

**Energy Efficiency / Demand Response
Plan: Plan Year 2 (6/1/2009-5/31/2010)**

**Evaluation Report:
Retro-Commissioning Program**

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Section E. Executive Summary

This report presents a summary of the findings and results from the Impact and Process Evaluation of the 2009 (PY2) Commercial & Industrial Retro-Commissioning Program.¹ This Program provides a platform to assist commercial and industrial customers improve performance and reduce energy consumption through the systematic evaluation of existing building and industrial systems. Low- and no-cost measures are targeted and implemented to improve system operation, reduce energy use and demand, and, in many cases, improve occupant comfort. The Smart Ideas Retro-Commissioning Program aims to streamline the typical retro-commissioning process in order to facilitate quick-turnaround projects that yield savings in the program year they are initiated. Streamlining in this manner addresses the nature of Illinois program design which measures the spending and results primarily in the year of implementation.

The program in 2009 (PY2) represents the first year of full scale implementation of the Retro-Commissioning Program following a pilot of the program in PY1. Many lessons learned in PY1 were applied successfully to the program in PY2:

- The program schedule was modified within regulatory constraints to facilitate completion of planned projects.
- A cohort of eligible retro-commissioning service providers (RSPs) adequately delivered the program to participants in lieu of the Program Administrator who did the work in PY1.
- Program guidelines were organized.
- Standards for calculating savings were established and mostly adhered to.

E.1 Evaluation Objectives

The primary objectives of the Impact Evaluation are to review reported savings for installed measures, to recommend general improvements to the savings estimation process, and to quantify gross and net savings impacts from review of the program tracking and engineering calculations. The Process Evaluation addresses key process-related program strengths and weaknesses and identifies ways in which the program can be improved.

E.2 Evaluation Methods

Table E-1 provides a summary of the data collection activities conducted as part of this evaluation. As this table shows, the primary data collection activity for the process evaluation

¹ The 2009 program year began June 1, 2009 and ended May 31, 2010.

was in-depth interviews with program management and implementation staff, as well as participating RSPs and customers. Impact evaluation activities focused on reports and data submitted in participant files, as well as on-site data collection.

Table E-1. Evaluation Methods

Data Collection Type	Targeted Population	Sample Frame	Sample Design	Sample Size	Timing
Desk Engineering Review	All implemented Retro-Commissioning Measures	Tracking Spreadsheet	-	census	Aug-Sept 2010
On-site Engineering Review	Chilled Water Measures	Tracking Spreadsheet	-	5 projects	September 2010
In-depth Phone Interviews	ComEd Program Manager	Contact from ComEd	Program Manager	1	August 2010
	Program Implementer	Contact from ComEd	Nexant Program Manager	1	August 2010
	Retro-Commissioning Service Providers	Tracking Spreadsheet	Attempted census (6)	4	September 2010
	Program Participants	Tracking Spreadsheet	Attempted census (13)	5	September/October 2010

E.3 Key Findings

Program Year 2 represented the first full year of implementation for the Smart Ideas Retro-Commissioning Program. A total of 14 sites comprising 15 buildings participated in the program, and more than 100 measures were implemented among those sites. One of these sites dropped out of the program prior to completion of its obligations, but did receive some incentive from ComEd and did implement several retro-commissioning measures. For the purposes of this discussion this site is a participant.²

² However, this participant was not contacted for the survey of participants.

Table E-2 below provides the PY2 evaluation-adjusted gross savings estimates for the Program.

Table E-2. Ex Post Program Savings

Gross and Net Parameter and Savings Estimates	PY2 ex ante	PY2 Evaluation Adjusted	Realization Rate
Participants	14	14	100%
Gross MWh Savings	7,846.6	7,174.1	91.4%
Gross kW Savings	927.6	1,112.8	120.9%
Net-to-Gross Ratio (1-FR)		0.916	
Net MWh Savings	NA	6,574.1	83.8%
Net kW Savings	NA	1,027.9	110.8%

Key Impact Findings

The PY2 gross *ex ante* energy savings for this program were 7,847 MWh. The gross savings *ex ante* savings exceeded program goals by about 20%. The evaluation adjusted gross saving realization rate is 91%. The reasons for a realization rate less than 100% include infrequent errors in engineering calculations and inaccurate assumptions that affect those estimates. Among these factors are:

1. Not systematically including latent cooling effects, both in mechanical cooling and economizer savings estimates.
2. Inconsistent application of assumed values for motor loading, the effects of VFD efficiency, and other baseline assumptions that influence measure savings.
3. Omission of demand savings estimates for measures that will impact summer demand.
4. Improper analysis of two types of measures for which savings were estimated in situations when savings is not appropriate.

Each of these items represents isolated cases. In this respect they show that efforts to encourage universal defaults and methods have been generally successful. In future program years we would expect these sorts of problems will diminish. Consistent application of methods and assumptions will enhance the repeatability, consistency, and veracity of savings estimates as the

program expands the number of third party Retro-Commissioning Service Providers (RSPs) as the primary delivery and savings estimation entities.

Free-Ridership is very low with this program as a whole. All surveyed participants either scored the program incentives as a very important influence on their decision to implement retro-commissioning, or they cited the influence of their retro-commissioning service provider in their decision. These same service providers report the program had a very important influence in their recommendation to offer retro-commissioning services. Thus the program was crucial for the participant either directly or indirectly through their service provider.

Isolated measures had indicators of free-ridership – mostly when equipment was in a known state of poor operation. Examples of poorly operating equipment include: circumvented controls with poor sensor readings or inability to perform a process with the intended setpoints of equipment. When problems were known, participants anticipated implementing remedies two years in the future, absent the program. Among the five participants who answered NTG questions, site-level NTG were 0.78, 0.86, 0.94, 1.0 and 1.0. The overall program NTG was 0.916 (free-ridership = 0.084 and spillover = 0.0).

Key Process Findings

Program Participation

As expected, participation in the Retro-Commissioning program increased substantially in PY2 as the program fully launched after its initial pilot year. Fourteen customers completed projects at 14³ facilities, resulting in *ex ante* gross energy savings of 7,847 MWh compared to the program's goal of 6,456 MWh. The average savings per project was 560 MWh per year, with individual projects ranging from 95 MWh to 1,220 MWh. Participating facilities represented a range of building types and included five office buildings, two hospitals, two industrial facilities, and one each of a large retail facility, an education facility, a museum, and a hotel.

The program also selected nine retro-commissioning service providers (RSPs) for PY2. Of these, six completed projects within the program year. The number of projects per RSP ranged from one to five.

Program Processes

Program processes have evolved since the pilot year, and program staff has done a good job incorporating lessons learned from the pilot phase into the PY2 program design. RSPs and

³ One project was cancelled after implementing some measures. The program counted its implemented and verified savings of 142 MWh/year.

customers find that participation processes are clearly explained. Some RSPs expressed frustration with certain parts of the application and review processes. This is not surprising as PY2 was the first year with RSP involvement and certain processes are still being refined. To address any potential issues, the program has implemented a strong communication and feedback process. This has enabled the program to quickly address and clarify issues and make any needed mid-course adjustments.

Program timelines still present problems for participants. Most projects miss the deadline by an average of two to three weeks for each phase. While this has been improving, as RSPs have gained more experience with the program, RSPs find the timelines too aggressive given the complexity of many retro-commissioning projects and difficulties getting access to many customer facilities during regular business hours.

Customer Satisfaction

Customers' satisfaction with the retro-commissioning program is high for the various program phases and the program overall. Interviewed customers were also satisfied with the timing of the different phases, with some admitting that delays in meeting milestones were due to internal circumstances. In addition, customers are generally very satisfied with their RSPs and would work with them again or refer them to others. Satisfaction is similar for participants with or without a prior working relationship with the RSP.

Retro-Commissioning Service Providers

The program selected nine RSPs for PY2, but only six completed PY2 projects. Service providers play a major role in the program and are responsible for much of the program's outreach and customer interface. Because of this, ComEd and Nexant maintain frequent contact with RSPs, and lessons learned are quickly shared with other participants. RSPs are required to attend training webinars from Nexant and find the trainings to be helpful.

Nexant performed annual performance reviews of participating RSPs and rated them on a series of metrics including the number of projects, quality of reports, project value, and customer satisfaction. Five of the six participating RSPs earned passing grades for their performance in PY2, while the sixth RSP must re-apply in the next program year cycle. RSPs found this process fair and helpful. The evaluation team commends the program for implementing this process as it is a helpful tool for the program to evaluate service providers and ensure that they are active in the program and deliver high quality work.

All interviewed RSPs noted that the program has had an effect on their business practices, including recommending retro-commissioning services more often and adding new staff.

All interviewed RSPs were generally very satisfied with the program.

Marketing and Outreach

Service providers are the primary promoters of the retro-commissioning program and are expected to generate leads. The leads come from a mix of existing and new customers for RSPs, largely depending on the level of activity for the service provider in ComEd’s territory. Unlike the pilot year, few leads are generated from ComEd account managers, and most account managers do not appear to be very engaged in promoting the program to their customers.

Introduction to the Program

Program Description

The *Smart Ideas* Retro-Commissioning (RCx) Program provides a platform to assist commercial and industrial customers to improve performance and reduce energy consumption through the systematic evaluation of existing building and industrial systems. Low- and no-cost measures are targeted and implemented to improve system operation, reduce energy use and demand, and, in many cases, improve occupant comfort. The Smart Ideas Retro-Commissioning Program aims to streamline the typical retro-commissioning process in order to facilitate timely turnaround projects that yield savings in the year they are initiated.

1.1.1 Implementation Strategy

The Program is open to all customers who meet the eligibility requirements:

- Receipt of electric service over ComEd wires regardless of the electric supplier;
- Peak demand greater than 500kW OR Compressed air plant greater than 500 HP installed compressor capacity (pilot in PY2); and
- Execution of a Program Agreement with the customer that they will spend up additional resources to implement retro-commissioning measures with a simple payback of 18 months or less.

Table 0-1. Size of Retro-Commissioning Study

Size of Retro-Commissioning Study	Implementation Commitment
Standard	\$10,000
Large Scale Studies	\$20,000

Completion of these requirements qualifies the participant for 100% reimbursement of the retro-commissioning service fees.⁴

Unlike Prescriptive or Custom Programs that focus on new efficient equipment, the Retro-Commissioning Program focuses on using existing equipment more efficiently to save energy while still delivering the required services to support the building occupants. Successful retro-commissioning requires experienced service providers and cooperation and buy-in of the facility staff to implement, frequently, operational changes. The Smart Ideas Retro-Commissioning Program accomplishes this by assembling two teams. The “program team” is assembled for each project to provide oversight, technical support, and the program-related retro-commissioning services to the customer. The program team will consist of a ComEd Account Manager (where applicable), a ComEd Program Manager, the assigned Retro-commissioning Service Provider (RSP), and a member for the Program Administrator (PA) contractor: in this case, Nexant. The “customer team” generally consists of the building owner (or owner’s representative), the facility engineers/managers, and their mechanical, electrical, and/or controls contractors.

Roles of the Program Administrator

Day-to-day administration of the Retro-commissioning Program is performed by a third-party program administrator (PA), Nexant, Inc. The PA is responsible for all aspects of the program including participant coordination, technical resources, RSP recruitment and training, logistical support, and technical review at each phase of the program.

Program Timeline

The program is delivered in four main phases.

1. Application Phase
2. Planning Phase
3. Implementation Phase
4. Verification Phase

The phases are described with original planning expectations for timing of the phases. In practice the timing benchmarks are difficult to attain in a 12-month timeframe.

⁴ In PY2 incentives for the retro-commissioning study were determined on an *ad hoc* basis. Incentives and participant commitments were determined by ComEd to make the program available and acceptable to participants with a range of size and retro-commissioning needs.

Application Phase. The facility owner or representative completes the application material and submits paperwork to the Program Administrator. Based on the application material and some follow-up with the site, the PA selects sites that have the highest likely savings opportunities. After accepting a project for the Program, a Retro-Commissioning Service Provider (RSP) is assigned, if necessary.^{5,6} Projects that are screened out are given detailed reasons for non-acceptance. If other Smart Ideas programs are more appropriate, the customer is directed to applicable programs. *This phase lasts about 1-2 weeks.*

Planning Phase. The project planning phase commences after the customer and RSP complete the application. Activities include a kick-off meeting with the PA, ComEd representatives, and the RSP with the customer team during which expectations are described and roles and responsibilities are defined. A site assessment and data acquisition plan is also completed by the RSP during this phase. The findings of this plan are used to generate the Retro-Commissioning Plan for the project and assess potential measures and project economics.

The Retro-Commissioning Plan establishes the framework and direction for the Implementation Phase. Upon completion of the retro-commissioning plan, another meeting is held with the owner representative and engineering staff to review the scope of the plan and the impacts and economics of the identified potential measures. At the completion of the Planning Phase, the facility owner enters into the formal Program Agreement.

The Program Agreement includes several components that define the roles and responsibilities of each party. The primary goal is gaining the customer's spending commitment - \$10,000 or \$20,000, depending on the magnitude of the retro-commissioning study – for agreed-upon retro-commissioning measures that result in a bundled estimated simple payback of 1.5 years or less.

These measures must be installed within the program year the project is started. For projects that are not completed within one calendar year, the customer will be expected to refund the cost of the retro-commissioning study. Additionally, the agreement acts as a decision point at which the customer selects measures from the Planning report that they wish to pursue for further investigation in the next phase.

The planning phase takes about 1.5 to two months to complete

⁵ In most cases, the RSP generated the lead: and therefore, is the default RSP. Assignment only occurs when the customer is not yet working with an RSP.

⁶ Retro-Commissioning Service Providers are qualified through the Program by ComEd staff and the Program Administrator. RSP training conducted by the PA and ComEd must be completed prior to participation with the program.

Implementation Phase. This work takes the consensus decisions from the Planning Phase and builds on them. Additional field data is gathered to better define, augment, add to, or discard measures presented in the Plan. The RSP and customer's team members work together to implement the measures in the Plan. This may involve coordination of multiple contractors to ensure that the Plan measures are executed to save energy.

This phase of a project takes about three months.

Verification Phase. After measures are implemented, the RSP evaluates data from the facility to determine that measures are operating as intended to save energy. These data might be observations of installed and/or repaired equipment, trend data from an automation system, or data from dataloggers installed after the measure was implemented. The RSP prepares a report describing the status of implementation and revised savings estimates based on observations and measurements.

Verification can take one to six months depending on the measures implemented and the desirability of seasonal data to verify proper operation.

An important feature of the Smart Ideas Retro-Commissioning Program is the timing of each phase. All projects commence and must be implemented during a single program year in order to qualify for the free retro-commissioning services. Based on experience gained during the pilot program year, ComEd began the PY3 participant recruitment process late in 2009 to facilitate completing administrative tasks and preliminary site observations before the summer cooling season at the start of PY3. This schedule allows for more analysis of cooling measures prior to the May 31 end of the program year.⁷

The purpose of the still tight timeframe is to maintain engagement with the customer to see the measures implemented. One of the key shortcomings of retro-commissioning is time required to do a full analysis and then implement and verify installed measures. Studies done for other retro-commissioning programs across the country frequently span 12-24 months. However, this long cycle can create problems for Program success, such as personnel turn-over, lack of focus, and changing customer priorities. Other utilities have needed to supplement incentives to get measures implemented after completion of the study portion of the retro-commissioning process.⁸ Keeping to the Program schedule helps ensure accountability of all parties and tracks measures through implementation.

⁷ Advancing the participation schedule was not implemented in PY2 given the implementation-evaluation cycle.

⁸ Xcel Energy, 2007-2009 retro-commissioning program. Email communication to retro-commissioning trade allies October 2009 and January 2010 and others. Incentives were increased for measures implemented within proscribed time limits as and payback incentive criteria were relaxed to include measures with a short as 9 month payback to encourage measure implementation.

Program Delivery Mechanisms and Marketing Strategy

The program is marketed primarily through one-on-one marketing to candidate facilities by the Program's qualified Retro-Commissioning Service Providers (RSPs). ComEd program staff and the PA, as well as ComEd Account Managers also contribute to program promotion. The PA and ComEd collaborated to produce marketing materials, and the PA conducts marketing training with ComEd support.

Retro-Commissioning Service Provider (RSP) Participation

A total of nine RSPs were recruited for PY2. Five RSPs participated in retro-commissioning in commercial facilities. In addition one RSP, who specializes in compressed air systems, was leading a pilot compressed air project under the retro-commissioning program. The list of approved commercial building and compressed air RSPs expands significantly in PY3. RSPs are approved from one year to the next pending satisfactory performance reviews and interviews conducted by ComEd.

Evaluation Questions

The Evaluation Team identified the following key researchable questions for PY2

Impact Questions:

1. What is the level of gross and net annual energy (kWh) and peak demand (kW) savings induced by the program?
2. What is the level of free ridership associated with this program? How can it be reduced? Is spillover an effect for this program?
3. Did the program achieve its goals? Why and why not?

Process questions:

The process evaluation questions focused on six key areas:

1. Has the program, as implemented, changed from Program Year 1? If so, how, why, and was this an advantageous change?
2. What challenges have occurred in program implementation and how were they handled?
3. How effectively is the program being administered? What methods could be implemented to improve the efficacy of program delivery?

4. Are the program processes effective for smoothly providing incentives to customers and motivating RSPs to participate?
5. What are key barriers to participation for eligible ComEd customers? How can they be addressed by the program?
6. How did customers and eligible RSPs become aware of the program? What marketing strategies could be used to boost program awareness and participation, if needed?

The full list of researchable questions can be found in the Evaluation Plan.

Evaluation Methods

This evaluation of the Smart Ideas Retro-Commissioning (RCx) Program reflects the first full-scale year of the program. During program year 2009 (PY2), which ran from June 1, 2009 – May 31, 2010, fourteen facilities participated in the Retro-Commissioning Program. Among those 14 sites, more than 100 retro-commissioning measures (RCMs) were implemented and verified, thus qualifying the sites for waiver of retro-commissioning service costs. The 14 program participants were shepherded through the program by six different retro-commissioning service providers (RSPs). One participant cancelled participation prior to fulfilling all commitments, but they did receive some incentives from ComEd and they did implement some recommendations; therefore, they are included among program participants.

Analytical Methods

Measures implemented through this program are diverse and not applicable to prescriptive or deemed savings estimates due to the unique circumstances of each participant and measure. The Process evaluation utilized surveys with key personnel at ComEd and Nexant, Inc., the Program Administrator, third-party RSPs, and program participants. Program planning and marketing materials were also analyzed.

1.1.2 Impact Evaluation Methods

Measure impacts were each examined individually for a census of program participants. RSPs submitted detailed data and engineering calculations for each measure and Navigant reviewed the calculations for accuracy and completeness. In most cases when there was climate dependency in the savings estimates, measure savings were estimated with temperature bin calculations and typical meteorological year data. For sites that implemented measures that affect operation of their cooling equipment, Navigant conducted on-site inspection and verification of measure installation as well as review of operating parameters and some trend data from the summer of 2010.

Gross Program Savings

Each implemented measure and many proposed⁹ measures were individually reviewed. The evaluation verified that appropriate algorithms, methods, and data sets were used. During the review Navigant compared calculation parameters to realistic assumptions and applied prescribed parameter defaults as needed when measure calculations deviated from expected norms. Measure savings were verified and/or adjusted, as needed, for each implemented measure for each participant. Gross savings were examined on a participant level, measure end-use level, and measure-type level. Aggregate savings of the individual measures comprise the program gross savings.

Net Program Savings

Net-to-gross (NTG) savings research is based on self-report methods where participants answer questions about their awareness of the measures identified and their inclination to pursue corrective actions for those measures. Navigant applied installation-specific NTG ratios where our research found free-rider influence. The evaluation team attempted interviews with a census of program participants. Participant interviews also probed for evidences of spill-over. The Evaluation team also interviewed one PY1 participant with respect to spillover.

1.1.3 Process Evaluation Methods

The process evaluation utilized interviews with key personnel at ComEd and Nexant, Inc., the program implementer. In addition, we performed interviews with program RSPs and participating customers. Program design, implementation, training, and marketing materials were also reviewed.

⁹ Even measures that were not implemented contain key information about facility operations, setpoints and interactive effects among energy end-uses.

Data Sources

Table 0-1. Principal Data Sources Contributing to the PY2 Evaluation

Data Collection Type	Targeted Population	Sample Frame	Sample Design	Sample Size	Timing
In-depth Phone Interview	ComEd RCx Program Staff	Contact from ComEd	ComEd RCx Program Manager	1	August 2010
	RCx Implementation Staff	Contact from ComEd	Nexant Program Manager	1	August 2010
	Retro-commissioning Service Providers	Program database	Attempted census (6)	4	September 2010
	PY2 Participants	Program database	Attempted census (13)	5	September/October 2010

Program and Implementer Staff Interviews

We conducted two in-depth interviews to support the process evaluation, one with the ComEd Retro-Commissioning Program Manager and one with Nexant implementation staff. The interviews focused on program processes to better understand the goals of the program, how the program was implemented, the perceived effectiveness of the program, and the changes from the PY1 pilot phase.

Review of Program Materials

As part of the evaluation process, the evaluation team reviewed program materials developed by ComEd and Nexant. These are summarized in Table 0-2.

Table 0-2. Program Materials Reviewed for PY2 Process Evaluation

Category	Materials Reviewed
Program design and implementation	Program design document PY2 application PY2 participant manual

Category	Materials Reviewed
	PY2 RSP manual PY2 operations manual Program calculation and MV guidelines ComEd Account Manager training presentation List of RCx service providers Examples of planning, implementation and verification reports
Program marketing	ComEd RCx brochure RCx fact sheet Chicago History Museum case study BOMA, green hotels and E3 outreach presentations NCBC presentation Schedule of marketing activities Marketing plan
RSP training and outreach	RSP training presentations Training sign-in sheets RSP RCx brochure example

Interviews with RSPs

The evaluation team conducted in-depth interviews with four of the six PY2 retro-commissioning service providers (RSPs). These four RSPs implemented 11 of the 14 PY2 projects (including the cancelled project). Our questions focused on program awareness, program processes, the effects of the program on business practices, free-ridership, program drop-outs, marketing and outreach, training, RSP performance review, barriers to participation, and general feedback and recommendations. The guide used for these interviews is included in Appendix 5.1.

Interviews with Participants

The evaluation team also conducted in-depth interviews with 5 of the 13 PY2 program participants 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, and general program feedback and recommendations. The interview guide used for these interviews is included in Appendix 5.1.

Sampling Plan

For the impact evaluation, Navigant evaluated a census of all projects. More than 100 measures at fourteen sites were implemented, totaling an estimated 7,846,600 kWh savings and 927 peak kW, based on *ex ante* estimates.

The process evaluation team also attempted interviews with a census of the 6 RSPs and 13 participant customers in the PY2 program (excluding the cancelled project). As a result, no sampling plan was necessary for either impact or process evaluations.

Program Level Results

The Navigant team performed both Impact and Process Evaluation tasks for this program in its first full-scale year. Unlike the pilot program last year, PY2 included many more participants and coordinated the activities of six third-party RSPs.

Impact Results

1.1.4 Verification and Due Diligence

Measure installation verification for the Retro-Commissioning (RCx) Program is an iterative process that involves the customer, RSP, PA and finally the evaluator. The customer must implement sufficient measures to gain the incentive which waives the retro-commissioning study costs. The RSP must guide the customer through implementation and check that measures are installed to get paid for services performed, and the PA must verify savings for ComEd. The evaluator's task is, thus, simplified to spot check measures verified by previous parties and ensure that measures, due to be installed between the acceptance of the verification report and the end of the program year, are indeed complete.

In general, the evaluators concluded that the Verification Report and supporting data and calculations provided sufficient confirmation that the measures were installed as described. A very few PY2 measures were installed late in the program year or would not have proof of predicted savings until the midst of the cooling season – after the end of the program year. These late stage measures were all related to chilled water systems or associated cooling towers. While the RSPs and PA could verify that control measures were programmed or repairs scheduled, their operation had not been verified before M&V reports were finalized. Navigant focused our on-site inspections and data gathering on these measures.

Navigant identified six projects with significant chilled water savings components. Evaluators visited five of these sites in September 2010 and verified installation and planned operation of measures for energy savings. While on-site, Navigant also verified other measures installed at

those sites. Measure installation at the sixth and final chilled water site was verified by phone interview. Despite the need to get these final data for the program, the evaluator does note that these steps are the responsibility of the RSP and PA. PY3 activities have started even earlier than PY2 with the intent of gathering data for cooling measures during the summer of 2010.

Due diligence work for this evaluation focused on the savings calculations for each measure. Navigant performed detailed reviews of all calculations and assumptions. In general, Navigant found the calculations accurately constructed, based on clearly measured data rather than rules of thumb and transparent in spreadsheet form. In rare instances, we found calculation errors due to erroneous inputs and omissions of relevant impacts and inconsistencies in assumptions from measure to measure on the same system.

Consistency of savings estimation approaches among RSPs was somewhat erratic. Calculation spreadsheets varied from comprehensive to overly simplistic, and content and inputs were not always consistent. For PY2 the PA, with input from ComEd and the evaluators, developed guidelines for analysis approaches and inputs. In some cases the guidelines were not consistently followed. For PY4 guidelines will be supplemented with calculation templates for common measures. Benefits of the guidelines and templates include:

- Standardized weather data sets. Different data sets can provide different results. ComEd, the evaluator and PA have agreed that TMY2 data will be used in PY2 and the standard will be TMY3 data in subsequent years. These resources include sufficient data for determining psychrometric parameters like enthalpy, humidity ratio, dew point temperature, and wet bulb temperature.
- The templates include default values for key engineering parameters when measured values are not available, for example: motor loading; motor, fan, and pump efficiency (by size); VFD efficiency; chiller efficiency (by age and/or type); and the “adjusted cube-law exponent” for measures that include VFDs. The RSP Manual states that “Calculations based solely on rules of thumb or unsupported assumptions are not acceptable.” In some cases, an RSP must make assumptions for some of these parameters when measured data is not available. The guidelines state a clear priority in input parameters for calculations: (1) measured data; (2) estimates from manuals, nameplates and equipment schedules; and (3) default values.
- Inclusion of latent cooling estimates, where appropriate.
- Guidance on calculating demand savings. Retro-commissioning measures frequently target wasteful operation of equipment during un-occupied hours; and thus, they generate considerable energy savings. Peak demand savings from these measures is unlikely and kW savings estimates should reflect only peak hours when savings will

occur. PJM has strict requirements for demand savings estimates and RSPs must submit calculations that conform to those requirements.

Despite the range of approaches in PY2, there were very few lapses in engineering methods.

Frequently, RSPs made assumptions that were more conservative than the program guidelines. A conservative approach such as this is common to retro-commissioning analysis. Some measures are so simple to implement and the primary effects generate sufficient savings that there is no inclination to analyze secondary and tertiary effects of an action. From the RSPs' and customer's perspectives this approach makes sense. Less time spent on analysis of simple cost-effective measures frees resources for analyzing more complex measures. From the perspective of the sponsoring utility, however, these additional savings are real and should be counted. Where there was no further justification for overly conservative estimates, the evaluation restored guideline defaults and/or supplemented estimated savings with secondary effects of the measures as could be determined with available data. Examples of supplemental savings include *ex post* addition of latent cooling savings, demand savings and/or using guideline-based defaults parameters.

1.1.5 Tracking System Review

Because of the unique nature of retro-commissioning measures, Retro-Commissioning Program participants are not tracked within the overall *Smart Ideas* commercial program tracking database. The PY2 tracking instrument is a modified version of the spreadsheet used in the pilot phase of the program. The spreadsheet tracks project level data such as contacts and milestone dates and measure-level data for each project. This simple spreadsheet is adequate for the program now with relatively low participation, but as the program expands, it will be useful to have a more comprehensive and sortable tracking system such as a relational database format or a more sophisticated spreadsheet.

1.1.6 Gross Program Impact Parameter Estimates

PY2 of the Retro-Commissioning program has fourteen unique participants representing 15 buildings. One university has two buildings included in a single retro-commissioning project. Table 0-1. describes some attributes of the participant buildings and the *ex ante* savings estimates.

Savings estimates are made at three different stages of the retro commissioning process. In the Planning Phase, the RSP estimates saving for all RCMs identified based on the limited information of the site survey and interviews with facility staff. These estimates provide an input to the decision whether or not the project will proceed to the Program Agreement with the customer and implementation of selected measures. In PY2 anticipated savings, customer feedback and the RSP fee had to indicate savings of 15 cents / kWh or less to proceed to the Program Agreement and implementation.

Savings estimates are repeated during the Implementation Phase based on new data developed through research that might cause differences in how the measures are implemented versus how they were planned. The final savings estimates are developed during the Verification Phase based on performance data acquired after implementation. The final set of savings estimates are the *ex ante* savings for the program. Table 0-1. shows the *ex ante* savings per site.

Several of the PY2 participants have notable attributes. Two sites had specific goals. The large retail site has ice storage capability for shifting summer cooling loads to off-peak hours. This function did not work adequately and the retro-commissioning project aimed to make that control regimen completely functional. Hospital B was a chilled water retro-commissioning project with the goal of eliminating operation of less-efficient air-cooled chillers during the summer months and shifting chilled water loads to the more efficient central plant by correcting flow and pumping problems throughout the hospital. Finally, ComEd introduced a compressed air component to the Retro-commissioning Program in PY2. A large heavy-industry site served as a pilot of the compressed air system.

Table 0-1. Ex ante Electric Savings Estimates

	Facility Floor Area ft ²	Baseline Annual Electric kWh	Energy Intensity kWh/ft ²	Verification Phase (<i>ex ante</i>)		
				Savings Estimate kWh	Savings Estimate kW	Savings as % of total kWh
Office A	803,000	13,299,414	16.6	755,400	0	5.7%
Office B	650,000	18,600,000	28.6	677,239	280.9	3.6%
Office C	741,000	14,530,258	19.6	568,208	76	3.9%
Office D	368,000	8,075,255	21.9	423,973	76	5.3%
Office E	166,400	3,202,501	19.2	763,851	36	23.9%
Museum	36,000	2,768,561	76.9	94,785	0	3.4%
Hotel	1,078,900	18,026,800	16.7	627,600	0	3.5%
University	486,900	11,485,399	23.6	588,002	0.0	5.1%
Large Retail	450,000	6,051,300	13.4	308,184	231.3	5.1%
Mixed & Light Ind. A	252,113	7,884,000	31.3	337,328	35.9	4.3%
Mixed & Light Ind. B	330,100	8,370,000	25.4	141,759	31.1	1.7%
Hospital A	1,065,405	27,828,379	26.1	763,729	0	2.7%
Hospital B	503,447	22,226,634	44.1	576,484	20.7	2.6%
Heavy Industry	4,250,000	135,000,000	31.8	1,220,102	139.7	0.9%
Total				7,846,644	927.6	

Most savings, as a percent of total energy use, is typical for retro-commissioning projects. Office E is exceptional and represents a facility that was operating 24x7 unnecessarily with less-than-optimal air control. The heavy industrial site has a smaller savings ratio due to the limited scope of the project which focuses only on compressed air and did not address manufacturing or heating and cooling processes.

1.1.7 Gross Program Impact Results

The 14 sites all met the eligibility criteria and all have extensive automation capabilities to change operating parameters to add new control algorithms and trend key parameters to determine effects of RCMs. The following figures and tables present information about the sites and RCM impacts.

Navigant examined all calculations and reviewed data submitted as part of the verification of savings from the RSP. Our due diligence on the calculations determined that, with two notable exceptions, the estimates at this stage are well developed and defensible, with modest changes – some increasing and some decreasing gross savings.

Table 0-2. Savings and Realization Rates by Site

	Verification Phase		Evaluation		Realization Rates	
	kWh	kW	kWh	kW	kWh	kW
Office A	755,400	0.0	755,400	0.0	100%	NA
Office B	677,239	280.9	218,308	52.5	32%	19%
Office C	568,208	76.0	723,850	106.3	127%	140%
Office D	423,973	76.0	287,780	51.5	68%	80%
Office E	763,851	36.0	742,979	69.6	97%	193%
Museum	94,785	0.0	98,259	0.0	104%	NA
Hotel	627,600	0.0	667,800	59.0	106%	Inf
University	588,002	0.0	573,505	0.0	98%	NA
Large Retail	308,184	231.3	273,427	216.9	89%	94%
Mixed & Light Ind. A	337,328	35.9	167,624	18.2	50%	51%
Mixed & Light Ind. B	141,759	31.1	118,637	54.1	84%	174%
Hospital A	763,729	0.0	763,292	324.1	100%	Inf
Hospital B	576,484	20.7	563,140	20.8	98%	100%
Heavy Industry	1,220,102	139.7	1,220,102	139.7	100%	100%
Total	7,846,644	927.6	7,174,103	1,121.8	91%	121%

Realization Rates on a participant- level are reasonably close to 100% with a couple notable exceptions.

- The RSP who completed the Office B project made an error in engineering judgment, and included winter energy savings from reducing outdoor air with new minimum ventilation setpoints and controls. In practice this measure has no winter savings since proper economizer operation will never mix less outdoor air than the existing setpoints.

- Office D is a case of competing *Smart Ideas* programs. The lighting retro-commissioning measure suggested minimizing afterhours lighting for the cleaning staff using wall switches. The facility is also installing occupancy sensors that will have the same effect for most spaces, and they are receiving an incentive through the Prescriptive program to do so. Savings ought not be double-counted. The occupancy sensors are the more reliable alternative, so the evaluation team eliminated savings credit for this measure in the retro-commissioning program and notified Prescriptive program evaluators that the occupancy sensor application should not also be penalized, should it become part of the evaluation sample in future years.
- The Mixed & Light Industrial A analysis also included a mistake in the engineering calculations, utilizing inappropriate temperature differences when calculating heating and cooling loads for measures that merely changed room setpoints.

Other smaller errors were discovered *infrequently* during the evaluation that had lesser impact on overall savings. The types of errors included:

- Not including latent cooling savings
- Not applying correct motor loading assumptions when measured data were not available.
- Not calculating *any* demand savings for measures with peak summer impacts.
- Inappropriate demand savings estimation methods.

None of the errors Navigant discovered through the evaluation process were systematic. On the other hand, errors of these types were flagged during the evaluation of the pilot program and normally we would expect the Program Administrator to catch them. Additional diligence by the PA will be needed in the future as the Program grows. Planned participation for PY3 exceeds the capacity and budget for Navigant to examine a census of reports and calculations. The PA and evaluation team will need to coordinate closely to ensure that every site receives adequate quality control review.

Navigant grouped the retro-commissioning measures into six broad end-use categories that include most types of measures included in retro-commissioning. Figure 0-1 shows the distribution of *ex post* savings among measure end-uses.

- **Chillers** includes such measures as chilled water temperature reset, compressor staging, and water-side economizers.
- **Cooling tower** includes fan and cell staging and condenser water temperature control.

- **Economizer and Ventilation Control** includes economizers repair and optimization and ventilation control based on CO₂ levels in return air.
- **Air-handler** includes measures that change the schedule of fan operation and fan control setpoints such as air temperatures, minimum airflows and/or static pressure setpoints.
- **Heating** are measures that include boiler pumps or terminal box setpoints and/or control.
- **Pump** measures that include primary-secondary pumping controls, variable primary pumping, impeller trimming and proper pump speed control based on feed-back parameters.
- **Compressed Air** measures can include leak detection and repair, compressed air plant optimization through staging or reducing system pressures or low-cost end-use modification such as using engineered nozzles rather than open orifices.

In addition to thinking of measures by end-use, Navigant grouped the measures according to their upgrade type. Figure 0-2 shows the distribution of *ex post* savings among measure types.

- **Scheduling** measures are those that merely turn off equipment (HVAC, compressed air lighting) when their service is not required for occupants.
- **Optimization** includes measures that improve control algorithms, or setpoints.
- **Repairs** are measures that address broken equipment such as failed actuators or sensors.
- **Equipment** measures are relatively few and generally fairly inexpensive for retro-commissioning measures. In PY2 equipment measures included new filter media.

Among the RCMs implemented at the PY2 sites, air handlers, compressed air and chiller measures are the largest energy savers by end-use. Optimization measures dominate the savings by measure type, and most of the optimization involves chillers and air-handler control algorithms and set-point optimization.

Figure 0-1. Program Evaluated Savings (kWh) by End-Use Category

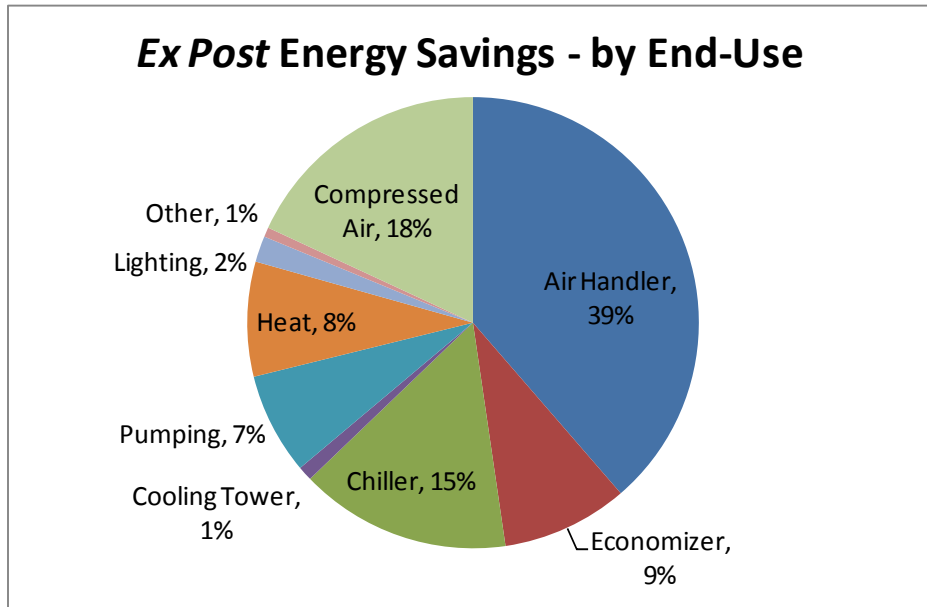
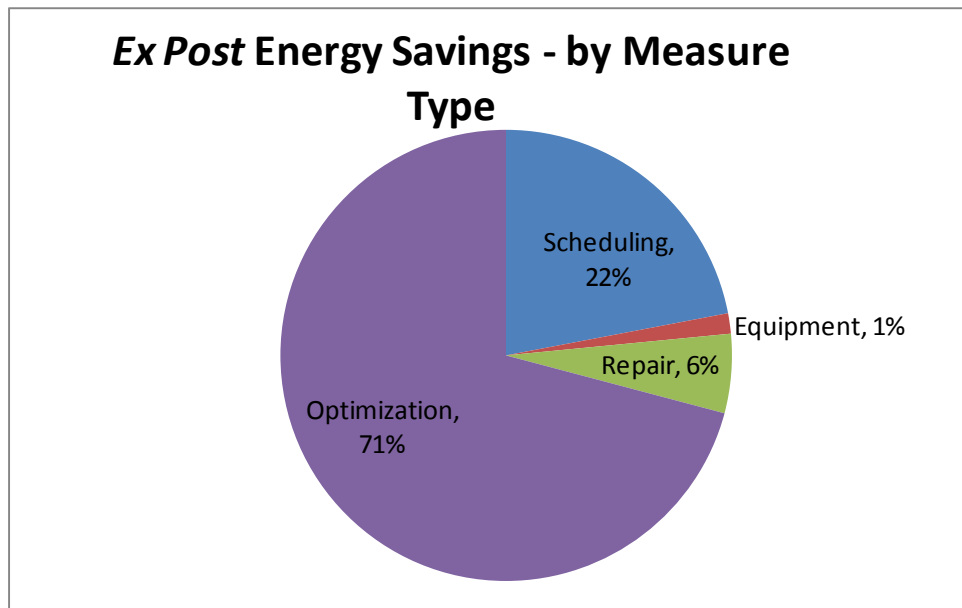


Figure 0-2. Program Evaluated Savings (kWh) by Measure Type



Realization rates among measure end-uses are generally high. The lowest realization rates reflect the issues noted in the discussion of Table 0-2. The minimum ventilation calculation error accounts for more than 75% of the reduced economizer savings, and the reduction of night time lighting savings at Office D accounts for almost all of the reduced lighting end-use savings.

Table 0-3. Savings and Realization Rates by Measure Category

	Verification Phase		Evaluation		Realization Rates	
	kWh	kW/mo	kWh	kW/mo	kWh	kW/mo
Air Handler	2,823,690	138.0	2,866,338	218.9	102%	159%
Economizer	1,203,889	326.7	636,701	249.8	53%	76%
Chiller	1,069,353	240.1	1,061,778	418.4	99%	174%
Cooling Tower	88,403	0.0	72,886	0.0	82%	NA
Pumping	507,738	29.5	510,359	49.7	101%	168%
Heat	575,887	42.1	577,752	28.8	100%	68%
Lighting	259,099	0.0	130,299	0.0	50%	NA
Other	67,961	8.1	49,522	13.3	73%	165%
Compressed Air	1,250,623	143.1	1,268,468	142.9	101%	100%
Total	7,846,644	927.6	7,174,103	1,121.8	91%	121%

1.1.8 Net Program Impact Results

Once gross program impacts have been estimated, net program impacts are calculated by multiplying the gross impact estimate by the Net-to-Gross (NTG) ratios.

$$\text{NTG Ratio} = 1 - \text{Free-ridership} + \text{Spillover}$$

Among participants interviewed for the process evaluation, the Navigant Team determined site-level NTG. The overall program NTG is a saved kWh-weighted average of the NTG of the sites interviewed.

$$\text{NTG}_{\text{overall}} = \frac{\sum \text{NTG}_{\text{site}} \times \text{kWh}_{\text{site}}}{\sum \text{kWh}_{\text{site}}}$$

Free-Ridership

Free-ridership determination is a combination of three attributes investigated during participant surveys.

1. Influence of the program on the decision to perform retro-commissioning.
2. Whether the participant was already aware of issues identified through the retro-commissioning process and
3. If they were aware of issues what would have been the timing for addressing those issues, absent the program.

The evaluation completed interviews with five participants of an attempted census (13). All five participants ranked the program influence very high (9 or 10 on a scale of 0-10). Three expressed that they were aware of some of the measures identified by retro-commissioning and among those three two indicated they would have addressed those issues two years later, absent the program.

The free-ridership questions established a free ridership rate of zero for two of the sites and between 4.5% and 22% for the other three. The two sites that had larger (greater than 10%) indications of free-ridership all had equipment deficiencies known to the appropriate people in the company. In one case sensors in the automation system were returning nonsense data. Control routines that had used those sensors for inputs were altered to circumvent those erroneous data.

The other site involved a hospital with a new wing. The design intent of the new construction was that the hospital's central chilled water plant would supply the space with cooling whenever the chiller plant was on-line. During seasons when the central plant was off-line, dedicated cooling equipment for the new wing would provide the cooling. Since construction of the new wing, the hospital had never been able to shift the cooling load to the central chilled water plant. Facility personnel knew that the problem was present, but had not diagnosed the problem or contemplated solutions. The dedicated equipment had sufficient capacity such that the poor water balancing would not create a crisis. The addition opened in 2007, and during the process evaluation interview site personnel said that absent the Retro-Commissioning Program, they would have addressed the chilled water problem in another two years.

The Evaluation estimate for overall program free-ridership is 8.4%

Spillover

The Evaluation Team researched the question of program spillover. Our PY2 participant survey asked about spillover, and we followed up on an anecdotal report that one of the PY1 participants might be pursuing further projects. None of the five interviewed PY2 participants have implemented additional retro-commissioning or energy efficiency measures since the

program that did not receive a rebate. Of the five, two have done nothing and three have received rebates or are in the process of participating in the Smart Ideas for your Business Custom Program, but none has done a non-rebated project.

The PY1 participant is similarly engaged with efficiency projects. The PY1 project was one building of a multi-building campus. Since last year they have installed lighting retrofits through the Smart Ideas programs at a couple buildings on campus, and they are planning retro-commissioning-type work at other buildings on campus. At this point they have only installed monitoring and metering points to track future benefits from operational changes, but they have not begun the retro-commissioning process at any other sites.

Absent any site-specific indications of free-ridership or spill-over these factors are 0.0.

Net Program savings, are reported in Table 0-4.

Table 0-4. Net Program Savings

Gross and Net Savings Parameters	PY2	Realization Rate
Evaluation-Adjusted Gross MWh Savings	7,174.1	91.4%
Evaluation-Adjusted Gross kW Savings	1,112.1	119.8%
Net-to-Gross Ratio (1-FR+SO)	0.916	
Evaluation-Adjusted Net MWh Savings	6,574.1	83.8%
Evaluation-Adjusted Net kW Savings	1,027.9	110.8%

1.1.9 Statistical Confidence and Precision

Statistical confidence and precision is based on the sample size relative to the population. For both the gross and net impact analysis, all participants were included in the sample, thus the sample was a census. Given that this is a census, the result is known with certainty, that is the error bounds are zero, and thus there is no need for precision or reliability measurements that would be part of an estimate based on a sample.

Process Evaluation Results

The process component of the Smart Ideas for Your Business Retro-Commissioning Program evaluation focused on program design and implementation, program processes, marketing and

outreach, RSPs, and participant satisfaction. The primary data sources for the process evaluation were review of program materials and interviews with program and implementation staff, RSPs, and participating customers.

1.1.10 Program Theory and Logic Model

Based on information provided by the program manager and implementation staff, there were no significant changes to the desired outcomes of the program or to the key activities undertaken to achieve these outcomes.¹⁰ As a result, the program theory/logic model was not revised for PY2. Please refer to the PY1 report for more information on this topic and the program theory and logic model for the Retro-Commissioning Program.

1.1.11 Program Participation

In PY2, the RCx program met its participation target of completing projects at 14 facilities.¹¹ According to the program tracking database, 27 applications, consisting of 34 buildings, were reviewed by the program in PY2. Of these, 13 were completed through the verification phase, one was cancelled after the implementation of some measures, and four were cancelled prior to the implementation phase. In addition, six projects were not accepted into the program, two were moved into PY3, and one has a pending information request.

The 13 completed PY2 projects resulted in *ex ante* energy savings of 7,847 MWh per year, surpassing the program goal of 6,456 MWh. The average savings per project was 594 MWh per year, with individual projects ranging from 95 MWh to 1,220 MWh. Participating facilities represented a range of building types and included five office buildings, two hospitals, two industrial facilities, and one each of a large retail facility, an education facility, a museum, and a hotel. The facility floor area ranged from 36,000 to 4,250,000 square feet, and annual energy usage ranged from 36,000 to 135,000,000 kWh.

1.1.12 Program Changes from PY1

In PY1, the program was in its pilot phase, and not all planned program processes had been fully implemented. Notably, RSP recruitment and training had not been completed in PY1, and Nexant performed most of the RSP responsibilities, including customer recruitment and on-site work. In addition, program marketing had not been fully implemented, due to the limited roll-

¹⁰ In PY1, RSP recruitment and training had not been fully completed, resulting in the implementer performing some of the RSP functions. In addition, marketing of the program had not been fully implemented. However, the theory behind the PY2 program and the key planned activities, outputs, and outcomes were the same as in PY1.

¹¹ One project was cancelled after implementing some measures. The program counted its implemented and verified savings of 119 MWh/year.

out of the program. In PY2, these processes were largely in place. The program also hired additional implementation staff and put in place a new program manager.

Apart from changes associated with the full launch of the program, program staff have done a good job of applying lessons learned from the PY1 pilot phase to the PY2 program. Key changes include:

- **Extension of the project timelines.** Recognizing the difficulty participants had in completing projects within 12 months, the program started accepting new applications prior to the beginning of the program year, thus extending the timeline to 18 months. It should be noted that this change occurred during PY2 and therefore did not benefit PY2 projects.
- **Earlier discussion of customer agreement.** In an effort to help projects meet project schedules, the program began discussing the customer agreement much earlier in the participation process and is now asking customers to perform their legal review of the document concurrently with the planning stage to save time. Even with this added focus, about half of customers still need to forward the agreement to their management or legal team late in the process. RSPs reported that customers' lengthy legal review was often a hurdle to overcome.
- **Increase in customer commitment for complex projects.** In PY1, the program only required a \$10,000 minimum commitment from customers in return for free RSP services. In PY2, ComEd made *ad hoc* changes to this commitment for larger and more complex projects. These changes were later formalized for PY3 applications with an increase in the required commitment to \$20,000 for projects where the RSP fee is greater than \$60,000. The larger requirement helps to ensure that the project delivers the expected energy savings for the program and remains cost-effective. According to the program manager, this increase was accepted by both RSPs and customers and did not affect participation (only two of the PY2 projects were subject to the *ad hoc* changes to this requirement). Interviewed RSPs confirmed this.

1.1.13 Program Processes

Participation Process

Service providers are generally satisfied with the participation process. They found that the program and its processes were clearly explained by ComEd and Nexant staff. The program manager noted that the explanation of the program's processes is continuously evolving, and customers are made aware of issues uncovered by previous participants or RSPs. One area identified by a service provider as being unclear was the ineligibility of certain costs in the planning phase. This RSP required the services of an automation controls contractor to better understand the facility's controls, and the RSP was not aware that this consulting cost was not

covered as part of the program incentive. The RSP identified this issue to the program staff who now better inform potential participants about what types of cost are included in the incentive.

A common theme among the interviewed RSPs was the high level of paperwork required by the program. Comments ranged from noting the “volume of documentation required by Nexant” to calling the process “cumbersome” and “painful.” RSPs believe there is a large amount of redundancy in the paperwork and find that they are often completing the same information for multiple phases. One RSP thought that the process had multiple unnecessary review points in the process that could be streamlined. Another believes that the excessive documentation was to meet the program’s needs but offered little value to their customers. In general, RSPs recognize that the paperwork and review processes are necessary but thought that they could be streamlined.

One RSP commented that, as a result of PY2 projects, they now spend much more time and money to frontload the work in the planning phase of the project to uncover all possible measures and then less during the actual implementation. This is because the determination of retro-commissioning measures and expected energy savings are made during the planning phase. Because Nexant often requests more information on energy savings in later stages of the planning phase, the RSP found that it is easiest to collect more information than what is required while in the field during the planning phase.

Another RSP with extensive retro-commissioning experience found the planning process to be more detailed than similar programs in other markets:

“Our experience with this program versus other similar programs around the country is that the planning phase is more detailed than similar programs run by other utilities. In other words, the evaluation goes much more in-depth than similar programs elsewhere. Part of it is because ComEd is paying for the upfront part without any customer requirement, so they need to make sure that they are getting what they are getting.”

Interviewed participants also thought that the program was well explained by the program staff and the RSP. They were generally satisfied with the program’s reports, including their content and structure. Specific points of satisfaction with the reports were that they were easy to understand for a non-technical person and that they also recommended energy saving opportunities available through other ComEd programs. One participant stated that the reports contained too much detail for their purposes.

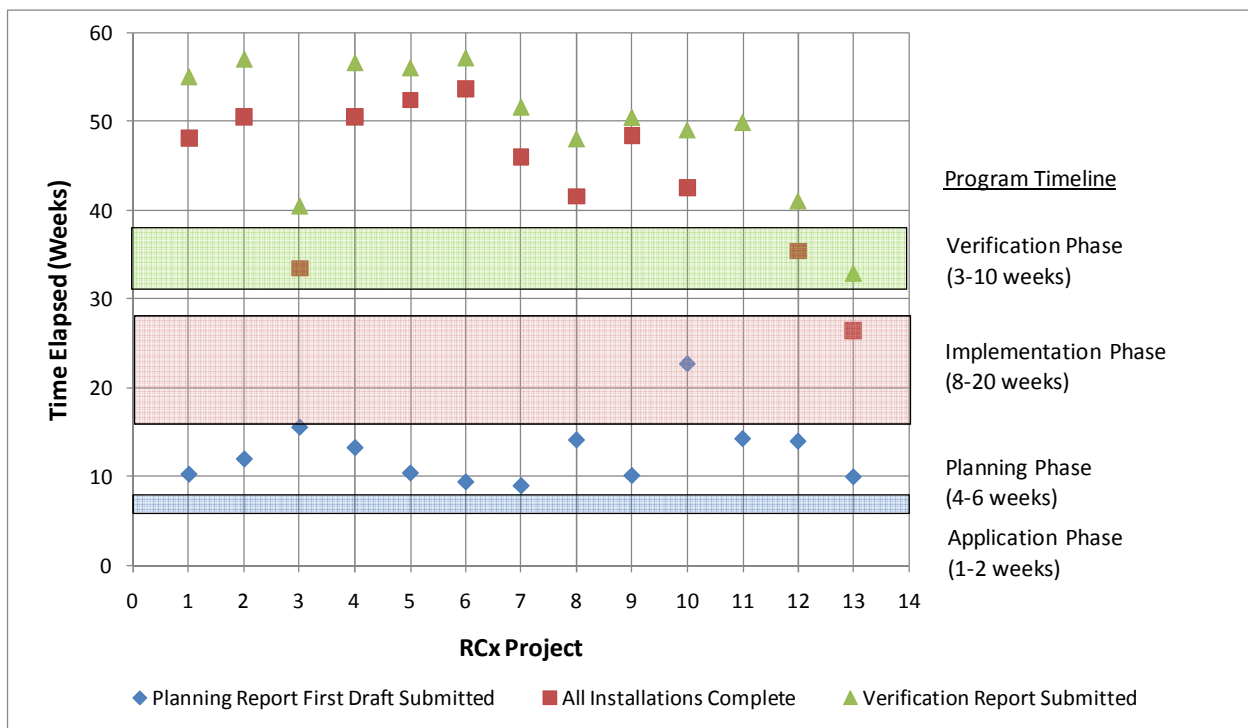
Program Timelines

The participation process is broken into four phases: the application phase, the planning phase, the implementation phase, and the verification phase. The Participant Manual lists target timelines for each phase. However, according to the program manager, these deadlines were not met in PY2 with each phase lasting an average of about two to three weeks longer than

expected. Some of this delay is attributable to the introduction of new service providers to the program as it takes some time for RSPs to understand the program deliverables. Other reasons identified by the program manager for the delay are customer-oriented, including waiting on information or data from customers and trying to schedule meetings. The program manager noted that as the program has gained traction in PY2 and PY3 and RSPs gain experience with the program, the slippages in schedule have decreased (but they are still present).

Figure 0-3 presents the specified timelines for the planning, implementation, and verification phases as well as the actual completion of each phase for the 13 PY2 projects. The figure shows that none of the 13 projects finished the application phase within the required time frame (six to eight weeks after project initiation), and only one project finished the implementation and verification phases on time (within 28 and 38 weeks of initiation, respectively). In most cases, the implementation phase appears to have caused overall slippages in the project schedule.

Figure 0-3. Program Timeline and Actual Project Completion in PY2



Source: PY2 Program Tracking Database; Presentation for RSP Training Meeting (February 2009).

Participating service providers agree that customer challenges have contributed to the delays, but also believe that the program’s timelines are too aggressive for the complexity of retro-commissioning projects. Contributing to the delays is RSPs’ access to the facilities, which is often limited to non-business hours or weekends and RSPs’ limited staffing in PY2. RSPs also

noted that much of the program's paperwork has to be repeated for every phase of the project, leading to unnecessary administrative time. As one RSP explained:

"We have had issues with the schedule on 100% of our projects. I think the schedules are too aggressive and unrealistic. Again, if you were doing retro-commissioning on a 50,000 square foot commercial building with rooftop units, I think the schedule is fine. If you're looking at doing this on a healthcare facility where we need to go in second or third shift to look at certain units because we can't even touch them during the day, you know the reality is we get one to two days a week at a site. We get one to two days a week at best at these facilities and the amount of time and the amount of work that's required just does not fit into the schedules they provide."

Interviewed participants are generally satisfied with the program timelines. Several mentioned that the project took longer than initially planned, but recognized that they were often the limiting factor. Participants echoed RSPs comments that the facilities' hours of operations and corporate review of documents contributed to the delay. One participant stated that he was very impressed with the service provider's flexibility to work around the facility's hours of operation.

Program Drop-Outs

According to the program manager, there are two main reasons potential participating customers drop out of the program. The first reason is if the project does not qualify during the application phase, e.g., when the benchmark data do not show enough energy savings opportunities, the facility lacks certain control capabilities, or major equipment retrofits are planned for the next year or two.¹² The second common reason is due to changes in the building ownership or company management during the course of the project. In PY2, only one project was cancelled after the application phase.¹³

Data Tracking

The ComEd program manager is very pleased with the timeliness and quality of the data he receives from the implementer. The program manager receives updates of the tracking database every week as well as an operations report with a high level summary of the program. The program manager notes that he has enough information to run any sort of analysis needed and cannot think of any data that is missing.

¹² Applicants who require equipment retrofits are channeled into the prescriptive and custom programs. This is the case in approximately 10% of applications.

¹³ This project was terminated due to the misrepresentation of the program by a contractor and subsequent interference with the service provider. Due to the project's early cancellation, the program only counted the energy savings based on the implemented measures.

1.1.14 Retro-Commissioning Service Providers

The program selected nine RSPs for PY2, but only six completed projects in this program year. Of the three RSPs that did not complete any projects, one incorrectly believed that the program would deliver customers to them; another was purchased by a larger firm and shifted some of their strategic focus; and the third did not have a presence in the service territory.

Although RSPs stated that the program's processes and requirements were clearly explained, both program staff and service providers find that it takes some time for new service providers to fully understand the program's processes and requirements. The more projects a service provider performs, the better they become at understanding, explaining, and performing retro-commissioning services. ComEd and Nexant expect that with 10 to 15 RSPs participating in PY3 some quality and delivery issues may continue as the new service providers learn the nuances of the program.

RSP Performance Reviews

At the end of PY2, Nexant conducted a performance review of the six active RSPs and rated them on a series of metrics. The ranking system is based on a 60-point scale, and the service providers are ranked by total score. If a service provider scores less than 40 points, they are required to re-apply in the next program year cycle. The performance metrics are: number of projects accepted, quality of reports, improvements of quality of deliverables over time, meeting of deadlines, project value (dollar savings per kWh, harvest rate, energy savings per project), and customer satisfaction. RSPs who do not complete a project will receive no points in the performance review and will have to re-apply for the next program year. In PY2, five of the six RSPs with completed projects scored above 40. The scores are not available to the public but can be used to help an account manager or the program refer an RSP to a customer looking for a service provider.

The program manager stated that RSPs are very receptive to the performance metrics. The review allows them to see how their work compares to their competition and to receive feedback on their performance. Service providers agree with this assessment. RSPs found the performance review to be fair and useful, but stated that the review did not identify any areas of improvement of which they were unaware. One RSP commented that the review process is good to keep non-participating or poorly participating firms out of the program.

Program participants were generally very satisfied with their service providers and would recommend them to other firms. Satisfaction is similar for participants with or without a prior working relationship with the RSP.

Training

RSPs are required to complete training to participate in the retro-commissioning program. The trainings are conducted by Nexant through a webinar and take place every two to three months. During PY2, three different courses were offered: an introductory training, an implementation training, and a safety awareness training.

According to the program manager, RSPs provided few comments about the trainings and were generally appreciative of having their knowledge refreshed. ComEd and Nexant received no negative feedback regarding the trainings. Service providers interviewed by the evaluation team found the trainings to be helpful but noted that they often just reinforced existing knowledge. The RSPs did not identify any technical issues or barriers experienced in their participation in the program that could not be overcome with more specific training from Nexant.

RSP Satisfaction

RSPs were satisfied with the program in PY2 and found that it met or exceeded their expectations. Three of the four interviewed firms had no previous retro-commissioning business in the ComEd service territory, so the program helped to create a new revenue source with a growing body of work. RSPs were very satisfied with the support from ComEd and Nexant, but less satisfied with the amount of paperwork, which they believe could be streamlined. Overall, RSPs found that the benefits of participating in the program outweighed the drawbacks and their satisfaction was high.

Effects of Program on RSP Business Practices

All interviewed RSPs stated that the ComEd retro-commissioning program had an effect on their business practices. Two of the four interviewed service providers did not perform retro-commissioning as a service before participating in the program. Both firms now promote retro-commissioning to their customers, including those that are not eligible to participate in the program or are outside of ComEd's service territory. As the ComEd program has gained traction, customer awareness has increased:

"The buzz about retro-commissioning that this program actually created is getting customers to start to look at it all over the place."

The two other interviewed RSPs had previously performed retro-commissioning, but only one had experience in the ComEd service territory. As a result of the program, both firms have increased their focus in the market.

Three of the four interviewed RSPs added staff as a result of their participation in the retro-commissioning program. In addition, one RSP noted that retro-commissioning has mitigated

the negative impact of the poor economic climate as they have shifted staff to retro-commissioning projects from other, declining types of services. One RSP described making an effort to identify other potential energy efficient measures, such as chillers, during the retro-commissioning process to help bring in future business. This can help their customers better plan their capital investment budgets and take advantage of other ComEd incentive programs.

1.1.15 Marketing and Outreach

Service providers are the primary promoters of the retro-commissioning program and are expected to generate leads. The leads come from a mix of existing and new customers, largely depending on the prior level of activity of the RSP in ComEd's service territory. Unlike the pilot year, few leads were generated from ComEd account managers in PY2.

Participants learned about the retro-commissioning program in a variety of ways. Of the five interviewed participants, two learned about the program through their RSP, two from ComEd program staff or program communications, and one from their ComEd account manager.

Leads

According to the program tracking database, the program had contact with over 150 companies in PY2 of whom approximately 90 were referred to the program. Staff from the ComEd Retro-Commissioning Program or Nexant were responsible for 24% of documented referrals, while a ComEd account manager made the referral only twice (2%). Service providers generated the lead in 74% of the cases.

Notably, RSPs with the most leads did not necessarily complete the most projects in PY2. For example, one RSP generated 19 leads but only completed one PY2 project. In contrast, another RSP generated leads for eight projects and completed five of them. Leads that do not turn into completed projects might become an issue for the program if the program has to spend resources on processing a lot of ineligible leads and might lead to dissatisfaction among customers who do not qualify for the program. According to the program manager, this issue has improved in PY3, as RSPs have more experience with the program and types of projects that qualify. The program should continue to monitor this issue.

Table 0-5. Source of Referral of PY2 Projects

RSP	Number of PY2 Leads	Number of Completed PY2 Projects
RSP 1	19	1
RSP 2	15	3
RSP 3	10	2
RSP 4	8	5
RSP 5	6	1
RSP 6	2	1

Source: PY2 Program Tracking Database.

Marketing Materials

The interviewed RSPs find the marketing materials (sell sheet and brochure) to be effective because they give an overview of the program. In practice, RSPs and program staff find the marketing collateral to be most effective as a leave-behind. They find that it is best to introduce and explain the program and process in person and then provide the materials as a method for the customer to explain the program internally to others. According to one RSP, the program’s marketing materials were still very limited in PY2 but have since improved. The addition of case studies was a particularly welcome change.

Account Managers

Account managers play a varied role in the ComEd Retro-Commissioning Program. Account managers are invited to every milestone meeting of the process, and program staff regularly update them on projects. However, the program manager and implementer report that most ComEd account managers do not attend these meetings. The program manager believes that the lack of participation from the account managers is unfortunate, as the retro-commissioning process often generates good will towards ComEd staff that the account managers may be missing.

Nexant conducted marketing interviews with RSPs in September and October of 2009 to learn how the program can better help the service providers promote the program to their customers. They found that RSPs wanted to see more active outreach from ComEd account managers and the program manager to ensure that customers are aware of retro-commissioning and the incentive before the RSP contacts the customer.

1.1.16 Customer Satisfaction

Participants' satisfaction with the program is very high. Interviewed participants stated that they found the application process to be easy; in many cases, the RSP completes most of the application. As discussed above, participants were satisfied with the participation process as well as the reports provided, despite the delays in the schedule. All interviewed participants were satisfied with the performance of their service providers. Several participants also commented on the level of communication and professionalism of the ComEd and Nexant staff. Participants could not identify any significant ways to improve the program.

The interviewed participants were also very pleased with the results of the implemented retro-commissioning measures. In addition to making their facility more efficient, some participants also commented on how the process helped educate their staff on how to properly run and monitor their building's systems.

1.1.17 Barriers to Participation

According to service providers and some of the interviewed customers, the primary barrier preventing customers from performing retro-commissioning at their facilities is the upfront cost of the study as any potential energy savings are unknown. The program covers the cost of the study, but some of the initial barrier remains as participants are required to commit to at least \$10,000 without full knowledge of the resulting savings. The lack of a definite savings before the study is especially troublesome for business that require a certain return on investment or payback period before funding can be approved. One RSP also identified participating firms' legal review as a barrier to participation in the program. According to this RSP, some larger companies have to complete an extensive legal review process before making changes to their facilities. Despite the program staff's efforts to encourage the review to begin as soon as possible, the length of time for legal review remains an issue.

Service providers identified two primary barriers that prevent more firms from working with the program: (1) a lack of expertise in retro-commissioning and (2) a lack of presence in ComEd's service territory (for firms who do have retro-commissioning experience). Provided that a firm can overcome these obstacles, participating RSPs believe there are no major barriers to participation.

1.1.18 Statistical Confidence and Precision

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 sample was a census. Given that this is a census, the result is known with certainty, that is the error bounds are zero, and thus there is no need for precision or reliability measurements that would be part of an estimate based on a sample. Given that not all participants responded to interview requests

there is the potential for non-response bias but we have no evidence to suggest that this is likely to be a significant issue.

Cost Effectiveness Review

This section addresses the cost effectiveness of the Retro-Commissioning program. Cost effectiveness is assessed through the use of the Total Resource Cost (TRC) test. The TRC test is defined in the Illinois Power Agency Act SB1592 as follows:

“ ‘Total resource cost test’ or ‘TRC test’ means a standard that is met if, for an investment in energy efficiency or demand-response measures, the benefit-cost ratio is greater than one. The benefit-cost ratio is the ratio of the net present value of the total benefits of the program to the net present value of the total costs as calculated over the lifetime of the measures. A total resource cost test compares the sum of avoided electric utility costs, representing the benefits that accrue to the system and the participant in the delivery of those efficiency measures, to the sum of all incremental costs of end-use measures that are implemented due to the program (including both utility and participant contributions), plus costs to administer, deliver, and evaluate each demand-side program, to quantify the net savings obtained by substituting the demand-side program for supply resources. In calculating avoided costs of power and energy that an electric utility would otherwise have had to acquire, reasonable estimates shall be included of financial costs likely to be imposed by future regulations and legislation on emissions of greenhouse gases.”¹⁴

ComEd uses DSM^{More}TM software for the calculation of the TRC test.¹⁵ The DSM^{More} model accepts information on program parameters, such as number of participants, gross savings, free ridership and program costs, and calculates a TRC which fits the requirements of the Illinois legislation. Environmental benefits have been quantified for CO₂ reductions, using a value of \$0.013875 per kWh.

One important feature of the DSM^{More} model is that it performs a probabilistic estimation of future avoided energy costs. It looks at the historical relationship between weather, electric use and prices in the PJM Northern Illinois region and forecasts a range of potential future electric energy prices. The range of future prices is correlated to the range of weather conditions that could occur, and the range of weather is based on weather patterns seen over the historical record. This method captures the impact on electric prices that comes from extreme weather conditions. Extreme weather creates extreme peaks which create extreme prices. These extreme prices generally occur as price spikes and they create a skewed price distribution. High prices are going to be much higher than the average price while low prices are going to be only

¹⁴ Illinois Power Agency Act SB1592, pages 7-8.

¹⁵ Demand Side Management Option Risk Evaluator (DSM^{More}) software is developed by Integral Analytics.

moderately lower than the average. DSMore is able to quantify the weighted benefits of avoiding energy use across years which have this skewed price distribution.

Table 0-6 summarizes the unique inputs used in the DSMore model to assess the TRC ratio for the Retro-Commissioning program in PY2. Most of the unique inputs come directly from the evaluation results presented previously in this report. Measure life estimates and program costs come directly from ComEd. All other inputs to the model, such as avoided costs, come from ComEd and are the same for this program and all programs in the ComEd portfolio.

Table 0-6. Inputs to DSMore Model for Retro-Commissioning Program

Item	Value Used
Measure Life	3 years
Participants	14
Annual Gross Energy Savings	7,174 MWh
Gross Coincident Peak Savings	1.1 MW
Net-to-Gross Ratio	92%
Utility Administration and Implementation Costs	\$152,060
Utility Incentive Costs	\$ 1,382,590
Participant Contribution to Incremental Measure Costs	\$20,089

With the CACES program, incentives were paid to the HVAC contractors performing the services, and incentive costs were included as administrative costs for the TRC calculation. Based on these inputs, the Illinois societal TRC for this program is 1.41 and the program passes the TRC test. The standard TRC calculation produced by DSMore is 1.07.

Conclusions and Recommendations

1.1.19 Program Impacts

PY2 for the Retro-commissioning Program represents the transition year between the pilot program and large-scale implementation. PY2 witnessed 6 RSPs and 14 participants. PY3 currently has more RSPs and three times as many participants. The integration of RSPs and projects into the program will undoubtedly raise new issues over the coming program year. The PY2 Retro-Commissioning Program was effective in implementing program processes that move eligible customers into the program and facilitate the implementation of energy saving retro-commissioning measures. Realization rates across participants, measure end-uses and measure-types were generally good with a few exceptions.

As expected, savings are greatest among air-handling and chilled water end-uses. Compressed air savings will be a growing element of the program as that end-use is more widely addressed by additional qualified RSPs. Measures that optimize operation of existing equipment

dominates the savings by types of measures installed and scheduling accounts for much of the rest of the savings. In this respect the Retro-commissioning program remains true to its intent to leverage existing resources to improve overall efficiency. Numerous capital projects were also noted for referral to the Custom and Prescriptive Programs.

Spreadsheet tools used to estimate program savings were generally well-conceived and showed internal accuracy and adherence to engineering methods. As PY3 rolls out with even more RSPs, the evaluation team expects more variability in savings estimation methods. In the preceding sections, we make recommendations to make standardize savings estimates across various RSPs and reduce inconsistencies.

1.1.20 Program Processes

Program Participation

As expected, participation in the Retro-Commissioning program increased substantially in PY2 as the program fully launched after its initial pilot year. Fourteen customers completed projects at 14¹⁶ facilities, resulting in *ex ante* gross energy savings of 7,847 MWh compared to the program's goal of 6,456 MWh. The average savings per project was 560 MWh per year, with individual projects ranging from 95 MWh to 1,220 MWh. Participating facilities represented a range of building types and included five office buildings, two hospitals, two industrial facilities, and one each of a large retail facility, an education facility, a museum, and a hotel.

The program also selected nine retro-commissioning service providers (RSPs) for PY2. Of these, six completed projects within the program year. The number of projects per RSP ranged from one to five.

Program Processes

Program processes have evolved since the pilot year, and program staff have done a good job incorporating lessons learned from the pilot phase into the PY2 program design. RSPs and customers find that participation processes are clearly explained. Some RSPs expressed frustration with certain parts of the application and review processes. This is not surprising as PY2 was the first year with RSP involvement and certain processes are still being refined. To address any potential issues, the program has implemented a strong communication and feedback process. This has enabled the program to quickly address and clarify issues and make any needed mid-course adjustments.

¹⁶ One project was cancelled after implementing some measures. The program counted its implemented and verified savings of 119 MWh/year.

Program timelines still present problems for participants. Most projects miss the deadlines by an average of two to three weeks for each phase. While this has been improving, as RSPs have gained more experience with the program, RSPs find the timelines too aggressive given the complexity of many retro-commissioning projects and difficulties getting access to many customer facilities during regular business hours.

Customer Satisfaction

Customers' satisfaction with the retro-commissioning program is high for the various program phases and the program overall. Interviewed customers were also satisfied with the timing of the different phases, with some admitting that delays in meeting milestones were due to internal circumstances. In addition, customers are generally very satisfied with their RSPs and would work with them again or refer them to others. Satisfaction is similar for participants with or without a prior working relationship with the RSP.

Retro-Commissioning Service Providers

The program selected nine RSPs for PY2, but only six completed PY2 projects. Service providers play a major role in the program and are responsible for much of the program's outreach and customer interface. Because of this, ComEd and Nexant maintain frequent contact with RSPs, and lessons learned are quickly shared with other participants. RSPs are required to attend training webinars from Nexant and find the trainings to be helpful.

Nexant performed annual performance reviews of participating RSPs and rated them on a series of metrics including the number of projects, quality of reports, project value, and customer satisfaction. Five of the six participating RSPs earned passing grades for their performance in PY2, while the sixth RSP must re-apply in the next program year cycle. RSPs found this process fair and helpful. The evaluation team commends the program for implementing this process as it is a helpful tool for the program to evaluate service providers and ensure that they are active in the program and deliver high quality work.

All interviewed RSPs noted that the program has had an effect on their business practices, including recommending retro-commissioning services more often and adding new staff.

All interviewed RSPs were generally very satisfied with the program.

Marketing and Outreach

Service providers are the primary promoters of the retro-commissioning program and are expected to generate leads. The leads come from a mix of existing and new customers for RSPs, largely depending on the level of activity for the service provider in ComEd's territory. Unlike the pilot year, few leads are generated from account managers, and most account managers do not appear to be very engaged in promoting the program to their customers.

Recommendations

1.1.21 Impact Recommendations

In general, the evaluation finds the program savings impacts well founded. Similar to measures installed through a Custom Program, establishing impact guidelines are difficult in an environment with many nuanced effects. Retro-commissioning is even more difficult given that operator behavior can have a large effect on impacts. Impact recommendations echo some of the recommendations following the PY1 pilot program.

- An initial step in retro-commissioning should be a general allocation of energy use among end-uses such as interior lights, exterior lights, heating, fans, cooling and pumping calibrated to installed equipment capacity and historic usage. The allocation places bounds on savings estimates and provides a benchmark for evaluating the results of calculations. Navigant believes that an allocation step might have brought attention to engineering errors identified in the evaluation.
- While significant effort has gone into setting up calculation templates, RSPs did not use them in PY2. Multiple unique calculation spreadsheets might be due to the timing of issuing consensus templates after PY2 was well underway. We strongly encourage adoption of the template calculation templates. Standard templates will improve inclusion of secondary effects, ensure sound engineering is the basis of savings estimates, promote accurate calculation of peak demand impacts and facilitate quality control and future evolution efforts.
- The Program Administrator should establish internal guidelines for quality control. The increasing number of projects and service providers could overwhelm the Program resources. Policies should establish which measures should receive detailed review, how many projects / measures per RSP, stratification of review based on size or measure type. If recurring problems are found in the quality control sample, how should similar measures be addressed, etc.
- The PA should communicate with the evaluation team regarding project or measure sampling for program quality control efforts. The evaluators can use this information to construct the verification sample and ensure adequate evaluation of program measures and savings without duplicating the verification work of the PA.

1.1.22 Process Recommendations

The evaluation team notes that several of the recommendations for program processes have been discussed before and in some cases are being implemented by ComEd for PY3 and PY4.

- Consider reevaluating the time requirements for each phase as most projects do not meet them and RSPs consider them too aggressive for the work required. Explore flexibility in the legislation-mandated timeline, as you have with early enrollment in PY3

and now PY4. Retro-commissioning projects typically span 1 ½ to 2 years between contract signing and measure implementation.

- Streamline the application and review process. For example, reduce duplicate information required for each phase of the project and eliminate review of documents that have already been reviewed and have not changed.
- Continue strong communication and feedback practices, including:
 - Sharing of technical or process issues with RSPs and participants as soon as possible, either in the initial meetings about the project or in RSP trainings. This will help lower the learning curve for newer RSPs by relaying the lessons learned from past projects.
 - Rating of RSP's performance. This is a helpful tool for the program to evaluate service providers and ensure that they are active in the program and deliver high quality work.
 - Soliciting feedback from customers about the program as well as their RSP.
- Continue to monitor the number of leads generated by RSPs and the rate of conversion into completed projects. Leads that do not turn into completed projects might become an issue for the program if the program has to spend resources on processing a lot of ineligible leads and might lead to dissatisfaction among customers who do not qualify for the program.

Increase engagement of ComEd account managers in program outreach. Given that retro-commissioning is not a widely known concept, program staff and RSPs find that it is most effective to introduce the program in person. Account managers would be ideally suited to inform their large customers of the program and its opportunities.