

**LED Street Lighting Program
PY7 Evaluation Report**

FINAL

**Energy Efficiency/Demand Response Plan:
Plan Year 7
(6/1/2014-5/31/2015)**

**Presented to
Commonwealth Edison Company**

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E. Executive Summary

This report presents a summary of the findings and results from the impact evaluation of the ComEd PY7¹ LED Street Lighting Program. The LED Street Lighting Program encourages early retirement of High Pressure Sodium (HPS) and Mercury Vapor (MV) fixtures and replacement with Smart Light Emitting Diode (LED) fixtures. The program launched in June 2014 as a pilot program and will continue as an Illinois Power Agency program. The Illinois Power Agency (IPA) approval during 2014 was for the initial program duration from June 2015 through May 2017. The PY7 effort was a pilot before the program scaled up in PY8. The PY7 pilot consisted of two non-competitive municipalities² with total demand under 100 kW. In PY7, the program replaced 735 lights. The program is planning to replace 10,000 lights in PY8, 20,000 lights in PY9. This report describes the impact evaluation of the PY7 pilot program with recommendations for program enhancements.

E.1. Program Savings

Table E-1 summarizes the electricity savings from the LED Street Lighting Program. Navigant used information collected by ComEd from non-competitive municipal streetlight billing accounts to calculate ex ante gross energy savings. The tracking system did not include ex ante demand savings. Navigant reviewed the tracking system data and calculations to verify the energy gross savings to be 460 MWh.

Table E-1. PY7 Total Program Electric Savings

Savings Category	Energy Savings (MWh)	Winter Peak Demand Savings (MW)
Ex Ante Gross Savings	460	NA
Verified Gross Savings	460	0.076

Source: ComEd tracking data and Navigant team analysis.

E.2. Findings and Recommendations

The following describes our program findings and recommendations.

Program Savings Achievement

Finding 1. Overall, the LED Street Lighting program achieved verified gross savings of 460 MWh with a corresponding verified gross realization rate of 100 percent for energy savings.

Finding 2. Although street lighting is not currently in the Illinois Statewide Technical Reference Manual for Energy Efficiency Version 3.0³ (Illinois TRM v3.0), it is possible to calculate winter peak demand savings for LED street lights if the lights are set to dusk to dawn operation since the street lights are operating during PJM winter peak demand hours (PJM hours are:

¹ The PY7 program year began June 1, 2014 and ended May 31, 2015.

² ComEd defines non-competitive municipalities as accounts with under 100kW of total demand.

³ *State of Illinois Technical Reference Manual version 3.0* from <http://www.ilsag.info/technical-reference-manual.html>.

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)⁴. For example, the average hours of daylight in January 2016 are approximately between 7:10 AM and 4:50 PM⁵. The street lights should operate during the hours of 6:00 AM to 7:00 AM and from 5:00 PM to 7:00 PM in the winter peak hours. In February 2016 the hours of daylight are approximately between 6:30 AM and 5:30 PM⁶. It is possible to use one winter coincidence factor for all the municipalities based on the sunrise and sunset data. Navigant calculated the winter peak coincidence factor to be 68 percent. Navigant calculated this value 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. 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.

Finding 3. Since there is no street lighting measure in the Illinois TRM, ComEd calculated a streetlight average hours of use of 342 hours per month/4,104 hours per year.⁷ Navigant calculated a similar number, 4,303 hours per year, for total hours of darkness for 2014 using the Astronomical Applications Department, U.S. Naval Observatory⁸. Since Navigant’s hours of use calculation was within 10% of ComEd’s, Navigant accepted ComEd’s number for this evaluation.

Recommendation 1. Since the street lighting measures are not covered in the TRM, Navigant suggests that ComEd provide the information collected during the LED replacement regarding baseline and efficient fixtures wattages and their quantities for the purpose of verification.

Recommendation 2. Navigant recommends that ComEd and the EM&V team use an agreed upon value for hours of use for street lighting and use this value for the future evaluation years.

⁴ PJM Manual 18: PJM Capacity Market Revision: 31 Effective Date: February 25, 2016, page 99: <https://www.pjm.com/~media/documents/manuals/m18.ashx>. Accessed March 29, 2016.

⁵ Timeanddate.com for the Chicago region in January 2016.

⁶ Timeanddate.com for the Chicago region in February 2016.

⁷ Email from ComEd, January 21, 2016, “fixtures are assumed to operate 342 hours per month throughout the year.”

⁸ U.S. Naval Observatory, Astronomical Applications Department web site: http://aa.usno.navy.mil/data/docs/Dur_OneYear.php. Accessed 3/31/2016.

1 Introduction

1.1 Program Description

The Smart LED Street Lighting Program (Street Lighting) seeks to secure energy savings through encouraging municipalities that have ComEd-owned high-intensity discharge (HID) street lights to replace their Mercury Vapor (MV) and High Pressure Sodium (HPS) fixtures with Smart Light-Emitting Diode (LED) fixtures. The program encourages early retirement of HID street lights. Approximately 73,000 HID lighting fixtures are ComEd-owned and rented by non-competitively declared municipalities⁹.

The Street Lighting program launched in June 2014. The program was marketed to municipalities primarily through outreach by ComEd External Affairs personnel. PY7 was a pilot year before the program scaled up in PY8. The PY7 pilot included two municipalities each with total demand under 100 kW, and replaced 735 lights.

1.2 Evaluation Objectives

The evaluation team identified the following key researchable questions for PY7.

1.2.1 Impact Questions

1. What are the program's annual total verified gross savings?
2. Are the ex-ante per-unit gross impact savings correctly calculated in the tracking system and reasonable for this program?

⁹ ComEd defines non-competitive municipalities as accounts with under 100kW of total demand.

2 Evaluation Approach

The evaluation approach for the PY7 Street Lighting Program included reviewing tracking system data and savings calculations.

2.1 Overview of Data Collection Activities

The core data collection activity included verification of the program tracking data and savings calculations. Data collection activity is shown in the following table.

Table 2-1. Primary Data Collection Activity

What	Who	When	Comments
Engineering Review	Navigant	January and February 2016	Reviewed installation file for two participating municipalities

Source: Navigant

2.2 Verified Savings Parameters

Table 2-2 presents the sources for parameters that the evaluation used in the verified gross savings calculations. For this evaluation, evaluation research produced the parameters.

Table 2-2. Verified Gross Savings Parameter Data Sources

Input Parameters	Data Source(s)	Deemed or Evaluated?
Installed Quantities	Program tracking data analysis	Evaluated
Lighting Measure Hours of Use (HOU) (4,104)	ComEd calculation verified by evaluation research	Evaluated
Lighting Measure Delta Watts by Fixture Type	Program tracking data analysis	Evaluated
Gross Realization Rate	Program tracking data analysis	Evaluated

2.2.1 Verified Gross Program Savings Analysis Approach

Navigant used the information in the tracking system and performed research to provide program recommendations.

Navigant performed the following steps to verify gross energy savings of the LED Street Lighting Program:

1. Conducted an engineering review of the tracking system data and the energy savings estimates for the installed measures.
2. Verified the savings algorithm to be:

$$kWh_{savings} = Q * \Delta W * HOU$$

Where:

Q = Quantity of Lights

ΔW = Baseline fixture wattage minus the new LED fixture wattage

HOU = Hours of use

3. Validated ComEd's hours of use: ComEd used an average of 342 hours of use per month, which results in 4,104 hours of use per year. Navigant calculated the total hours of darkness for 2014 to be 4,303 hours per year using the Astronomical Applications Department, U.S. Naval Observatory¹⁰. 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. Since there is no LED street lighting or street lighting measure in the Illinois TRM and since Navigant's hours of use calculation is within 10% of ComEd's value, Navigant accepted ComEd's number for this evaluation.
4. Verified gross savings are the product of verified per unit savings and verified measure quantities.

¹⁰ U.S. Naval Observatory, Astronomical Applications Department web site: http://aa.usno.navy.mil/data/docs/Dur_OneYear.php. Accessed 3/31/2016.

3 Gross Impact Evaluation

The PY7 LED Street Lighting Program achieved overall verified gross savings of 460 MWh at a gross realization rate of 1.00. This section presents results of our evaluation activities to verify program savings.

3.1 Tracking System Review

Navigant conducted a consistency check on the LED Street Lighting Program tracking data to validate the PY7 data¹¹. The tracking data included the fixtures that were removed and the newly installed LED fixtures. We examined values for per unit energy savings at the measure level in the following manner:

- Reviewed project documentation for quantities and replacement wattage values, and
- Verified hours of use.

3.2 Program Volumetric Findings

The evaluation review of the PY7 Street Lighting Program tracking data found a total of 820 fixtures removed and 735 LED fixtures installed. The program can only receive credit for 1-to-1 fixtures retrofitted. The extra baseline fixtures were not counted in the gross savings program total.

Table 3-3. PY7 Volumetric Findings Detail

Participation	Total
Customer Participants*	2
Street Light Replacements	735

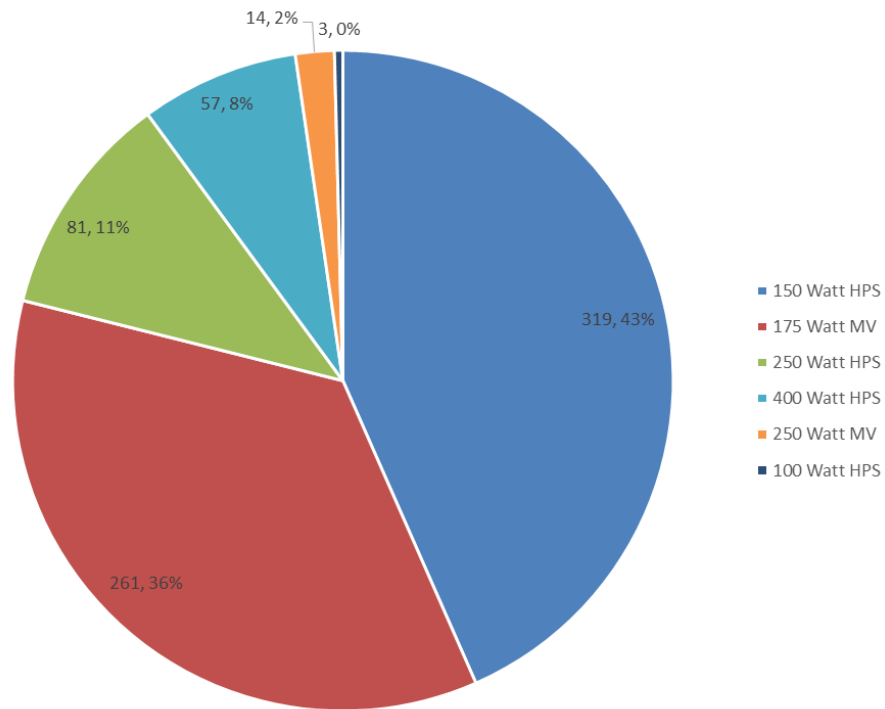
Source: ComEd tracking data and Navigant team analysis.

* Municipalities

Figure 3-1 shows the relative quantity of the types of the 735 baselines fixture wattages that were replaced by LED street lights, and Table 3-4 shows the quantities for each baseline fixture type from greatest to least quantities retrofitted.

¹¹ Email attachment “Bensenville and Lombard Energy Savings.xlsx” sent December 22, 2015.

Figure 3-1. Quantity (Number, Percentage of Total) and Type of Baseline Fixtures Replaced



HPS = High Pressure Sodium. M&V = Mercury Vapor
 Source: Evaluation Analysis

Table 3-4: Quantity of Baseline Fixtures Removed

Baseline Fixture	Quantity Removed
150 Watt HPS	319
175 Watt MV	261
250 Watt HPS	81
400 Watt HPS	57
250 Watt MV	14
100 Watt HPS	3

Source: ComEd Tracking Data

3.3 Gross Program Impact Parameter Estimates

The EM&V team conducted research to validate the parameters that were not specified in the Illinois TRM v3.0, shown in Table 3-6.

ComEd provided Navigant with a value of 342 hours per month/4,104 hours per year based on estimated hours without daylight for Northeast Illinois.¹² Navigant also calculated the total hours of darkness for 2014 to be 4,303 using the Astronomical Applications Department, U.S. Naval Observatory¹³. Based on the small overall difference, Navigant agrees ComEd’s value is reasonable for non-competitive municipalities. Navigant recommends that ComEd and the EM&V team use an agreed upon value for hours of use for street lighting and use this value for the future evaluation years.

ComEd created a table to align baseline fixtures type and wattage values with LED fixtures to establish the delta watts for the replacements. ComEd gathered baseline and energy efficient wattage values from municipal streetlight billing accounts, as show in Table 3-5. Navigant researched secondary sources and determined the wattage table to be reasonable.^{14,15} These sources suggest that because of the wide variety of LED products in the marketplace, the main concern is that the LED lumen output and light distribution matches that of the baseline fixture.

Table 3-5. Baseline and New LED Fixture Delta Watts

Baseline Fixture	EE Fixture	Delta Watts
100-MV W	LED 40-60 W	77
175-MV W	LED 40-60 W	172
250-MV W	LED 61-80 W	208
400-MV W	LED 120-160 W	302
HPS-70 W	LED 40-60 W	37
HPS-100 W	LED 40-60 W	76
HPS-150 W	LED 61-80 W	102
HPS-250 W	LED 120-160 W	159
HPS-400 W	LED 120-160 W	327

Source: ComEd tracking data

Navigant estimated a verified gross energy realization rate (defined as the ratio of the verified gross energy savings to ex-ante gross energy savings as reported in the tracking system) of 100 percent for the pilot program.

¹² Email from ComEd, January 21, 2016, “fixtures are assumed to operate 342 hours per month throughout the year.”

¹³ U.S. Naval Observatory, Astronomical Applications Department web site: http://aa.usno.navy.mil/data/docs/Dur_OneYear.php. Accessed 3/31/2016.

¹⁴ <http://energy.gov/eere/ssl/outdoor-lighting-resources>, accessed 3/31/2016.

¹⁵ <http://www.dot.state.mn.us/research/TS/2013/201304TS.pdf>, accessed 3/31/2016.

Table 3-6. Verified Gross Savings Parameters

Gross Savings Input Parameters	Value	Deemed or Evaluated?
Quantity	Varies	Evaluated
†Hours of Use	342/month	Evaluated
Measure Type and Eligibility	Varies	Evaluated
Gross Savings per Unit	Varies	Evaluated
Verified Realization Rate on Ex-Ante Gross Savings (Lighting)	1.00	Evaluated

Source: Navigant Analysis

†HOU value for municipality accounts with total demand less than 100 kW

3.4 Verified Gross Program Impact Results

The resulting total program verified gross energy savings is 460 MWh, shown in Table 3-7.

Table 3-7. PY7 Verified Gross Impact Savings Estimates by Measure Type

	Gross Energy Savings (MWh)	Winter Peak Demand Savings (MW)
PY7 Total		
Ex-Ante Gross Savings	460	NA
Verified Gross Realization Rate	1.00	NA
Verified Gross Savings	460	0.076

Source: ComEd Tracking Data and Navigant team analysis.

4 Findings and Recommendations

This section summarizes the key impact findings and recommendations.

Program Savings Achievement

Finding 1. Overall, the LED Street Lighting program achieved verified gross savings of 460 MWh with a corresponding verified gross realization rate of 100 percent for energy savings.

Finding 2. Although street lighting is not currently in the Illinois Statewide Technical Reference Manual for Energy Efficiency Version 3.0¹⁶ (Illinois TRM v3.0), it is possible to calculate winter peak demand savings for LED street lights if the lights are set to dusk to dawn operation since the 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)¹⁷. For example, the average hours of daylight in January 2016 are approximately between 7:10 AM and 4:50 PM¹⁸. The street lights should operate during the hours of 6:00 AM to 7:00 AM and from 5:00 PM to 7:00 PM in the winter peak hours. In February 2016 the hours of daylight are approximately between 6:30 AM and 5:30 PM¹⁹. It is possible to use one winter coincidence factor for all the municipalities based on the sunrise and sunset data. Navigant calculated the winter peak coincidence factor to be 68 percent. Navigant calculated this value 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. 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.

Finding 3. Since there is no street lighting measure in the Illinois TRM, ComEd calculated a streetlight average hours of use of 342 hours per month/4,104 hours per year.²⁰ Navigant calculated a similar number, 4,303 hours per year, for total hours of darkness for 2014 using the Astronomical Applications Department, U.S. Naval Observatory²¹. 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.²² Since there is no LED street lighting or street lighting measure in the Illinois TRM and Navigant’s hours of use calculation was within 10% of ComEd’s, Navigant used the custom hours of 4,104 for this evaluation.

¹⁶ State of Illinois Technical Reference Manual version 3.0 from <http://www.ilsag.info/technical-reference-manual.html>.

¹⁷ PJM Manual 18: PJM Capacity Market Revision: 31 Effective Date: February 25, 2016, page 99:

<https://www.pjm.com/~media/documents/manuals/m18.ashx>. Accessed March 29, 2016.

¹⁸ Timeanddate.com for the Chicago region in January 2016.

¹⁹ Timeanddate.com for the Chicago region in February 2016.

²⁰ Email from ComEd, January 21, 2016, “fixtures are assumed to operate 342 hours per month throughout the year.”

²¹ U.S. Naval Observatory, Astronomical Applications Department web site:

http://aa.usno.navy.mil/data/docs/Dur_OneYear.php. Accessed 3/31/2016.

²² U.S. Naval Observatory, Astronomical Applications Department web site:

http://aa.usno.navy.mil/data/docs/Dur_OneYear.php. Accessed 3/31/2016.

Recommendation 1. Since the street lighting measures are not covered in the TRM, Navigant suggests that ComEd provide the information collected during the LED replacement regarding baseline and efficient fixtures wattages and their quantities for the purpose of verification.

Recommendation 2. Navigant recommends that ComEd and the EM&V team use an agreed upon value for hours of use for street lighting and use this value for the future evaluation years.

Program Tracking Database

Finding 4. The evaluation team noticed there were 36,400 watt high pressure sodium fixtures listed on one tab of the ex-ante savings spreadsheet, and then these same fixtures were switched to 36,400 watt mercury vapor fixtures listed on the next tab of the spreadsheet. It is unclear why the baseline fixture types changed between tabs. Navigant used the 400 watt high pressure sodium fixtures in the ex-post analysis based on the initial list of fixtures replaced.

Recommendation 3. ComEd should use a consistent fixture list for each spreadsheet tab to prevent the fixture listings from being switched.