# ComEd Industrial Systems Combined Evaluation Report

**Energy Efficiency / Demand Response Plan:**
**Plan Year 9 (PY9)**

**Presented to**
**ComEd**

February 14, 2019

***Prepared by:***

**Navigant**

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**Submitted to:**

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## Table of Contents

# 1. Introduction

This report combines the key deliverables from the evaluation of the Industrial Systems Program for PY9. Each of these deliverables were drafted, reviewed and finalized during the course of the PY9 evaluation.

# APPENDIX A. ComEd Industrial Systems Impact Evaluation Report 2018-04-12 Final

# ComEd Industrial Systems Optimization Impact Evaluation Report

**Energy Efficiency / Demand Response Plan:**
**Plan Year 9 (PY9)**

**Presented to**
**Commonwealth Edison Company**

**FINAL**

*April 12, 2018*

***Prepared by:***


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## Table of Contents



## List of Tables and Figures

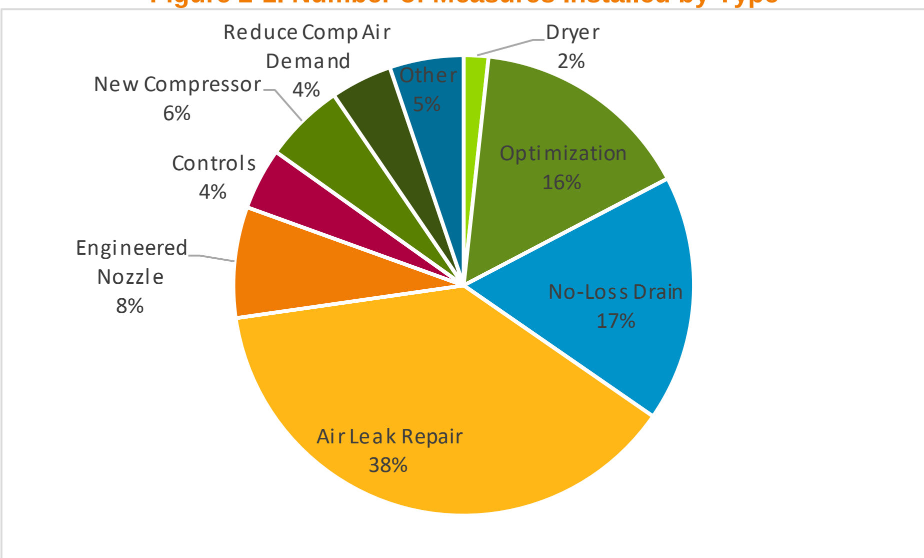
# 1. Introduction

This report presents the results of the impact evaluation of ComEd's PY9 Industrial Systems Optimization Program. It presents a summary of the energy and demand impacts for the total program broken out by relevant measure and program structure details. Section 6 (Appendix 1) presents the impact analysis methodology. PY9 covers June 1, 2016 through December 31, 2017.

# 2. Program Description

The Industrial Systems Optimization Program offers a combination of technical assistance and financial incentives. The technical assistance includes an industrial systems study which assesses the performance of the facility's industrial compressed air, process cooling, and refrigeration systems to ensure efficient, economical operation. The program had 92 participants in PY9 and the measures consisted primarily of compressed air. Air leaks and no-loss drains made up approximately 55% of the measures in the program. Other measures included installing new compressors, VSDs, and optimizing or adding new controls. The evaluation team mapped all the projects in the population to a measure group based on the project description. Figure 2-1 below provides the distribution of projects by measure group.

**Figure 2-1. Number of Measures Installed by Type**




*Source: Evaluation Analysis*

# 3. Program Savings

Table 3-1 summarizes the incremental energy and demand savings the Industrial Systems Optimization Program achieved in PY9.

**Table 3-1. PY9 Total Annual Incremental Savings**

| Savings Category | Energy Savings (kWh) | Demand Savings (kW) | Peak Demand Savings (kW) |
|---|---|---|---|
| Ex Ante Gross Savings | 38,665,705 | N/A | 4,954 |
| Program Gross Realization Rate | 84% | N/A | 85% |
| Verified Gross Savings | 32,523,735 | N/A | 4,211 |
| Program Net-to-Gross Ratio (NTGR) | 0.80 | N/A | 0.80 |
| Verified Net Savings | 26,018,988 | N/A | 3,368 |

*Source: ComEd tracking data and Navigant team analysis.*

# 4. Program Savings by Measure

Reported and evaluated savings for the Industrial Systems Optimization Program are at the site level and do not include measure-level savings. For more information about site-level savings see Section 7 (Appendix 2).

# 5. Impact Analysis Findings and Recommendations

## 5.1 Impact Parameter Estimates

The evaluation team performed engineering calculations to derive evaluated gross energy and demand savings based on data collected during the on-site audit or the desk review process. The savings are site-specific and require site-specific calculators and algorithms in conjunction with data collected from the site. The evaluation team used the data obtained during the M&V efforts to verify measure installation, determine installed measure characteristics, assess operating hours and relevant modes of operation, identify the characteristics of the replaced equipment, support the selection of baseline conditions, and perform ex post savings calculations. Each site evaluation used peak kW savings calculation methodology that was consistent with PJM peak summer demand requirements[1] for each project to calculate the peak kW reduction. The team estimated the lifetime energy and demand savings by multiplying the verified savings by the effective useful life for each measure.

The EM&V team conducted research to validate the non-deemed parameters for this custom program that the TRM did not specify. The results are shown in Table 5-1.

[1] PJM defines the coincident summer peak period as 1:00-5:00 PM Central Prevailing Time on non-holiday weekdays, during the months of June through August.

**Table 5-1. Verified Gross Savings Parameters**

| Gross Savings Input Parameters | Value | Deemed or Evaluated? |
|---|---|---|
| Gross Energy Savings Realization Rate | 0.84 | Evaluated |
| Gross Peak Demand Savings Realization Rate | 0.85 | Evaluated |
| NTG Ratio | 0.80 | Deemed* |
| Net Energy Savings (kWh) | 26,018,988 | Evaluated |
| Net Peak Demand Savings (kW) | 3,368.488 | Evaluated |

* Source: ComEd_NTG_History_and_PY8_Recommendation_2016-02-26_Final_EMV_Recommendations.xlsx, which is to be found on the IL SAG web site here: http://ilsag.info/net-to-gross-framework.html

Figure 5-1 shows a comparison of the energy and demand realization rates for every site. The PY9 energy-savings realization rate results ranged from 0.28 to 1.21, which resulted in a program-level energy realization rate of 0.84. The demand-savings realization rates for the ten projects in the gross sample ranged from 0.24 to 1.16. Only three out of the ten projects had realization rates within 10 percent of one for the energy savings; whereas, four of the ten were within 10 percent of one for the demand savings.

**Figure 5-1. Energy and Demand Realization Rates**

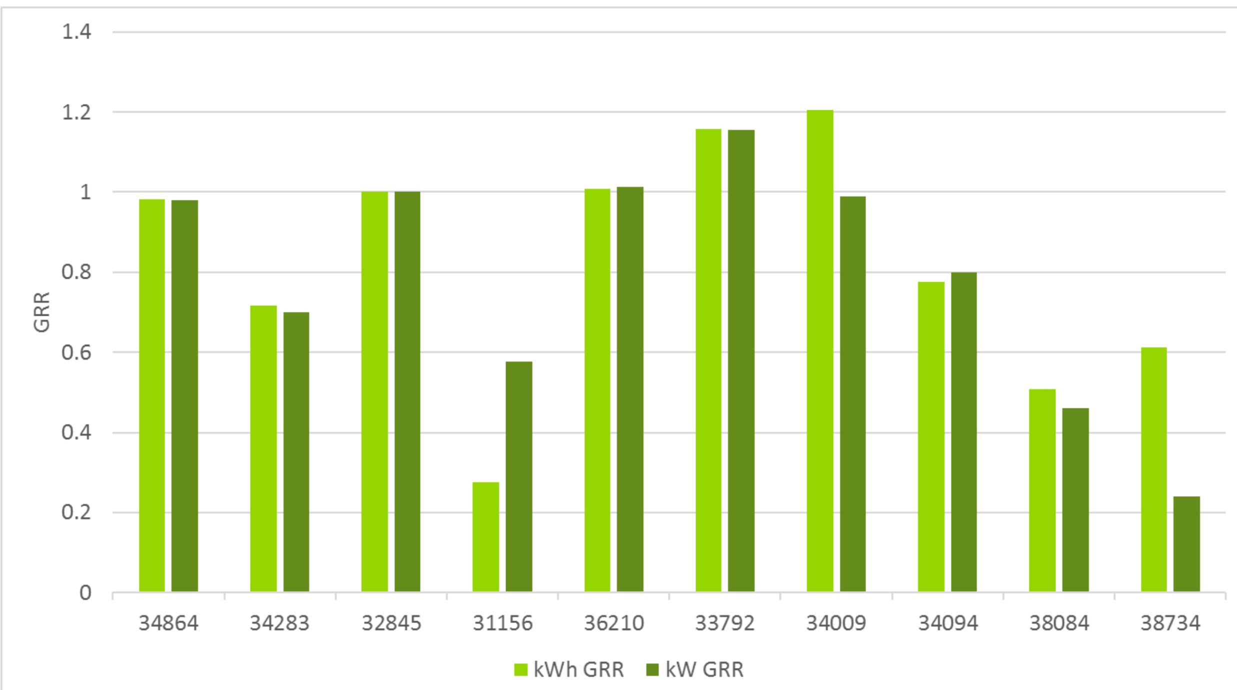
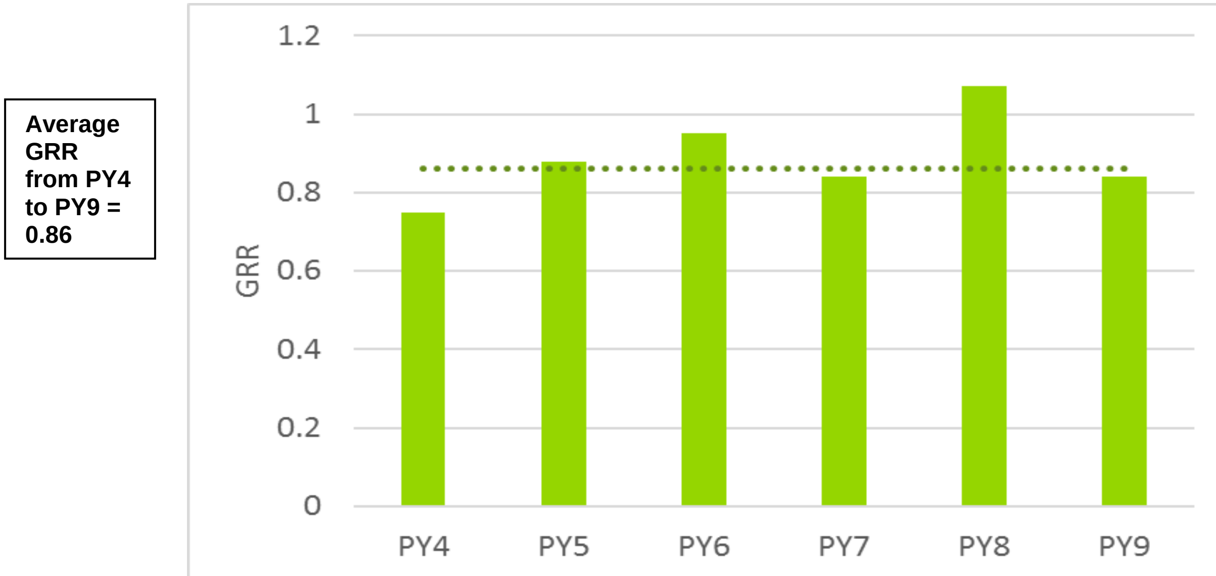



Figure 5-2 below compares the overall program-level energy gross realization rates over the past years. PY9 realization rate of 0.84 is low compared to the previous year, but it is comparable to the median (0.86) of GRR over the past six years. Following the recommendations and early feedback provided by the evaluation team on the large and complicated projects is likely to increase the GRR closer to 1.0 for future program cycles.

**Figure 5-2. Energy Gross Realization Rates Across Program Years**




## 5.2 Other Impact Findings and Recommendations

The evaluation team has developed several recommendations based on findings from the PY9 evaluation; they are as follows:

**Finding 1.** There was one site (34283) where the pre- and post- metering and analysis showed inconsistencies in calculation structure and methodology between the multiple datasets. This resulted in errors in the ex ante analysis. Compressors that were not part of the project scope were included in the metered data. Similarly, there were differences in the logging method, where one set of metering data included logged amps, while the other set included power logging.

**Recommendation 1.** The evaluation team recommends ensuring consistency in analysis methodology and logging where possible. This may require verifying the pre-installation meter data to ensure that a similar approach is taken. This will provide clarity when analyzing the pre-case and the post-case. Providing the metering configuration in documentation will alleviate the questions surrounding the metering data.

**Finding 2.** The evaluation reduced savings for one facility (31156) significantly as the savings relied heavily on compressor sequencing that was occurring manually. Relying on the customer to optimally sequence the compressors is unreliable as there are any number of factors that can cause inefficient operation.

**Recommendation 2.** Adding a compressed air controller that can select the most appropriate compressor based on system demands to a customer's system would be beneficial, especially in cases where there are large swings in compressed air load. These situations will ensure that a customer still sees project savings while not requiring constant monitoring. This is especially advantageous when the customer does not have dedicated staff who are compressed air system experts.

**Finding 3.** One project (31156) had installed high efficiency air gun nozzles to reduce the compressed air demand. The onsite evaluation found that the workers did not like the added weight of the nozzles on the air guns. Also, the shape of the nozzles was inappropriate for the job. This resulted in workers removing most of the nozzles and re-attaching the old nozzles. This resulted in reduced savings.

**Recommendation 3.** Discussions with personnel using equipment prior to the installation of the equipment would be useful. In this case, installing a few high-efficiency air nozzles as a test could have determined that the nozzles were not the right application. Secondly, many energy efficiency programs require the removal of old equipment so that re-installing that old equipment would not be possible.

**Finding 4.** Several projects used idealized or standard assumptions in their savings that did not match the site-specific conditions as documented in the project files. These included a project utilizing a leak repair template (34094) and several projects making assumptions about compressor operation (33792 & 31156). For these projects, and project 38734, the savings calculations from the ex ante model were not validated using the actual meter data. Project 34283 provided metered data that was not validated, where one of the flow meters resulted in an inaccurate CFM reading. Project 34283 did not account for the artificial demand, which raised the project savings by over 20%. Project 38084 assumed that the compressed air system trimming would occur with one dedicated compressor. However, the data shows multiple compressors trimmed in parallel. Project 34009 inadvertently removed the leak savings from the final claimed savings while 34094 did not include the energy usage of the installed fans.

**Recommendation 4.** The evaluation reiterates a past recommendation that the program engineers should review graphical representations of the metered data. We also want to note that standardized assumptions are acceptable, but they should always be validated through comparisons to metering, especially when that data is already available. Sanity checking and quality control of data, even metering data, are key to ensuring that savings calculations are valid and accurate. CAGI data sheets are a useful source of compressor data and should be utilized for sanity check measures.

# 6. Appendix 1. Impact Analysis Methodology

## 6.1 Sampling

### 6.1.1 Gross Impact (M&V) Sample

Consistent with the evaluation plan, the evaluation team used a stratified random sampling approach to select the gross impact sample of eight projects. The evaluation team sorted projects based upon the level of ex ante kWh savings and placed the projects in three strata as shown in Table 6-1.

**Table 6-1. PY9 Program Participation by Sampling Strata**

| Sampling Strata | Ex Ante kWh Impact Claimed | Ex Ante kW Impact Claimed | Tracking Records | Incentive Paid to Applicant |
|---|---|---|---|---|
| 1 | 14,366,945 | 1,654 | 4 | 962,688 |
| 2 | 10,967,538 | 1,377 | 12 | 418,378 |
| 3 | 13,331,222 | 1,923 | 76 | 285,179 |
| PY9 Total | 38,665,705 | 4,954 | 92 | 1,666,246 |

*Source: Evaluation Team analysis*

Table 6-2 provides a profile of the gross impact M&V sample for the Industrial Systems Optimization Program in comparison with the program population. The table shows the resulting sample, which consists of ten projects. These projects make up approximately 14 million kWh of the ex ante impact claim, which represents 38 percent of the ex ante impact claimed for the program population. The table also shows the ex ante-based kWh sample weights for each of the three strata.

**Table 6-2. PY8 Gross Impact Sample by Strata**

| Population Summary | | | | Completed Interviews | | |
|---|---|---|---|---|---|---|
| Sampling Strata | Number of Tracking Records (N) | Ex-ante kWh Impact Claimed | kWh Weights | Number of Tracking Records (n) | Ex-ante kWh | Sampled % of Population kWh |
| 1 | 4 | 14,366,945 | 0.37 | 3 | 11,091,509 | 77% |
| 2 | 12 | 10,967,538 | 0.28 | 3 | 1,988,915 | 18% |
| 3 | 76 | 13,331,222 | 0.34 | 4 | 1,524,241 | 11% |
| PY9 Total | 92 | 38,665,705 | - | 10 | 14,604,665 | 38% |

*Source: Evaluation Team analysis*

### 6.1.2 Roll-up of Savings

There are two basic statistical methods for combining individual gross realization rates from the sample projects into an estimate of verified gross kWh savings for the population when using stratified random sampling. These two methods are referred to as “separate” and “combined” ratio estimation.[2] In the case of a separate ratio estimator, a separate gross kWh savings realization rate is calculated for each stratum and then combined. In the case of a combined ratio estimator, evaluation team completes a single gross kWh savings-realization rate calculation without first calculating separate gross realization rates by stratum.

The evaluation team used the separate ratio estimation technique to estimate verified gross impacts for the Industrial Systems Optimization Program. The separate ratio estimation technique follows the steps outlined in the California Evaluation Framework[3], which identifies best practices in program evaluation. The evaluation team matched these steps to the stratified random sampling method that they used to create the sample for the program. The evaluation team used the standard error to estimate the error bound around the estimate of verified gross impacts.

[2] A full discussion and comparison of separate vs. combined ratio estimation can be found in Sampling Techniques, Cochran, 1977, pp. 164-169.
[3] Tec Market Works, “The California Evaluation Framework,” Prepared for the California Energy Commission, June 2004. Available at http://www.calmac.org

# 7. Appendix 2. Impact Analysis Detail

The Industrial Systems Optimization Program sample includes 10 sites across three strata, as shown in Table 7-1. Most of the ex post energy and demand savings are in strata one, which account for approximately 78% of the ex post energy savings and approximately 76% of the ex post demand savings. Each site's savings can be broken down into various high efficiency industrial measure, such as VFDs, new compressors and leak repairs.

**Table 7-1. PY9 Energy Savings by Strata**

| Strata | Sample Size | Ex Ante Gross Savings (kWh) | Verified Gross Realization Rate | Verified Gross Savings (kWh) | NTGR * | Verified Net Savings (kWh) | Technical Measure Life | Persistence | Effective Useful Life (EUL)† |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 14,366,945 | 92% | 13,219,244 | 0.80 | 10,575,396 | 7 | 1 | 7 |
| 2 | 3 | 10,967,538 | 78% | 8,585,451 | 0.80 | 6,868,361 | 7 | 1 | 7 |
| 3 | 4 | 13,331,222 | 80% | 10,719,039 | 0.80 | 8,575,231 | 7 | 1 | 7 |
| | Total | 38,665,705 | 84% | 32,523,735 | 0.80 | 26,018,988 | 7 | 1 | 7 |

* A deemed value. Source: ComEd_NTG_History_and_PY9_Recommendations_2016-02-26_Final.xlsx, which is to be found on the IL SAG web site here: http://ilsag.info/net-to-gross-framework.html.
† EUL is a combination of technical measure life and persistence.
*Source: ComEd tracking data and Navigant team analysis.*

**Table 7-2. PY9 Peak Demand Savings by Strata**

| Strata | Sample Size | Ex Ante Gross Peak Demand Reduction (kW) | Verified Gross Realization Rate | Verified Gross Peak Demand Reduction (kW) | NTGR* | Verified Net Peak Demand Reduction (kW) |
|---|---|---|---|---|---|---|
| 1 | 3 | 1,654 | 91% | 1,513 | 0.80 | 1,210 |
| 2 | 3 | 1,377 | 98% | 1,354 | 0.80 | 1,083 |
| 3 | 4 | 1,923 | 70% | 1,344 | 0.80 | 1,075 |
| Total | | 4,954 | 85% | 4,211 | 0.80 | 3,368 |

* A deemed value. Source: ComEd_NTG_History_and_PY9_Recommendations_2016-02-26_Final.xlsx, which is to be found on the IL SAG web site here: http://ilsag.info/net-to-gross-framework.html.
*Source: ComEd tracking data and Navigant team analysis.*

Table 7-3 and Table 7-4 show the savings by site. Most of the savings are due to project 34864; which accounts for approximately 39% of the ex post gross energy savings and ex post demand savings.

**Table 7-3. PY9 Energy Savings by Site**

| Sampled Application ID | Sample Strata | Ex Ante Gross Savings (kWh) | Verified Gross Realization Rate | Verified Gross Savings (kWh) | NTGR * | Verified Net Savings (kWh) |
|---|---|---|---|---|---|---|
| 34864 | 1 | 5,731,351 | 98% | 5,625,044 | 0.80 | 4,500,035 |
| 34283 | 1 | 2,755,041 | 72% | 1,975,305 | 0.80 | 1,580,244 |
| 32845 | 1 | 2,605,117 | 100% | 2,605,117 | 0.80 | 2,084,094 |
| 31156 | 2 | 736,596 | 28% | 203,496 | 0.80 | 162,797 |
| 36210 | 2 | 649,426 | 101% | 655,399 | 0.80 | 524,319 |
| 33792 | 2 | 602,893 | 116% | 698,039 | 0.80 | 558,431 |
| 34009 | 3 | 510,496 | 121% | 615,592 | 0.80 | 492,474 |
| 34094 | 3 | 258,868 | 78% | 200,753 | 0.80 | 160,602 |
| 38084 | 3 | 503,680 | 51% | 255,388 | 0.80 | 204,310 |
| 38734 | 3 | 251,197 | 61% | 153,841 | 0.80 | 123,073 |
| | Total | 14,604,665 | NA | 12,987,974 | 0.80 | 10,390,379 |

* A deemed value. Source: ComEd_NTG_History_and_PY9_Recommendations_2016-02-26_Final.xlsx, which is to be found on the IL SAG web site here: http://ilsag.info/net-to-gross-framework.html.
*Source: ComEd tracking data and Navigant team analysis.*

**Table 7-4. PY9 Peak Demand Savings by Site**

| Sampled Application ID | Sample Strata | Ex Ante Gross Peak Demand Reduction (kW) | Verified Gross Realization Rate | Verified Gross Peak Demand Reduction (kW) | NTGR* | Verified Net Peak Demand Reduction (kW) |
|---|---|---|---|---|---|---|
| 34864 | 1 | 655 | 98% | 642 | 0.80 | 514 |
| 34283 | 1 | 322 | 70% | 226 | 0.80 | 181 |
| 32845 | 1 | 303 | 100% | 303 | 0.80 | 242 |
| 31156 | 2 | 40 | 58% | 23 | 0.80 | 19 |
| 36210 | 2 | 101 | 101% | 102 | 0.80 | 82 |
| 33792 | 2 | 78 | 116% | 90 | 0.80 | 72 |
| 34009 | 3 | 73 | 99% | 72 | 0.80 | 58 |
| 34094 | 3 | 42 | 80% | 33 | 0.80 | 27 |
| 38084 | 3 | 65 | 46% | 30 | 0.80 | 24 |
| 38734 | 3 | 22 | 24% | 5 | 0.80 | 4 |
| | Total | 1,700 | NA | 1,527 | 0.80 | 1,221 |

* A deemed value. Source: ComEd_NTG_History_and_PY9_Recommendations_2016-02-26_Final.xlsx, which is to be found on the IL SAG web site here: http://ilsag.info/net-to-gross-framework.html.
† Based on evaluation research findings.
*Source: ComEd tracking data and Navigant team analysis.*

The evaluation team has provided ComEd with site-specific M&V reports for each verified project. These site-specific impact evaluation reports summarize the ex ante savings in the Final Application submitted, as well as the ex post M&V plan, data collected at the site and all the calculations and parameters used to estimate savings. Table 7-3 summarizes the results for each project. The evaluation team uncovered some issues in seven of the ten projects, resulting in a realization rate that differs from 100%. This could have resulted in a larger discrepancy in realization rate if the realization rates were not offset by other large discrepancies that swung the other way. Some key observations from these site-specific evaluation results are discussed below for each project which saw large differences in savings.

- Project #34283: Three major findings attributed to the difference in savings for this project. The baseline operating data included compressors that were not included in the project scope, and therefore overestimated the energy consumption during the baseline period. The metered data for one of the flow controllers was not reporting accurate readings. Finally, the ex ante savings did not account for the reduction in artificial demand, which increased savings.
- Project #31156: This project is manually controlled, making it difficult for the savings to persist. Over the course of the project, the operation of the air compressors changed and resulted in degraded system performance.
- Project #34009: The largest change in savings comes from changing the operating hours for the leaks to 8,736 from 7,077 hours. The other changes to the savings were due to the operating conditions found during the on-site inspection.
- Project #34094: The evaluation team used a similar approach to the ex ante calculations, but made a few adjustments, including changing the compressor curve to the actual curve and considering the compressor fixed demand. In addition, the team fixed an error in the calculations of the kWh/lb, thereby decreasing the energy savings.
- Project #38084: The savings were reduced due to the ex ante analysis assuming that a reduction in CFM demand would result in a direct reduction in the CFM of the VFD trim compressor. However, based on the provided data, only a portion of the CFM reduction resulted in a reduction in the VFD compressor.
- Project #33792: The savings for this project were increased based on the metered operation of the system. The original analysis calculated the savings based on an “idealized” operation of the system. During much of the operating time this was reasonable. However, during some of the operating period Compressor 1 would operate unloaded for a period without providing useful CFM to the system. Adding in the savings for reducing the CFM to nearly eliminate the operation of Compressor 1 also nearly eliminates the time that this compressor ran unloaded.
- Project #38734: The evaluated savings were significantly reduced compared to the ex ante savings levels. The ex ante modeled system operation was not validated with the available metered data and overestimated the savings. Ex post savings were estimated using combination of metered data (wet operation) and the ex ante model (dry operation).

# 8. Appendix 4. TRC

Total Resource Cost (TRC) related data for the ten projects in the Industrial Systems Optimization Program sample can be found in Table 8-1.

**Table 8-1. TRC Table. Total Resource Cost Savings Summary[4]**

| Application ID | Research Category | Units | Quantity | Effective Useful Life | Ex Ante Gross Savings (kWh) | Ex Ante Gross Peak Demand Reduction (kW) | Verified Gross Savings (kWh) | Verified Gross Peak Demand Reduction (kW) |
|---|---|---|---|---|---|---|---|---|
| 34864 | Refrigerant Dryer | Each | 1 | 7 | 5,731,351 | 655 | 5,625,044 | 642 |
| 34283 | Compressor Controller | Each | 1 | 10 | 2,755,041 | 322 | 1,975,305 | 226 |
| 32845 | New Compressor | Each | 1 | 11 | 2,605,117 | 303 | 2,605,117 | 303 |
| 31156 | New Compressor | Each | 1 | 10 | 736,596 | 40 | 203,496 | 23 |
| 36210 | Repair Air Leaks | Each | 1 | 2 | 649,426 | 101 | 655,399 | 102 |
| 33792 | Repair Air Leaks | Each | 1 | 3 | 602,893 | 78 | 698,039 | 90 |
| 34009 | Repair Air Leaks | Each | 1 | 5 | 510,496 | 73 | 615,592 | 72 |
| 34094 | Reduce Comp Air Demand | Each | 1 | 13 | 258,868 | 42 | 200,753 | 33 |
| 38084 | Repair Air Leaks | Each | 1 | 2 | 503,680 | 65 | 255,388 | 30 |
| 38734 | VFD Drive | Each | 1 | 7 | 251,197 | 22 | 153,841 | 5 |

[4] For projects with multiple measures, Weighted Average Measure Life (WAML) is listed in the table. WAML is estimated using verified ex-post measure savings as the weight. Also, the TRC table only includes cost-effectiveness analysis inputs available at the time of finalizing this PY9 impact evaluation report. Additional required cost data (e.g., measure costs, program level incentive and non-incentive costs) are not included in this table and will be provided to evaluation at a later date. Further, EULs are subject to change and are not final due to ongoing analysis.

# APPENDIX B. ComEd Industrial Systems PY8 and PY9 NTG Memo 2018-08-25

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*Memorandum*

**To:** Erin Daughton, ComEd

**From:** Jennifer Fagan, Itron

**CC:** Thomas Johanson, ComEd; Jennifer Morris, ICC Staff; Jeff Erickson, Randy Gunn, Rob Neumann, Navigant

**Date:** August 25, 2018

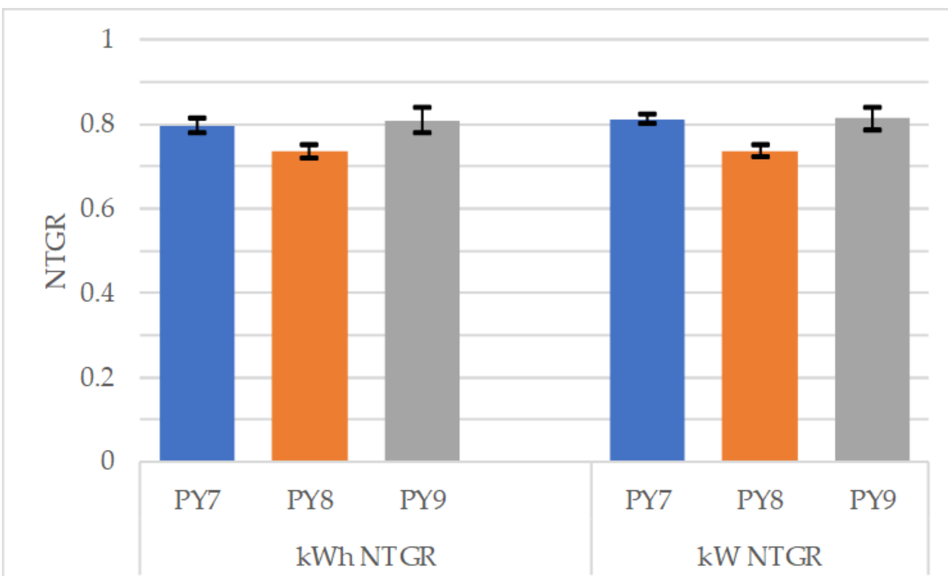
**Re:** Net-to-Gross Research Results from the PY8 and PY9 ComEd Industrial Systems Program

## SUMMARY OF FINDINGS

This memo presents the findings of the PY8 and PY9 net-to-gross ratios (NTGR) study of the ComEd Industrial Systems Program.

The evaluation research findings energy and demand-weighted NTGR for PY7, PY8, and PY9, are presented below in Figure 1. The PY8 evaluated kWh NTGR for Industrial Systems projects of 0.74 is somewhat lower than the PY7 NTGR of 0.80 while the PY9 value of 0.81 is slightly higher. These results indicate continuing strong program influence. Note that the 90 percent confidence interval (CI) of the PY9 kWh NTGR does overlap with the CI of the PY7 kWh NTGR, indicating that the PY9 kWh NTGR is not statistically different from the PY7 value.

**Figure 1. Evaluated NTGR by Program Year with 90% Confidence Intervals**




The EM&V team calculated a combined PY8 and PY9 NTGR. The team calculated tis value using savings weighted NTGRs from PY8 and PY9 and computing a weighted average value. The combined PY8/9 value of 0.77 is also somewhat lower than the PY7 NTGR of 0.80. *The EM&V team recommends that the combined PY8/9 value of 0.77 be used to compute program-verified savings for CY2019 projects going forward.* We recommend this combined value because it is based on a larger and more robust sample representing two-years' worth of projects, and it reflects the latest available information from the evaluation effort.

## INTRODUCTION

This memorandum presents the evaluation's PY8 and PY9 net-to-gross ratio (NTGR) estimates for ComEd's Industrial Systems Program. The evaluation team completed NTG interviews with participants for both PY8 and PY9. The analysis of the PY8 data was postponed until the conclusion of the PY9 evaluation and this memo reports findings for PY8, PY9 and combined PY8/PY9 NTGR results.

## EVALUATION RESEARCH NET IMPACT FINDINGS

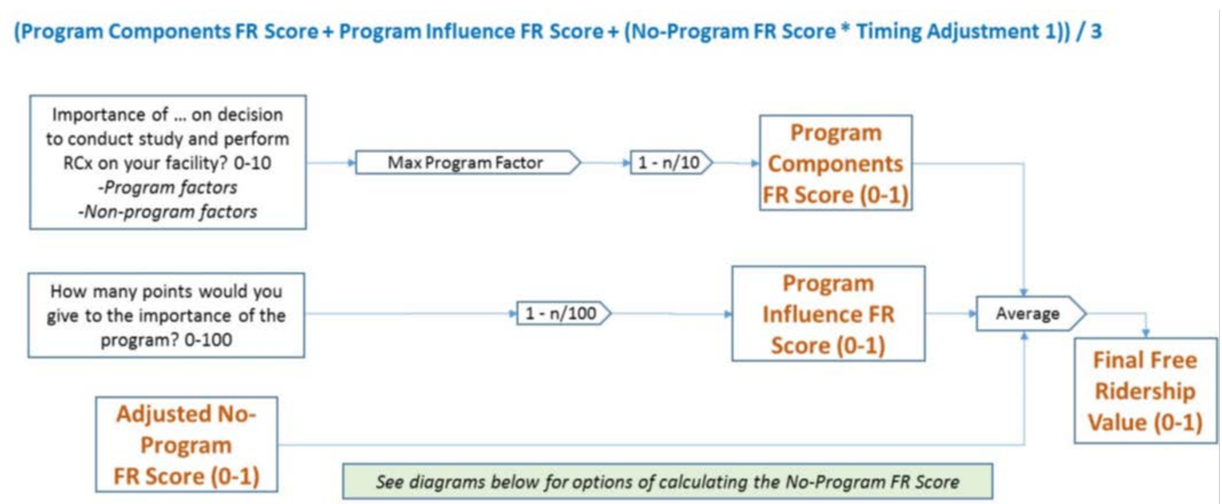
### NTG Algorithm Specifications

The PY8 and PY9 NTGR calculations were based on the Study-Based NTG algorithms specified in the Illinois TRM version 6.0[1]. Approval to use version 6.0 was provided by the Illinois Stakeholder Advisory Group and Illinois Commerce Commission staff via an email seeking permission dated April 2, 2018 and their lack of objections by April 16, 2018, which was interpreted as consensus. The NTG protocols in version 6.0 were developed by the Illinois Net-to-Gross Working Group, in their deliberations during the summer and fall of 2017.

The protocols provide two options for combining the three scores. These two options use different specifications to account for the impact of the program on project timing (referred to as "deferred free ridership"). Evaluators are to calculate free ridership using both options, and to select one option for purposes of calculating the annual incremental energy savings for comparing to the legislated goal.

Figure 2 below provides an overview of the Study-based NTG framework.

**Figure 2. Study-Based Free Ridership - Overview**




This framework allows for two options for computing score 3. These 2 variants are shown graphically in Figure 3 and Figure 4 below.

[1] Specifically, figures 3-4, 3-5 and 3-6.

**Figure 3. Study-Based Free Ridership – No-Program FR Score Option #1**

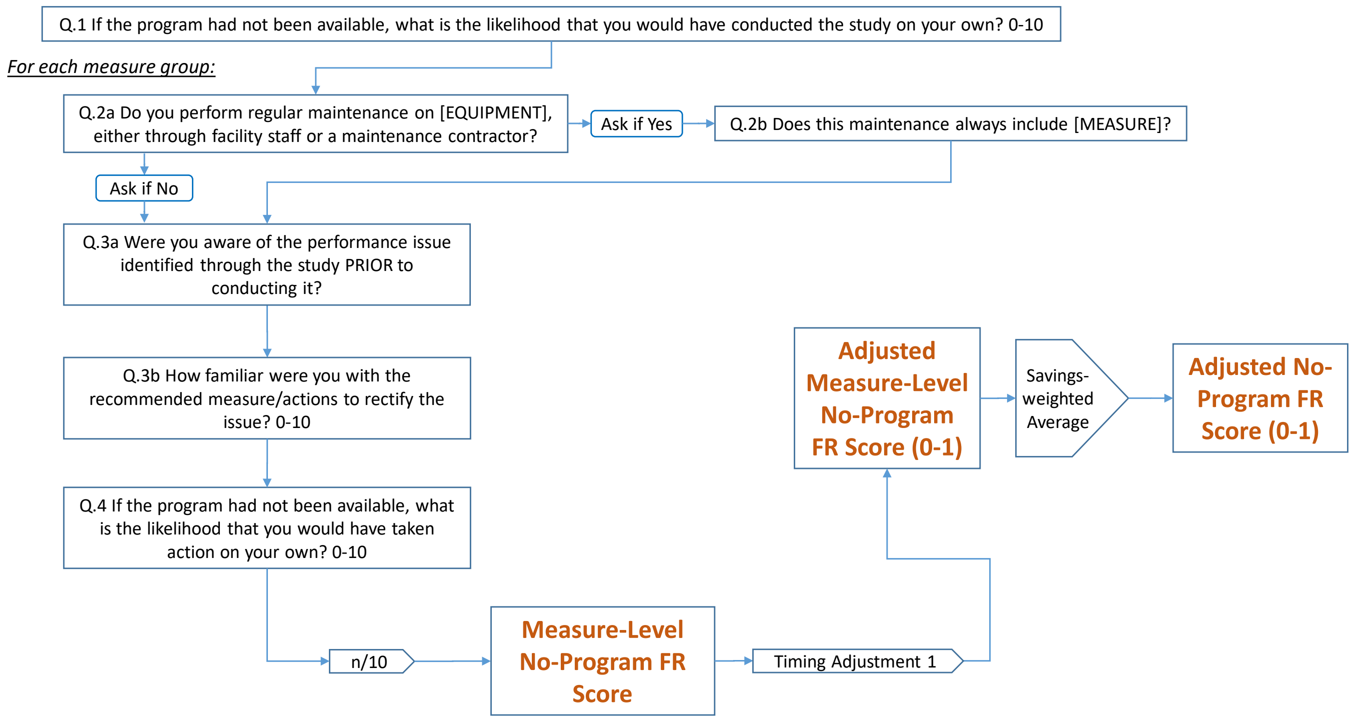
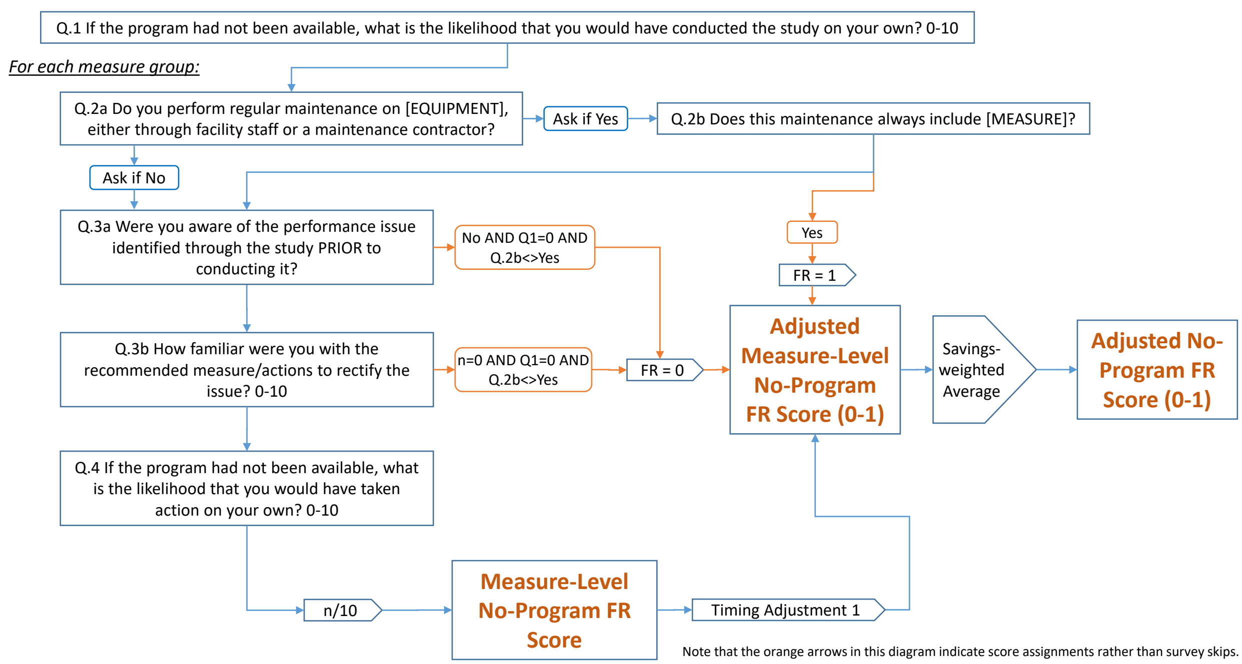



**Figure 4. Study-Based Free Ridership – No Program FR Score Option #2**




The evaluation team's preferred algorithm specification **is No-Program FR Score Option #1** (Figure 3). The majority of NTG findings discussed below are based on this version. We also analyzed the second option, Study-Based Free Ridership—No-Program FR Score Option #2 (Figure 4) and those findings will be presented as a sensitivity case later in this memo. The rationale for selecting Option #1 over Option #2 is that Option #1 considers the full body of evidence regarding no-program behavior in computing the No-Program FR Score. In contrast, Option #2 goes straight to a FR value of 0 (NTGR of 1.0) solely based on the decisionmaker self-reported responses that their routine maintenance excludes the incented equipment. This option does not consider other no-program evidence when computing the No-Program FR score. This essentially ignores the effect of the other no-program actions for such answer combinations, which in our view is inappropriate. This option also violates the general principal in the TRM that the NTG value should not be dependent on a single question.

## NTGR Calculation

The calculation of both the free ridership rate and each project's net-to-gross ratio (NTGR) is a multi-step process. Responses from the telephone survey are used directly to calculate a timing and selection score, a program influence score and a no-program score for each project (as outlined in Table 1 below for both versions of the NTGR algorithm). These three scores can take values of 0 to 10 where a lower score indicates a higher level of free-ridership. The calculation then averages those three scores and incorporates spillover findings to come up with a project-level net-to-gross ratio.

**Table 1. Net-to-Gross Scoring Algorithms for the PY8 and PY9 Industrial Systems Program**

| Scoring Element | Option #1 Calculation | Option #2 Calculation |
|---|---|---|
| **Timing and Selection Score.** The maximum self-reported score (on a 0 to 10 scale of importance) for the following program elements:<br>A. Availability of the program incentive<br>B. Comprehensive study funded by the program<br>C. Recommendation from account rep<br>D. Recommendation from program staff | Maximum of A, B, C, D | Maximum of A, B, C, D |
| **Program Influence score.** From a Total of 10 points, the self-reported number of points assigned to the importance of the Program in their decision to implement the <PROJECT> (as versus other non-program factors. | Points awarded to the program. Reduce by half if decision made BEFORE learning about rebate eligibility | Points awarded to the program. Reduce by half if decision made BEFORE learning about rebate eligibility |
| **No-Program score.** If the Program had not been available, the self-reported likelihood (on a 0 to 10 scale, where 0 is "Not at all likely" and 10 is "Extremely likely") that they would have installed exactly the same PROJECT, considering both the program-provided study and incentive. | Linear adjustment to self-reported No Program Likelihood Score and 10 (maximum score based on deferred installation 48 months or more later). | Value of 0.00 FR assigned to self-reported zero likelihood of performing study on their own, performing maintenance that excludes MEASURE, and lack of awareness of performance issue prior to study. Value of 1.00 FR assigned to self-reported likelihood of performing study on their own, performing maintenance that includes MEASURE. For all other response combinations, same as Option #1. |
| **Timing Adjustment.** Timing credit provided for deferred installation absent the Program. Linear adjustment with gradually increasing credit value for each year of deferral of 25% for one year,50% for two years, 75% for three years and 100% for four years or more. | Incorporated into No Program score. | Only applied to projects with response combinations meriting Option #1 approach. |
| Project-level Free-ridership (ranges from 0.00 to 1.00) | 1 minus Sum of scores (Timing and Selection, Program Influence, No-Program)/30 | Value of 0.00 FR assigned to self-reported zero likelihood of performing study on their own, performing maintenance that includes MEASURE, and lack of awareness of performance issue prior to study. For all other projects, same as Option #1. |
| PY8 and PY9 Project level Net-to-Gross Ratio (ranges from 0.00 to 1.00) | 1 minus Project level Free-ridership | 1 minus Project level Free-ridership |

## NTG Sample Design and Completed Surveys

During both PY8 and PY9, the original sample design consisted of 10 sample points that corresponded to and overlapped with the gross impact M&V sample. However, given customer willingness to participate and other factors, the final net samples did not fully match the gross sample. During PY8, telephone surveys were conducted for two waves of sample, yielding a total of 8 completed interviews. In PY9, surveys were completed for three waves of sample, and 8 interviews were completed. The 8 PY8 and 8

PY9 NTG completes represent a subset of the 10 gross M&V sample points in each year (i.e. they are completely overlapping).

Table 2 and Table 3 below summarize the number of completed telephone surveys in each year, and the percent of ex-ante kWh claims represented. The surveys completed represent 28 percent and 32 percent of ex-ante kWh claims in PY8 and PY9, respectively.

**Table 2. Profile of the PY8 Participant Survey Net-to-Gross Sample by Strata**

| | Program Population Summary | | | NTG Interviews Completed | | |
|---|---|---|---|---|---|---|
| Sampling Strata | Number of Records (N) | Ex Ante kWh Impact Claimed | kWh Weights by Strata | N | kWh | % of Population Ex Ante kWh |
| 1 | 6 | 13,201,979 | 0.36 | 3 | 8,174,960 | 62% |
| 2 | 13 | 11,411,710 | 0.31 | 2 | 1,329,208 | 12% |
| 3 | 55 | 12,286,999 | 0.33 | 3 | 824,572 | 7% |
| **TOTAL IS** | **74** | **36,900,688** | **-** | **8** | **10,328,740** | **28%** |

**Table 3. Profile of the PY9 Participant Survey Net-to-Gross Sample by Strata**

| | Program Population Summary | | | NTG Interviews Completed | | |
|---|---|---|---|---|---|---|
| Sampling Strata | Number of Records (N) | Ex Ante kWh Impact Claimed | kWh Weights by Strata | N | kWh | % of Population Ex-Ante kWh |
| 1 | 4 | 14,366,945 | 0.37 | 3 | 11,091,509 | 77% |
| 2 | 12 | 10,967,538 | 0.28 | 2 | 783,129 | 7% |
| 3 | 76 | 13,331,222 | 0.34 | 3 | 516,881 | 4% |
| **TOTAL IS** | **92** | **38,665,705** | **-** | **8** | **12,391,519** | **32%** |

## Weighted NTG Results Based on Option #1 Free Ridership Algorithm (Preferred specification)

Weighted results are presented in this section for each sampling size stratum, and for the program overall. To produce an estimate of the net-to-gross ratio (NTGR), the individual NTGRs for each of the projects in the sample were weighted by the size of the savings estimates (savings) associated with the project, and the proportion of the total sampling domain savings represented by each sampling stratum. NTGR results are weighted by kWh savings.

The separate ratio estimation technique was used to estimate NTGR for the program. The separate ratio estimation technique follows the steps outlined in the California Evaluation Framework. The standard error was used to estimate the error bound around the estimate of verified evaluation NTGR.

The EM&V team examined spillover effects and found none, as discussed below in the spillover section.

### *PY8 NTG Results*

The PY8 program level NTGR, along with precision estimates, is shown below in Table 4. The overall program NTGR for PY8 is 0.74, which is somewhat lower than the PY7 value of 0.80. By strata, the mean energy NTGR values are 0.77 for stratum 1 (large sized projects), 0.67 for stratum 2 (medium sized projects), and 0.76 for stratum 3 (small sized projects) which indicates the free-ridership level for the largest and smallest size project categories (strata 1 and 3) is lower than the free-ridership of the medium project size category (stratum 2).

**Table 4. PY8 MWh NTG Ratio and Relative Precision at 90% Confidence Level**

| Sampling Strata | Relative Precision ± % | Low | Mean | High |
|---|---|---|---|---|
| 1 | 0% | 0.77 | 0.77 | 0.77 |
| 2 | 4% | 0.64 | 0.67 | 0.70 |
| 3 | 4% | 0.73 | 0.76 | 0.79 |
| **Total** | **2%** | **0.72** | **0.74** | **0.75** |

By stratum, highlights include the following:

- For all three of the stratum 1 projects, the NTGRs were 0.77, indicating medium high program influence. All projects' decisionmakers cited the rebate's importance in meeting their investment criteria. Without the program, a portion of the measures incented by the program would have been implemented, but the largest energy savers would have been delayed 2 years or more, or never installed.
- For stratum 2 projects, NTGRs ranged from 0.64 to 0.70, again pointing to medium high program influence levels. In one case, while the company had to replace aging equipment, the availability of program incentives and the study that was funded by the program were both important in the type of equipment they selected. The study was considered important because it not only helped identify air leaks, but also provided information on the specific type of compressors to be purchased. In another, the customer would have gotten around to installing the rebated measures eventually, one to two years later.
- NTGRs for the three stratum 3 projects ranged from 0.69 to 0.80, again indicating a medium high level of program influence. The program rebate was rated highly for many projects, for moving the project payback to an acceptable level, and/or helping to pay for some of the up-front costs for more expensive energy efficient equipment. In all cases, without the program, they would have gotten around to installing the rebated measures eventually, more than 1 to 2 years later.

### *PY9 NTG Results*

The PY9 program level NTGR, along with precision estimates, is shown below in Table 5. The program-level PY9 mean energy NTGR averaged 0.81. In general, PY9 mean energy NTGR values are much higher than in PY8 and slightly higher than in PY7. NTGR values for the three Industrial Systems sampling strata are 0.81 for stratum 1 (large sized projects), 0.88 for stratum 2 (medium sized projects), and 0.75 for stratum 3 (small sized projects). The improvement in the PY9 program-level NTGR over the PY8 value is largely driven by the strong program influence/low free ridership levels exhibited by the largest sized projects (strata 1 and 2).

**Table 5. PY9 kWh NTG Ratio and Relative Precision at 90% Confidence Level**

| Sampling Strata | Relative Precision ± % | Low | Mean | High |
|---|---|---|---|---|
| 1 | 6% | 0.76 | 0.81 | 0.86 |
| 2 | 5% | 0.83 | 0.88 | 0.93 |
| 3 | 2% | 0.74 | 0.75 | 0.76 |
| **Total** | **3%** | **0.79** | **0.81** | **0.83** |

Stratum-level highlights include the following:

- For the largest stratum 1 projects, NTGRs varied widely and ranged from 0.53 to 0.90. The NTGR for this stratum averaged 0.81. Circumstances surrounding these projects' decisions to install energy efficient equipment were very different.
    - For the project with the lowest NTGR, key motivations for the project were energy cost reduction and the objective of achieving more process stability, so that their air pressure did not fluctuate. Without the program, there was a 6 out of 10 probability they would have installed the same equipment within 6 months of when they did.
    - Both projects with the highest NTGRs cited compressed air as accounting for a large portion of their manufacturing cost, providing them substantial motivation to reduce it. The study performed by the service provider was highly influential in helping these customers identify sources of inefficiency and steps they could take to address them. Without the program there was a moderate probability they would have installed the same equipment, some 24 months later. Thus, the program had a strong acceleration effect.
- For stratum 2 projects, NTGRs ranged from 0.83 to 0.93 with a mean value of 0.88. For these projects, the program features, including the audit/feasibility study, the rebate and the assistance provided by program staff were key decision influences. Regarding the technical study, one decisionmaker commented that "a big advantage of the study is that it quantifies the amount and value of energy savings. Not knowing how much energy savings is worth is a barrier, and we need that specific information in order to sell the project to our Finance department." Absent the program, the customers cited a low 3 in 10 likelihood of installing the same measures, some 2 years later.
- Across the smallest stratum 3 projects, NTGR values were tightly clustered around a 0.73 to 0.77 range. They averaged 0.75, indicating a medium high level of program influence. Prime influences included the desire to reduce air leaks and associated energy waste, the program audit/feasibility study, and the program rebate. These firms reported a low probability of installing the same equipment absent the program and would have done so between 18 months and 4 years later.

The PY8 and PY9 project-specific NTGRs are plotted in Figure 5 and Figure 6, respectively. Each plot point in the figure represents a sampled project. The plot points are grouped by strata. The green and blue horizontal lines denote the stratum-level energy and demand weighted NTGRs, respectively. Note that the lines overlap significantly, particularly for PY8, indicating the energy and demand weighted NTGR values are nearly identical.

**Figure 5. PY8 Sample NTGR by Stratum**

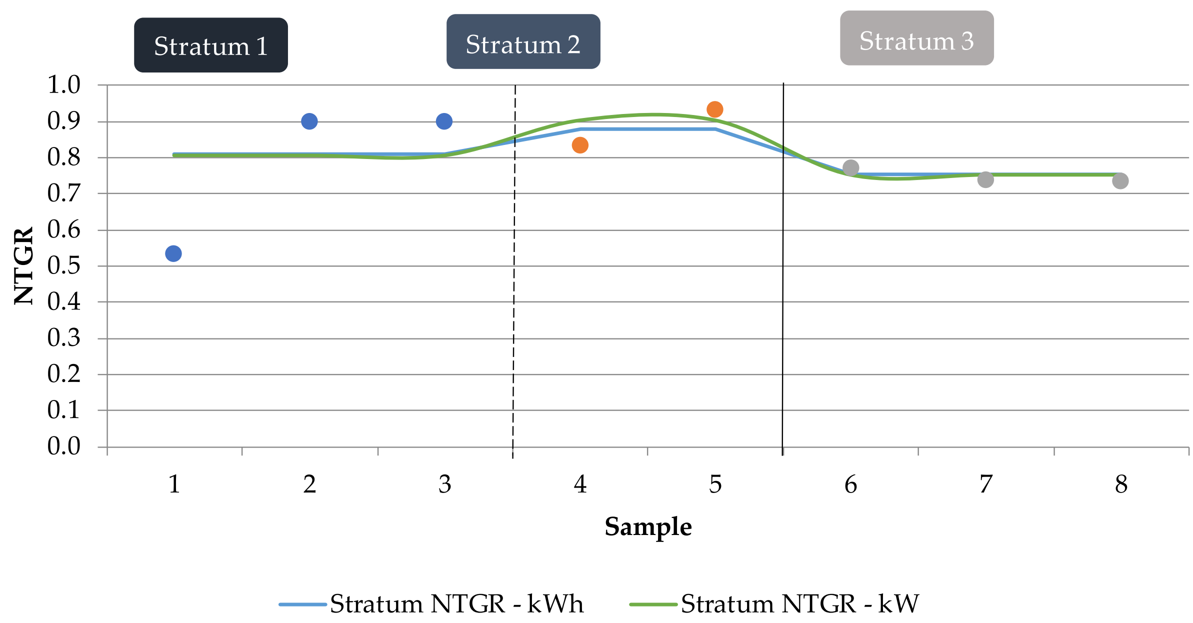
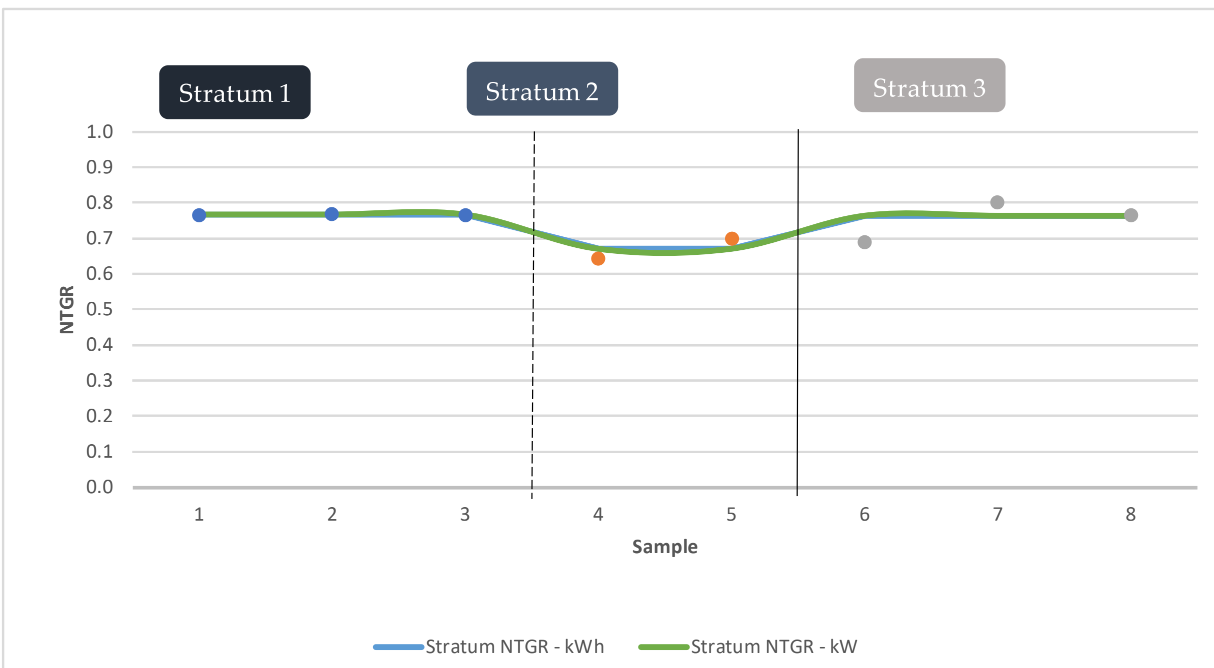


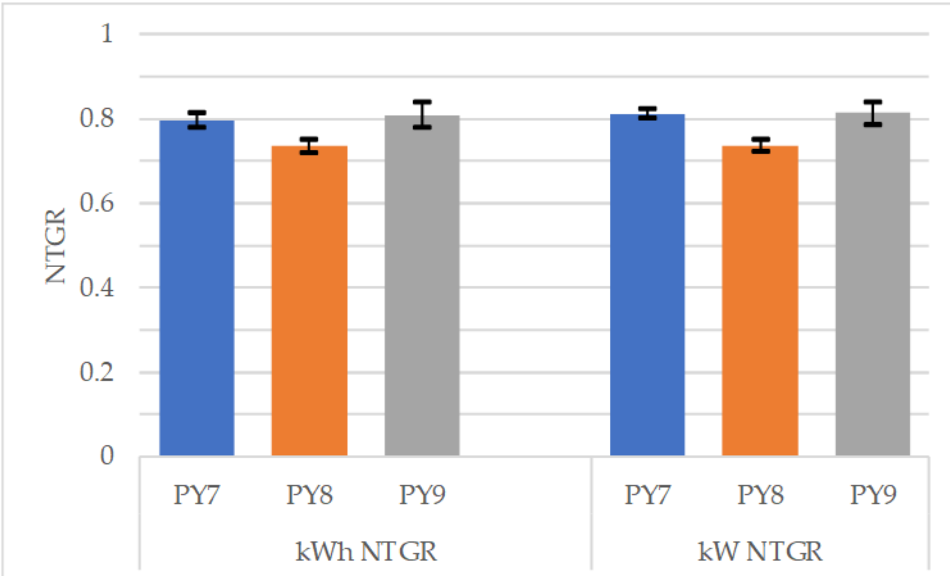

**Figure 6. PY9 Sample NTGR by Stratum**




The evaluation research findings energy and demand-weighted NTGR by program year, for PY7, PY8, and PY9, are presented below in Figure 7. The PY8 evaluated kWh NTGR for Industrial Systems projects of 0.74 is somewhat lower than the PY7 NTGR of 0.80 while the PY9 value of 0.81 is slightly higher. These results indicate continuing strong program influence. Note that the 90 percent confidence interval

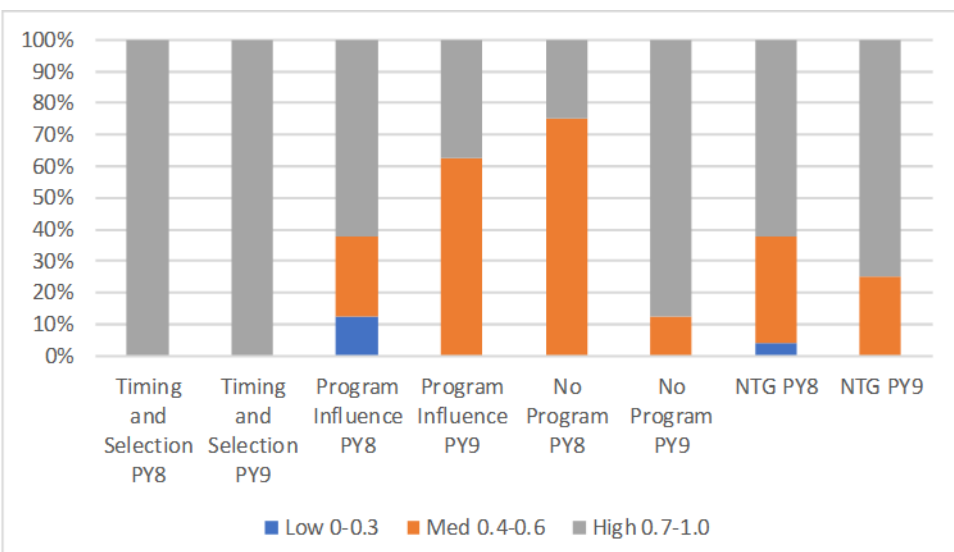
(CI) of the PY9 kWh NTGR does overlap with the CI of the PY7 kWh NTGR, indicating that the PY9 kWh NTGR is not statistically different from the PY7 value.

**Figure 7. Evaluated NTGR by Program Year with 90% Confidence Intervals**




A breakdown of the NTGR by the three component scores is shown in Figure 8. The timing and selection score reflects the importance of various program and program-related elements in the customer's decision and timing of the decision in selecting specific program measures. The program influence score reflects the relative degree of influence the program had on the customer's decision to install the specified measures as versus non-program factors. The no-program score captures the likelihood of various actions the customer might have taken at this time and in the future if the program had not been available.

**Figure 8. NTGR Level by Component Scores**



A scan of the PY8 vs. PY9 bars provides additional insight into a key causal factor for the increase in the NTGR value between PY8 and PY9. The concentration of High and Medium values is moderately to significantly higher in PY9 than PY8 for the Program Influence and No Program scores. As a result, for the overall NTGR, the share of High and Medium scores in PY9 exceeds that in PY8 by a small margin.

### *Combined PY8 and PY9 Results*

The evaluation team also computed a combined PY8 and PY9 NTGR. This value was determined using savings weighted NTGRs from PY8 and PY9 and computing a weighted average value. The combined PY8/9 value of 0.77 is moderately less than the PY7 NTGR of 0.80. *We recommend that the combined PY8/9 value of 0.77 be used to compute program-verified savings for CY2019 projects going forward.* We recommend this combined value because it is based on a larger and more robust sample representing two-years' worth of projects, and it reflects the latest available information from the evaluation effort. This recommendation is consistent with the planned research spelled out in our PY8 and PY9 evaluation plans.

**Table 6. Combined PY8 and PY9 MWh NTG Ratio**

| Year | N | kWh | Weight | NTGR | NTG SE |
|---|---|---|---|---|---|
| PY8 | 74 | 36,900,688 | 49% | 0.74 | 1% |
| PY9 | 92 | 38,665,705 | 51% | 0.81 | 2% |
| **IS PY8/PY9** | **166** | **75,566,393** | | **0.77** | **2%** |

## Sensitivity Case - Weighted NTG Results Based on No Program FR Score Option #2

The evaluation team also performed a sensitivity analysis based on the No Program FR Score Option #2. Results are lower due to the greater weight given to the higher weight provided to the alternative specification for the No Program score. This algorithm varies from Option 1 with respect to how it treats the effect of the study performed by the program and the effect of timing in the calculation of the No-Program score. Option 1 adjusts for Timing within the No-Program score, then averages the 3 scores. Option 2 uses the following procedure:

- It assigns a value of 0.00 FR to the self-reported zero likelihood of the customer performing study on their own, performing maintenance that excludes the MEASURE, and lack of awareness of performance issue prior to the study. It assigns a value of 1.00 FR for the self-reported likelihood of the customer performing study on their own, and performing maintenance that includes the MEASURE, For all other response combinations, same as Option #1.

The Timing adjustment factor, if applied, is based on the formula below:

**Timing Adjustment Factor (Free Ridership Score)** as equal to:

1 - ((Number of Months Expedited - 6)/42)*((10 - Likelihood of Implementing within One Year)/10)

### *NTG No Program FR Score Option #2 –PY8 Weighted NTG Results*

The PY8 program-level NTGR for Option #2 of the algorithm, along with precision estimates, is shown below in Table 7. The overall program NTGR for PY8 is 0.75, which is very slightly lower than the Option 1 value of 0.74. This difference is due to the heavier weight placed in Option 2 on self-reported no-program maintenance that includes the incented equipment in the No-Program score. Option 1 excludes these factors.

**Table 7. No Program FR Score Option #2 PY8 NWh NTG Ratio and Relative Precision at 90% Confidence Level**

| Sampling Strata | Relative Precision ± % | Low | Mean | High |
|---|---|---|---|---|
| 1 | 10% | 0.61 | 0.68 | 0.75 |
| 2 | 4% | 0.64 | 0.67 | 0.69 |
| 3 | 9% | 0.81 | 0.89 | 0.97 |
| **Total IS PY8 Option 2** | **5%** | **0.71** | **0.75** | **0.78** |

### *NTG Option 2 – PY9 Weighted NTG Results*

For this second option of the NTG algorithm, the PY9 program level NTGR, along with precision estimates, is shown below in Table 8.. The program-level PY9 mean energy NTGR average of 0.70 is much lower than the NTGR of 0.81 under NTG Option 1. Again, this decrease is due to the heavier weight given to the self-reported no-program maintenance that includes the incented equipment in the No-Program score under Option 2 as versus Option 1 (which excludes these considerations.

**Table 8. No Program FR Score Option 2 PY9 kWh NTG Ratio with Relative Precision at 90% Confidence Level**

| Sampling Strata | Relative Precision ± % | Low | Mean | High |
|---|---|---|---|---|
| 1 | 7% | 0.59 | 0.64 | 0.68 |
| 2 | 28% | 0.51 | 0.70 | 0.90 |
| 3 | 2% | 0.74 | 0.75 | 0.76 |
| **Total IS PY9 Option 2** | **8%** | **0.64** | **0.70** | **0.75** |

Figure 9 (PY8) and Figure 10 (PY9) below compare the evaluated kWh NTGRs for Options 1 and 2 for each sampling stratum. For PY8, when compared to Option 1, the mean energy NTGR values are much lower (0.69 vs. 0.81) for stratum 1 (large sized projects), much lower (0.67 vs. 0.88) for stratum 2 (medium sized projects), and much higher (0.89 vs. 0.90 for stratum 3 (0.89 vs. 0.75) for small sized projects. The improved results for stratum 3 projects is the reason for the slight increase in the average program NTGR.

In PY9, when compared to Option 1, NTGR values for the three Industrial Systems sampling strata are much lower (0.64 vs. 0.81) for stratum 1, much lower (0.70 vs. 0.88) for stratum 2, and the same (0.75) for stratum 3.

Figure 9. Comparison of PY8 Evaluated NTGR by NTG Option and Stratum

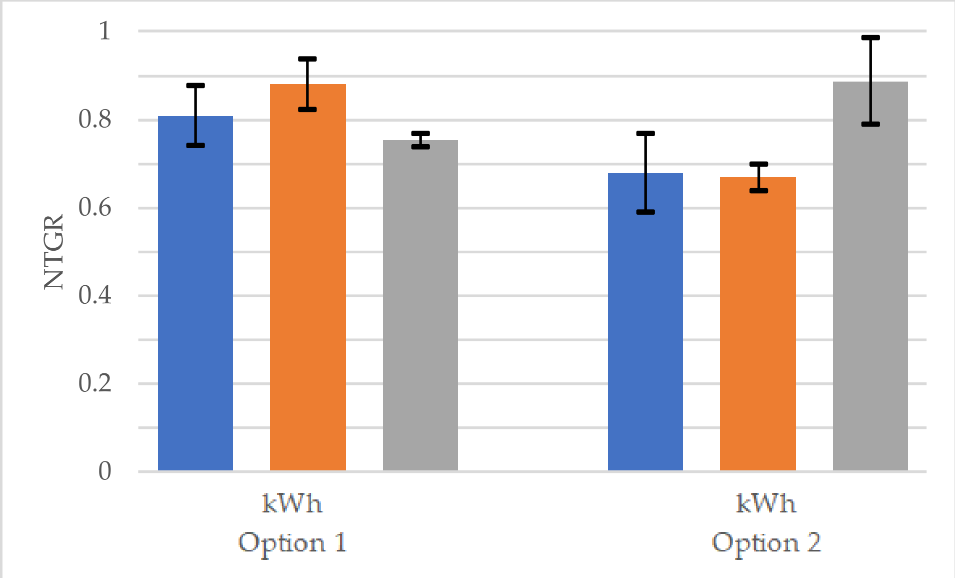
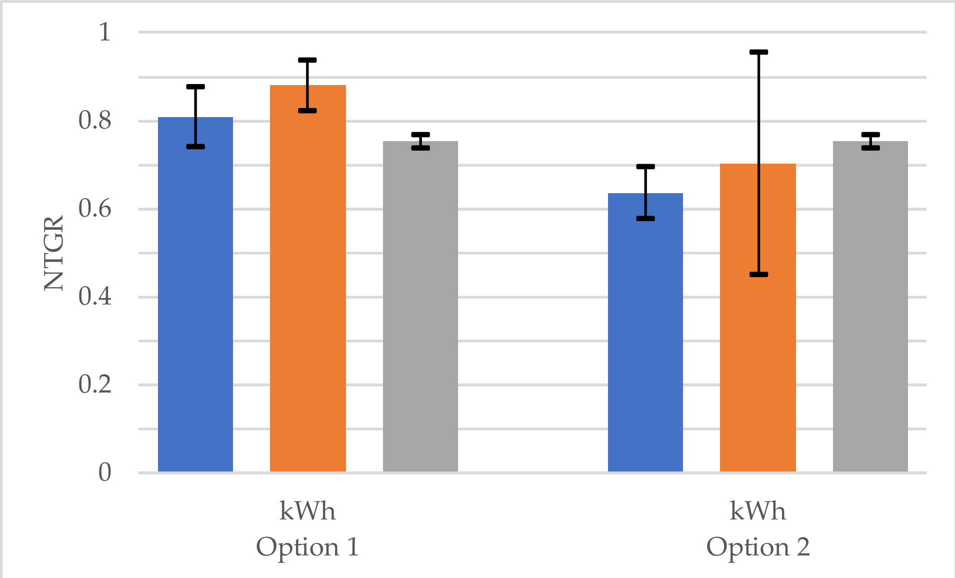



Figure 10. Comparison of PY9 Evaluated NTGR by NTG Option and Stratum




## Procedures to Reduce Free Ridership

Without a doubt, the large non-residential market is perhaps the most challenging to address in terms of the size and sophistication of end-use customers and suppliers, and the complexity of end-user projects. As a result, a certain amount of free ridership is to be expected in this market. The Industrial Systems program has continued to demonstrate medium-high program influence, and the level of free ridership found in this evaluation may be the minimum that could be expected in this market.

The NTGRs for the Industrial Systems program have fluctuated between 0.68 and 0.81 since the program began, and are in line with similar study-based programs offered elsewhere in the U.S. However, the combined PY8/9 NTGR value of 0.77 suggests that a moderate level of free ridership is still present.

One option available to ComEd to reduce free ridership is to conduct screening for free ridership on a project-by-project basis, particularly for projects suspected of having higher levels of free ridership. In cases where it is found, the program implementer should continue and expand their current pre-approval process to provide more explicit consideration and re-formulation of projects already planned for completion by the customer. *Note that this option does not equate to rejecting a customer for energy efficiency funding. Instead, the concept is to "upsell" the customer to an energy efficiency project that they weren't already planning to do on their own.*

**Project -Level Screening Procedure.** One way to assess the rate of free ridership likely on a given project is to critically examine the key reasons behind the project **before** the incentive is approved. For example:

- Has the project already been included in the capital or operating budget? Has the equipment already been ordered or installed?
- Is the measure one that the company or other comparable companies in the same industry/segment routinely installs as a standard practice? Is the measure installed in other locations, without co-funding by incentives? Is the measure potentially Industry Standard Practice?
- Is the project being done, in part, to comply with regulatory mandates (such as environmental regulations)?
- Are the project economics already compelling without incentives? Is the rebate large enough to make a difference in whether or not the project is implemented?
- Is the company in a market segment that is ahead of the curve on energy efficiency technology installations? Is it part of a national chain that already has a corporate policy to install the proposed technology?
- Does the proposed measure have substantial non-energy benefits? Is it largely being considered for non-energy reasons (such as improved quality or increased production)?
- Is the project payback quite short even without the incentive?

By conducting a brief interview regarding these issues before the incentive is approved, ComEd can better assess the likely degree of free ridership and may be able to then decide if the project should be excluded or substantially re-scoped to a higher efficiency level.

## Spillover

Spillover effects were addressed in the PY8 and PY9 evaluations, based on responses to a battery of spillover questions in the telephone survey. Detailed spillover-related findings from the surveys are reported in Table 9 below.

**Table 9. Detailed Spillover Related Findings for PY8 and PY9**

| | Evidence of Spillover | |
|---|---|---|
| **Spillover Question** | **PY8** | **PY9** |
| Since receiving an incentive for the project we just discussed, did you implement any ADDITIONAL energy efficiency measures at this facility or at your other facilities within ComEd's service territory that did NOT receive incentives through any utility or government program? | Of the 8 surveyed customers that responded, 5 (63%) implemented an additional measure without receiving an incentive. All implemented one energy efficiency measure. | Of the 8 surveyed customers that responded, two (25%) implemented an additional measure without receiving an incentive. |
| What type of energy efficiency measure was installed without an incentive? | Four of the five respondents implemented Energy efficient LED lamps, The fifth respondent installed Ten Energy Efficient motors | #1 - Two VFDs on Cooling Equipment; #2 - Between 20 and 30 LED lamps (did not provide baseline technology) |
| On a scale of 0 to 10, where 0 means "not at all significant" and 10 means "extremely significant," how significant was your experience in the ComEd program in your decision to implement this energy efficiency measure? | Significance rating of 0 for 4 of the 5 respondents with LED lamps who replace them as a normal replacement practice, Remaining respondent with Energy Efficiency motors provided a significance rating of 10 but then commented that it was driven by their corporate policy for continuous improvement revealing the program wasn't important after all. | Ratings of #1 - 8 and #2 - 0 |
| Why did you purchase this energy efficiency measure without the financial assistance available through the ComEd's program? | Motor respondent didn't know a rebate was available, plus it was too small. | #1 - The rebate was not sufficient to justify the hassle of applying for it. #2 - Has a load over 10 MW and was ineligible for ComEd's program |

Only one respondent each in PY8 and PY9 installed a measure with potential savings that could be possibly be attributed to calculation of the spillover ratio. The PY8 respondent provided information revealing that the program wasn't important after all in influencing their decision. The PY9 respondent did not provide baseline lighting information to support a savings calculation but did provide other information that indicated the savings would be very low. Therefore, no spillover is attributable to either the PY8 or PY9 program.

## Cronbach's Alpha Results

Cronbach's Alpha is a measure of internal consistency or reliability. It is used to assess how closely related a set of items are as a group. In this memo, Cronbach's Alpha is used to assess how closely related the items going into the NTG score are to each other. In general, the higher the measured Cronbach's Alpha value, the more consistent and reliable are the results. However, given the small number of items (i.e., the 3 scores) being considered in this application of Cronbach's Alpha, a high alpha value is not expected. Realistically, Alpha values ranging from 0.4 to 0.6 are considered an acceptable measure of reliability for this analysis given the small number of items being analyzed.

We used the Standardized Cronbach's Alpha calculation as specified below:

$$\alpha = \frac{N \cdot \bar{r}}{1 + (N - 1) \cdot \bar{r}}$$

Where:

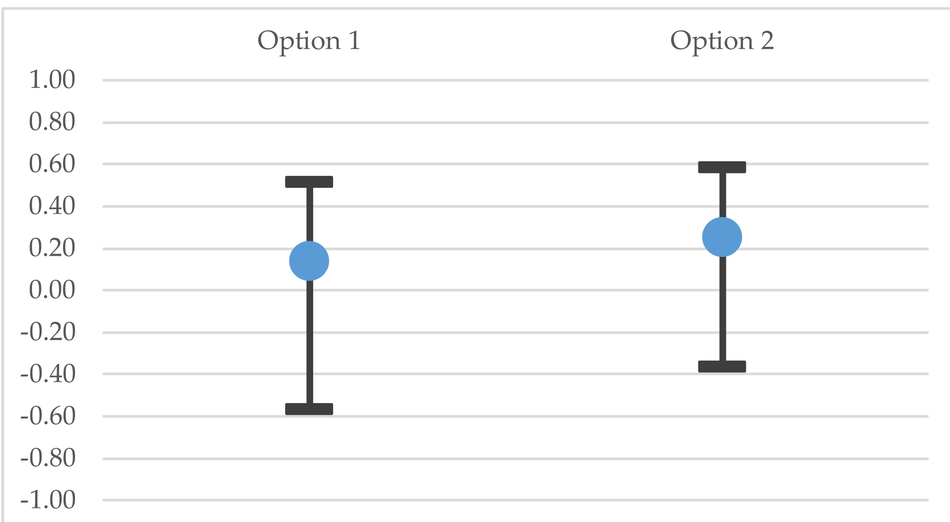
$N$ = the number of items
$\bar{r}$ = the average correlation

We calculated the Cronbach Alpha for each program year, for the two algorithm variations discussed previously.

Figure 11 below presents the Cronbach's Alpha and the 90% confidence intervals for the two NTGR algorithm variations for the Data Centers Program. Overall Cronbach's Alpha values for PY8/9 combined were quite low, 0.14 (Option 1) and 0.25 (Option 2).

Note that the confidence intervals around Alpha are expected to be quite large due to the relatively small sample sizes. The results for both years combined show wide confidence bands and low Alpha values for both algorithm versions, due to the relatively small sample size and diverse project-level NTGR results implying a lack of inter-item correlations.

**Figure 11. PY8/9 Industrial Systems Program Cronbach's Alpha and 90% Confidence Intervals for the Two Algorithm Variations (N=16)**



## APPENDIX: INDUSTRIAL SYSTEMS PROGRAM NTG HISTORY

| | Industrial Systems Optimization (Compressed Air in EPY4) |
|---|---|
| EPY1 | Program did not exist |
| EPY2 | Program did not exist |
| EPY3 | Program did not exist |
| EPY4 | **Retroactive application of NTG** of 0.67 for kWh and 0.72 for kW (EPY4 Compressed Air)<br>**Free-Ridership** 33% kWh and 0.28 kW<br>**Spillover** 0%<br>**Method**: Customer self-report. 7 surveys completed from a population of 9. |
| EPY5 | SAG Consensus:<br>• 0.67 |
| EPY6 | SAG Consensus:<br>• 0..67 |
| EPY7 | **NTG: 0.68**<br>**Free-Ridership: 0.33**<br>**Participant Spillover: 0.01**<br>**Nonparticipant Spillover: Negligible**<br>Free Ridership and participant spillover was measured in a participant survey on 35 projects. Interviews were completed with 5 of 11 Data Center projects. |
| EPY8 | **Recommendation (based upon PY6 research):**<br>**NTG, kWh: 0.74**<br>**Free Ridership, kWh: 0.26**<br>**Spillover, kWh: Negligible**<br>**NTG, kW: 0.83**<br>**Free Ridership, kW: 0.17**<br>**Spillover, kW: Negligible**<br><br>NTG research methods in PY6 consisted of participant and technical service provider survey data collection and analysis (n=17).<br><br>The net program impacts were quantified solely on the estimated level of Free-Ridership. Information regarding participant spillover was also collected, but ultimately did not support a finding of any spillover. |
| EPY9 | **Industrial Systems NTG: 0.80**<br>**Industrial Systems Free Ridership: 0.20**<br>**Industrial Systems Spillover: Negligible**<br>**NTG Research Source:**<br>Free-Ridership: PY7 Participant and vendor self-report data<br>Spillover: PY7 Participant and vendor self-report data |
| EPY10 | **Industrial Systems NTG kWh: 0.80**<br>**Industrial Systems NTG kW: 0.81**<br>**Industrial Systems Free Ridership kWh: 0.20**<br>**Industrial Systems Free Ridership kW: 0.19**<br>**Industrial Systems Spillover: Negligible**<br>**NTG Research Source:**<br>Free-Ridership: PY7 Participant and vendor self-report data<br>Spillover: PY7 Participant and vendor self-report data<br>The evaluation team performed telephone surveys in PY8, but the analysis will be performed and combined with PY9 findings. |

*Source: http://ilsagfiles.org/SAG_files/NTG/2017_NTG_Meetings/Final/ComEd_NTG_History_and_PY10_Recommendations_2017-03-01.pdf*