



ComEd Matrix K-12 Private Schools and Colleges IPA Program Impact Evaluation Report

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

Presented to
ComEd

DRAFT

March 28, 2018

Prepared by:

Rick Berry
Navigant Consulting, Inc.

Nishant Mehta
Navigant Consulting, Inc.

www.navigant.com

Submitted to:

ComEd
Three Lincoln Centre
Oakbrook Terrace, IL 60181

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

Patricia Plympton, Assoc. Dir.
202.253.9356
Patricia.Plympton@Navigant.com

Disclaimer: This report was prepared by Navigant Consulting, Inc. ("Navigant") for ComEd based upon information provided by ComEd and from other sources. Use of this report by any other party for whatever purpose should not, and does not, absolve such party from using due diligence in verifying the report's contents. Neither Navigant nor any of its subsidiaries or affiliates assumes any liability or duty of care to such parties, and hereby disclaims any such liability.

TABLE OF CONTENTS

1. Introduction	1
2. Program Description	1
3. Program Savings.....	2
4. Program Savings by Measure.....	2
5. Impact Analysis Findings and Recommendations	4
Impact Parameter Estimates.....	4
Fluorescent and LED Lighting	4
LED Exit Sign.....	4
Other Impact Findings and Recommendations.....	5
Finding 4.....	6
6. Appendix 1. Impact Analysis Methodology	6
Fluorescent and LED Lighting	7
LED Exit Sign.....	7
7. Appendix 2. Impact Analysis Detail.....	8

LIST OF TABLES AND FIGURES

Figure 2-1. PY9 Measure Savings by Type	1
Figure 2-2. PY9 Energy Savings by Space Type	2
Table 2-1. PY9 Volumetric Findings Detail	1
Table 3-1. PY9 Total Annual Incremental Savings	2
Table 4-1. PY9 Energy Savings by Measure	3
Table 4-2. PY9 Demand Savings by Measure.....	3
Table 4-3. PY9 Peak Demand Savings by Measure	4
Table 5-1. Verified Gross Savings Parameters.....	5
Table 5-2. Projects with Building Type Adjustments.....	5
Table 6-1. IL TRM v5.0 Lighting Algorithm Input Values	6
Table 6-2. Fluorescent and LED Custom and Deemed Values Comparison	7
Table 6-3. LED Exit Sign Custom and Deemed Values Comparison	8
Table 7-1. Measures Impacted by Finding 3.....	8

1. INTRODUCTION

This report presents the results of the impact evaluation of ComEd's PY9 Matrix K-12 Private Schools and Colleges 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. PY9 covers June 1, 2016 through December 31, 2017.

2. PROGRAM DESCRIPTION

The Matrix K-12 Private Schools and Colleges (Matrix Schools) Program aids small private educational establishments¹ which include private pre-schools and K-12 schools, private colleges and trade/technical schools to implement energy efficiency measures. Matrix Energy Services (Matrix) implements the program. Matrix K-12 Private Schools program's eligible measures include LED exit signs, LED lamps, LED fixtures, reduced wattage T8 retrofits, and high-output T5 fluorescent fixtures.

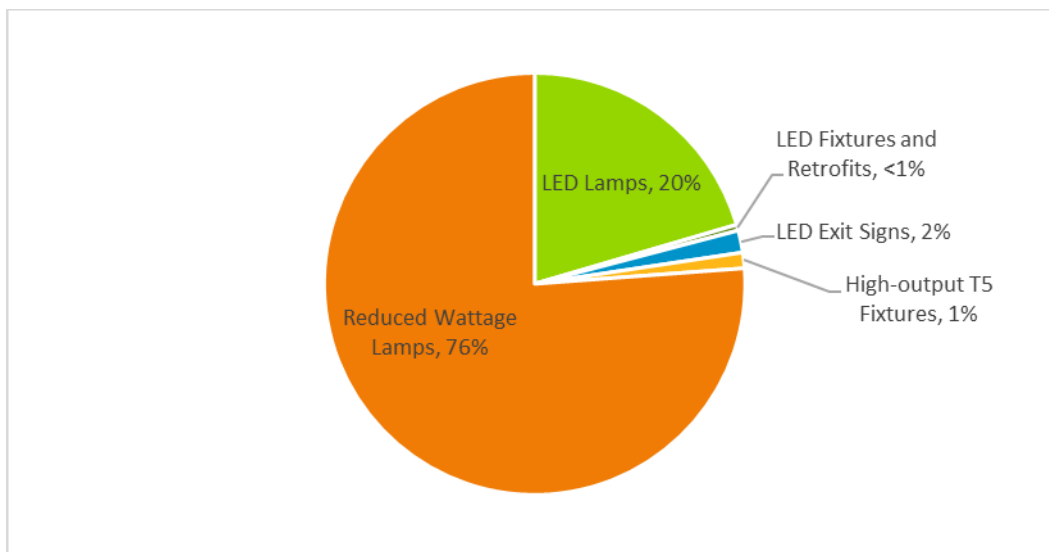
In PY9, the Matrix Schools program had 28 participants and distributed 4,362 measures as shown in the following table and graph.

Table 2-1. PY9 Volumetric Findings Detail

Participation	PY9
Participants	28
Total Measures	4,362
Number of Measures/Project	156

Source: ComEd tracking data and Navigant team analysis.

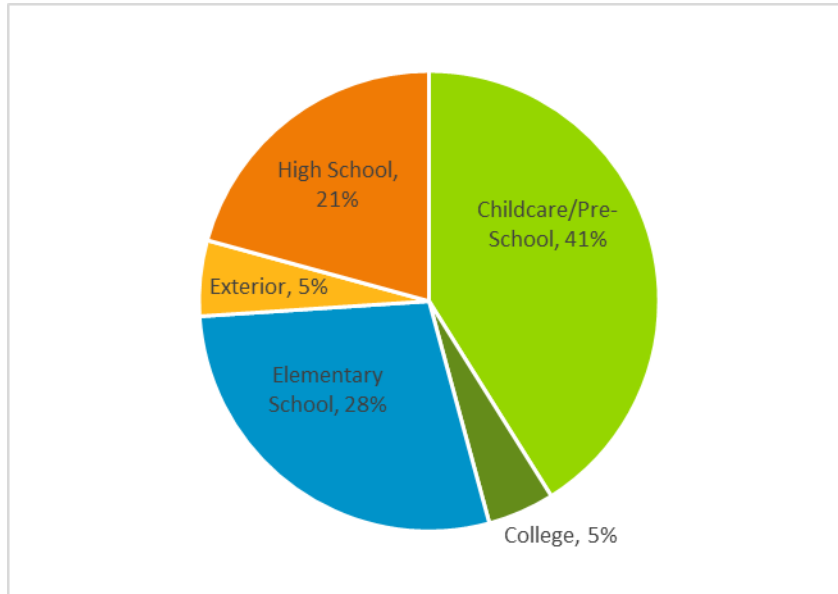
Figure 2-1. PY9 Measure Savings by Type



Source: Evaluation Analysis

¹ "Small commercial and industrial" customers are defined as customers with peak demands of 100 kW or less.

Figure 2-2. PY9 Energy Savings by Space Type



Source: Evaluation Analysis

3. PROGRAM SAVINGS

Table 3-1 summarizes the incremental energy and demand savings for the Matrix Schools Program. The 105 percent realization rate on peak demand savings is a result of one project not claiming any ex ante demand savings. See Finding 4 for additional detail.

Table 3-1. PY9 Total Annual Incremental Savings

Savings Category	Energy Savings (kWh)	Demand Savings (kW)	Peak Demand Savings (kW)
Ex Ante Gross Savings	799,293	NR	200
Program Gross Realization Rate	100%	NA	105%
Verified Gross Savings	801,221	302	210
Program Net-to-Gross Ratio (NTGR)	0.95	0.95	0.95
Verified Net Savings	761,160	287	199

Source: ComEd tracking data and Navigant team analysis.
NR = not reported

4. PROGRAM SAVINGS BY MEASURE

The Matrix Schools program tracked 82 unique measures which were categorized into the nine measure categories shown in the following tables. The reduced wattage linear fluorescent retrofits accounted for 76 percent of the total program 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)†
Lighting	LED Can Retrofit	1,383	96%	1,333	0.95	1,267	NA	NA	15.0
Lighting	LED Candelabra Lamp	2,735	94%	2,563	0.95	2,434	NA	NA	13.1
Lighting	LED Directional Lamp	77,603	99%	76,716	0.95	72,880	NA	NA	14.0
Lighting	LED Exit Sign	13,245	102%	13,530	0.95	12,854	NA	NA	16.0
Lighting	LED Fixture	2,696	85%	2,285	0.95	2,171	NA	NA	10.2
Lighting	LED General Lamp	68,630	112%	76,570	0.95	72,741	NA	NA	13.5
Lighting	LED Globe Lamp	8,017	102%	8,187	0.95	7,778	NA	NA	15.0
Lighting	Reduced Wattage T8	611,310	100%	610,401	0.95	579,881	NA	NA	15.0
Lighting	High-output T5 Fixtures	13,674	70%	9,636	0.95	9,154	NA	NA	15.0
	Total‡	799,293	100%	801,221	0.95	761,160	NA	NA	14.8

Source: ComEd tracking data and Navigant team analysis.

* 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.

‡ Numbers do not sum exactly due to rounding.

Table 4-2. PY9 Demand Savings by Measure

End Use Type	Research Category	Ex Ante Gross Demand Reduction (kW)	Verified Gross Realization Rate	Verified Gross Demand Reduction (kW)	NTGR*	Verified Net Demand Reduction (kW)
Lighting	LED Can Retrofit	NR	NA	0.7	0.95	0.6
Lighting	LED Candelabra Lamp	NR	NA	0.9	0.95	0.9
Lighting	LED Directional Lamp	NR	NA	31	0.95	30
Lighting	LED Exit Sign	NR	NA	2	0.95	2
Lighting	LED Fixture	NR	NA	0.5	0.95	0.4
Lighting	LED General Lamp	NR	NA	28	0.95	27
Lighting	LED Globe Lamp	NR	NA	3	0.95	3
Lighting	Reduced Wattage T8	NR	NA	231	0.95	220
Lighting	High-output T5 Fixtures	NR	NA	4	0.95	4
	Total†	NR	NA	302	0.95	287

Source: ComEd tracking data and Navigant team analysis.

NR = not reported

* 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>

† Numbers do not sum exactly due to rounding.

Table 4-3. PY9 Peak Demand Savings by Measure²

End Use Type	Research Category	Ex Ante Gross Peak Demand Reduction (kW)	Verified Gross Realization Rate	Verified Gross Peak Demand Reduction (kW)	NTGR*	Verified Peak Net Demand Reduction (kW)
Lighting	LED Can Retrofit	0.481	102%	0.5	0.95	0.5
Lighting	LED Candelabra Lamp	0.533	100%	0.5	0.95	0.5
Lighting	LED Directional Lamp	19.219	104%	20	0.95	19
Lighting	LED Exit Sign	1.223	100%	1	0.95	1
Lighting	LED Fixture	0.000	NA	0.0	0.95	0.0
Lighting	LED General Lamp	16.237	103%	17	0.95	16
Lighting	LED Globe Lamp	2.422	100%	2	0.95	2
Lighting	Reduced Wattage T8	157.449	105%	165	0.95	157
Lighting	High-output T5 Fixtures	2.690	100%	3	0.95	3
	Total†	200.254	105%	210	0.95	199

Source: ComEd tracking data and Navigant team analysis.

* 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>

† Numbers do not sum exactly due to rounding.

5. IMPACT ANALYSIS FINDINGS AND RECOMMENDATIONS

Impact Parameter Estimates

Energy and demand savings are estimated using the following formulae as specified in the TRM v5.0:

Fluorescent and LED Lighting³

$$\Delta kWh = \frac{Watts_{Base} - Watts_{EE}}{1000} * Hours * WHF_e * ISR$$

$$\Delta kW = \frac{Watts_{Base} - Watts_{EE}}{1,000} * ISR * WHF_d * CF$$

LED Exit Sign⁴

$$\Delta kWh = \frac{Watts_{Base} - Watts_{EE}}{1000} * Hours * WHF_e$$

$$\Delta kW = \frac{Watts_{Base} - Watts_{EE}}{1,000} * WHF_d * CF$$

The lifetime energy and demand savings are estimating by multiplying the verified savings by the effective useful life for each measure. The EM&V team evaluated the parameters that were not specified in the TRM. The results are shown in the following table.

² For details on coincidence factors used, please see Table 6-1.

³ Identical algorithms in IL TRM v5.0, 4.5.4 LED Bulbs and Fixtures; 4.5.3 High Performance and Reduced Wattage T8 Fixtures and Lamps

⁴ IL TRM v5.0, 4.5.5 Commercial LED Exit Signs

Table 5-1. Verified Gross Savings Parameters

Gross Savings Input Parameters	Deemed ‡ or Evaluated?
Quantity	Evaluated
Measure Type and Eligibility	Evaluated
Gross Savings per Unit	Evaluated
Verified Realization Rate on Ex Ante Gross Savings	Evaluated

‡ State of Illinois Technical Reference Manual version 2.0 from <http://www.ilsag.info/technical-reference-manual.html>.

Other Impact Findings and Recommendations

Finding 1. Navigant conducted online research using site addresses provided in the tracking data and found several projects in the tracking data base that did not have an accurate building type for the project according to the TRM categories. The building type was adjusted in the verified savings. This adjustment impacted the algorithm parameters such as operation hours, waste heat factors and coincidence factors. This finding affected the savings in the five projects identified below.

Recommendation 1. Navigant recommends a quality control check be performed on the data collected from the implementers to review the correct application of building types.

Table 5-2. Projects with Building Type Adjustments

Project ID	Ex Ante Building Type	Verified Building Type
63	Elementary School	Childcare/Pre-School
88	Elementary School	Childcare/Pre-School
139	College	Elementary School
141	College	Elementary School
35	High School	Elementary School

Source: Evaluation Analysis

Finding 2. The lighting equipment installed in exterior locations (as indicated by ex ante hours of 4,903) used IL TRM v5.0 algorithm input values for the building types listed in the tracking data and not for “exterior” space types. This finding affected 13 measures across eight projects.

Recommendation 2. Navigant recommends the savings algorithms used to produce ex ante savings be updated to correctly address measures installed in exterior applications.

Finding 3. In Project 81, the input values of several measures reflect interior installations despite the location descriptions indicating exterior locations (i.e., “soffit” and “front outdoor”). Navigant assumed these measures were installed outside of the building and the IL TRM v5.0 algorithm input values for “exterior” applications were used. This finding affected 104 installed LED General Lamp and LED Directional Lamp measures in Project 81. See Table 7-1 for details.

Recommendation 3. Navigant recommends updating the tracking data and energy savings calculation to reflect outdoor applications for these measures.

Finding 4. Project 35 does not have any demand savings claimed in the tracking data. The verified peak demand savings for this project total 10.26 kW.

Recommendation 4. Navigant recommends correcting the tracking data regarding Project 35.

Finding 5. The hours of operation for Project 92 do not match the IL TRM v5.0 hours for the applicable building type. The source of the ex ante hours values (2,161 hours for lamps, 2,814 hours for fixtures) is unknown.

Recommendation 5. Navigant recommends correcting the tracking data regarding Project 92.

Finding 6. Project 48 contains one fluorescent fixture measure (“400 Watt Metal Halide ⇒ FL-T5, 4’ 4 Lamp, 54 Watt, 5000K”) which uses algorithm operational hours, waste heat factors and coincidence factors from IL TRM v4.0 instead of TRM v5.0.

Recommendation 6. Navigant recommends correcting the tracking data for this measure.

Finding 7. Several measures have locations which suggest very low hours of operation. These include storage closets, janitorial closets, attics and mechanical spaces. Navigant did not adjust the savings for these measures in the verified savings due to uncertainty, but these spaces are not likely to provide the full savings that the IL TRM v5.0 estimates.

Recommendation 7. Navigant recommends considering adjusting the program to reduce the installation of lighting in spaces that have low hours of operation.

6. APPENDIX 1. IMPACT ANALYSIS METHODOLOGY

As described in Section 5, energy and demand savings were estimated using Illinois TRM v5.0. The Illinois TRM deems most input parameters for lighting measures and are provided below.

Table 6-1. IL TRM v5.0 Lighting Algorithm Input Values

Building/Space Type	Fixture Annual Operating Hours	Screw-Based Lamp Annual Operating hours	Waste Heat Cooling Energy (WHF _e)	Waste Heat Cooling Demand (WHF _d)	Coincidence Factor
Childcare/Pre-School	2,860	2,860	1.17	1.29	0.72
College	3,395	2,588	1.06	1.39	0.63
Elementary School	3,038	2,118	1.17	1.29	0.72
High School	3,038	2,327	1.18	1.39	0.72
Exterior	4,903	4,903	1	1	0

Source: State of Illinois Technical Reference Manual version 5.0

Fluorescent and LED Lighting⁵

$$\Delta kWh = \frac{Watts_{Base} - Watts_{EE}}{1000} * Hours * WHF_e * ISR$$

$$\Delta kW = \frac{Watts_{Base} - Watts_{EE}}{1,000} * ISR * WHF_d * CF$$

Where:

- Watts_{Base}* = Input wattage of existing or baseline system
- Watts_{EE}* = Input wattage of proposed system
- Hours* = Shower length in minutes with baseline showerhead
- WHF_e* = Waste heat factor for energy
- ISR* = In Service Rate
- WHF_d* = Waste heat factor for demand
- CF* = Summer peak coincidence factor

Table 6-2. Fluorescent and LED Custom and Deemed Values Comparison

Value	Variable	Source	Deemed/ Custom
Varies	Watts _{Base}	Program Tracking Data	Custom
Varies	Watts _{EE}	Program Tracking Data	Custom
Varies by Building Type	Hours	IL TRM 4.5.3-4	Deemed
Varies by Building Type	WHF _e	IL TRM 4.5.3-4	Deemed
1.0	ISR	IL TRM 4.5.3-4	Deemed
Varies by Building Type	WHF _d	IL TRM 4.5.3-4	Deemed
Varies by Building Type	CF	IL TRM 4.5.3-4	Deemed

LED Exit Sign⁶

$$\Delta kWh = \frac{Watts_{Base} - Watts_{EE}}{1000} * Hours * WHF_e$$

$$\Delta kW = \frac{Watts_{Base} - Watts_{EE}}{1,000} * WHF_d * CF$$

Where:

- Watts_{Base}* = Input wattage of existing or baseline system
- Watts_{EE}* = Input wattage of proposed system
- Hours* = Shower length in minutes with baseline showerhead
- WHF_e* = Waste heat factor for energy
- WHF_d* = Waste heat factor for demand
- CF* = Summer peak coincidence factor

⁵ Identical algorithms in IL TRM v5.0, 4.5.4 LED Bulbs and Fixtures; 4.5.3 High Performance and Reduced Wattage T8 Fixtures and Lamps

⁶ IL TRM v5.0, 4.5.5 Commercial LED Exit Signs

Table 6-3. LED Exit Sign Custom and Deemed Values Comparison

Value	Variable	Source	Deemed/ Custom
Varies	Watts _{Base}	Program Tracking Data	Custom
Varies	Watts _{EE}	Program Tracking Data	Custom
8,766	Hours	IL TRM 4.5.5	Deemed
Varies by Building Type	WHF _e	IL TRM 4.5.5	Deemed
1.0	ISR	IL TRM 4.5.5	Deemed
Varies by Building Type	WHF _d	IL TRM 4.5.5	Deemed
1.0	CF	IL TRM 4.5.5	Deemed

7. APPENDIX 2. IMPACT ANALYSIS DETAIL

Table 7-1. Measures Impacted by Finding 3

Measure ID	Measure	Location	Qty
M79	Incandescent, 75 Watt Lamp, Medium Base, BR30 Shape ⇒ 14 Watt LED, Medium Base, BR30 Shape, 3000K	Soffit	4
M80	Incandescent, 75 Watt Lamp, Medium Base, BR30 Shape ⇒ 14 Watt LED, Medium Base, BR30 Shape, 3000K	Upper Soffit	6
M81	Incandescent, 60 Watt Lamp, Medium Base, A19 Shape ⇒ 9.5 Watt LED, Medium Base, A19 Shape, 3000K	Westroom back door	4
M82	Incandescent, 60 Watt Lamp, Medium Base, A19 Shape ⇒ 9.5 Watt LED, Medium Base, A19 Shape, 3000K	Front Outdoor	80
M83	Incandescent, 60 Watt Lamp, Medium Base, A19 Shape ⇒ 9.5 Watt LED, Medium Base, A19 Shape, 3000K	Common Area Back Door	2
M84	Incandescent, 75 Watt Lamp, Medium Base, BR30 Shape ⇒ 14 Watt LED, Medium Base, BR30 Shape, 3000K	Rear Security	6
M85	Incandescent, 60 Watt Lamp, Medium Base, A19 Shape ⇒ 9.5 Watt LED, Medium Base, A19 Shape, 3000K	Nap Room Back Door	2

Source: ComEd tracking data and Navigant team analysis.