ComEd LED Street Lighting Impact Evaluation Report

Energy Efficiency / Demand Response Plan: Plan Year 9 (PY9) (6/1/2016-12/31/2017)

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1. INTRODUCTION

This report presents the results of the impact evaluation of ComEd's Program Year 9 (PY9) LED Street Lighting Program for utility-owned fixtures only. PY9 covers June 1, 2016 through December 31, 2017.

The municipally-owned fixtures portion of the program, assumed from DCEO in June of 2017 and managed by ComEd through December 2017, will be evaluated in a separate report. This report presents a summary of the energy and demand impacts for ComEd-owned fixtures broken out by relevant measure and program structure details. The appendix presents the impact analysis methodology.

2. PROGRAM DESCRIPTION

The LED Street Lighting program, launched in 2014, encourages early retirement of ComEd-owned High-Pressure Sodium (HPS), Mercury Vapor (MV), and Metal Halide (MH) fixtures serving municipalities and replacing them with Light-Emitting Diode (LED) fixtures. The program has grown substantially over the last three years from generating 460,000 kWh of savings in PY7 to 4,497,199 kWh in PY9 for the utility-owned fixtures only. The municipally-owned portion of the program will be reported separately.

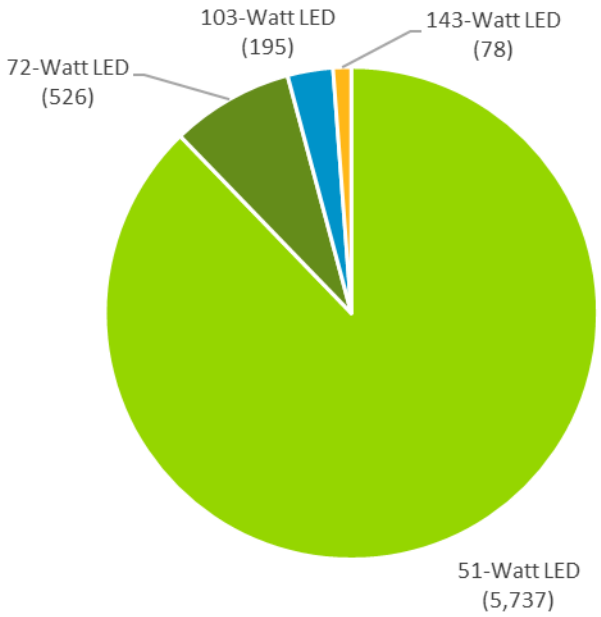
The program had 54 participants (as defined by municipality) in PY9 and distributed 6,536 measures as shown in the following table and graph.

Table 2-1. PY9 Volumetric Findings Detail

Participation	
Participants	54
Total Measures	6,536
Number of Units/Projects	1
Installed Projects	6,536

Source: ComEd tracking data and Navigant team analysis.

Figure 2-1. Number of Energy Efficient Measures Installed by Type



Source: Evaluation Analysis

3. Program Savings

Table 3-1 summarizes the incremental energy and demand savings the ComEd-owned LED Street Lighting 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	4,497,391	0	0
Program Gross Realization Rate	100%	NA	NA
Verified Gross Savings*	4,497,199	1,045	711
Program Net-to-Gross Ratio (NTGR)	1.00	1	1
Verified Net Savings	4,497,199	1,045	711

* The verified gross savings is slightly less than ex ante savings values even though the realization rate rounds to 100 percent.
Source: ComEd tracking data and Navigant team analysis.

4. Program Savings by Measure

The program includes four measures, as shown in Table 4-1. The measures include 51-, 72-, 103-, and 143-watt LED street lighting fixtures. The 51-watt LED measure contributed over 80 percent of the 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	51-Watt LED	3,769,088	100%	3,768,933	1.00	3,768,933	NA	NA	12
Lighting	72-Watt LED	491,636	100%	491,605	1.00	491,605	NA	NA	12
Lighting	103-Watt LED	171,672	100%	171,668	1.00	171,668	NA	NA	14
Lighting	143-Watt LED	64,995	100%	64,993	1.00	64,993	NA	NA	14
	Total	4,497,391		4,497,199		4,497,199			

* 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 was based of the technical measure life of the fixtures as found in the specification sheets for the fixtures installed (50,000 and 60,000 hours for each respective measure) divided by 4,303 annual hours of use for an effective useful life of 11.62 and 13.94 years which were rounded to 12 and 14 years respectively.

Source: ComEd tracking data and Navigant team analysis.

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	51-Watt LED	-	NA	876	1.00	876
Lighting	72-Watt LED	-	NA	114	1.00	114
Lighting	103-Watt LED	-	NA	40	1.00	40
Lighting	143-Watt LED	-	NA	15	1.00	15
	Total	-		1,045		1,045

* 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 4-3. PY9 Summer 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 Peak Net Demand Reduction (kW)†
Lighting	51-Watt LED	-	NA	-	1.00	-
Lighting	72-Watt LED	-	NA	-	1.00	-
Lighting	103-Watt LED	-	NA	-	1.00	-
Lighting	143-Watt LED	-	NA	-	1.00	-
	Total	-		-		-

* 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.

† The table reflects the summer peak demand associated with the program for which there is no summer peak demand savings. However, the program does generate winter peak demand savings which is outlined in Appendix

Source: ComEd tracking data and Navigant team analysis.

The program does not generate summer peak demand savings since LED street lights are set to dusk-to-dawn operation and do not operate during the coincident summer peak period. The Illinois TRM stipulates that the coincident summer peak period is from 1:00-5:00 PM Central Prevailing Time on non-holiday weekdays, June through August.

5. Impact Analysis Findings and Recommendations

5.1 Impact Parameter Estimates

Energy and demand savings are estimated using the following formulas:

$$\Delta\text{kWh} = ((Watts_{base} - Watts_{EE}/1000) * Hours$$

$$Total\ kWh_{savings} = Q * \Delta kWh$$

$$\Delta\text{kW} = ((Watts_{base} - Watts_{EE}/1000)$$

$$Total\ kW_{savings} = Q * \Delta kW$$

$$\Delta kW_{peak} = \Delta kW * CF$$

$$Total\ kW_{peak\ savings} = Q * \Delta kW$$

Where:
$Watts_{base}$ = Baseline lighting fixture wattage
$Watts_{EE}$ = Energy efficient lighting fixture wattage
Hours = Annual hours of use
Q = Quantity of measures
CF = Coincidence factor

Navigant calculated HOUs to be 4,303 based on the average annual total hours of darkness for 2016 using the Astronomical Applications Department, U.S. Naval Observatory[1]. Darkness refers to sunrise and sunset, which is conventionally referred to the times when the upper edge of the disk of the Sun is on the horizon. Atmospheric conditions are assumed to be average, and the location is in a level region on the Earth's surface. Navigant and ComEd have agreed to using these HOUs since there is no LED street lighting or street lighting measure in the Illinois TRM.

The lifetime energy and demand savings are estimating by multiplying the verified savings by the effective useful life for each measure. Navigant calculated the effective useful life of each measure based on the specific measure TM-21 lumen maintenance measure hours divided by the 4,303 HOUs since there is no LED street lighting or street lighting measure in the Illinois TRM.

The EM&V team conducted research to validate the parameters that were not specified in the TRM. The results are shown in Table 5-1.

[1] U.S. Naval Observatory, Astronomical Applications Department web site: http://aa.usno.navy.mil/data/docs/Dur_OneYear.php. Accessed 3/31/2016.

Table 5-1. Verified Gross Savings Parameters

Gross Savings Input Parameters	Value	Deemed* or Evaluated?
Quantity	Varies	Evaluated
Annual Hours of Use	4,303	Evaluated
Coincidence Factor	0.68	Evaluated
Measure Type and Eligibility	Varies	Evaluated
Gross Savings per Unit, Sampled Non-Deemed Measures	Varies	Evaluated
Verified Realization Rate on Ex-Ante Gross Savings (Lighting)	1.0	Evaluated

* State of Illinois Technical Reference Manual version 5.0 from http://www.ilsag.info/technical-reference-manual.html.

5.2 Other Impact Findings and Recommendations

Program Participation

Finding 1. The program replaced ComEd owned street lighting in 54 municipalities and installed 6,536 LED street lights.

Program Savings

Finding 2. Overall, the LED Street Lighting Program achieved verified gross savings of 4,497,199 kWh with a corresponding verified gross realization rate of 100 percent for energy savings.

Finding 3. In PY9, ComEd's target was to replace 7,000 fixtures and produce 3,800,000[2] kWh of net energy savings. Overall, the program achieved 118 percent of its planning target with verified net savings of 4,497,199 kWh.

Finding 4. Overall, the verified winter net peak demand reduction was 711 kW and the verified total net demand reduction was 1,045 kW.

Finding 5. 908 of the baseline fixtures could not be verified because nameplate information on these fixtures were not legible. For this evaluation, ComEd provided the billed baseline wattage for these fixtures, which Navigant believes is sufficient. ComEd should address this issue and identify and document which fixtures are being replaced.

Tracking Data

Finding 6. The tracking data could be cleaned up to prevent confusion to improve the verification process as there are currently internal notes and potential color-coding throughout the tracking data without explanation for these notes or color-coding.

Recommendation 1.

- Navigant recommends that ComEd continues to standardize and improve its template for data tracking to help eliminate data entry errors.
  - Add a column indicating in which program year the fixture replacement occurred.
  - Remove color-coding or provide insight into color-coding methodology to help remove ambiguity in the verification process.

Finding 7. Navigant found that the program replaced an existing LED with a lower wattage LED. The program replaced (1) 100-W LEDs with (1) 72-W LED.

Recommendation 2. Navigant recommends that ComEd update program documentation to include cases where existing LEDs streetlights are replaced by energy efficient LED streetlights.

[2] ComEd's revised target July 2017.

Impact Analysis

Finding 8. The calculated summary kWh values for four municipalities were incorrect.

- All four of these municipalities had annual hours of use of 4,304 as opposed to the agreed upon 4,303. Navigant worked with ComEd to resolve and determined that it was a data entry error.

6. Appendix 1. Impact Analysis Methodology

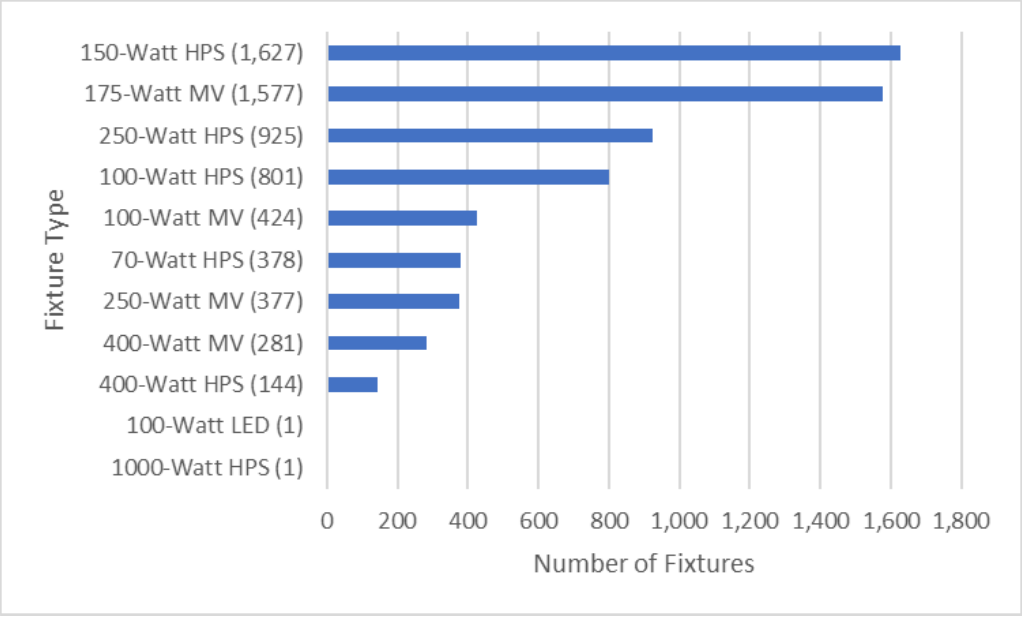
Navigant's impact analysis methodology included a consistency check on the LED Street Lighting program tracking data to validate the PY9 data. The tracking data included the fixtures that were removed and the newly installed LED fixtures. Navigant examined values for per unit energy savings at the measure level in the following manner:

- Reviewed project documentation for quantities and replacement wattage values.
- Verified hours of use.
- Combined data for all participants into one dataset.

7. Appendix 2. Impact Analysis Detail

In addition to the above analysis, Navigant has included figures detailing a breakdown of baseline fixture counts and energy savings, demand savings, and fixture count by municipality. Figure 7-1 shows the count of baseline fixtures that were replaced through the program. 150-watt HPS and 175-watt MV fixtures represented approximately half of all the fixtures that were replaced

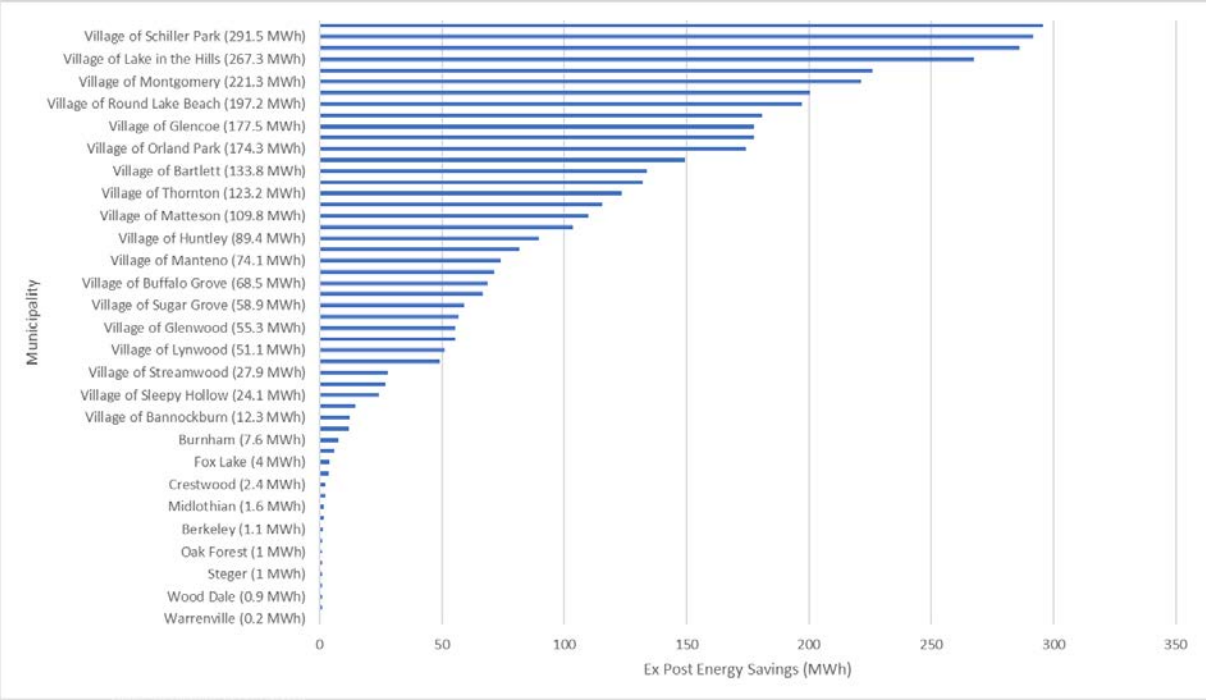
Figure 7-1. Baseline Fixture Count



Source: ComEd tracking data and Navigant team analysis

Figure 7-2 shows energy savings by municipality. The ten highest participating municipalities achieved over 50 percent of the program savings.

Figure 7-2. Energy Savings by ComEd owned Municipality



Source: ComEd tracking data and Navigant team analysis

8. Appendix 3. Total Resource Cost Detail

The Total Resource Cost (TRC) variable table below 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. Note, that the effective useful life is subject to change and is not final.

Table 8-1: Total Resource Cost for Program Measures

End Use Type	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)
Lighting	51-Watt LED	Each	5,737	12	3,769,088	-	3,768,933	596
Lighting	72-Watt LED	Each	526	12	491,636	-	491,605	78
Lighting	103-Watt LED	Each	195	14	171,672	-	171,668	27
Lighting	143-Watt LED	Each	78	14	64,995	-	64,993	10

Source: *ComEd tracking data and Navigant team analysis*

9. Appendix 4. Winter Peak Demand Savings

Table 9-1. PY9 Winter 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 Peak Net Demand Reduction (kW)
Lighting	51-Watt LED	-	NA	596	1.00	596
Lighting	72-Watt LED	-	NA	78	1.00	78
Lighting	103-Watt LED	-	NA	27	1.00	27
Lighting	143-Watt LED	-	NA	10	1.00	10
	Total	-		711		711

* 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.

Table 9-1 shows the winter peak demand savings associated with the program since LED street lights are set to dusk-to-dawn operation. Street lights are operating during PJM winter peak-demand hours (PJM hours are: weekdays 6:00 AM-8:00 AM and 5:00 PM-7:00 PM Central Time Zone, between January 1 and February 28, and non-holidays). Navigant calculated winter peak demand savings using a coincidence factor of 68 percent. Navigant calculated this value in the LED Street Lighting Program PY7 Evaluation Report by using the average hours of darkness in 2015 for the PJM winter hours of weekdays 6:00 AM-8:00 AM and 5:00 PM-7:00 PM Central Time Zone, between January 1 and February 28, and non-holidays.