NAVIGANT

ComEd and Nicor Gas
Strategic Energy Management Program
Impact Evaluation Report

Energy Efficiency / Demand Response Plan:
Electric Program Year 9 (EPY9)
Gas Program Year 6 (GPY6)

Presented to

Commonwealth Edison Company

Nicor Gas

FINAL

April 12, 2018

Prepared by:

Dustin Bailey
Navigant Consulting

Jean Rokke
Navigant Consulting

www.navigant.com

Strategic Energy Management Program Impact Evaluation Report

Submitted to:

ComEd
Three Lincoln Centre
Oakbrook Terrace, IL 60181

Nicor Gas
1844 Ferry Road
Naperville, IL 60563

Submitted by:

Navigant Consulting, Inc.
150 N. Riverside, Suite 2100
Chicago, IL 60606

Contact:

Randy Gunn, Managing Director
312.583.5714
Randy.Gunn@Navigant.com

Jeff Erickson, Director
608.497.2322
Jeff.Erickson@Navigant.Com

Rob Neumann, Associate Director
312.5832176
Rob.Neumann@Navigant.com

Kevin Grabner, Associate Director
608.497.2323
Kevin. Grabner@Navigant.Com

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1. INTRODUCTION

This report presents the results of the impact evaluation of ComEd's Electric Program Year 9 (EPY9) and Nicor Gas' Program Year 6 (GPY6) Strategic Energy Management (SEM) Program. It presents a summary of the energy and demand impacts for the total program and broken out by relevant measure and program structure details. The appendix presents the impact analysis methodology. EPY9/GPY6 covers June 1, 2016 through December 31, 2017.

2. PROGRAM DESCRIPTION

The Strategic Energy Management (SEM) Program, managed by both ComEd and Nicor Gas, began as a pilot in EPY8/GPY5. The goal of the SEM Program is to apply a process of continuous energy management improvements that result in energy savings and demand reduction. The program seeks to educate participants in the identification of low cost and no cost measures, improve process efficiency, and reduce energy usage through behavioral changes. To encourage these savings, Nicor Gas provides an incentive of $0.10 per therm saved. In the Pilot year, ComEd provided a 10 percent bonus to rebates given on capital projects; after that year, an incentive of $0.01 per kWh saved has been given. While the utilities jointly manage the program, CLEAResult implements the day-to-day operation.

The program achieves energy savings through operational and maintenance (O&M) improvements, incremental increases in capital energy efficiency projects, additional capital projects that would not otherwise have been considered (e.g., process changes, consideration of energy efficiency in all capital efforts), and improved persistence for O&M and capital projects.

The SEM Program savings are calculated using site specific models developed by CLEAResult that have statistical regression analysis built into the model. The energy model uses two years of utility data prior to program participation. This data is associated with site information such as production and temperature to create baseline models that estimate a site's baseline usage based on these variables.

After program participation begins, the model compares baseline energy usage to post-participation consumption, adjusted for temperature and production, and any differences attributed to SEM activities.

The Pilot year began with 10 industrial participants enrolling in Cohort 1. In its second year, EPY9/GPY6, the program continued with seven of the Cohort 1 industrial participants and the addition of Cohort 2 with nine participants. Cohort 2 expanded the customer segment to include hospitals and universities in addition to the industrial segment. In August 2017, a Practitioner group was formed comprising of seven industrial and three commercial participants from Cohorts 1 and 2. This practitioner group was formed from sites that participated in the past and focused on maintaining changes and identifying new opportunities. Several of these sites had multiple models resulting in the 21 projects that were reviewed as a part of this evaluation.

Table 2-1. Cohort and Practitioner Timeline

Participant Group	Customer Segment	Time Period
Cohort 1 (Year 1)	10 Industrial	November 2, 2014 – October 31, 2015
Cohort 1 (Year 2)	7 Industrial	January 2, 2016 – December 31, 2016
Cohort 2 (Year 2)	2 Industrial 3 Hospitals 4 Universities	June 1, 2016 – May 31, 2017

Source: Navigant team analysis.

ComEd's goals for SEM in EPY9 were 6 GWhs of energy savings and to develop strong customer relationships resulting in increased participation in capital projects. Similarly, Nicor Gas' goals for Cohort 3 were SEM energy savings of 150,000 therms and an additional 200,000 therms of energy savings through Nicor's Business Energy Efficiency Rebate (BEER) and Business Custom programs. This program far exceeded these goals and acted as a "feeder" program into other utility offered programs such as BEER and Custom.

3. Program Savings

Table 3-1 and Table 3-2 summarize the incremental energy and demand savings the SEM Program achieved in PY9. The program had 21 participants in EPY9/GPY6 as shown in the above table. This program currently does not have demand savings calculators since savings are calculated using a whole building models.

Table 3-1. ComEd EPY9 Total Annual Incremental Savings

Savings Category	Energy Savings (kWh)	Demand Savings (kW)	Peak Demand Savings (kW)
Ex Ante Gross Savings	13,088,906	NA	NA
Program Gross Realization Rate	1.22	NA	NA
Verified Gross Savings	15,977,950	NA	NA
Program Net-to-Gross Ratio (NTGR)	1.00	NA	NA
Verified Net Savings	15,977,950	NA	NA

Source: ComEd and Nicor Gas tracking data and Navigant team analysis.

Table 3-2. Nicor Gas GPY6 Total Annual Incremental Savings

Savings Category	Energy Savings (Therms)
Ex Ante Gross Savings	1,917,723
Program Gross Realization Rate	1
Verified Gross Savings	1,917,797
Program Net-to-Gross Ratio (NTGR)	1
Verified Net Savings	1,917,797

Source: ComEd and Nicor Gas tracking data and Navigant team analysis.

4. Program Savings by Measure

The SEM program tracked and evaluated savings at the site level, rather than measure level. SEM Site level detail can be found in Appendix 2. Impact Analysis Detail. Site details can be found in Section 5.2

5. Impact Analysis Findings and Recommendations

5.1 Impact Parameter Estimates

As a behavioral based, model program, the program does not have standard impact parameters that are used to determine program savings. The program savings are calculated using billing regression methodologies built into the program models that are customized for each site.

5.2 Other Impact Findings and Recommendations

Details regarding site by site results are shown below:

Site 2
There appears to be an equation error in the SEM Tracking Models for this site. The implementer calculated an adjusted actual energy savings which subtracted a new plating line's energy from the actual energy. However, at the 3/27/2016 data point, the model's equation for adjusted actual energy stops accounting for the new plating-line.

Site 5
Navigant removed one more outlier for this site than the implementer. This outlier was the data taken during 10/3/16-10/9/2016 when the total production was higher than 110% of the maximum production level in the baseline period. The implementer noted the same outlier but retained this point after conducting analysis and determining that the point was not statistically different than others around it. The implementer capped the variable at the limit of 110% the baseline maximum, allowing the site to claim a conservative amount of savings to avoid penalizing the site and removing the savings altogether. Navigant chose not to keep the data point as capping the data point creates a mismatch with the actual billing data used to estimate savings.

Site 8
Navigant removed two outliers from this site. The first data point is that between 11/21/2016 and 11/26/2016 where the adjusted production of PM23 (production variable in model) was 69% of the minimum adjusted production of PM23 in the baseline period. The second data point is that between 12/26/12016 and 1/1/2017 where the adjusted production of PM23 was zero. The implementer marked both points as outliers as well by highlighting them in red but decided to keep both without explanation in their report.

Navigant removed the same two outlying data points from the gas model for this site as for the electric model above.

Site 9
Navigant removed one outlier from 4/2/2016 to 4/8/2016. During this period, the Mill 1's production was more than 110% of the maximum production in the baseline. Lighting capital projects were also installed at this site in the baseline period on 10/01/2015. The implementer recorded that these lighting projects were not in place during the measurement period of the model so no savings were prorated in the measurement period. However, it seems more likely that these lighting projects would have affected the measurement period. These projects were installed late in the baseline period and therefore may not have been fully considered in the baseline model. Navigant was concerned that this project may have been directly affecting the whole building site usage in the measurement period and accounted for the savings portion obtained by the lighting incentivized projects in the measurement period.

Site 11
An incentivized lighting project was installed at this site in the baseline period on 7/15/2015. The implementer recorded that these lighting projects were not in place before the measurement period so no savings were prorated in the measurement period. However, it seems more likely that these lighting projects would have affected the measurement period. These projects were installed late in the baseline period and therefore may not have had been fully considered in the baseline model. Navigant was concerned that this project may have been directly affecting the whole building site usage in the measurement period. Navigant accounted for the portion savings obtained by lighting incentivized projects by adding it to the measurement period.

Site 12
Navigant removed three outliers from the savings for this site. In all three cases, 7/17/2017-7/23/2016, 7/24/2016-7/30/2016, and 8/7/2016-8/13/2016, the cooling degree days CDD-70 were higher than the 110% maximum of the baseline. This resulted in the realization rate falling by 4%.

Site 13
Navigant removed one outlier from the savings for this site at the 7/17/2017-7/23/2016 data point. The cooling degree days CDD-65 was much higher than the 110% maximum of the baseline.

Site 15 through Site 18
Navigant removed four outliers from the savings for these projects. In three cases, 7/17/2017-7/23/2016, 7/24/2016-7/30/2016, and 8/7/2016-8/13/2016, the cooling degree days CDD-70 were higher than the 110% maximum of the baseline. One outlier occurred at 7/17/2017-7/23/2016 in which the cooling degree days CDD-55 was higher than the 110% maximum of the baseline.

Site 20
Navigant removed three outliers from the savings for this site. In all three cases, 7/17/2017-7/23/2016, 7/24/2016-7/30/2016, and 8/7/2016-8/13/2016, the cooling degree days CDD-70 were higher than the 110% maximum of the baseline.

Site 21
The electric savings for this site are much higher than the implementer reported. Navigant identified that a capital project that was installed by the SEM program had a negative effect on the SEM savings. The SEM program correctly removed the impact of the capital project savings by using reported ex ante savings, but between 10/20/2016 and 12/31/2016 the capital project did not seem to result in the savings equal to claimed ex ante savings resulting in the negative impact on the SEM savings. Navigant calculated the impact of this issue in several ways including adding a variable to represent this event. This variable was statistically significant and aligned with the installation of several process equipment VFD's projects. When this effect was accounted for the site realization rate increased because the ex post savings increased.

Finding 1: As identified above, many sites had issues with the values of post variables falling outside of accepted standards more than 110% of maximum baseline or less than 90% of minimum baseline. In these cases, the model may not accurately represent what is occurring during these periods.

Recommendation 1:

- The implementer should continue to identify when the values of the variables fall outside of these accepted levels and account for them appropriately, by testing their impact and/or removing them as needed.
- Justification for removal of a data point should be clear and grounded in real-world effects, as much as possible, and not just model inconsistencies.
- Any time periods with outliers in the baseline should be compared to the post condition to identify any seasonal effects.

- If outliers require removal of data points, savings should be adjusted to represent 12 months of savings.

Finding 2: The capital project occurring at site 21 greatly affected the claimed SEM savings for the site and the SEM Program. This is a controls project that did not achieve savings for the initial four to five months of the project. The SEM Program correctly removed the impact of the capital project savings by using reported ex ante savings, but between 10/20/2016 and 12/31/2016 the capital project did not seem to result in the savings equal to claimed ex ante savings, resulting in the negative impact on the SEM savings. Navigant calculated the impact of this issue in several ways including adding a variable to represent this event. When this effect was accounted for the site realization rate increased because the ex post savings increased.

Recommendation 2: If the models display strange results when considering installed capital projects, the implementer should coordinate with the capital project team or the utility to resolve the issue.

Finding 3: Currently, when an energy model results in negative savings the program claims zero savings for the site. Navigant followed this procedure and the reported ex-post savings reflects this practice. If negative savings are included as a part of the program savings, the final savings are as follows:

Table 5-1. EPY9/GPY6 Savings Including Negative Results

Program Details	Ex Post Evaluation	Negative Savings Included
Participants	21	21
Total Ex Ante Savings (kWh)	13,088,906	8,646,900
Total Ex Post Savings (kWh)	15,977,950	11,585,585
Electric RR	1.22	1.34
Total Ex Ante Savings (Therm)	1,917,723	986,679
Total Ex Post Savings (Therm)	1,917,797	1,058,656
Gas RR	1	1.07

This practice of zeroing negative savings projects runs the risk of biasing results. Navigant does not feel that the program is causing sites to use more energy. Instead, the negative savings in the energy models are likely due to unaccounted for site energy fluctuations such as: process changes, equipment changes, etc. This energy fluctuation could be caused by changes that occur at the site that are not identified by the model and it could affect savings both negatively or positively.

Recommendation 3: Further evaluation research into the negative savings discussion should be conducted in CY2018 to better understand this issue. Evaluation will consider and work with program leads to research the source of negative savings in CY2018 or CY2019. To further that research, the NREL Strategic Energy Management (SEM) Evaluation Protocol[1] states "Evaluators should report point estimates of SEM program savings for the reporting period and standard errors or confidence intervals to indicate the program savings uncertainty." The implementer should consider including factors that indicate the level of uncertainty for program savings so that there can be more confidence in final results. These overall program

[1] https://www.nrel.gov/docs/fy17osti/68316.pdf

error bands should be discussed internally with the evaluator and the utility to provide confidence in the final claimed savings.

6. Appendix 1. Impact Analysis Methodology

6.1 Verified Gross Program Savings Analysis Approach

Verified gross savings from the EPY9/GPY6 SEM Program were calculated using implementer provided engineering models that are grounded in site-specific data. These multi-regression models draw upon site data including energy usage, production, weather data and seasonality effects (including holidays or shutdowns). Electric and gas savings were independently evaluated using separate energy models. The verified gross savings reported includes interactive effects. With very few exceptions, the program design and calculation approach for the SEM Program does not allow us to quantify and remove the interactive effects due to the installation of multiple measures within the same timeframe. These methods closely follow the guidance of the NREL UMP protocol for SEM but the program should consider including the level of uncertainty as indicated above in Finding 3.

Navigant staff carefully reviewed the models using the following procedure:

- A site-specific analysis approach was implemented. Because this program contains primarily behavioral-based changes, the International Performance Measurement and Verification Protocol (IPMVP) option C – billing/metered data regression, was the main approach to impact evaluation.

- The data collection focused on verifying and/or updating the assumptions that feed into the implementer's energy model for each site. This data included: program tracking data and supporting documentation (project specifications, invoices, etc.), utility billing and interval data, Navigant-calibrated building automation system (BAS) trend logs and telephone conversations with onsite staff.

This data was used with other information collected from the site to identify operating characteristics of the site both pre- and post- program participation. If major changes occurred at the site during or after the SEM activities, Navigant adjusted the energy model to account for these changes. The changes that could affect the model savings include:

- Change in hours of operation
- Change in numbers of employees
- Change in production
- Other measures installed at the site that were implemented through other Utility EE/DR programs or outside of the ComEd or Nicor Gas programs.

6.2 Verified Net Program Savings Analysis Approach

Navigant calculated the verified net energy and demand savings by multiplying the verified gross savings estimates by a deemed net-to-gross ratio (NTGR). Table 6-1 shows the deemed NTGR values for EPY9

and GPY6. The deemed NTGR value of 1.00 for electric savings and 1.00 for gas savings were agreed to by stakeholders in discussions in the SAG.[2]

Table 6-1. Deemed NTGR Values for EPY9/GPY6

Program Channel	EPY9/GPY6 Deemed NTGR Value
Electric	1.00
Natural Gas	1.00

Source: ComEd_NTG_History_and_PY9_Recommendations_2016-02-26_Final.xlsx and Nicor_Gas_GPY6_NTG_Values_2016-02-29_Final.xlsx, which are to be found on the http://www.ilsag.info/net-to-gross-framework.html

7. Appendix 2. Impact Analysis Detail

The program had an electric realization rate (RR) above 1.0 due to a site over estimating the impact of a capital project on the site's SEM savings. This was not the fault of the SEM Program, which used the reported ex ante savings provided by the utility. Instead, savings for the capital project were overestimated and not fully realized for several months which negatively impacted the SEM savings. Table 7-1 summarizes the site by site level incremental electric and gas savings the SEM Program achieved in EPY9/GPY6. A detailed site by site summary is included in Section 5.2.

[2] Source: ComEd_NTG_History_and_PY9_Recommendations_2016-02-26_Final.xlsx and Nicor_Gas_GPY6_NTG_Values_2016-02-29_Final.xlsx, which are to be found on the IL SAG web site here: http://www.ilsag.info/ntg_2016.html

Table 7-1. PY9 Energy Savings by Measures

Site	Ex Ante Gross Savings (KWh)	Ex-Post Gross Savings (KWh)	Verified Gross Realization Rate	Ex Ante Gross Savings (Therms)	Ex-Post Gross Savings (Therms)	Verified Gross Realization Rate
Site 1	0	0	0.00	0	0	0.00
Site 2	852,198	852,112	1.00	0	0	0.00
Site 3	2,606,757	2,606,757	1.00	665,917	665,917	1.00
Site 4	0	0	0.00	0	0	0.00
Site 5	948,907	911,592	0.96	329,338	325,059	0.99
Site 6	0	0	0.00	0	0	0.00
Site 7	952,272	952,203	1.00	10,633	10,675	1.00
Site 8	0	0	0.00	0	0	0.00
Site 9	71,190	69,224	0.97	0	0	0.00
Site 10	3,175,951	3,036,442	0.96	0	0	0.00
Site 11	282,587	277,231	0.98	0	0	0.00
Site 12	27,983	1,231	0.04	0	0	0.00
Site 13	0	0	0.00	13,334	13,707	1.03
Site 14	1,155,823	1,155,823	1.00	0	0	0.00
Site 15	800,201	800,201	1.00	0	0	0.00
Site 16	0	0	0.00	69,046	69,046	1.00
Site 17	0	0	0.00	0	0	0.00
Site 18	0	0	0.00	29,019	29,270	1.01
Site 19	148,865	148,865	1.00	25,498	25,498	1.00
Site 20	547,576	497,321	0.91	0	0	0.00
Site 21	1,518,595	4,668,946	3.07	774,938	778,626	1.00
Total	13,088,905	15,977,948	1.22	1,917,723	1,917,798	1.00

Source: ComEd and Nicor Gas tracking data and Navigant team analysis.

Also see site details in Section 5.2.

For each site, Navigant reviewed and updated the implementer provided engineering models. Navigant staff generally followed the process below for this review:

Step 1- Navigant recreated the provided energy models to ensure they aligned with the provided data.

Step 2- Navigant confirmed that the model saving calculations accounted for all capital projects.

Step 3- Navigant identified and accounted for any short-term effects that were occurring outside of the SEM influence. The telephone interviews with the site staff confirmed these changes.

Step 4- Navigant made additional changes to the model as needed. Changes may include excluding certain outlier data points or including additional variables.

Several sites reported no electric or gas savings ex ante. Although activities were completed at these sites the energy model was unable to detect energy savings occurring at these site for a variety of reasons. For these sites, Navigant claimed zero savings to align with the implementer but each site model was verified and checked.

8. Appendix 3. TRC Detail

Table 8-1. PY9 SEM Impact Evaluation TRC Variables

Project	Unit	Measure Life	Ex Ante kWh	Verfied kWh Savings
Site 1	Per Site	5	0	0
Site 2	Per Site	5	852,198	852,198
Site 3	Per Site	5	2,606,757	2,606,757
Site 4	Per Site	5	0	0
Site 5	Per Site	5	948,907	911,592
Site 6	Per Site	5	0	0
Site 7	Per Site	5	952,272	952,272
Site 8	Per Site	5	0	0
Site 9	Per Site	5	71,190	69,224
Site 10	Per Site	5	3,175,951	3,036,442
Site 11	Per Site	5	282,587	277,231
Site 12	Per Site	5	27,983	1,231
Site 13	Per Site	5	0	0
Site 14	Per Site	5	1,155,823	1,155,823
Site 15	Per Site	5	800,210	800,210
Site 16	Per Site	5	0	0
Site 17	Per Site	5	0	0
Site 18	Per Site	5	0	0
Site 19	Per Site	5	148,865	148,865
Site 20	Per Site	5	547,576	49,321
Site 21	Per Site	5	1,518,595	4,668,946
Total			13,088,914	15,530,112

* This TRC variable table only includes cost-effectiveness analysis inputs available at the time of finalizing PY9 impact analysis and findings. 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 once complete.