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ComEd Custom Incentives Combined Evaluation Report

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

Presented to ComEd

February 14, 2019

Prepared by:

Navigant

www.navigant.com

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ComEd Custom Incentives Combined Evaluation Report

Submitted to:

ComEd
Three Lincoln Centre
Oakbrook Terrace, IL 60181

Submitted by:

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1. INTRODUCTION

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

APPENDIX A. COMED CUSTOM INCENTIVES PY9 IMPACT EVALUATION REPORT 2017-04-17 FINAL

NAVIGANT

ComEd Custom Incentives Impact Evaluation Report

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

Presented to
Commonwealth Edison Company

FINAL

April 17, 2018

Prepared by:

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Itron, Inc.

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1. INTRODUCTION

This report presents the results of the impact evaluation of ComEd's PY9 Custom Incentives Program. It presents a summary of the energy and demand savings impacts for the total program broken out by relevant measure and program structure details. The appendix presents the impact analysis methodology. PY9 covers June 1, 2016 through December 31, 2017.

Based on the gross impact sample of twenty projects in PY9, the evaluation results yielded an energy savings gross realization rate of 0.86 and peak demand gross realization rate of 1.60. To calculate net savings, the evaluation team used a deemed net-to-gross ratio (NTGR) of 0.58 for energy and demand in accordance with the Illinois Stakeholder Advisory Group (SAG)-approved values. These deemed NTGRs for energy and demand are based on the PY7 NTG analysis.

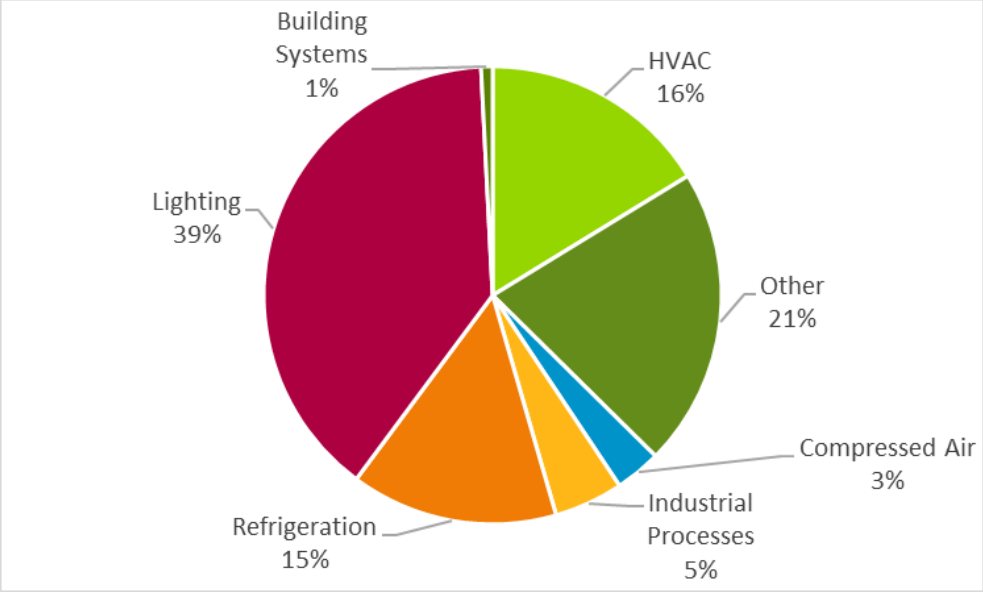
Overall, the program team succeeded in ensuring the installation and proper operation of the implemented measures. The program team continues to collect site-specific pre- and post-metered data for all projects, which enables accurate estimation of ex ante savings. In general, the program team successfully collected site-specific pre- and post-measurement and verification (M&V) data using acceptable methods based on industry practices. The M&V data provided by the program team was useful for the evaluation and allowed the evaluation team to complete the analysis for seven of the twenty projects in the sample using a desk review procedure. For these seven projects, the evaluation team conducted a telephone interview with the site contact to verify the installation of the equipment, validate the data provided by the program team, and facilitate the collection of missing data needed to complete the review.

2. PROGRAM DESCRIPTION

ComEd's Smart Ideas for Your Business suite of energy efficiency programs for business customers includes a Custom Incentives (Custom) program. This program provides a custom incentive, based on a formula, for less common or more complex energy-saving measures installed in qualified retrofit and equipment replacement projects. Custom incentives are available based on the project's kWh savings, provided the project meets all program eligibility requirements. For eligible projects, the program pays an incentive of $0.07/kWh saved. This is the seventh year of implementation of the Custom program.

The program had 117 participants in PY9 and consisted of mostly Lighting, "Other", HVAC, and Refrigeration measures as shown in Figure 2-1. Lighting constitutes approximately 39% of the measures in the PY9 population. The measure end-use listed in the final tracking database was used to create the measure distribution chart.

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 Custom Incentives 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	48,447,199	N/A	3,521
Program Gross Realization Rate	0.86	N/A	1.60
Verified Gross Savings	41,746,338	N/A	5,620
Program Net-to-Gross Ratio (NTGR)	0.58	N/A	0.58
Verified Net Savings	24,212,876	N/A	3,260

Source: ComEd tracking data and Navigant team analysis.

4. Program Savings by Measure

Savings for the Custom Incentive Program are sampled on and reported at a strata level and do not have measure-level savings. For more information about strata- and site-level savings see Appendix 2.

5. Impact Analysis Findings and Recommendations

The evaluation team reviewed ComEd's tracking data extract to determine reported PY9 ex ante gross savings. The verified gross program impacts for the evaluation for the Custom program were developed based on combination of on-site M&V analysis and engineering desk reviews.

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 therefore 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 were not specified in the TRM. The results are shown in Table 5-1.

Table 5-1. Verified Gross Savings Parameters

Gross Savings Input Parameters	Value	Deemed * or Evaluated?
Gross Energy Savings Realization Rate	0.86	Evaluated
Gross Peak Demand Savings Realization Rate	1.60	Evaluated
NTG Ratio	0.58	Deemed*
Net Energy Savings (kWh)	24,212,876	Evaluated
Net Peak Demand Savings (kW)	3,260	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 below shows a comparison of the energy and demand realization rates for every site. The PY9 energy-savings realization rate results ranged from 0.10 to 1.88, which resulted in a program-level realization rate of 0.86. The peak demand-savings realization rates for the twenty projects in the gross sample ranged from 0.09 to 1.43. Eleven of the twenty projects did not claim any ex ante peak demand savings.[2] For twelve out of the twenty projects, the realization rates were within 10 percent of 1.0 for the energy savings; on the other hand, only two of the nine projects were within 10 percent of 1.0 for the peak demand savings.

[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.
[2] During the evaluation analysis, the team found that only one of these sites had no peak demand savings.

Figure 5-1. Energy and Demand Realization Rates

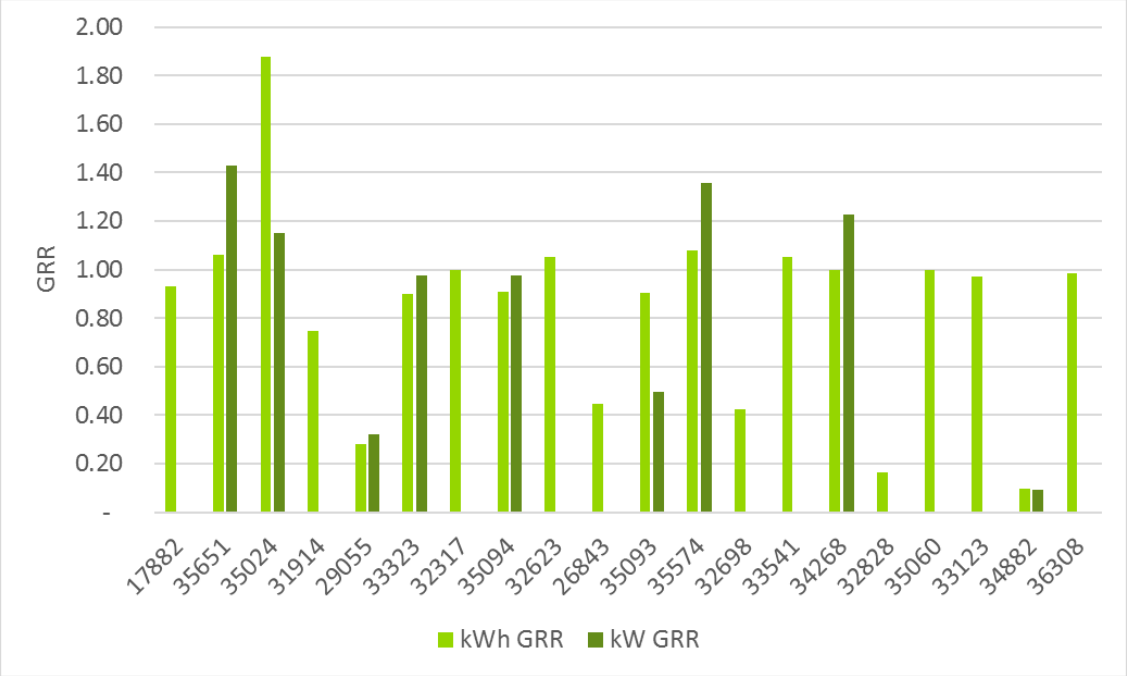
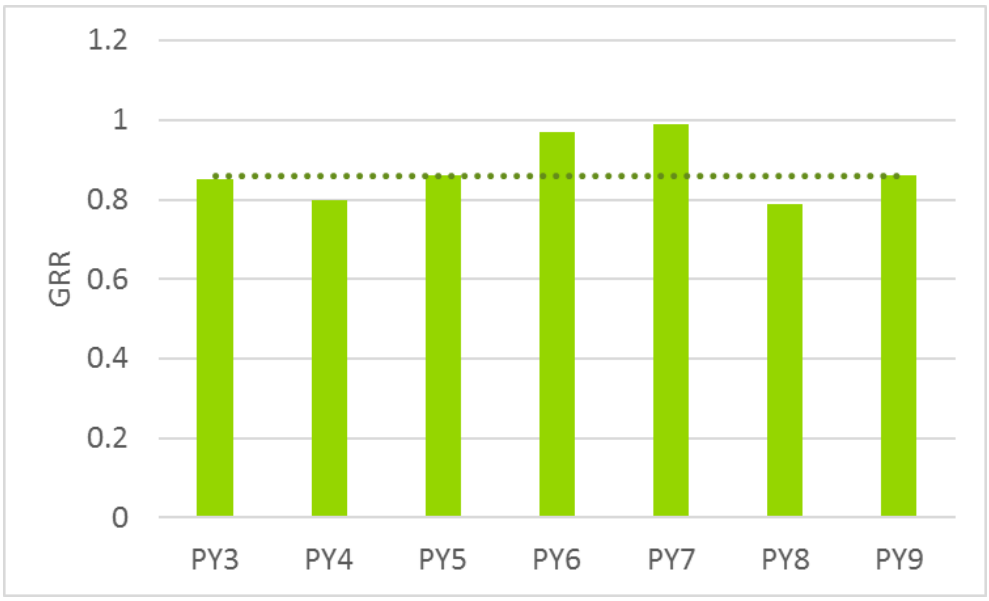


Figure 5-2 below compares the overall program-level energy gross realization rates (GRR) over the past years. There was a general upwards trend between PY4 and PY7 but a dip occurred in PY8 and PY9. However, the PY9 GRR of 0.86 is higher than the previous year and it is comparable to the median (0.86) of GRR over the past seven years. For the future programs years, the implementation team should follow the findings and recommendations when applicable. Following the recommendations and early feedback provided by the evaluation team on the large and complicated projects will bring the GRR closer to 1.0 for the future program cycles.

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



5.2 Other Impact Findings and Recommendations

Finding 1. For lighting projects, key parameters in the ex-ante savings estimate like the operating hours, interactive effects and the coincidence factors were found to be inaccurate. (e.g., 35094, 33323, 35651,35024 and 35094)

Recommendation 1. For the lighting projects in the Custom program, it is critical that the site specific operating hours are used instead of using defaults values from the TRM. For small lighting projects, where no measurements are performed for estimating the operating hours, interviews with multiple facility staff should be conducted to estimate the operating hours. Also, the interactive effects and coincidence factors used in the savings estimates should be consistent with the latest version of the TRM.

Finding 2. There were multiple instances (31914,33123 and 34882) where the evaluation team adjusted the ex-ante calculations because the baseline system was incorrectly selected or modeled.

Recommendation 2. Baseline selection is one of the most challenging issue for a custom program. Extra care should be taken during the baseline selection process and industry/facility standard practice should be used for capacity expansion or natural replacement projects. If there are any doubts about the baseline selection, the implementation team should pass it through the evaluation team for early feedback before the savings are finalized.

Finding 3. There were a few projects (32828, 34882, 32698 and 17882) with major issues surrounding the methodology or assumptions used in the ex-ante savings calculation.

Recommendation 3. The evaluation team recommends using additional quality control procedures to identify the deficiencies in the ex-ante calculations. Whenever possible, the savings should be validated using an alternate approach as a sanity check. Care should be taken to adjust metered operation to account for annual changes to operation due to production, temperature or other factors.

Finding 4. Lack of claimed demand savings for some projects continues to be an issue for the ComEd Custom program. For PY9, there were nine projects in the evaluation sample where the ex-ante demand savings were not claimed for which the evaluation team found non-zero savings.

Recommendation 4. Savings should be claimed for all projects that save energy over the PJM peak summer period of 1:00-5:00 PM Central Prevailing Time on non-holiday weekdays, during the months of June through August and reported in the tracking system.

6. Appendix 1. Impact Analysis Methodology

6.1 Sampling

6.1.1 Profile of Population

The table below presents the three sampling strata used in the evaluation of the Custom Incentives Program. This was based on a total of 117 tracking records. Table 6-1 presents the number of records by strata, along with the claimed ex ante gross MWh and kW.

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	11,309,438	897	4	682,695
2	18,863,237	1,130	15	1,229,287
3	18,274,524	1,495	98	1,136,803
PY9 Total	48,447,199	3,521	117	3,048,785

Source: Evaluation Team analysis

6.1.2 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 twenty projects. The evaluation team sorted projects based upon the level of ex ante kWh savings and placed the projects in three strata.

Table 6-2 provides a profile of the gross impact M&V sample for the Custom Incentives Program in comparison with the program population. The table shows the resulting sample, consisting of twenty projects. These projects make up approximately 23 million kWh of the ex-ante impact claim, which represents 48 percent of the ex ante impact claim 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				Sampled Projects		
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	11,309,438	0.23	4	11,309,438	100%
2	15	18,863,237	0.39	8	10,043,736	53%
3	98	18,274,524	0.38	8	2,032,841	11%
PY9 Total	117	48,447,199	-	20	23,386,015	48%

Source: Evaluation Team analysis

6.1.3 Roll-up of Savings

There are two basic statistical methods for combining individual GRR from the sample projects into an estimate of verified gross kWh savings for the population when stratified random sampling is used. These two methods are referred to as “separate” and “combined” ratio estimation.[3] 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 Custom Incentives Program. The separate ratio estimation technique follows the steps outlined in the

[3] A full discussion and comparison of separate vs. combined ratio estimation can be found in Sampling Techniques, Cochran, 1977, pp. 164-169.

California Evaluation Framework[4], 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.

7. Appendix 2. Impact Analysis Detail

The Custom Incentives Efficiency program sample includes twenty sites across three strata, as shown in Table 7-1. Most of the savings are due to four sites, which make up the top stratum. These sites account for approximately 59% of the ex post energy savings and approximately 55% of the ex post peak demand savings.

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	4	11,309,438	1.21	13,689,793	0.58	7,940,080	N/A	N/A	12.4
2	8	18,863,237	0.81	15,243,769	0.58	8,841,386	N/A	N/A	12.4
3	8	18,274,524	0.70	12,812,777	0.58	7,431,411	N/A	N/A	12.4
Total		48,447,199	0.86	41,746,338	0.58	24,212,876	N/A	N/A	12.4

* 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 7-3 shows the peak demand savings by strata. Verified gross realization rate for all the stratum is over 1.0 as the ex-ante demand savings were not claimed for some of the projects. The evaluation team estimate the ex-post peak demand savings for the projects where applicable and this resulted in high GRR for peak demand.

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	4	897	1.69	1,515	0.58	879
2	8	1,130	1.10	1,247	0.58	723
3	8	1,495	1.91	2,859	0.58	1,658
Total		3,521	1.60	5,620	0.58	3,260

* 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.

[4] Tec Market Works, "The California Evaluation Framework," Prepared for the California Energy Commission, June 2004. Available at http://www.calmac.org

Table 7-4 and Table 7-5 show the savings by site. Most of the savings are due to projects 17882, 35651, 35024 and 31914; which account for approximately 59% of the ex post energy savings and approximately 55% of the 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)
17882	1	4,175,494	0.93	3,882,207	0.58	2,251,680
35651	1	2,049,207	1.06	2,171,632	0.58	1,259,547
35024	1	3,399,058	1.88	6,375,614	0.58	3,697,856
31914	1	1,685,679	0.75	1,260,340	0.58	730,997
29055	2	1,329,962	0.28	373,565	0.58	216,668
33323	2	1,283,634	0.90	1,152,504	0.58	668,452
32317	2	1,606,432	1.00	1,606,432	0.58	931,731
35094	2	1,087,127	0.91	986,543	0.58	572,195
32623	2	1,063,245	1.05	1,117,935	0.58	648,402
26843	2	1,361,549	0.45	610,156	0.58	353,890
35093	2	1,298,749	0.90	1,175,228	0.58	681,632
35574	2	1,013,038	1.08	1,094,186	0.58	634,628
32698	3	471,730	0.42	200,458	0.58	116,266
33541	3	135,577	1.05	142,335	0.58	82,554
34268	3	524,032	1.00	524,032	0.58	303,939
32828	3	269,260	0.16	43,945	0.58	25,488
35060	3	199,305	1.00	199,003	0.58	115,422
33123	3	221,016	0.97	214,193	0.58	124,232
34882	3	120,672	0.10	11,521	0.58	6,682
36308	3	91,249	0.98	89,794	0.58	52,081
Total		23,386,015	NA	23,231,623	0.58	13,474,341

** 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)
17882	1	0	-	248	0.58	144
35651	1	330	1.43	471	0.58	273
35024	1	567	1.15	651	0.58	378
31914	1	0	-	145	0.58	84
29055	2	256	0.32	82	0.58	48
33323	2	150	0.98	147	0.58	85
32317	2	0	-	183	0.58	106
35094	2	128	0.98	125	0.58	73
32623	2	0	-	89	0.58	52
26843	2	0	-	119	0.58	69
35093	2	311	0.49	154	0.58	89
35574	2	133	1.36	180	0.58	105
32698	3	0	-	1	0.58	0
33541	3	0	-	15	0.58	9
34268	3	73	1.23	90	0.58	52
32828	3	0	-	0	0.58	0
35060	3	0	-	55	0.58	32
33123	3	0	-	9	0.58	5
34882	3	22	0.09	2	0.58	1
36308	3	0	-	10	0.58	6
Total		1,970	NA	2,777	0.58	1,611

** 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 end of year summary 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 7-4 summarizes the results for each project. The evaluation team uncovered some issues in twelve of the twenty projects, which resulted in energy or demand realization rates with a discrepancy of greater than 10% from a realization rate of 1.0. Some key observations from these site-specific evaluation results are discussed below for each project that saw large differences in savings.

- Project #35024: The major difference in savings is the increase in the HOU of the warehouse lighting to 8,760. The team also adjusted the CF and interactive effects to reflect the TRM version 5.0.

- Project #29055: The main reason for reduction of the savings for this project is adjustments made to the analysis based on the high efficiency lighting installed at the new facility. Another reason is the operating sequence of the VFD compressor identified during the evaluation site visit.
- Project #31914: The ex ante and ex post analysis differ in approach, as the evaluation team did not agree on the ex ante approach of comparing energy usage of one building to another without an in-depth analysis of the differences between the two buildings. Therefore, it is not possible to determine the specific factors which led to the low GRR.
- Project 33323: The major difference in the ex ante and ex post savings was due to reduction in operation hours of the entry way lighting to 4,380 hours per year. The evaluation team adjusted the operational hours based on the interview with the customer. In addition, the team adjusted the interactive effects and Coincident Factors to make them consistent with the TRM version 5.0.
- Project #26843: The reduction in savings for this project was primarily due to the load on the chiller system being significantly less than anticipated in the original analysis, which accounted for approximately 99% of the adjustment to the savings.
- Project 35093: The 10% reductions in ex ante savings for this project was due to the adjustments made to HVAC interactive effects. The team updated the energy and demand savings interactive effects for this project to be consistent with the Illinois TRM V5.
- Project 35574: The ex ante demand savings calculations were incorrect. The evaluation? team assumed that the peak demand would be equal to the maximum observed pre- and post-case interval values. Additionally, the interval data was not converted to power kW from half-hour energy kWh values.
- Project #32698: The initial metering was typical for the winter operation, but did not accurately reflect the summer operation when greater flow was required. The ex post analysis utilized a larger amount of data to incorporate the typical annual operation of the facility, resulting in reduced savings estimates.
- Project #32828: The significant reductions in ex post savings for this project were due to multiple adjustments to the analysis. Ex post analysis limited the savings to temperatures above 45° F to be consistent with the pre-operation profile? and it resulted in a 50% reduction in savings. Additionally, changing the cooling load profile to sensible cooling rather than using enthalpy reduces the savings by an additional 30%.
- Project #34882: Ex-ante savings overestimated the baseline demand usage for the installed equipment. The evaluation team updated the baseline based on the manufacturer specification sheets and the site visit. Adjusting the baseline assumptions for this project resulted in a 71% reduction in savings. The savings were further reduced based on the measured idle demand of similar units to the baseline units installed at the site.

8. APPENDIX 4. TRC

Total Resource Cost (TRC) related data for the twenty projects in the Custom Incentive Program sample can be found in Table 9-1.

Table 8-1. TRC Table. Total Resource Cost Savings Summary[5]

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)
17882	Process Cooling	Each	1	13	4,175,494	-	3,882,207	248
35651	Indoor Custom Lighting	Each	1	12	2,049,207	330	2,171,632	471
35024	Lighting-Outdoor & Indoor	Each	1	12	3,399,058	567	6,375,614	651
31914	Custom - Industrial Refrigeration	Each	1	13	1,685,679	-	1,260,340	145
29055	Ammonia Compressor with VSD	Each	1	15	1,329,962	256	373,565	82
33323	Custom - Lighting	Each	1	12	1,283,634	150	1,152,504	147
32317	Custom-Process Efficiency	Each	1	13	1,606,432	-	1,606,432	183
35094	Custom Lighting	Each	1	12	1,087,127	128	986,543	125
32623	Process Cooling	Each	1	13	1,063,245	-	1,117,935	89
26843	Process Cooling and Efficiency	Each	1	13	1,361,549	-	610,156	119
35093	Custom Lighting - Indoor & Outdoor	Each	1	12	1,298,749	311	1,175,228	154
35574	Custom - Industrial Refrigeration	Each	1	13	1,013,038	133	1,094,186	180
32698	VSD on Well	Each	1	15	471,730	-	200,458	1
33541	Custom - other	Each	1	13	135,577	-	142,335	15
34268	Indoor & Outdoor	Each	1	12	524,032	73	524,032	90
32828	Customs - HVAC	Each	1	13	269,260	-	43,945	-
35060	Custom - Lighting	Each	1	12	199,305	-	199,003	55
33123	Bridgestone Americas Tire MAU	Each	1	13	221,016	-	214,193	9
34882	Custom - Process Efficiency	Each	1	13	120,672	22	11,521	2
36308	Custom - Refrigeration	Each	1	13	91,249	-	89,794	10

[5] Source: ComEd tracking data and Navigant team analysis. This TRC variable 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. EUL details are subject to change and are not final.

APPENDIX B. COMED CUSTOM INCENTIVES PY8 AND PY9 NTG MEMO 2018-08-27 FINAL

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Verona, WI 53593

Memorandum

To: Erin Daughton, ComEd

From: Jennifer Fagan, Itron

CC: Milos Stefanovic, ComEd; Jennifer Morris, ICC Staff; Jeff Erickson, Randy Gunn, Rob Neumann, Navigant

Date: August 27, 2018

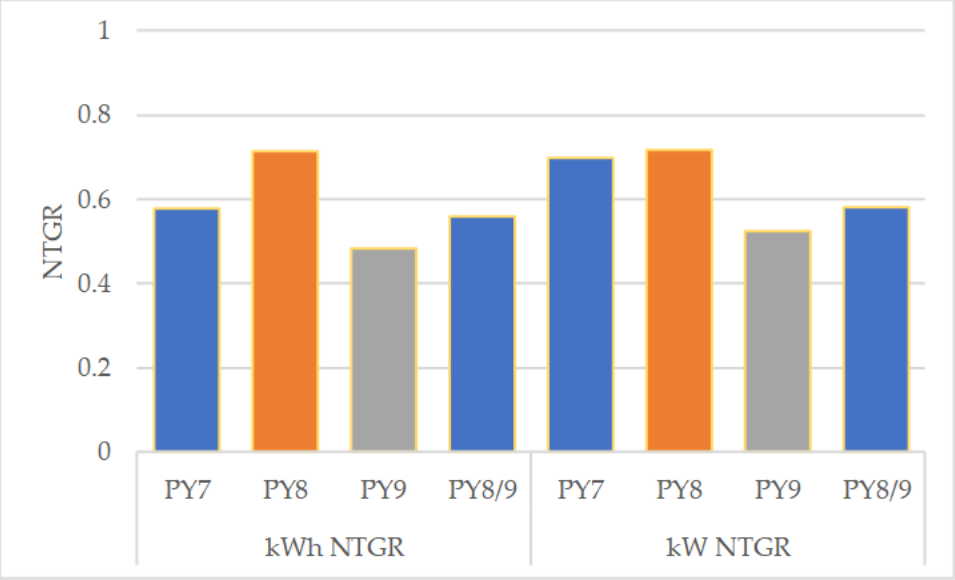
Re: Net-to-Gross Research Results from the PY8 and PY9 ComEd Custom Program

SUMMARY OF FINDINGS

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

The Evaluation Research findings' energy and demand-weighted net-to-gross ratio (NTGR) by program year, for PY7, PY8, and PY9, are presented below in Figure 1-1. The PY8 evaluated kWh NTGR for Custom projects of 0.71 is higher relative to the PY7 NTGR of 0.58; however, the PY9 evaluated kWh NTGR of 0.45 is lower.

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



The EM&V team also calculated a combined PY8 and PY9 NTGR. The team developed this value using savings weighted kWh NTGRs from PY8 and PY9 and computing a weighted average value. The combined PY8 and PY9 kWh NTGR value of 0.56 is similar to the PY7 kWh NTGR of 0.57. *The EM&V team recommends that the combined PY8 and PY9 kWh NTGR value of 0.56 be used to compute program-verified savings for CY2019 projects going forward.* We are recommending 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 Research*[1] PY8 and PY9 net-to-gross ratio (NTGR) estimates for ComEd's Custom Rebates program. Regarding PY8, note that net-to-gross (NTG) interviews were completed immediately following the end of the program year, but analysis of the PY8 data was postponed until the conclusion of the PY9 evaluation. Thus, 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 NTG algorithms specified in the Illinois TRM version 6.0. 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.

The evaluation team's preferred algorithm specification **is Core Free Ridership Algorithm 1**, shown graphically below (Figure 3-1). The majority of NTG findings discussed below are based on this version. The second option, Core Free Ridership Algorithm 2 (Figure 3-2) has also been analyzed, and those findings will be presented as a sensitivity case later in this memo. The rationale for selecting Algorithm 1 over Algorithm 2 is that Algorithm 1 provides for equal weighting of each of the three scores, which represent different ways of determining program influence. In contrast, Algorithm 2 applies a 50% weight to the program's effect on the timing of the project, which we believe is too high. Such a high weighting essentially discounts the effect of the other factors influencing program influence, which in our view is inappropriate.

[1] It should be noted that the NTGR estimates presented here are the evaluation verified estimates (based on the PY9 participating customer and non-participating retailer surveys).

Figure 3-1. Core Free Ridership Algorithm 1

(Program Components FR Score + Program Influence FR Score + (No-Program FR Score * Timing Adjustment 1)) / 3

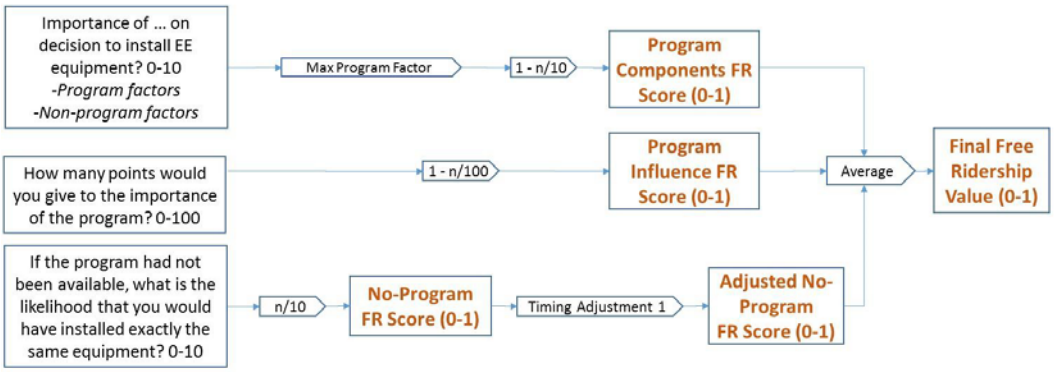
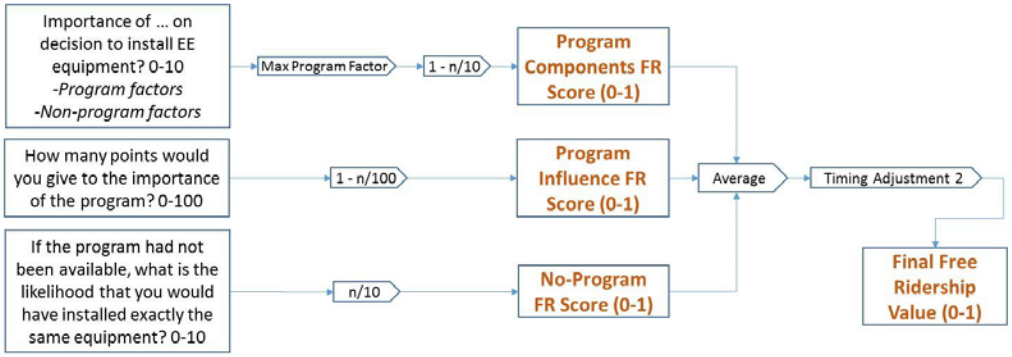


Figure 3-2: Core Free Ridership Algorithm 2

((Program Components FR Score + Program Influence FR Score + No-Program FR Score) / 3) * Timing Adjustment 2



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 3-1 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. For example, values of 2 for each score would yield a NTGR of 0.20 and a level of 80% free ridership (i.e., 1 - 0.20 NTGR = 80% FR) The calculation then averages those three scores and incorporates spillover findings to come up with a project-level net-to-gross ratio.

Table 3-1. Net-to-Gross Scoring Algorithms for the PY8 and PY9 Custom Program[2]

Scoring Element	Algorithm 1 Calculation	Algorithm 2 Calculation
Timing and Selection Score. The maximum self-reported score (on a 0 to 10 scale of importance) for the following program elements: A. Availability of the program incentive B. Technical assistance from program staff C. Recommendation from program staff D. Information from program marketing materials E. Endorsement or recommendation by account rep F. Recommendation from an equipment vendor	Maximum of A, B, C, D, E, and F	Maximum of A, B, C, D, E, and F
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 the same PROJECT.	Linear adjustment to self-reported No Program Likelihood Score and 10 (maximum score based on deferred installation 48 months or more later).	Self-reported No Program Likelihood.Score.
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.	Applied to the average of the Timing and Selection, Program Influence and No-Program scores
Project-level Free-ridership (ranges from 0.00 to 1.00)	1 minus Sum of scores (Timing and Selection, Program Influence, No-Program)/30	1 minus the average of the Timing and Selection, Program Influence and No-Program scores, adjusted for Timing
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 20 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

[2] Based on the NTG algorithm specifications in TRM v.6.0 Attachment A (Illinois Statewide Net-to-Gross Methodologies)

match the gross sample. During PY8, the evaluation team conducted telephone surveys for two waves of sample, yielding a total of 16 completed interviews. In PY9, the team conducted surveys for three waves of sample, and 19 interviews were completed. However, one of the PY9 survey completes was dropped from the analysis frame because the project was not completed. Therefore, the PY9 findings are based on a total of 18 completed interviews to support the calculation of the net-to-gross ratio calculation. The 16 PY8 and 18 PY9 NTG completes represent a subset of the 20 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 38 percent and 48 percent of ex ante kWh claims in PY8 and PY9, respectively.

Table 3-2: 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	% of kWh	% of Population Impacts Surveyed
1	4	9,412,193	0.28	3	5,655,362	60%
2	14	12,928,025	0.38	7	6,317,952	49%
3	57	11,608,685	0.34	6	841,698	7%
TOTAL CUSTOM	75	33,948,903	-	16	12,815,012	38%

Table 3-3. 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	% of kWh	% of Population Impacts Surveyed
1	4	11,309,438	0.23	4	11,309,438	100%
2	15	18,863,237	0.39	8	10,043,736	53%
3	98	18,274,524	0.38	6	1,672,332	9%
TOTAL CUSTOM	117	48,447,199	-	18	23,025,506	48%

Weighted NTG Results Based on Core Free Ridership Algorithm 1 (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 ex ante 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 ex ante kWh.

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.

Information regarding participant spillover was also collected, but ultimately did not support a finding of any spillover. Therefore, no spillover was included in the calculation of NTGR for PY8 or PY9, as discussed below in the Spillover section.

PY8 NTG Results

The PY8 program level NTGR, along with precision estimates, is shown below in Table 3-4. The overall program NTGR for PY8 is 0.71, which represents a significant improvement over PY7. By stratum, the mean energy NTGR values are 0.81 for stratum 1 (large sized projects), 0.73 for stratum 2 (medium sized projects), and 0.62 for stratum 3 (small sized projects) which indicates the free-ridership level for the largest sized projects (stratum 1) is lower than the free-ridership of the smaller project sizes. The strong results for stratum 1 projects are a key factor in the improved PY8 NTG results.

Table 3-4. PY8 MWh NTG Ratio and Relative Precision at 90% Confidence Level

Sampling Strata	Relative Precision ± %	Low	Mean	High
1	1%	0.80	0.81	0.82
2	12%	0.64	0.73	0.82
3	13%	0.54	0.62	0.70
Custom PY8	**6%**	**0.67**	**0.71**	**0.76**

By stratum, highlights include the following:

- For all three of the stratum 1 interviews completed, the NTGRs ranged from 0.80 to 0.83, indicating strong program influence. In all cases, the customer knew about the program well ahead of their decision, the program rebate helped them to meet key economic metrics for investment, and their equipment had significant remaining life, giving them discretion over whether to install the rebated measure or to retain their old equipment.
- For stratum 2 projects, NTGRs ranged from 0.10 to 1.00 indicating wide variation. For those projects with the highest NTGRs, the program rebate was a key factor in enabling them to meet their company's required economic threshold for making this type of investment. One customer noted that energy prices in Illinois are not as high as other states, and therefore, energy efficiency projects have longer payback periods, which makes it harder for them to justify the investment absent any incentive. Projects with the lowest NTGRs had the following common characteristics – measures had significant non-energy

benefits, were routinely installed at all their other locations, or were selected to replace aging equipment.

- NTGRs for stratum 3 projects ranged from 0.37 to 0.75, indicating a medium level of free ridership. 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.

PY9 NTG Results

The PY9 program level NTGR, along with precision estimates, is shown below in in Table 3-5. The program-level PY9 mean energy NTGR averaged 0.45. In general, PY9 mean energy NTGR values are much lower than in PY8 and somewhat lower than PY7. NTGR values for the three Custom sampling strata are 0.50 for stratum 1 (large sized projects), 0.37 for stratum 2 (medium sized projects), and 0.51 for stratum 3 (small sized projects) which generally indicates the free-ridership level for the largest sized projects (stratums 1 and 2) is somewhat higher than the free-ridership of the smaller project sizes.

Table 3-5. PY9 kWh NTG Ratio and Relative Precision at 90% Confidence Level

Sampling Strata	Relative Precision ± %	Low	Mean	High
1	0%	0.50	0.50	0.50
2	27%	0.27	0.37	0.47
3	44%	0.29	0.51	0.73
Custom PY9	**21%**	**0.36**	**0.45**	**0.54**

Stratum-level highlights include the following:

- For the largest stratum 1 projects, NTGRs varied widely and ranged from 0.27 to 0.73. The NTGR for this stratum averaged 0.50. Circumstances surrounding these customers' decisions to install energy efficient equipment were very different.
    - For those projects with the lowest NTGRs, non-energy benefits were a strong motivation. One customer was highly motivated to pursue LEED Silver certification to support their firm's marketing strategy. Energy cost reduction was only a secondary objective. This is a good example of a project motivated by a non-energy benefit. Another customer needed to improve the lighting in their work environment, and LEDs provided the perfect solution. Absent the program, they would have installed the same measure at the same time they did.
    - For the project with the highest NTGR, the program audit and feasibility study and rebate played a large role in their decision to do the project at this time. Without the program, 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 0.00 to 0.77 with a mean value of 0.41. For those projects with the highest NTGRs, the program features, including the audit and feasibility study, the rebate and the assistance provided by program staff were key decision influences. Projects with lower NTGRs were characterized by decisions that were largely dictated by their standard corporate

policies or practices such as one firm's decision to incorporate LEDs into their prototype store designs several years ago and another firm's policy to use on-load transformers at their other facilities around the U.S.

- Across the smallest stratum 3 projects, NTGRs ranged from 0.05 to 0.90, and averaged 0.51, indicating a medium level of free ridership. It is interesting to note that project NTGRs were clustered around medium-high values (0.63 to 0.90, four projects), and extremely low values (0.05 to 0.19, two projects). The program rebate was the number one driver for the high NTGR projects. For the low NTGR projects, prime influences included the urgent need to replace old equipment, and the need to meet corporate sustainability goals. These firms would have installed the same equipment at about the same time, absent the program.

The PY8 and PY9 project-specific NTGRs are plotted in Figure 3-3 and Figure 3-4, 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 strata 1 and 2 were combined for the demand weighted NTGR, as there was only a single stratum 1 project with demand savings.

Figure 3-3: PY8 Sample NTGR by Stratum

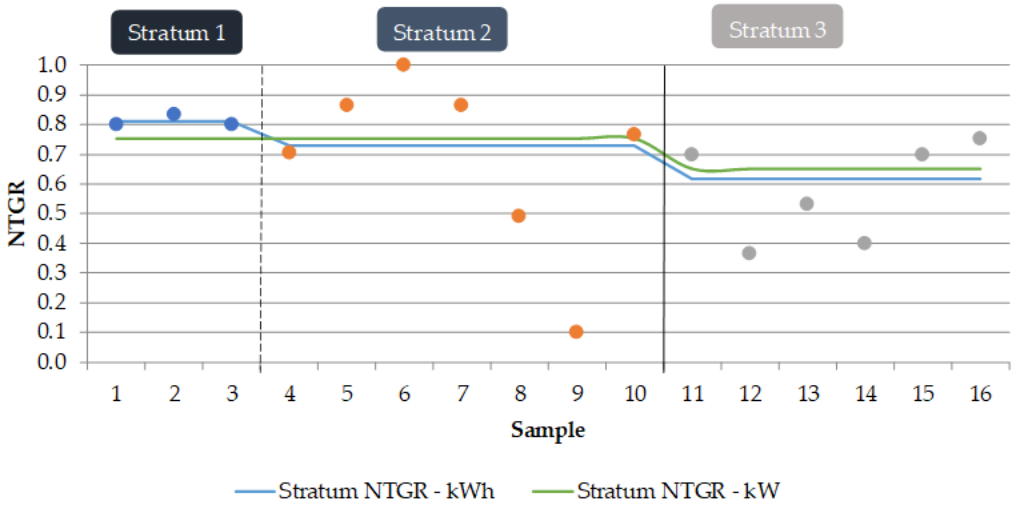
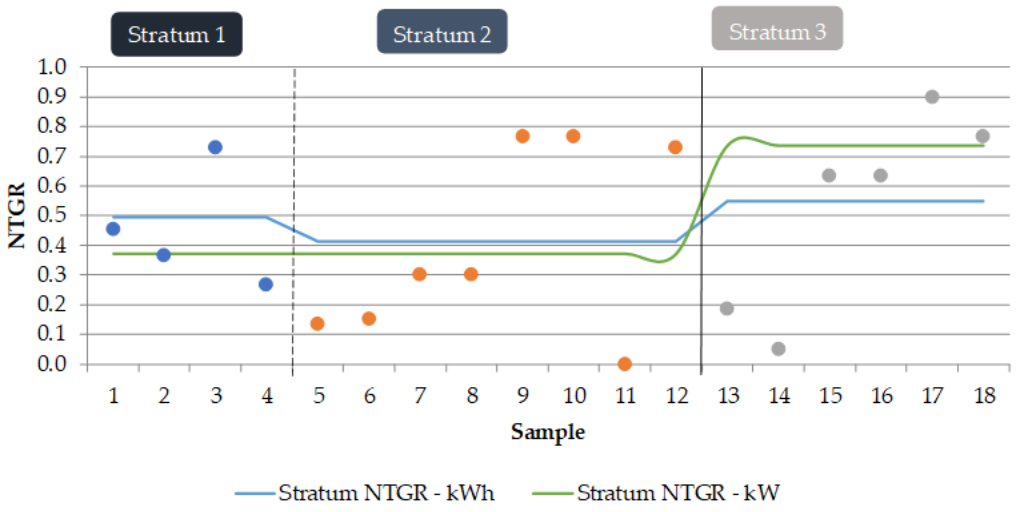
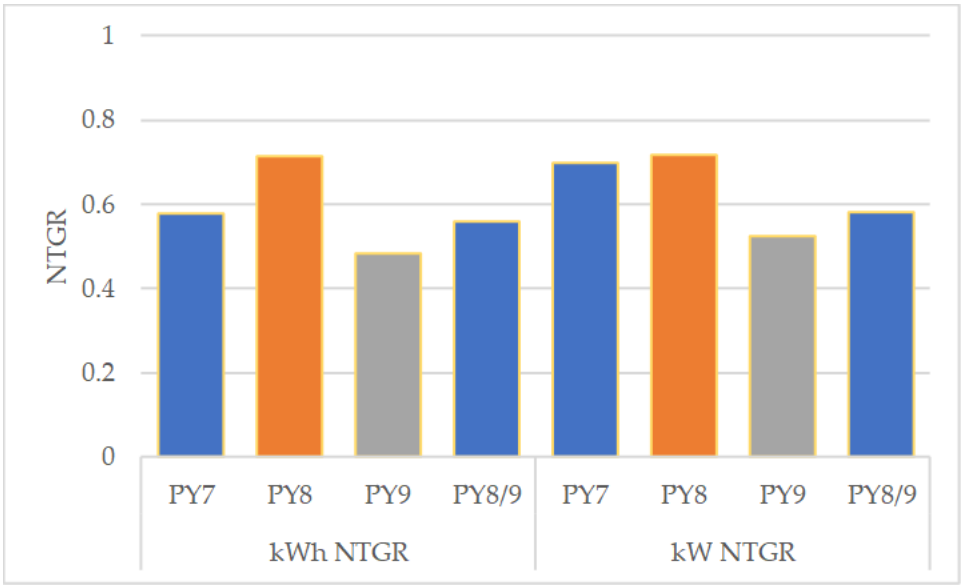


Figure 3-4: PY9 Sample NTGR by Stratum



The evaluation research findings energy and demand-weighted NTGR by program year, for PY7, PY8, and PY9, are presented below in Figure 3-5. The PY8 evaluated kWh NTGR for Custom projects of 0.71 is improved relative to the PY7 NTGR of 0.58; however, the PY9 evaluated kWh NTGR of 0.45 is lower.

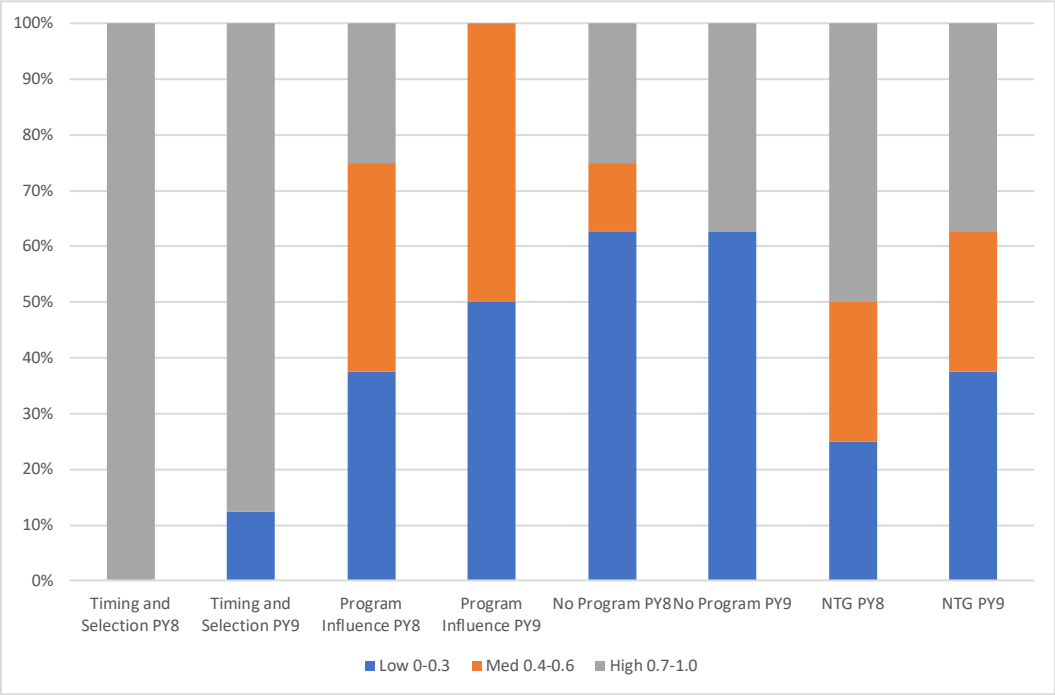
Figure 3-5. Evaluated NTGR by Program Year with 90% Confidence Intervals



A breakdown of the NTGR by the three component scores is shown in Figure 3-6. 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

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 3-6. NTGR Level by Component Scores



A scan of the PY8 vs. PY9 bars provides additional insight into a key causal factor for the drop in the NTGR value between PY8 and PY9. For all three scores, the concentration of High values is moderately to significantly higher in PY8 than PY9. As a result, for the overall NTGR, the share of High scores in PY8 exceeds that in PY9 by a wide margin. Stratum-level causal factors leading to these results were discussed previously. In general, PY9 projects were characterized by program-related factors that were either less important or not applicable to the final decisions to do the project.

Combined PY8 and PY9 Results

The evaluation team calculated a combined PY8 and PY9 NTGR. The team determined this value using savings weighted NTGRs from PY8 and PY9 and computing a weighted average value. The combined PY8 and PY9 value of 0.56 is similar to the PY7 NTGR of 0.57. *The evaluation team recommends that the combined PY8 and PY9 value of 0.56 be used to compute program-verified savings for CY2019 projects going forward.*

Table 3-6. Combined PY8 and PY9 MWh NTG Ratio

Year	N	kWh	Weight	NTGR	NTG SE
PY8	75	33,948,903	41%	0.71	3%
PY9	117	48,447,199	59%	0.45	7%
Custom PY8/PY9	192	82,396,102	**100%**	**0.56**	**6%**

Sensitivity Case - Weighted NTG Results Based on Core Free Ridership Algorithm 2

The evaluation team also performed a sensitivity analysis based on Core Free Ridership Algorithm 2. NTG results are slightly higher due to the greater weight given to the acceleration (i.e. timing) effect of the program. This algorithm varies from Algorithm 1 with respect to how it treats the effect of timing in the calculation of the NTGR. Algorithm 1 adjusts for Timing within the No-Program score, then averages the 3 scores. Algorithm 2 determines the No-Program Score without a Timing adjustment, averages the 3 scores, then applies a Timing adjustment factor to the 3-score average, 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)

While not intuitive, this formula is designed to apply a linear adjustment factor to self-reported deferral (i.e., program induced acceleration) periods ranging from 6 months to 48 months. Thus, under this formula, a value of 6 months or less receives zero credit, and a value of 48 months or greater of accelerated adoption receives 100% credit.

NTG Algorithm 2 –PY8 Weighted NTG Results

The PY8 program-level NTGR for version 2 of the algorithm, along with precision estimates, is shown below in Table 3-7 . The overall program NTGR for PY8 is 0.79, which is somewhat higher than the Algorithm 1 value of 0.71. This timing “bump” is due to reports by several decisionmakers reported that the program accelerated the installation of their installed project compared to if there had been no program and incentive.

Table 3-7. Algorithm 2 PY8 MWh NTG Ratio and Relative Precision at 90% Confidence Level

Sampling Strata	Relative Precision ± %	Low	Mean	High
1	1%	0.95	0.96	0.97
2	13%	0.68	0.78	0.88
3	13%	0.58	0.67	0.76
Custom PY8 Alg 2	**6%**	**0.74**	**0.79**	**0.84**

NTG Algorithm 2 –PY9 Weighted NTG Results

For this second version of the NTG algorithm, the PY9 program level NTGR, along with precision estimates, is shown below in Table 3-8. The program-level PY9 mean energy NTGR average of 0.48 is slightly higher than the NTGR of 0.45 under NTG Algorithm 1. Again, this small bump is due to the heavier weight given to the acceleration (timing) effect under Algorithm 2 as versus Algorithm 1.

Table 3-8. Algorithm 2 PY9 kWh NTG Ratio and Relative Precision at 90% Confidence Level

Sampling Strata	Relative Precision ± %	Low	Mean	High
1	0%	0.50	0.50	0.50
2	38%	0.21	0.34	0.47
3	46%	0.34	0.62	0.91
Custom PY9 – Alg 2	**25%**	**0.36**	**0.48**	**0.60**

Figure 3-7 (PY8) and Figure 3-9 (PY9) below compare the evaluated NTGRs for Algorithms 1 and 2 for each sampling stratum. For PY8 (Figure 3-7) when compared to Algorithm 1, the mean energy NTGR values are 0.96 (Algorithm 2) vs. 0.81 (Algorithm 1) for stratum 1 (large sized projects), 0.76 (Algorithm 2) vs. 0.73 (Algorithm 1) for stratum 2 (medium sized projects), and 0.67 (Algorithm 2) vs. 0.62 (Algorithm 1) for stratum 3 (small sized projects). The higher results for stratum 1 projects are the sole reason for the increase in the average program NTGR.

In PY9 (Figure 3-8), when compared to Algorithm 1, NTGR values are lower for stratum 1 (0.41 for Algorithm 2 vs. 0.50 for Algorithm 1), higher (0.43 for Algorithm 2 vs. 0.36 for Algorithm 1) for stratum 2, and much higher (0.62 for Algorithm 2 vs. 0.51 for Algorithm 1) for stratum 3. For both PY8 and PY9, these results indicate that the free-ridership level based on both Algorithms 1 and 2 for the largest sized projects (stratums 1 and 2) is higher than the free-ridership of the smaller project sizes.

Figure 3-7. Comparison of PY8 Evaluated NTGR by NTG Algorithm and Stratum

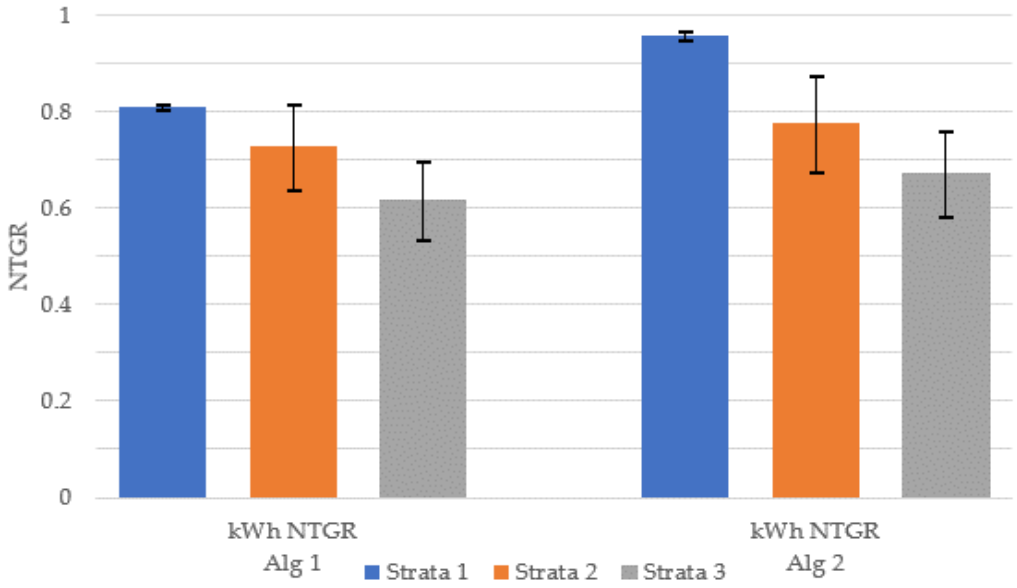
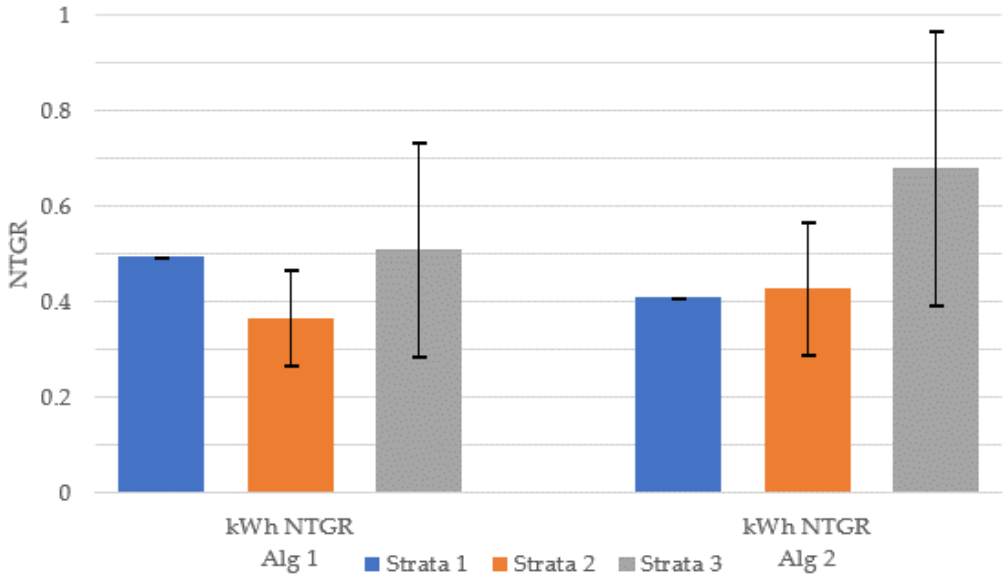


Figure 3-8. Comparison of PY9 Evaluated NTGR by NTG Algorithm and Stratum



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. Despite these challenges, there are several different strategies available to ComEd to adjust program design elements and implementation procedures to reduce free ridership. These recommendations are as follows:

Recommendation: Adopt procedures to limit or exclude known free riders.

The best way to accomplish this is to conduct screening for high free ridership on a project-by-project basis. 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. The NTGRs for the Custom Program have fluctuated between 0.56 and 0.72 since the program began, and are in line with similar programs offered elsewhere in the U.S. However, the decline in the PY9 NTGR to 0.45 suggests that a more aggressive approach is warranted, since the NTG ratios indicate significant free ridership is still present.

Recommendation: Adjust the incentive formula.

Another path is for the program to set the standard for incentive eligibility higher across-the-board so that all such projects will need to meet a higher standard to qualify. Note that **none** of these options equates 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.

Screening out Free Riders

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 or 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 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 impacts? 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

The evaluation team also researched Spillover effects 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 3-9 below.

Table 3-9. 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 16 surveyed customers that responded, one (6%) implemented an additional measure without receiving an incentive. This respondent implemented one energy efficiency measure.	Of the 18 surveyed customers that responded, one implemented an additional measure without receiving an incentive.
What type of energy efficiency measure was installed without an incentive?	Energy efficient chiller, rating of 130,000 Btu/hr, efficiency rating 0.96. (did not provide tons of capacity or COP)	Energy efficient 60-watt lamps to replace 150-watt lamps (n=90)
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 10	Don't know
If you had not participated in the ComEd program, how likely is it that your organization would still have implemented this measure? Use a 0 to 10, scale where 0 means you definitely would NOT have implemented this measure and 10 means you definitely WOULD have implemented this measure?	Likelihood rating of 0 – would have installed on their own 2 years later	Don't know
Why did you purchase this energy efficiency measure without the financial assistance available through the ComEd's program?	They applied too late for an incentive	The energy savings and payback were sufficient. Also, they needed to address immediate issues.

Only one respondent each in PY8 and PY9 installed a measure with potential savings that could be attributed to calculation of the spillover ratio. Unfortunately, the PY8 respondent did not know the tonnage of the installed equipment, which is critical to support a savings estimate calculation. The PY9 respondent did not provide an importance score to link (attribute) their decision back to the ComEd program. 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 three 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 3-9 and Figure 3-10 below present the Cronbach's Alpha and the 90% confidence intervals for the two NTGR algorithm variations for the PY8 and PY9 Custom Program, respectively. Overall Cronbach's Alpha values for PY8 were quite low, 0.37 (Algorithm 1) and 0.50 (Algorithm 2). In PY9, Alpha values were significantly higher, 0.88 for both Algorithms.

Note that the confidence intervals around Alpha are expected to be quite large due to the relatively small sample sizes. In PY8, the results show wide confidence bands and low Alpha values, particularly for Algorithm 1, due to the relatively small sample size and diverse project-level NTGR results implying a lack of inter-item correlations. In PY9 however, the Alpha results for the two algorithm variants are identical. Most likely this is because the formula leads to higher values when the inter-item correlations are higher (as was the case in PY9).

Figure 3-9: PY8 Custom Program Cronbach's Alpha and 90% Confidence Intervals for the Two Algorithm Variations (N=16)

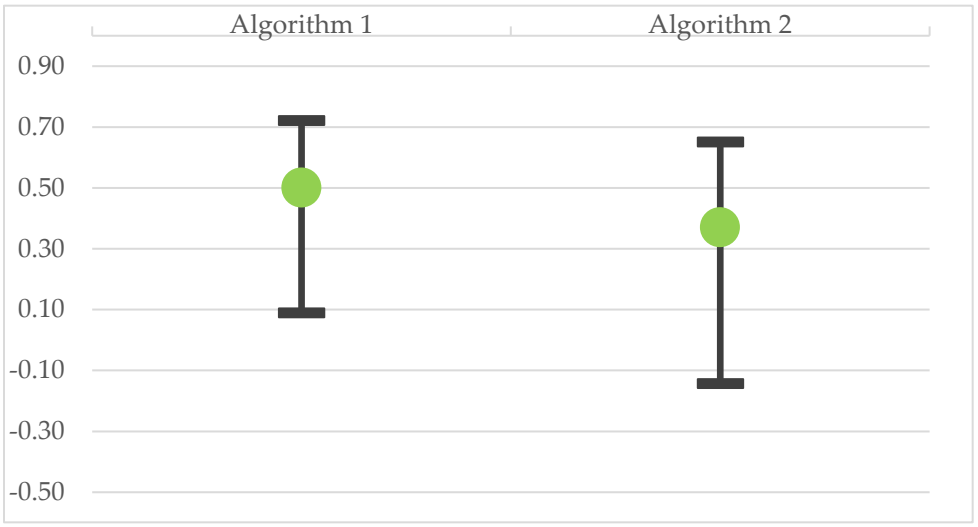
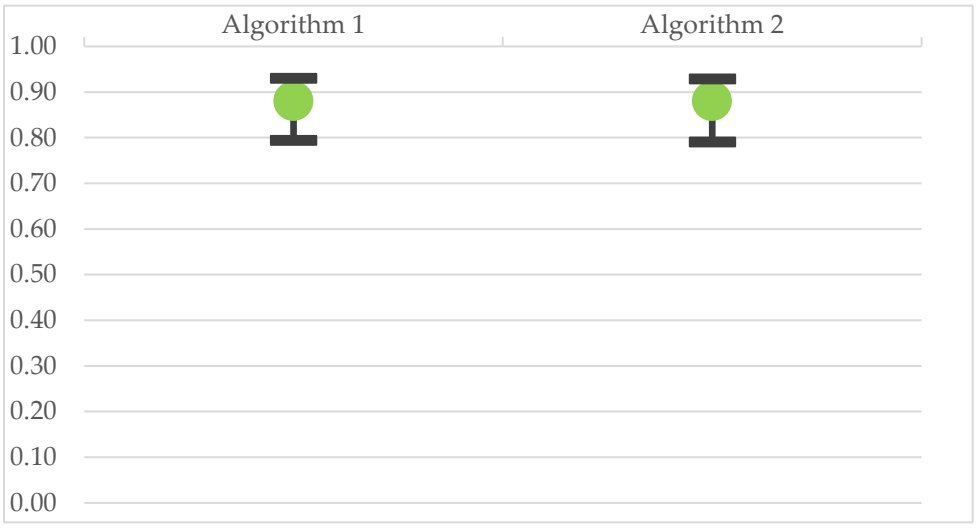


Figure 3-10: PY9 Custom Program Cronbach's Alpha and 90% Confidence Intervals for the Two Algorithm Variations (N=18)



APPENDIX C. COMED CUSTOM INCENTIVES PY9 PUBLIC SECTOR IMPACT EVALUATION REPORT 2018-08-28 FINAL

NAVIGANT

ComEd Public Sector Custom Impact Evaluation Report

Energy Efficiency / Demand Response Plan:
Plan Year 9 (PY9) Bridge Period - (June 2, 2017 – December 31, 2017)

Presented to
Commonwealth Edison Company

FINAL

August 28, 2018

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1. Introduction

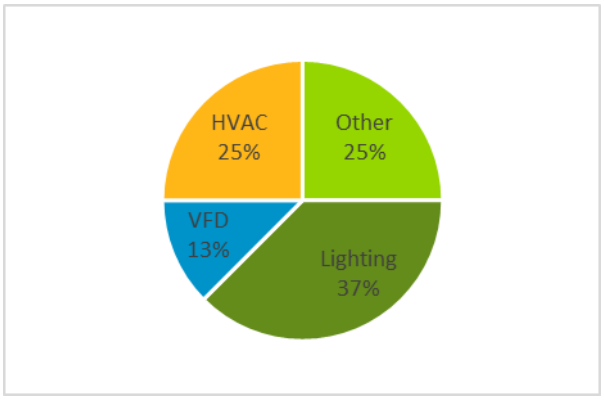
This report presents the results of the impact evaluation of ComEd's Public Sector Custom Program PY9 bridge period, June 2, 2017 through December 31, 2017. It presents a summary of the energy and demand impacts for the total program, broken out by relevant measure and program structure details. Section 7 (Appendix)1 presents the impact analysis methodology.

2. Program Description

ComEd's Smart Ideas for Your Business suite of energy efficiency programs for public sector customers includes a Custom Incentives (Custom) Program. This program provides a custom incentive, based on a formula, for less common or more complex energy-saving measures installed in qualified retrofit and equipment replacement projects. Custom incentives are available based on the project's kWh savings, provided the project meets all program eligibility requirements. For eligible projects, the program pays an incentive of $0.07/kWh saved.

The program had eight participants during the PY9 bridge period. The projects consisted of HVAC, VFD, Lighting, and "Other" measures, as shown in Figure 2-1. There were three lighting projects, two HVAC projects, two "Other" projects, and one VFD project. The evaluation team created the measure distribution chart using measure end uses listed in the final tracking database.

Figure 2-1. Number of Measures Installed by Type



3. Program Savings

Table 3-1 summarizes the incremental energy and demand savings the Custom Incentives 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	466,676	N/A	2
Program Gross Realization Rate	0.96	N/A	34.48
Verified Gross Savings	447,093	N/A	71
Program Net-to-Gross Ratio (NTGR)	0.83	N/A	0.82
Verified Net Savings	371,087	N/A	58

Source: ComEd tracking data and Navigant team analysis.

4. Program Savings by Measure

The program includes four measures as shown in the following table. The Lighting and VFD measures contributed the most savings.

Table 4-1. PY9 Energy Savings by Measure

End Use Type	Research Category	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)†
Other	Other	11,590	90%	10,431	0.83	8,657	13	1	13
Lighting	Lighting	292,979	87%	253,860	0.83	210,704	12	1	12
VFD	VFD	121,447	118%	143,848	0.83	119,394	15	1	15
HVAC	HVAC	40,661	96%	38,954	0.83	32,332	15	1	15
	Total	466,676	96%	447,093	0.83	371,087			

* 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 4-2. PY9 Peak Demand Savings by Measure

End Use Type	Research Category	Ex Ante Gross Peak Demand Reduction (kW)	Verified Gross Realization Rate	Verified Gross Peak Demand Reduction (kW)	NTGR*	Verified Net Peak Demand Reduction (kW)
Other	Other	0	-	0	0.82	0
Lighting	Lighting	2	13.84	28	0.82	23
VFD	VFD	0	-	42	0.82	35
HVAC	HVAC	0	-	0	0.82	0
	Total	2	34.48	71	0.82	58

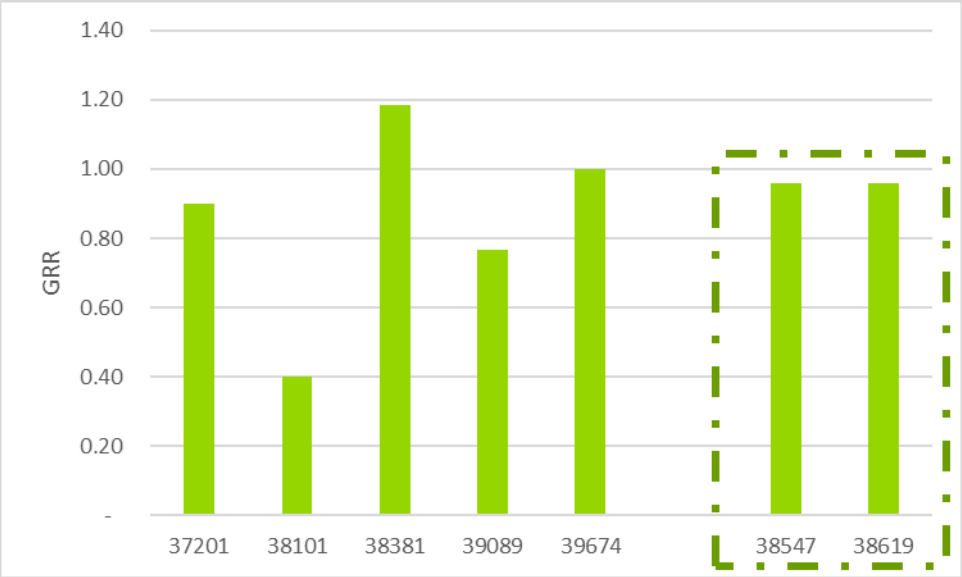
* A deemed value. Source: ComEd_NTG_History_and_PY9_Recommendations_2016-02-26_Final.xlsx, which is to be found on the IL SAG web site here: http://ilsag.info/net-to-gross-framework.html.
Source: ComEd tracking data and Navigant team analysis.

5. Program Impact Analysis Findings and Recommendations

Figure 5-1 below shows a comparison of the energy rates for every site. The bridge period PY9 energy-savings realization rate results ranged from 0.40 to 1.18, which resulted in a program-level energy realization rate of 0.96. The peak demand savings are not shown here, as only one of the eight sites reported demand savings, while the evaluation team found peak demand savings for three total sites. One of the eight sites did not report any energy or demand savings and is therefore not included in the figure below.

The evaluation team did not receive enough documentation about projects 38547 and 38619 to be able to evaluate them. Therefore, they were assigned the program-level GRR of 0.96.

Figure 5-1. Energy Realization Rates



Finding 1. There are eight projects in the population tracking data, but one project did not report any energy or demand savings.

Recommendation 1. Periodically checking the database and removing projects that are not applicable will help to ensure a complete and accurate portrayal of program status.

Finding 2. For two of the eight projects, the team received insufficient documentation for a desk review. For project 38547, none of the multiple calculators provided matched the final savings in the tracking data. For project 38619, the eQuest model was not provided, so the evaluation team was not able to review the calculations.

Recommendation 2. Documentation is key for the evaluation team to accurately validate the claimed savings. Ensuring that paperwork and calculations match the claimed savings in the tracking data shows traceability and transparency in the savings calculations.

Finding 3. Lack of claimed demand savings for projects continues to be an issue for the ComEd Custom Program. Peak demand savings were only claimed for one of the eight projects in the population.

Recommendation 3. Demand savings should be claimed for all projects that save energy over the PJM peak summer period of 1:00-5:00 PM Central Prevailing Time on non-holiday weekdays, during the months of June through August and reported in the tracking system.

Finding 4. The calculations for many of the projects utilized minimal site-specific data and focused mostly on TRM values to inform project calculations.

Recommendation 4. The larger incentives of the Custom Program provide the unique opportunity to take advantage of site-specific information including meter data and onsite survey observations and findings to portray savings more accurately that are specific to that facility. Use of standard TRM assumptions should be kept to a minimum and should be replaced with meter data whenever possible. Future evaluation efforts will utilize a more robust onsite evaluation, and the use of standard TRM assumptions may hurt a project savings.

6. Appendix 1. Impact Analysis Methodology

The evaluation team performed engineering calculations to derive evaluated gross energy and demand savings based on the engineering desk review process. The savings are site-specific and therefore require site-specific calculators and algorithms in conjunction with data collected from the site. The evaluation team utilized the documentation provided to 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 evaluation of the Public-Sector Custom Program attempted a census of all eight projects in the program population. Two of the projects were found to be unreviewable, as there was insufficient documentation provided, and a third project had no ex ante claimed savings and no documentation available. Therefore, the evaluation team calculated a program-level realization rate based on their review of five projects. For the remaining project, that program-level realization rate was used to calculate the overall savings for those projects.

7. Appendix 2. Impact Analysis Detail

Table 7-1 and Table 7-2 show the savings by site. Most of the savings are due to projects 39674, 38381, and 39089, which account for almost 90% of the ex post energy savings and all the ex post demand savings.

Table 7-1. PY9 Energy Savings by Site

Sampled Application ID	End Use	Ex Ante Gross Savings (kWh)	Verified Gross Realization Rate	Verified Gross Savings (kWh)	NTGR *	Verified Net Savings (kWh)
37201	Other	11,590	90%	10,431	0.83	8,657
38101	Lighting	12,921	40%	5,168	0.83	4,290
38381	VFD	121,447	118%	143,848	0.83	119,394
39089	Lighting	134,554	77%	103,088	0.83	85,563
39674	Lighting	145,504	100%	145,603	0.83	120,851
38547	HVAC	7,737	96%	7,412	0.83	6,152
38619	HVAC	32,924	96%	31,542	0.83	26,180
38803	Other	-	-	-	0.83	-
	Total	466,676	96%	447,093	0.83	371,087

* 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.

[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 7-2. PY9 Peak Demand Savings by Site

Sampled Application ID	End Use	Ex Ante Gross Savings (kW)	Verified Gross Realization Rate	Verified Gross Savings (kW)	NTGR *	Verified Net Savings (kW)
37201	Other	-	-	-	0.82	-
38101	Lighting	2	-	-	0.82	-
38381	VFD	-	-	42	0.82	35
39089	Lighting	-	-	12	0.82	10
39674	Lighting	-	-	17	0.82	14
38547	HVAC	-	-	-	0.82	-
38619	HVAC	-	-	-	0.82	-
38803	Other	-	-	-	0.82	-
	Total	2	34.48	71	0.82	58

* 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.

The evaluation team uncovered some issues in three of the eight projects, which resulted in energy or demand realization rates with a discrepancy of greater than 10% from a realization rate of 1.0. Some key observations from these site-specific evaluation results are discussed below for each project that saw large differences in savings.

- Project #38101: The evaluation team believes that the ex ante calculation used 3,650 annual operating hours. The project calculation was provided in the form of a PDF and not a live calculation sheet, so we could not verify that. However, the post-inspection form provided in the documentation identifies the annual operating hours to be 1,460. Additionally, peak demand savings were claimed, even though the project was for outdoor lighting, which does not operate during peak periods.
- Project #38381: Documentation for the project states that a new system can reduce operation to 45hz at steady state. The ex ante baseline calculations were based on an operation at 45hz; however, as the operation at 45hz was a result of the new installed system, the evaluation team changed the baseline to 60hz. Additionally, the team calculated peak demand savings for this project.
- Project #39089: Only a PDF version of the calculator was provided, but it appeared to show the annual hours of operation as 0 in the post-case. Therefore, the savings provided were based on the baseline consumption. Due to a lack of any additional information, the evaluation team used operation hours of 8,766 (based on the TRM) to calculate savings.

8. APPENDIX 3. TRC DETAIL

Total Resource Cost (TRC) related data for the projects in the Custom Public Sector Program sample can be found in Table 8-1.

Table 8-1. Total Resource Cost Savings Summary

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)
37201	Other	Each	1	13	11,590	-	10,431	-
38101	Lighting	Each	1	12	12,921	2	5,168	-
38381	VFD	Each	1	15	121,447	-	143,848	42
39089	Lighting	Each	1	12	134,554	-	103,088	12
39674	Lighting	Each	1	12	145,504	-	145,603	17
38547	HVAC	Each	1	15	7,737	-	7,412	-
38619	HVAC	Each	1	15	32,924	-	31,542	-
38803	Other	Each	1	-	-	-	-	-

The Total Resource Cost (TRC) variable 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 later. Further, detail in this table (e.g., EULs) other than final PY9 savings and program data are subject to change and are not final.