Overall	
	Electricity	Gas	Electricity	Gas	Electricity	Gas
Program effects	0.92	0.84	0.98	0.98		
Timing & Selection	0.76	0.78	NA	NA		
No-Program Effects	0.78	0.84	0.98	0.99		
Net-of-Free-riders ¹³	0.82	0.82	0.98	0.99	0.90	0.91
Spillover	<0.01	<0.01	0.14	0.11	0.14	0.11
Overall NTG	0.82	0.82	1.12	1.10	1.04	1.02

Source: Navigant analysis.

Sample sizes for gas net-of-free-ridership are very small and individual responses can greatly sway results. For example, participant net-of-free-ridership for gas varies between 0.76 and 0.92, depending on the utility, with 0.822 being the savings-weighted average for all gas participants. Service provider-derived values were more consistent with an average of 0.98 from a range of 0.95 to 1.0.

Overall, the participant interviews included 46% and 53% of Program electric and gas savings, respectively. RSP interviews included 91% and 100% of electric and gas savings, respectively.

Spillover was a noticeable aspect of the program for service providers, but much less so for participants. Three of 25 interviewed participants reported implementing some retro-commissioning

¹³ Net-of-free rider = (1 - free-riders). Addition of spillover to the term comprises the full NTG ratio.

measures at the project site or other locations in Illinois, but only one credited the program with significant influence (7 on a scale of 0 to 10). Most of the RSPs report they are growing their retro-commissioning service, partially as a result of the RCx Program. All but two RSPs say growth is only with utility programs at this point. For those two RSPs their answers to follow-up questions indicated significant spillover effects from the RSP perspective. One RSP was working with similar sized facilities, and the other was working with those that were just under the size threshold for the program.

Key Impact Evaluation Recommendations

Navigant recommends updating utility electric and gas-specific NTG ratios for planning purposes, based on these research findings, and applying the gas NTG retrospectively to GPY1 savings since this is the first time NTG has been researched for the gas programs.

Peak Demand Savings Estimates

Navigant found that the RSPs continue to have different or no approaches for estimating peak demand savings for their RCx projects. Accurate accounting for demand savings does contribute to measure payback at the customer level and contributes to the Program's success, including more accurate benefit-cost ratios. Navigant recommends that the RCx Program should establish a standard methodology for demand savings estimates and those methods should be enforced during quality assurance steps.

Incomplete Savings Estimates

Some measures are low-risk and high-reward in terms of savings, and there is a temptation by RSPs to apply less rigorous calculations to quantify savings, since the RSPs are certain the customers will implement those measure. While this scenario expedites the retro-commissioning process and still benefits the customer, it results in lower than actual Program savings estimates.

Navigant recommends that during savings-calculation quality control steps RSPs look specifically for interactive and concurrent savings with a checklist by measure type. For example, equipment scheduling saves gas energy for ventilation as well as fan electric energy; fan static pressure reduction decreases fan heating, and discharge air temperature resets can change mass-flow rates and fan power. Navigant encourages the use of Program template calculators, which do include the concurrent and secondary effects, to improve the overall accuracy of savings estimates.

Navigant recommends exploring ways to encourage use of existing program-standard savings calculators which are available for ten common measures if measure savings is less than 75,000 kWh. Consider using incentives or fast-track Program processes when standard savings calculators are used.

Incomplete Training Tracking

A condition of program participation is having at least one participant staff member complete the Level 1 Building Operator Certification training. The program data base currently is not set up to track training participation for program compliance. Navigant recommends adding table(s) to the data base to track training for one or more individuals for each participating site. The table should link to project number for verification purposes.

Key Process Evaluation Findings and Recommendations

RSP Participation

The Program currently has 23 registered RSPs. While only nine RSPs completed projects in EPY4/GPY1, many of the others are working on projects for EPY5/GPY2 completion. While the effort to increase the number of participating RSPs between EPY3 and EPY4 was a success, there is still lost opportunity in having RSPs listed as part of the Program but not completing projects in a Program year.

Navigant recommends that because RSPs are the primary conduit for program participation, the IC should stress the importance of completing a project during the RSP training period. In addition, all RSPs should clearly understand that inactivity and no projects may result in a requirement to rebid their participation in the program, or removal from the program. Navigant also recommended conducting research with inactive RSPs in EPY5/GPY2 to determine the conditions of inactivity.¹⁴

Implementation Phase Support

The implementation phase of the Program continues to be the primary source of challenges. This phase is generally participant-led and the timely completion of projects is largely dependent on the customer keeping the project moving. RSPs expressed a concern that while they are not involved in this phase, they are still held responsible, via the RSP review process, for the timely completion of projects.

Navigant suggests that more effort is needed from Program Managers and the IC to engage the participants and keep the implementation phase moving along on a timely basis. Including implementation milestone dates in the implementation phase will provide status check points for each recommendation periodically. The milestones could be simple written status updates via email to the RSP, if projects are progressing, or part of a conference call or on-site meeting with the customer, as well as RSP and utility and/or program representatives, if the recommendations seem stalled.

Project Completion Timing

Timing of completing projects improved in EPY4/GPY1, but remains a challenge. In EPY3 almost 90% of projects were completed after May1 of the program year as compared to 45% in EPY4/GPY1. In the current program year, many projects were unable to meet their originally planned completion timelines. Timing challenges include:

- The program year, which ends on May 31, limits the RSP's testing season for cooling measures, creating problems in finishing projects on time.
- Lack of customer urgency to complete the various stages of the project process by the end of the Program year.
- The amount of back and forth between the RSPs and IC during the review process.
Customer timing perceptions varied by customer type:
- Large corporate participants indicated that the projects could have been completed more quickly; and,
- Smaller, non-profit, or more budget constrained participants indicated that being able to spread the implementation phase out over the course of more than one fiscal year would allow them to complete more projects through the program.

¹⁴ The utilities and Nexant implemented these two recommendations during the time the evaluation report was being written and finalized.

Navigant recommended that the utilities and Nexant stay more engaged with participants and RSPs to clear obstacles to implementation and analysis review. The study team also recommended setting up periodic meetings with each project team to learn of obstacles before they slow down the program processes.

Policy or Program Implications

The updated approach to estimating NTG ratios used for this program have been accepted by Illinois regulators and stakeholders. A similar approach was used in the evaluations of two other Northern Illinois Programs in the EPY4/GPY1 evaluation cycle, yielding somewhat similar results for the one Program for which the evaluation has been largely completed at this time. For programs in which trade allies play significant roles and have the best market perspective, Navigant believes that incorporating service provider views and increasing survey response rates can significantly improve the accuracy of NTG ratio estimates compared to approaches that rely exclusively on customer survey results.

Most previous RCx Program evaluations reviewed either did not conduct any type of net-to-gross analysis, or conducted a simplified NTG analysis. One previous evaluation of a California RCx Program conducted in 2006-2008 used a similar type of NTG analysis as Navigant used for PY1-PY3 for ComEd's RCx Program. The PY4 RCx evaluation discussed in this paper is the most rigorous NTG approach used for RCx Programs of which the authors are aware.

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