# Commonwealth Edison Company
# Energy Efficiency/Demand Response Plan
# Plan Year 1 (6/1/2008-5/31/2009)
# Evaluation Report:
# C&I Retro-Commissioning

**December 12, 2009**

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**ComEd**

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# E EXECUTIVE SUMMARY

The goal of this report is to present a summary of the findings and results from the Impact and Process Evaluation of the 2008 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 2008 (PY1) represents a pilot of the Retro-Commissioning Program. Introducing the Program as a pilot in PY1 enabled many refinements to the program processes with limited participation. The primary objectives of the Impact Evaluation are to review reported savings for installed measures, to recommend general improvements to the estimation process, and to quantify gross 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. The evaluation activities for 2009 and 2010 will address gross and net impacts.

## E.1 Evaluation Methods

Table 1 provides a summary of the data collection activities conducted as part of this evaluation. As this figure shows, the primary data collection activity for this evaluation was in-depth interviews with program management and implementation staff.

**Table 1. Data Collection Activities**

| Data Collection Type | Targeted Population | Sample Frame | Sample Design | Sample Size | Timing |
|---|---|---|---|---|---|
| Engineering Savings Estimate | All implemented Retro-Commissioning Measures | Tracking Spreadsheet | - | All | September 2009 |
| In-depth Phone Interviews | ComEd Program Manager | Contact from ComEd | Program Manager | 1 | April 2009 |
| | Program Implementer | Contacts from ComEd | Nexant Program Manager and Energy Specialist | 2 | May 2009 |

[1] The 2008 program year began June 1, 2008 and ended May 31, 2009.

# E.2 Key Findings

Program Year 1 represented the pilot projects for the Smart Ideas Retro-Commissioning Program. A total of four sites participated in the program and 19 measures were implemented among those sites.

Table 2 below provides the first-year evaluation-adjusted gross savings estimates for the Program. The impact evaluation activities for 2009 and 2010 will address gross and net impacts.

### Table 2. PY1 Gross and Net Savings Estimates

| Gross and Net Parameter and Savings Estimates | PY1 | Realization Rate |
|---|---|---|
| Evaluation-Adjusted Gross MWh Savings | 1,363 | 90.3% |
| Evaluation-Adjusted Gross kW Savings | 150.0 | 72.4% |
| Net-to-Gross Ratio (1-FR) *(ComEd Program Assumption)*[2] | 0.80 | |
| Evaluation-Adjusted Net MWh Savings | 1,090 | 72.2% |
| Evaluation-Adjusted Net kW Savings | 120.0 | 57.9% |

*Source: Analysis of program data.*

### Key Impact Findings

The PY1 gross *ex ante* energy savings for this program were 1,509 MWh. The gross savings were comparable to program goals for the pilot program. The resulting adjusted gross saving realization rate is 90.3%. The reasons for a realization rate less than 100% include minor errors in engineering calculations and assumptions that affect those estimates. Among these factors are:

1. Failure to systematically include 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 affect measure savings.
3. Estimates of demand savings for some measures that only have impacts during un-occupied hours (not during system peak).
4. Failure to provide measured data for verification or substantiated "rule-of-thumb" for one implemented measure.

Summit Blue recommends that ComEd introduce policies and/or default assumptions to address these issues. Consistent application of methods and assumptions will enhance the repeatability, consistency and veracity of savings estimates as the program rolls out with third party Retro-Commissioning Service Providers (RSPs) as the primary delivery and savings estimation entities.

[2] The value of 80% is based on the program plan presented in ComEd's *2008-2010 Energy Efficiency and Demand Response Plan* (November 15, 2007). Section 5.5 of the ComEd plan contains text specifying the net-to-gross ratio of 80% is drawn from the California Energy Efficiency Policy Manual, version 2 (2003). The Net Savings adjustment is supported by participant interviews discussed in section 3.1.5.

# 1 INTRODUCTION TO PROGRAM

The Smart Ideas Retro-Commissioning 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 year they are initiated.

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;
- Create or maintain an Energy Star Rating through EPA's Portfolio Manager; and
- Execution of a Program Agreement with the customer that they will spend up to $10,000 to implement retro-commissioning measures with a simple payback of 18 months or less.

## 1.1 Program Description

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 same service to the customer. Successful retro-commissioning requires experienced service providers and cooperation and buy-in of the facility staff. 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 Energy Efficiency Services staff member, 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.

The program is delivered in four main phases.

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

**Application Phase**. The facility owner or representatives 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, the Administrator assigns a Retro-Commissioning Service Provider (RSP).[3] 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 one week.*

**Planning Phase**. The project planning phase commences after assignment of the RSP. Activities include a kick-off meeting with the PA, ComEd representatives, and RSP with the customer team where 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, where findings 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 to require the customer to commit to spending at least $10,000 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 where 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*

**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.

[3] 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.

*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. The purpose of the 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. 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. Keeping to the Program schedule helps ensure accountability of all parties and tracks measures through implementation.

The program is marketed primarily through one-on-one marketing to candidate facilities by ComEd Account Managers, ComEd Energy Efficiency Services staff, the Program's qualified Retro-Commissioning Service Providers (RSPs), and Program Administrator staff. Marketing training is conducted by the PA for ComEd personnel and marketing materials were produced.

For PY1 pilot projects the Program Administrator, Nexant, Inc., also performed the duties of the RSP.

# 1.2 Evaluation Questions

The Evaluation Team identified the following key researchable questions. However, given the program's limited implementation as a Pilot in PY1, the Evaluation Team plans to address the majority of these questions during Program Years 2 and 3.

### Impact Evaluation 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 issue for this program?

3. Did the program achieve its goals? Why and why not?

### Process Evaluation Questions

1. What are key barriers to participation for eligible ComEd customers? What are key barriers to participation for eligible RSPs? How can they be addressed by the program?

2. How did customers become aware of the program? How did eligible trade allies become aware of the program? What marketing strategies could be used to boost program awareness and participation, if needed?

3. How efficiently is the program being administered? What methods could be implemented to improve the efficiency of program delivery?

4. How effective is the RSP training and how effective are they at marketing the program?

# 2 EVALUATION METHODS

This evaluation of the Smart Ideas Retro-Commissioning Program reflects only the pilot stage of the program. During program year 2008 (PY-2008), which ran from June 1, 2008 – May 31, 2009, four facilities completed the Retro-Commissioning Program process. Among those four sites, 19 retro-commissioning measures (RCMs) were implemented and verified, thus qualifying the sites for full waiver of retro-commissioning service costs. All four pilot sites were analyzed by the Program Administrator, Nexant, Inc., so that they could establish program tracking and flow internally before rolling the program out with third-party Retro-Commissioning Service Providers.

Given that this is an evaluation of the program pilot sites, the Summit Blue team chose lower cost approaches to this evaluation with the expectation that more effort will be required in subsequent years.

## 2.1 Analytical Methods

Measures implemented through this program are diverse and not applicable to prescriptive or deemed savings estimates. Measure impacts were examined individually. Detailed data and engineering calculations were provided for each measure and Summit Blue reviewed the calculations for accuracy and completeness. In most cases, measure savings were estimated with temperature bin calculations and typical meteorological year data.

The Process evaluation utilized surveys with key personnel at ComEd and Nexant, Inc., the Program Administrator. Program planning and marketing materials were also analyzed.

## 2.2 Data Sources

### Measure Savings

The primary data sources for the impact evaluation were the calculation and trend data spreadsheets turned over with the planning and verification reports. The verification reports provided full detail about the participant sites, the equipment installed, and the measures planned and implemented throughout the retro-commissioning process.

### Program and Implementer Staff Interviews

In support of the process evaluation, three in-depth interviews were conducted. Two of these interviews were conducted with the ComEd RCx Program Staff (Steve Baab and Sandra Henry); the other was conducted with the Project Manager for implementer Nexant (Sam Mueller). These interviews were completed over the phone in July and August of 2009. The interviews focused on program goals, implementation, marketing, participation processes, and overall effectiveness, as well as areas for improvement.

The process evaluation was based on marketing materials provided by ComEd and the interviews.

## 2.3 Sampling Plan

For the Impact Evaluation, Summit Blue evaluated a census of all projects. Nineteen projects at four sites were implemented, totaling an estimated 1,506,000 kWh savings and 220 average monthly kW based on *ex ante* values.

The process evaluation included interviews with ComEd Program managers and the Program Administrators, Nexant, Inc. No sampling plan was necessary for either impact or process evaluations.

# 3 PROGRAM LEVEL RESULTS

The Summit Blue team performed both Impact and Process Evaluation tasks for this program in its first year. Both evaluations are fairly limited in scope in this pilot program year. The studies were performed at only four sites, and a total of 19 measures were implemented. The Program Administrator performed all of the retro-commissioning pilot studies so feedback from third-party Service Providers is not relevant at this stage. Nonetheless, important findings from these pilots can be incorporated into future program years.

## 3.1 Impact

### 3.1.1 Verification and Due Diligence

Performing Verification and Due Diligence of a program in its pilot stage has both favorable and unfavorable attributes. The number of projects is small enough to give each a thorough examination, but there are not necessarily enough projects to discern a pattern of issues that might become problems down the road.

For the verification task, Summit Blue agreed to base our conclusions about whether measures were implemented on the Verification Report submitted by the RSP, which during this pilot phase is also the Program Administrator. Accepting verification in this manner is putting considerable faith in the RSP; however, the dual role of the PA and RSP adds extra assurance of the verification during this program year. In all cases, we felt the Verification Report and supporting data and calculations provided sufficient confirmation that the measures were installed as described. In subsequent years, Summit Blue plans spot verification of measures in conjunction with future on-site due diligence work.

Due diligence work for this evaluation focused on the savings calculations for each measure. Summit Blue performed detailed reviews of all calculations and assumptions. In general, Summit Blue found the calculations accurately constructed, based on clearly measured data rather than strictly rules of thumb and transparent in spreadsheet form. In rare instances, we found calculation errors due to erroneous inputs, double counting of savings, and omissions of relevant impacts and inconsistencies in assumptions from measure to measure on the same system. Correcting these deficiencies from one RSP vendor was not difficult, but Summit Blue is concerned that each RSP in future years will bring their own set of assumptions and procedures to the program and there might be irreconcilable inconsistencies based on methodology.

Summit Blue makes the following suggestions for future projects in order to introduce some consistency among RSPs without imposing a one-size-fits all method on the trade allies:

- Require an Energy Allocation step in the Planning Report. An early high-level review of systems and operating hours can be used to allocate energy use among the major end-uses (for example: lighting, cooling, heating, fans, pumps, and miscellaneous). This allocation could focus retro-commissioning efforts on problem areas and would put bounds on end-use estimates and prevent errors in savings estimates.

- In the weather data sets, include corresponding values for other psychometric parameters like enthalpy, humidity ratio, dew point temperature, and wet bulb temperature.

- Establish 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. There should be 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 optimal economizer operation. For example, there is generally an energy penalty in northern Illinois if economizers use 100% outdoor air with a high limit of outdoor air temperature equal to the return air temperature.

- 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.

The previous issues can be addressed within the structure of the program.

The final due diligence issue relates to the strict adherence to the program year calendar, which is a fundamental attribute of the program design. In some cases, the impact of a measure could not be calibrated to actual operation due to the time constraints of measure implementation. For example, estimates about cooling tower fan staging might be required without actually observing or monitoring the fans, because the planning stage occurs after chillers are shutdown in the fall and verification is completed before the following cooling season begins. In cases such as this, more emphasis will be required during future impact evaluations; however, it should not fall upon the evaluator to perform the verification task for the RSP.

### 3.1.2 Tracking System Review

Because of the unique nature of retro-commissioning measures, Retro-Commissioning Program participants are not tracked within the overall commercial program tracking database. The tracking system for the pilot phase of the program is a simple spreadsheet. This spreadsheet is adequate for a pilot program with 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.

Among parameters that should be tracked in the database is contact information for the several Program and participant personnel that are most involved with the project. Milestone completion dates for each of the project phases would also be useful if future process work reveals that the schedule is an impediment to the success of the program.

### 3.1.3 Gross Program Impact Parameter 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 indentified based on the limited information of the site survey and interviews with facility staff. These estimates provide a decision point whether or not the project will proceed to the Program Agreement with the customer and implementation of selected

measures. In general, the PA targets a minimum of about 5% savings for a project to proceed. This threshold is generally considered achievable for retro-commissioning studies.

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 3 shows the *ex ante* savings per site.

**Table 3. *Ex ante* Electric Savings Estimates**

| | Baseline Annual Electric kWh | Target Savings Threshold kWh | Verification Phase (*ex ante*) | | |
|---|---|---|---|---|---|
| | | | Savings Estimate kWh | Savings Estimate kW/month | Percent of Baseline kWh |
| Site 1 | 8,554,971 | 475,000 | 388,052 | 39.8 | 4.5% |
| Site 2 | 4,317,592 | 225,000 | 307,845 | 15.8 | 7.1% |
| Site 3 | 5,750,173 | 225,000 | 188,896 | 35.5 | 3.3% |
| Site 4 | 6,185,256 | 309,000 | 624,254 | 116.0 | 10.1% |
| Overall | 24,807,992 | 1,234,000 | 1,509,047 | 207.1 | 6.1% |

## 3.1.4 Gross Program Impact Results

Among the four sites examined as pilot projects, one was a museum, two were university buildings, and the fourth was a corporate office building. The 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.

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

**Table 4. Savings and Realization Rates by Site**

| | Verification Phase | | Evaluation | | Realization Rates | |
|---|---|---|---|---|---|---|
| | kWh | kW/mo | kWh | kW/mo | kWh | kW/mo |
| Site 1 | 388,052 | 39.8 | 396,317 | 37.6 | 102.1% | 94.6% |
| Site 2 | 307,845 | 15.8 | 298,081 | 15.5 | 96.8% | 98.2% |
| Site 3 | 188,896 | 35.5 | 176,693 | 33.1 | 93.5% | 93.3% |
| Site 4 | 624,254 | 116.0 | 491,754 | 63.8 | 78.8% | 55.0% |
| Total | 1,509,047 | 207.1 | 1,362,844 | 150.0 | 90.3% | 72.4% |

Relatively lower realization rates for Site 4 are primarily a result of three factors. One: RCM involved equipment scheduling that turned off certain equipment during unoccupied hours. The calculation mistakenly claimed peak demand savings during these hours. Two: two complementary measures for ventilation control double-counted some savings which reduces net savings when both are implemented.

Three: another measure to minimize un-intended summer space *heating* was based largely on engineering "rules of thumb" and concrete data regarding savings were not supportive. The measure itself was good operating advice that will have some savings, though those savings cannot be accurately quantified with the available data.

Summit Blue grouped the retro-commissioning measures into six broad categories that include most types of measures included in retro-commissioning, plus a catch-all category "other."

- **Chiller Optimization** includes such measures as chilled water temperature reset, compressor staging, and water-side economizers.

- **Cooling tower optimization** includes fan and cell staging and condenser water temperature control.

- **Economizer and Ventilation Control** includes economizers repair and optimization and ventilation control based on $CO_2$ levels in return air.

- **Equipment Scheduling** are measures that merely turn off equipment (HVAC and lighting) when their service is not required for occupants.

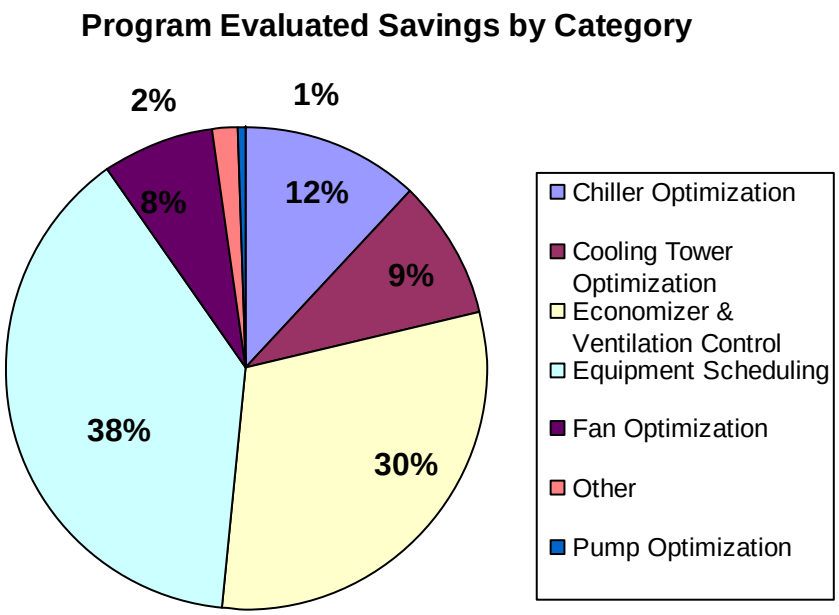
- **Fan optimization** includes air handler repairs and temperature control algorithms, static pressure reset, and optimal use of VFDs to achieve savings.

- **Other** measure types include heating system controls, compressed air improvements, zone temperature control, including winter set-backs and summer set-ups, and various system repairs that do not fall into other categories.

- **Pump optimization** are measures that include primary-secondary pumping controls, variable primary pumping, impeller trimming and proper pump speed control based on feed-back parameters.

Among the RCMs implemented at the pilot sites, equipment scheduling and economizer and ventilation control are the largest energy savers. These two measures together comprise more than two-thirds of program savings.

**Figure 1. Program Evaluated Savings (kWh) by Category**




Realization rates among measure are generally high, and they are consistent among the four sites. Lowest realization rates reflect measures that are not adequately substantiated with field data in either the planning or verification phase. Other low kW realization rates reflect measures that have impacts after hours only and full credit for peak savings were taken in the verification reports.

**Table 5. Savings and Realization Rates by Measure Category**

| | Verification Phase | | Evaluation | | Realization Rates | |
|---|---|---|---|---|---|---|
| | kWh | kW/mo | kWh | kW/mo | kWh | kW/mo |
| Chiller Optimization | 202,431 | 0.0 | 162,560 | 0.0 | 80.3% | NA |
| Cooling Tower Optimization | 189,001 | 26.6 | 127,871 | 26.5 | 67.7% | 99.7% |
| Economizer & Ventilation Control | 407,393 | 127.2 | 411,700 | 114.4 | 101.1% | 90.0% |
| Equipment Scheduling | 497,694 | 4.0 | 526,976 | 2.3 | 105.9% | 57.0% |
| Fan Optimization | 102,332 | 25.1 | 105,139 | 1.3 | 102.7% | 5.0% |
| Other | 102,599 | 23.4 | 21,772 | 4.7 | 21.2% | 20.0% |
| Pump Optimization | 7,597 | 0.8 | 6,826 | 0.9 | 89.9% | 108.0% |
| Total | 1,509,047 | 207.1 | 1,362,844 | 150.0 | 90.3% | 72.4% |

## 3.1.5 Net Program Impact Parameter Estimates

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

NTG Ratio = 1 – Free-ridership + Spillover

In Program planning documents ComEd assumed a program NTG Ratio = 80%[4]. ComEd implemented process changes over the course of PY1 with the goal of increasing the NTG ratio to 1.0.

Even though there were only 4 participants in the pilot of the program, the Summit Blue Team attempted NTG surveys with a census of program participants. Of the four participant sites, two were successfully interviewed for the 15-20 minute survey. Dropped sites included one site where key personnel had left the participating organization and one site was not available for the survey.

Between the two sites common opinions were expressed. The expected payback was a prime factor for program participation with other important factors including the program incentives, the age of the facility to be studied and the support and the endorsements of the utility staff. Personnel at both sites noted that they would have considered performing energy audits at these facilities absent the Program; however, they would have been performed at a later date for less budget and a more limited scope than the retro-commissioning studies. NTG ratios at these two sites bracketed the assumed NTG ratio from the program plan. Given the limited number of participants in the sample and the relative values, Summit Blue elects to leave the assumed NTG ratio unchanged for this evaluation. Further NTG research will be a focus for the PY2 evaluation.

## 3.1.6 Net Program Impact Results

Net Program savings, based on the 0.80 NTG estimate, are reported in Table 6.

**Table 6. Savings and Realization Rates by Measure Category**

| Gross and Net Parameter and Savings Estimates | PY1 | Realization Rate |
|---|---|---|
| Evaluation-Adjusted Gross MWh Savings | 1,363 | 90.3% |
| Evaluation-Adjusted Gross kW Savings | 150.0 | 72.4% |
| Net-to-Gross Ratio (1-FR) *(ComEd Program Assumption)*[5] | 0.80 | |
| Evaluation-Adjusted Net MWh Savings | 1,090 | 72.2% |
| Evaluation-Adjusted Net kW Savings | 120.0 | 57.9% |

[4] ComEd's 2008-2010 Energy Efficiency and Demand Response Plan, (November 15, 2007). Section 5.5 of the ComEd plan contains text specifying the net-to-gross ratio of 80% is drawn from the California Energy Efficiency Policy Manual, version 2 (2003).

[5] Ibid.

## 3.2 Process Evaluation

In PY1, the process evaluation was limited in scope and budget, reflecting the small scale and limited goals of the Pilot program. Research tasks included:

- In-depth interviews with ComEd RCx program staff, including the program manager, as well as a representative from Nexant, the program implementer;
- Development of a program theory and logic model for the Pilot program; and
- A review of program materials, including participant and RSP manuals.

As a result of this limited scope, the Evaluation Team's assessment of the RCx program does not include commentary related to the effectiveness of marketing efforts, RSP recruitment and participation, or barriers to customer participation. These topics will be addressed in the next evaluation cycle.

### 3.2.1 Program Theory

This section contains the program theory, logic model, and performance indicators of the RCx Pilot program. We created this model using discussions with program management and implementers, as well as program documentation. The purpose of program theory and logic models is to serve as:

- A communication tool by:
  - Allowing the implementer to show reasoning to other stakeholders.
  - Bringing common understanding between implementer and evaluator.
- An evaluation tool to:
  - Focus evaluation resources.
  - Clearly show what evaluation will do and expected answers from evaluation.
  - Provide a way to plan for future work effort.

The logic model (LM) is a graphic presentation of the intervention – what occurs and clear steps as to what change the activities undertaken by the intervention are expected to bring about in the targeted population. Logic models can be impact or implementation oriented. An impact model is sparse in terms of how the programs works, but clearly shows the outputs of the program and what they are aimed at affecting. Outcomes are changes that could occur regardless of the program and are generally written as such. The implementation model is how the program works and typically resembles a process flow chart. The model included here is an impact model.

We use numbered links with arrows between each box in the logic model. These numbers allow us to:

- Clearly discuss different areas of the model;
- Describe why moving from one box to the other brings about the description in the later box; and
- If hypothesis testing occurs within the evaluation, the model helps to indicate specific numbered links for hypotheses testing and the evaluation plan would explicate what we will and will not be tested within the evaluation. The main hypothesis testing for the ComEd programs is around energy impacts due to the program.

The program theory (PT) is a description of why the intervention is expected to bring about change. It may reference theories of behavioral change (e.g., theory of planned behavior, normative theory) or be based on interviews with the program managers as they describe their program.

*Creation of the logic model*

There are several different "looks" to logic models. For this evaluation, we are using a multi-level model that has a generic statement about resources in the header, activities in the first row, outputs of those activities in the second row, and outcomes in the third (proximal) and fourth (distal) rows. External factors are shown on the bottom of the diagram.

When we created the boxes in the logic model, we used the following "road-map."

***Activities*** – These are discrete activities that roll up to a single "box" that is shown in the model. It separates out activities that may be performed by different groups. Each activity typically has an output. We used program documentation (implementation plans) and/or discussion with program managers to determine activities.

***Outputs*** – These are items that can be counted or seen. It may be the marketing collateral of a marketing campaign, the audits performed by a program, or the number of completed applications. All outputs do not need to lead to an outcome. We used the same sources as for activities to determine outputs.

***Proximal Outcomes*** – These are changes that occur in the targeted population that the program directly "touches." Multiple proximal outcomes may lead to one or more distal outcomes.

***Distal Outcomes*** – These are changes that are implicitly occurring when the proximal outcome occurs. For example, an energy efficiency program may use marketing to bring about changes in Awareness, Knowledge, or Attitudes as a proximal outcome, which leads to the distal outcomes of: intent to take actions, which leads to actual installation of EE equipment, which leads to energy impacts.

***External Factors*** – These are known areas that can affect the outcomes shown, but are outside of the programs influence. Typically, these are big areas, such as the economy, environmental regulations, codes/standards for energy efficiency, weather, etc. Sometimes these can arise from our discussions with the program managers, but often they were thought about and included based on our knowledge.

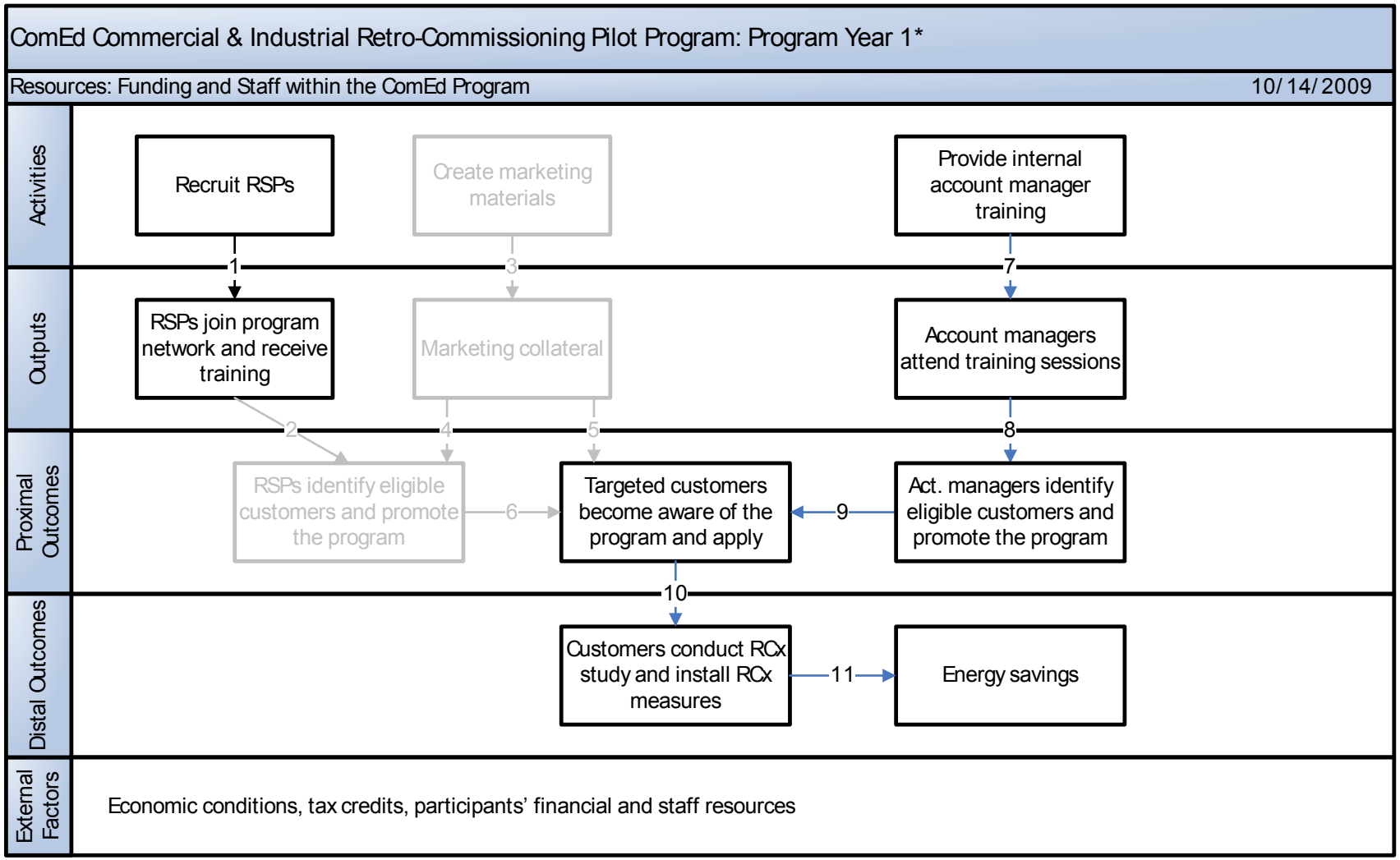
## Expanding the Impact Logic Model

Once the impact logic model was drafted, a table was created that describes the links, the potential performance indicators that could be used to test the link, the potential success criteria that would indicate the link was successful, and potential data sources of the link.

When thinking about how to write each of the performance indicators, we asked ourselves "What would we look at to judge whether the link description actions are occurring" and wrote the answer as the performance indicator.

Success criteria were created by us and are thought to be reasonable.

The Logical Model will be revisited in PY2 to include the evolution of the program process between PY1 and PY2.




** Boxes in light gray shading represent activities that are part of the program design but not were not fully implemented in PY1.*

## Table 2. Performance Indicators Table

| Link | Description of Link | Potential Performance Indicator | Potential Success Criteria for Performance Indicator | Evaluator Data Collection Activities Associated with Link |
|---|---|---|---|---|
| 1 | Through an RFP process, ComEd recruits qualified Retro-commissioning Service Providers (RSPs) for the program. As providers of RCx services, RSPs are in a unique position to identify viable project opportunities for the program. | 1. RSPs join the program<br>2. Customers are satisfied with RSPs | 1. 8 to 9 RSPs join the program<br>2. 90% of customers report being satisfied with their RSP | 1. Program documentation<br>2. Survey with program participants (not conducted in PY1) |
| 2 | Beginning in PY2, RSPs are the main marketing channel for the program and are actively involved in bringing customers into the program. ComEd provides training on program requirements and processes to RSPs so they can market the program. | 1. RSPs find the training informative<br>2. RSPs think the training helps them market the program<br>3. RSPs promote the program to their customers | 1. 90% of RSPs found the training informative<br>2. 90% of RSPs found the training helpful in promoting the program<br>3. 100% of RSPs report promoting the program to their customers | In PY1, the program relied on CAMs to identify viable projects and recruit participants. RSPs will be evaluated in PY2. |
| 3 | ComEd creates and distributes marketing materials (including brochures, a website, and co-branded materials for RSPs to distribute) that provide information about the RCx program. | 1. Marketing materials are effective in explaining the program and how to participate<br>2. Number of website hits and brochures distributed | 1. Marketing materials provide useful information and contain messages that will induce customers to participate<br>2. X website hits and X brochures distributed | Marketing materials were not actively used during PY1. Marketing efforts will be evaluated in PY2. |
| 4 | Co-branded marketing materials are developed for use by the RSPs in recruiting potential participants. The materials inform customers about the program and provide information about the value of RCx and how to participate. | 1. RSPs think the materials contain sufficient and useful information about the program<br>2. RSPs think the materials help them recruit participants<br>3. Participants recall receiving materials from their RSP<br>4. Participants find the materials useful in understanding the program | 1. 75% of RSPs think the materials contain the necessary program information<br>2. 75% of RSPs think the materials were helpful in promoting the program<br>3. 75% of participating customers recall receiving the materials<br>4. 75% of participating customers that received the materials found them useful. | Marketing materials were not actively used during PY1. Marketing efforts will be evaluated in PY2. |
| 5 | Customers are not aware of the RCx program or the free RCx study it offers. They view the program website and learn about the program and its benefits. | 1. Customers view the website<br>2. Customers find the information on the website useful | 1. 50% of customers report having visited the website<br>2. 75% of customers who have visited the website found it useful | Marketing materials were not actively used during PY1. Marketing efforts will be evaluated in PY2. |
| 6 | By approaching potential participants about the program, the RSPs reduce participation barriers such as lack of awareness. Eligible customers apply to participate in the RCx program. | 1. Applicants who were informed of the program by an RSP | 1. Not applicable for PY1 | In PY1, the program relied on CAMs to identify viable projects and recruit participants. RSPs will be evaluated in PY2. |

| Link | Description of Link | Potential Performance Indicator | Potential Success Criteria for Performance Indicator | Evaluator Data Collection Activities Associated with Link |
|---|---|---|---|---|
| 7 | ComEd provides internal training on retro-commissioning and the RCx program to ComEd Account Managers (CAMs). CAMs have established relationships with customers targeted by the RCx program and are therefore good channels for promoting the program and identifying potential participants. | 1. Account managers who participate in training | 1. 95% of account managers attend training | 1. Program documentation |
| 8 | Training sessions provide pertinent information to account managers. Account managers become familiar with the program and are able to identify eligible customers and promote the program to them. | 1. Account managers who are familiar with program<br>2. Account managers who promote the program to their customers | 1. 100% of trained account managers report being familiar with the RCx program<br>2. 100% of trained account managers report promoting the program to their customers | 1/2. Account manager interviews (not conducted in PY1) |
| 9 | By approaching potential participants about the program, the CAMs reduce participation barriers such as lack of awareness. Eligible customers apply to participate in the RCx program. | 1. Applicants who were informed of the program by their CAM | 1. 4 PY1 applicants have been informed about program by their CAM | 1. Review of program tracking data |
| 10 | ComEd business customers have not conducted RCx at their facilities because of a lack of awareness. Through the RCx study, the program increases awareness and identifies measures that the customer could install at low or no cost. Customers install measures presented in the RCx plan. | 1. RCx studies conducted<br>2. Savings potential of recommended RCx measures<br>3. Recommended RCx measures that are installed | 1. 4 RCx studies conducted<br>2. X MWh of savings potential identified<br>3. 50% of recommended RCx measures are installed | 1/2/3. Review of program tracking data |
| 11 | Installing the RCx measures will lead to energy savings because the facility will function more efficiently. | 1. Program savings realized | 1. Program meets PY1 savings goals | 1. Impact analysis (not conducted in PY1) |

## 3.2.2 Program Implementation

### Design Modification

The RCx team made a number of changes to the program structure outlined in ComEd's Demand Response and Energy Efficiency Plan before implementing the pilot program. The most significant change relates to the proposed incentive structure for retro-commissioning service. ComEd originally anticipated sharing the cost of the RCx study with participating customers and offering incentives for the installation of identified retro-commissioning measures (RCM). In place of this incentive structure, the RCx study was offered at no cost to participating customers as a way to overcome first cost barriers to participation. In addition, the ongoing support of RSPs during the implementation phase replaced the proposed provision of implementation incentives. Rationale for this modification is based on the design of the RCx program as one that helps participating customers identify and make no and low cost efficiency improvements.

As internal memos demonstrate, these modifications were well thought out. In-depth discussions with those involved in the program's implementation and delivery further suggest that the changes were beneficial to eligible customers. In order to examine this issue, customer satisfaction with the program's structure, including the incentive offered through engineering services, will be a key component of the evaluation activities performed during PY2.

A second area of notable deviation from the program plan relates to the delivery of engineering services. During the pilot phase, the program administrator, Nexant, filled the role envisioned for the program's RSPs until a group of providers was selected through a competitive RFP process. As the designated "service provider," Nexant staff members performed the RCx study, created all required project documentation, and supported the customer throughout the project period. While customer satisfaction with the services rendered will not be evaluated until PY2, interviews with program staff from both ComEd and Nexant indicate that communication between the two entities was effective and that the arrangement worked well for the short term.

### Program Participation

In Program Year 1, the RCx program met its participation target of completing projects at four facilities. At least one of these participants, the Chicago Historical Museum, will be used as a case study for the full scale RCx program.

### Program Marketing and Outreach

While the program originally planned to have the majority of marketing and outreach conducted by RSPs, the later timeframe for selecting them meant that the program had to implement a different approach for PY1. During the pilot phase, the RCx program was successfully marketed in a controlled and "focused manner" using ComEd Account Managers (CAM) and program staff. By educating CAMs about the program and RCx more generally, program staff increased the likelihood of reaching the desired type of customer and selecting those that best fit the program. The main mechanism used to raise awareness of the program during the pilot launch was a presentation provided to the CAMs for delivery to potential participants. The CAM used this tool as well as direct communication to identify customers with the greatest program potential and passed along that information to the program staff, who would then approach specific customers.

Program staff also did a good job of integrating mechanisms into the pilot program that will allow them to refine their marketing strategy over time. For example, the inclusion of a customer commitment to speak about the program and provide information for future case studies will provide easy access to valuable information about the participant experience for future marketing initiatives.

Additional marketing materials have already been developed for PY2, including co-branded program brochures for use by RSPs and a presentation for them to provide to potential customers. Based on the desire to conduct targeted outreach and the need to use specific screening criteria to determine acceptance into the program, internal RCx program materials stress the need to manage customer expectations. According to ComEd program staff, by July 2009, the program had received around 33 applications. Among these 16 have been accepted for PY2, six were rejected and eleven are still in the application process at the time of data collection for this report. Assessing the program's ability to maintain satisfaction even among those not accepted to the program is a priority for the PY2 evaluation.

### Participation Processes

The program has done a good job of integrating lessons learned from the pilot phase into the full scale program. One example is the standardization of program practices, such as the timing of discussions around the program commitment form. As noted by one staff member, during the pilot, the program agreement was raised with customers at various points in the process and expectations were not as clearly communicated as they could be. For PY2, the agreement form is presented to participants during the project kick-off meeting, which ensures up-front communication about the fact that it must be signed.

One of the main challenges associated with the participation process relates to the program year schedule, which does not necessarily match the timeline for project completion. The practice of retro-commissioning and the implementation of specific projects can be difficult to complete within a 12 month period. Additionally, managing a number of projects all in the same phase of completion is demanding for program staff and can raise uncertainty about the savings that will ultimately result in a given program year. While program documents characterize this as a "streamlined" process designed to "ensure that savings are realized within ComEd's program year, versus the standard timeframe for project completion, which is around 12 to 16 months after installation," this aspect of the program's design may not actually be optimal from a program management standpoint. Based on their experience during the pilot, RCx program staff members have already begun to think about potential approaches to address this obstacle.

## 3.2.3 Program Year 2009 (PY2) Evaluation Priorities

As described above, there are a number of research questions that could not be evaluated during PY1:

- **RSPs:** Now that the program has selected RSPs, the Evaluation Team will closely examine their experience in the program, including the training they receive and the role they play in marketing the program.
- **Participants:** Exploring how participants become aware of the program and what barriers may prevent them from participating will also be high priorities for the PY2 evaluation effort.
- **Free-Ridership:** PY2 research will include research into potential free-ridership among program participants.

## 3.3 Cost Effectiveness

This section addresses the cost effectiveness of the C&I 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."*[6]

ComEd uses DSMore™ software for the calculation of the TRC test.[7] The DSMore 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.

One important feature of the DSMore 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 MISO 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 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 7 summarizes the unique inputs used in the DSMore model to assess the TRC ratio for the C&I Retro-Commissioning program in PY1. 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.

[6] Illinois Power Agency Act SB1592, pages 7-8.

[7] Demand Side Management Option Risk Evaluator (DSMore) software is developed by Integral Analytics.

**Table 7. Inputs to DSMore Model for C&I Retro-Commissioning Program**

| Item | Value Used |
|---|---|
| Measure Life | 5 years |
| Participants | 4 |
| Annual Gross Energy Savings | 1,363 MWh |
| Gross Coincident Peak Savings | 0.2 MW |
| Net-to-Gross Ratio | 80% |
| Utility Administration Costs | $307,583 |
| Utility Incentive Costs | $213,360 |
| Participant Contribution to Incremental Measure Costs | $66,944 |

Based on these inputs, the TRC for this program is 0.79 and the program does not pass the TRC test. As noted previously in this report, this was a pilot year for the Retro-commissioning program. A great deal of administrative cost went into setting up the program while participation was restricted for testing purposes. It is expected that administrative costs will moderate and participation will increase in future years. The combined effect should be increased savings at a lower cost per unit, creating a TRC that is greater than one.

The Retro-commissioning program presents a unique situation regarding program costs. In this program, the incentive costs are the costs of the retro-commissioning studies performed for the customers free of charge. The studies themselves do not create any savings. Additional measures need to be installed by the customer to create savings. In this case, the participant pays the full incremental measure costs. Since the studies are considered to be incentives, they are a benefit to the customer and a cost to the utility and their net impact on the TRC test is zero. There is some thought that the costs of the studies should be added to the incremental measure costs for the purpose of calculating the TRC since it is necessary to perform the studies to achieve the measure savings. This is an issue which should be given more consideration in the PY2 evaluation of this program. For the PY1 evaluation, the incentive costs have not been added to the incremental measure costs.

At this time, additional benefits related to reduction of greenhouse gas emissions have not been quantified in the calculation of the TRC. These additional benefits would increase the given TRC benefit/cost ratio.

# 4 CONCLUSIONS AND RECOMMENDATIONS

The RCx pilot was effective in establishing program processes that move eligible customers into the program and facilitate the implementation of energy saving RCMs. While the integration of RSPs into the program will undoubtedly raise new issues over the coming program year, the following are initial recommendations for program improvement based on the pilot experience.

**Savings Estimation**: Spreadsheet templates used to estimate program savings were generally well-conceived and showed internal accuracy and adherence to engineering methods. As PY2 rolls out the evaluation team expects more variability in savings estimation methods with multiple third-party RSPs. In the preceding sections, we make recommendations to make standardize savings estimates across various RSPs and reduce inconsistencies.

**Program Timeframe**: Continue to examine and develop strategies that will create a more fluid implementation timeline. Program recognition of this problem is an important start and further discussion of this issue should be prioritized in PY2.

**Participant Feedback**: The program should establish a system for customers to provide feedback about their RSP so that program staff have access to continuous information about customer satisfaction and can address any performance issues that arise. Given the primary role of RSPs in marketing and delivering the program, any dissatisfaction with the firms or the services they provide needs to be identified and corrected immediately. Providing an avenue for this type of communication with customers will also enable the program to achieve its goal of increasing customer satisfaction with ComEd's DSM programs.

**Admission to the Program**: Given the need to manage customer expectations regarding the likelihood of admission into the RCx program, ComEd should monitor its application and acceptance rates. If the number of applications continues to rise while the number of successful applicants remains small, the program may confront customer frustration over program accessibility. By tracking application metrics, the program staff can better anticipate potential problems and develop strategies to mitigate their effects.