NAVIGANT

ComEd LED Street Lighting Combined Evaluation Report

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

Presented to
ComEd

February 14, 2019

Prepared by:

Navigant

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Submitted to:

ComEd
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1. INTRODUCTION

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

APPENDIX A. COMED LED STREET LIGHTING HOU MEMO 2017-06-21

NAVIGANT

Memorandum

To: Erin Daughton, Bill Burns, Martin Montes, Michael Brandt, Vince Gutierrez; ComEd Jennifer Morris; Illinois Commerce Commission

From: Jeff Erickson, Rob Neumann, Patricia Plympton, Nishant Mehta, and Chris Yoder; Navigant

Date: June 21, 2017

Re: LED Street Lighting Program Hours of Use for the ComEd and DCEO Programs

This memo is intended to provide guidance for ComEd's and Illinois Department of Commerce & Economic Opportunity's (DCEO) LED Street Lighting programs hours of use (HOU). Navigant recommends that ComEd use the 4,303 HOU value for each of the LED Street Lighting programs. That includes the DCEO's program and ComEd's LED Street Lighting program through the end of 2017 (PY9) and continue using the 4,303 HOU value in CY2018 and going forward, until a different value is researched or documented in the Illinois TRM.

Background

ComEd is transitioning the existing DCEO LED Street Lighting program into the ComEd portfolio (as of June 2017) based upon the requirements of the Illinois Future Energy Jobs Act passed in December 2017. The existing DCEO program uses the exterior – dusk-to-dawn building/space type 4,903 annual HOU from the Illinois Statewide Technical Reference Manual for Energy Efficiency Version 6.0 Volume 2: Commercial and Industrial Measures (TRM). The TRM 4,903 value is based on eQuest modeling data.

ComEd's LED Street Lighting program has been operating for two years utilizing the 4,104 annual HOU value. The 4,104 value is based on ComEd's internal research and similar to Navigant's own verified value of 4,303 which Navigant based on 2014 Astronomical Applications Department, U.S. Naval Observatory data for ComEd's service territory. Navigant calculated the 4,303 HOU based upon the annual duration of darkness for several years and concluded that the annual darkness fluctuates less than one percent from year-to-year.

ComEd sought guidance from Navigant as to which HOU value to use for each program and how to combine the approach of both programs in the future. Additionally, ComEd sought guidance on updating the TRM to include an established number for exterior lighting and possibly more detailed HOU values in future TRM updates. This memo is being issued to clarify which HOU should be applied for each program and how the TRM can be updated going forward.

Updating the Illinois Statewide Technical Reference Manual Version 6.0

Given the role of the TRM as a guiding document for the state, ComEd suggested that the TRM be revised to include one HOU that can be referenced for both LED Street Lighting programs. Since the DCEO LED Street Lighting program currently references the TRM's exterior – dusk-to-dawn building/space type HOU in section 4.5 Lighting End Use of the TRM, while ComEd's LED Street Lighting program uses a custom 4,104 HOU, the TRM building/space type should be

updated to reflect a more accurate HOU that would be consistently used throughout Illinois. Additional guidance on what should be include in the exterior – dusk-to-dawn building/space type could also be included.

This value can be updated through two approaches. The first approach would be to request errata filing to the TRM seeking to alter the HOU for the exterior – dusk-to-dawn building/space type. However, an errata presumes an error – this HOU discussion isn't truly an error. The second approach would be to leverage Section 3.2.1 TRM Mistakes and Omissions of the Policy Document in the TRM Policy Document. This second approach allows for omissions in the TRM to be corrected with agreement between all relevant parties including ComEd, the Illinois Commerce Commission, and the Illinois Stakeholder Advisory Group (SAG).

HOU Recommendations for PY9 and 2018

Navigant recommends that ComEd use the 4,303 HOU for the DCEO and ComEd LED Street Lighting programs during the bridge period which ends at the end of the 2017 (PY9) and use the same 4,303 HOU going forward into CY2018 and beyond. ComEd should continue using the 4,303 value for the DCEO program as well as the ComEd Street Lighting Program at the outset of CY2018 and going forward, until a new research is conducted.

Navigant also recommends ComEd request to update the HOU of the exterior – dusk-to-dawn building/space type to 4,303 leveraging Section 3.2.1 of the TRM Policy Document, since the current HOU for exterior – dusk-to-dawn lighting is not necessarily an error, but the current value is not reflective of the HOU of the LED street lights. Finally, Navigant recommends that ComEd utilize the HOU of 4,303 for each LED Street Lighting program regardless of whether the TRM is updated to ensure the most accurate HOU for the LED street lights is applied in each program.

APPENDIX B. COMED LED STREET LIGHTING PY9 IMPACT EVALUATION REPORT 2018-04-20

ComEd LED Street Lighting Impact Evaluation Report

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

Presented to Commonwealth Edison Company

April 20, 2018

Prepared by:

Chris Yoder
Navigant

Nishant Mehta
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NAVIGANT

ComEd LED Street Lighting Impact Evaluation Report

Submitted to:

ComEd
Three Lincoln Centre
Oakbrook Terrace, IL 60181

Submitted by:

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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.

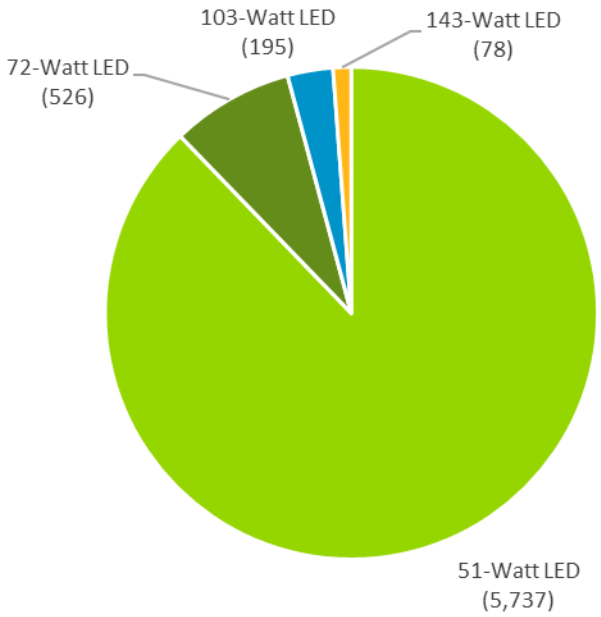
The program had 54 participants (as defined by municipality) in PY9 and distributed 6,536 measures as shown in the following table and graph.

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

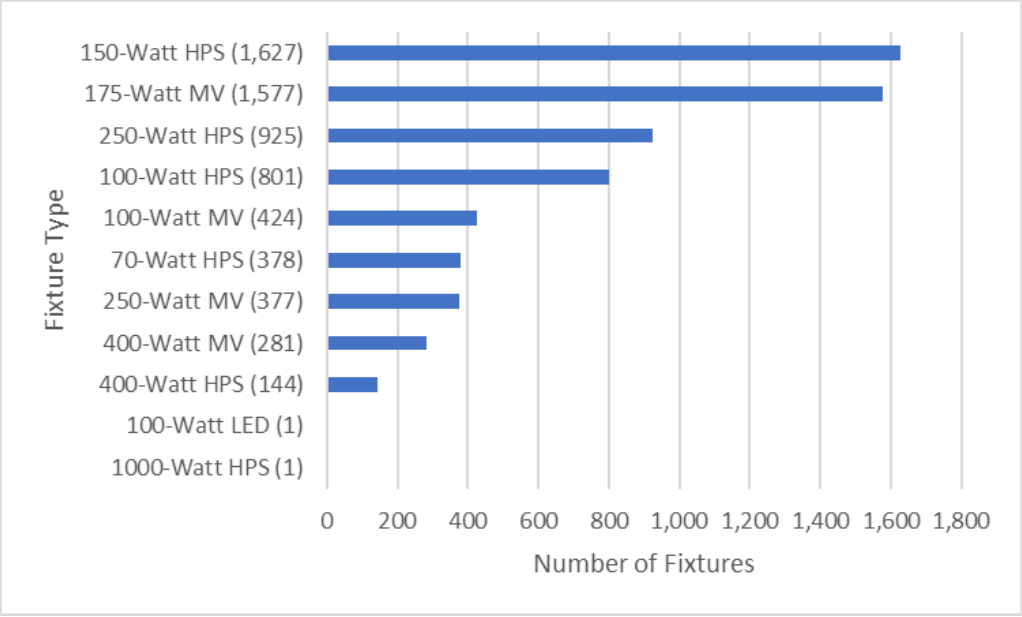
Navigant's impact analysis methodology included a consistency check on the LED Street Lighting program tracking data to validate the PY9 data. The tracking data included the fixtures that were removed and the newly installed LED fixtures. Navigant examined values for per unit energy savings at the measure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

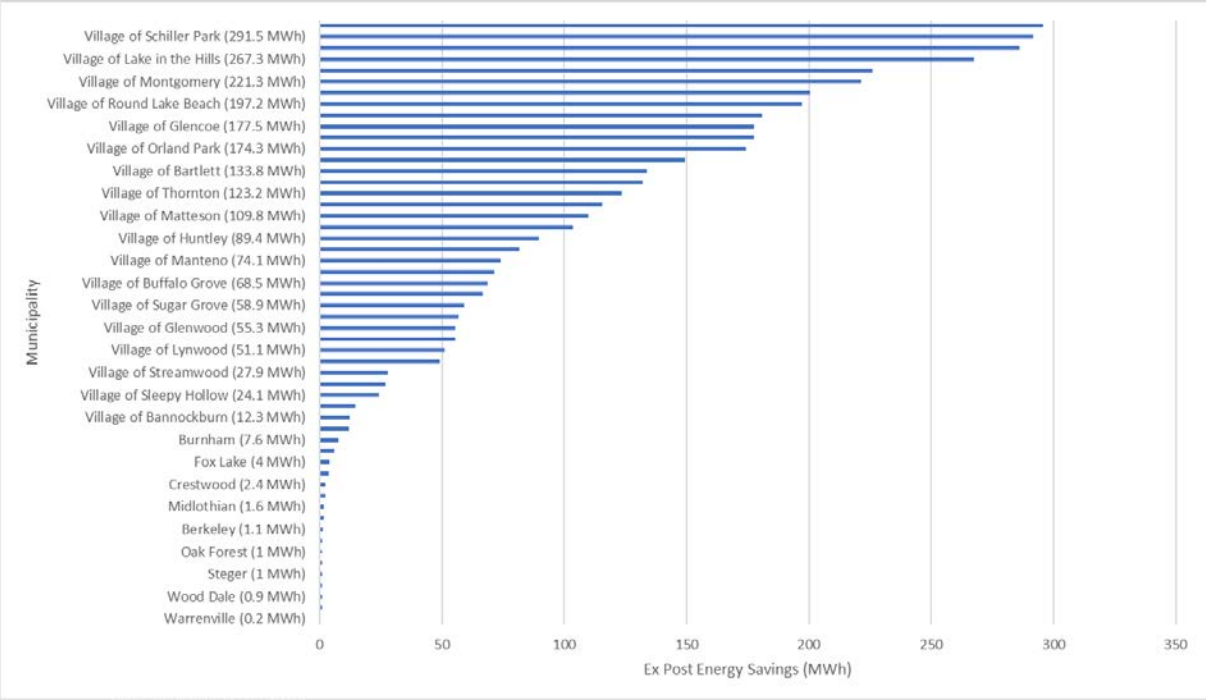
Figure 7-1. Baseline Fixture Count



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.

APPENDIX C. COMED PUBLIC SECTOR LED STREET LIGHTING PY9+ IMPACT EVALUATION REPORT 2018-08-28

NAVIGANT

ComEd Public Sector LED Streetlighting Program Impact Evaluation Report

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

Presented to
Commonwealth Edison Company

FINAL

August 28, 2018

Prepared by:

Chris Yoder
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ComEd Public Sector PY9 Bridge Period LED Street Lighting Impact Evaluation Report

Submitted to:

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ComEd Public Sector PY9 Bridge Period LED Street Lighting Impact Evaluation Report

1. INTRODUCTION

This report presents the results of the impact evaluation of public sector portion of the ComEd's LED Streetlighting (Streetlighting) Program for the PY9 Bridge Period, June 2, 2017 through December 31, 2017. 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.

2. PROGRAM DESCRIPTION

The Streetlighting Program encourages early retirement of ComEd-owned High-Pressure Sodium and Mercury Vapor fixtures serving municipalities with Light-Emitting Diode (LED) fixtures. Participation for PY8 and PY9 is limited to those municipalities whose street light account is less than 100kW. The 100kW limitations exist because IPA is the source of the funding for the program. Approximately 73,000 HID lighting fixtures are ComEd-owned and rented by non-competitively declared municipalities[1]. ComEd's criteria for selecting a LED replacement fixture considers the fixture height (normally 25-30 feet) and the road way configuration at the fixture location (number of lanes and intersection versus mid-block).

ComEd's criteria for selecting municipalities included:

- Municipality was in the advanced metering infrastructure portion of ComEd's territory.
- Municipality had more than 50 fixtures.[2]

The Streetlighting 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. The program expanded to 41 municipalities in PY8. In PY8, the program replaced 10,077 lights, exceeding its goal of replacing 10,000 lights in PY8. During the bridge period of PY9, ComEd assumed the public-sector programs including municipally owned street lighting and 26 municipalities utilized the program to install 14,303 new LED streetlights. When combining the 14,303 measures from ComEd's public sector program and the 6,536 from ComEd's utility-owned fixture program, the program incentivized 20,839 fixtures.

3. PROGRAM SAVINGS

The PY9 participants and measures are shown in the following tables and graphs.

Table 3-1 summarizes the LED Streetlight Program public sector (PS) participation achieved in PY9 bridge period.

[1] ComEd defines non-competitive municipalities as accounts with under 100kW of total demand.
[2] Email from ComEd Program Manager, January 4, 2017.

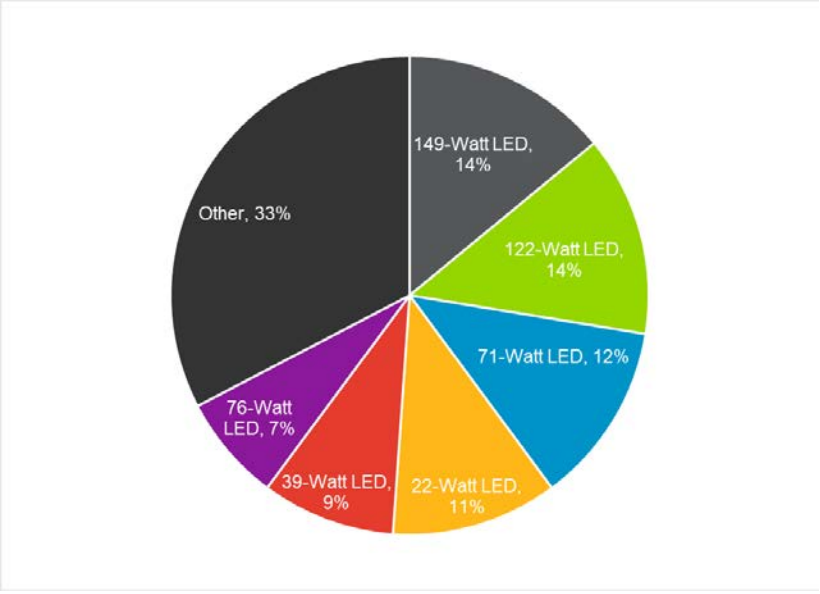
Table 3-1. PY9 Bridge Period Volumetric Findings Detail

Participation	PY9 Bridge Total
Participants*	26
Projects†	84
Measures Installed	14,303
Units/Project	Varies
149-Watt LEDs	2,002
122-Watt LEDs	1,931
71-Watt LEDs	1,752
22-Watt LEDs	1,605
39-Watt LEDs	1,290
76-Watt LEDs	1,027
Other LEDs	4,655

* Participants are defined as unique Customer Names
† Unique projects are defined as unique Project IDs
Source: ComEd tracking data and Navigant team analysis.

Figure 3-1 displays the Streetlighting Program's distribution of installed measures by type achieved in PY9 bridge period for the public sector.

Figure 3-1. Distribution of Measures Installed by Type



Source: Evaluation Analysis

Table 3-2 summarizes the incremental energy and demand savings the Streetlighting Program achieved in PY9 bridge period for the public sector.

Table 3-2. Streetlighting PY9 Bridge Total Annual Incremental Savings

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 Installations	12,954,935	100%	12,954,935	1.00	12,954,935	NA	NA	12
	Total	12,954,935		12,954,935		12,954,935			

* A deemed value. Source: ComEd_NTG_History_and_PY9_Recommendations_2016-02-26_Final.xlsx, which is to be found on the IL SAGweb 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.

4. Program Savings by Measure

Table 4-1. Streetlighting PY9 Bridge 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)
Lighting	LED Installations	12,954,935	100%	12,954,935	1.00	12,954,935
	Total	12,954,935		12,954,935		12,954,935

* 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 4-2. Streetlighting Bridge 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 Installations	3,011	100%	3,011	1.00	3,011
	Total	3,011		3,011		3,011

*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. Streetlighting PY9 Bridge 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)
Lighting	LED Installations	NA	NA	2,047	1.00	2,047
	Total	NA		2,047		2,047

* 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

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[3]. 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.

Table 5-1 summarizes the parameters and references used in verified gross and net savings calculation. Navigant calculated savings for each measure following algorithms defined by the Illinois TRM version 5.0.

[3] 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)	1.00	Evaluated

* State of Illinois Technical Reference Manual version 5.0 from http://www.ilsag.info/technical-reference-manual.html.
Source: ComEd tracking data and Navigant team analysis

5.2 Other Impact Findings and Recommendations

Program Participation

Finding 1. The program replaced municipality-owned street lighting in 26 municipalities and installed 14,303 LED street lights. When combined with the 6,536 ComEd-owned street lights replaced in PY9, the Streetlighting program incentivized a total of 20,839 fixtures.

Verified Gross Impacts and Realization Rate

Finding 2. The LED Street Lighting Program achieved verified gross savings of 12,954,935 kWh with a corresponding verified gross realization rate of 100 percent for energy savings.

Finding 3. In PY9, ComEd's achieved a total verified net savings of 17,452,138 kWh (12,954,935 kWh from municipality-owned fixtures and 4,497,199 kWh from ComEd-owned fixtures.)

Finding 4. Overall, the verified winter net peak demand reduction was 2,047 kW and the verified total net demand reduction was 3,011 kW (total verified winter net peak demand reduction was 2,758 kW and total verified total net demand reduction was 4,056 kW.)

Tracking Data

Finding 5. The tracking data could be cleaned up to prevent confusion to improve the verification process as there are currently no consistency in file names.

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 in the project level reports.
- Remove color-coding or provide insight into color-coding methodology to help remove ambiguity in the verification process.
- Ensure file naming is consistent so that R code can properly pull measure line information.

6. Appendix 1. Impact Analysis Methodology

6.1 Verified Gross Program Savings Analysis Approach

Navigant's impact analysis methodology to calculate verified gross program savings included a consistency check on the Streetlighting 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.

6.2 Verified Net Program Savings Analysis Approach

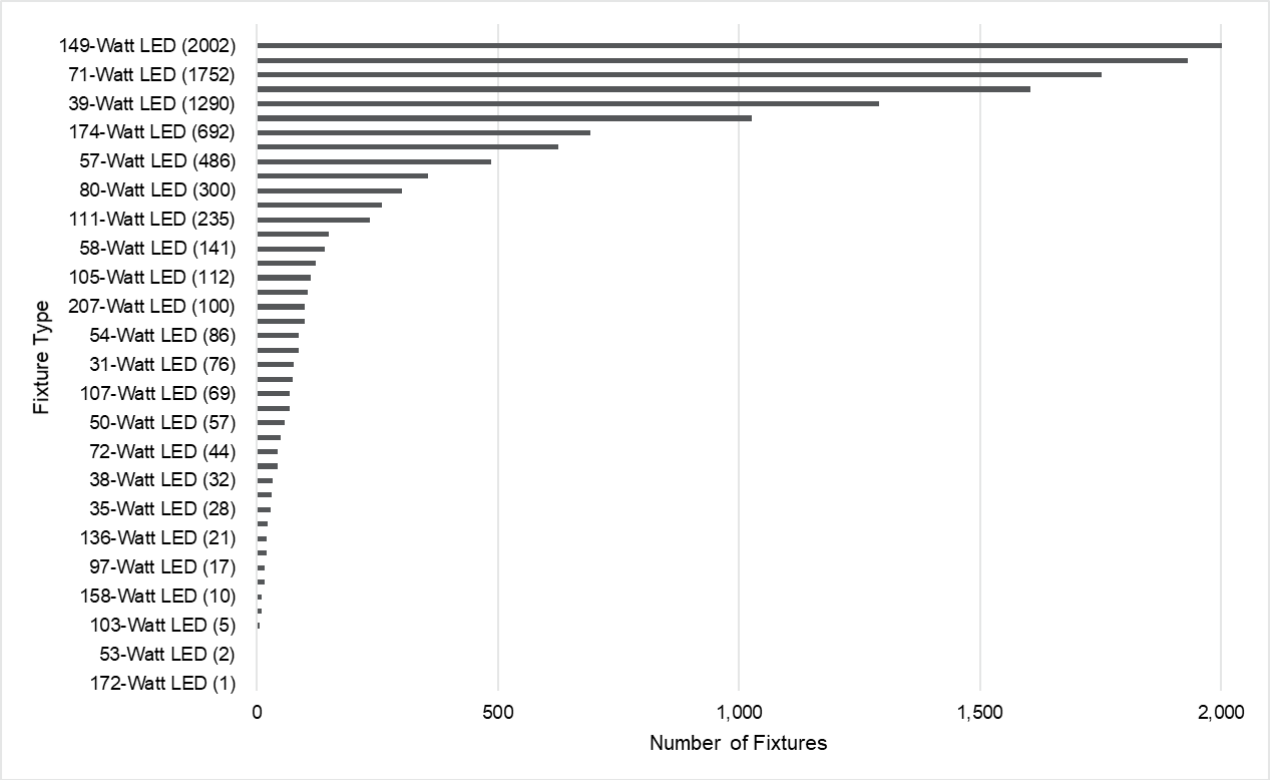
Navigant's impact analysis methodology to calculate verified net program savings included using a deemed value of 1.0 because detailed net-to-gross research has not been completed on municipality-owned fixtures and the NTG value for ComEd-owned fixtures is 1.0 since the fixtures require the assistance of the program to be retrofitted.

7. Appendix 2. Impact Analysis Detail

In addition to the above analysis, Navigant has included figures detailing a breakdown of energy efficient fixture counts and energy savings, demand savings, and fixture count by municipality.

Figure 7-1 shows the count of energy efficient fixtures that were replaced through the program. Four fixtures including the 149-watt, 122-watt, 71-watt, and 22-watt LED fixtures represented over half of all the fixtures that were replaced.

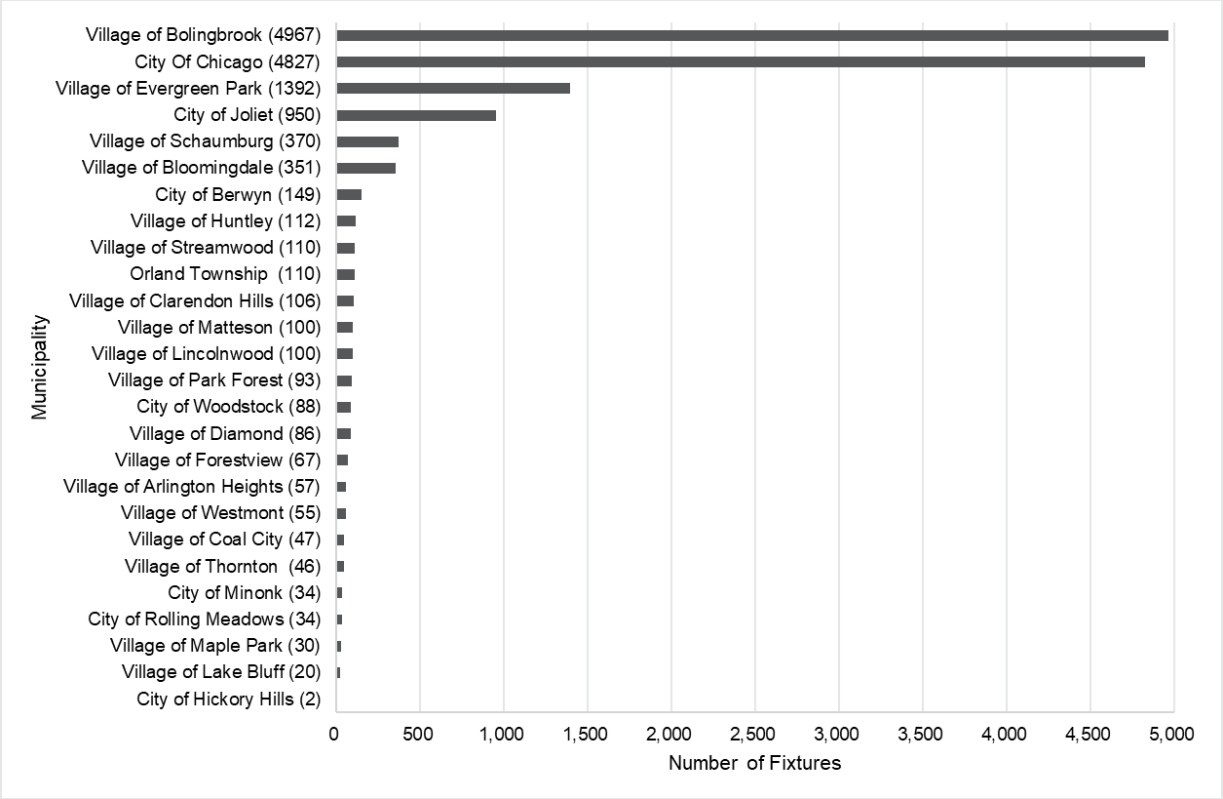
Figure 7-1. Energy Efficient Fixture Count



Source: ComEd tracking data and Navigant team analysis

Figure 7-2 shows energy savings by municipality. Three municipalities achieved approximately 80 percent of the program savings.

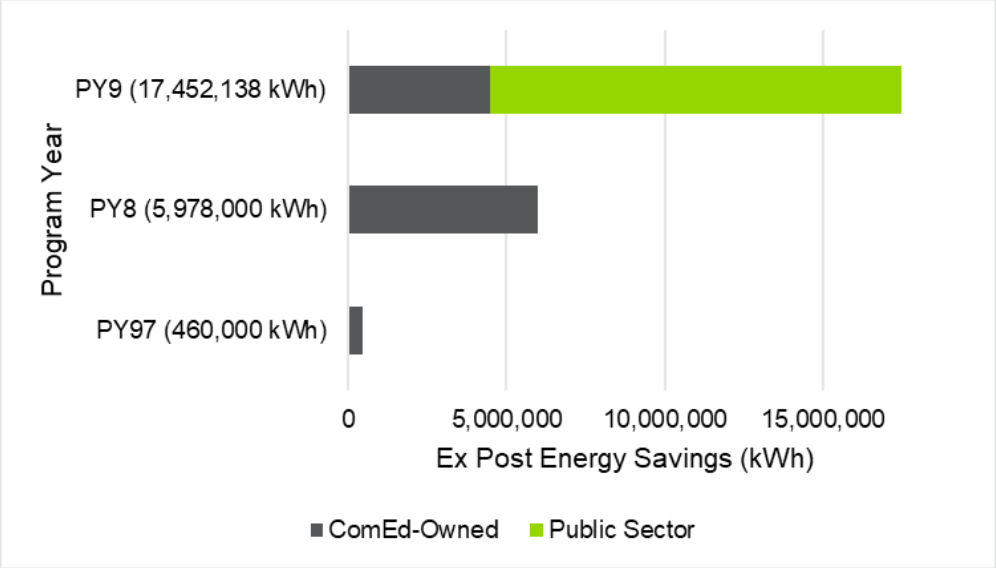
Figure 7-2. Energy Savings by Municipality-Owned Fixtures



Source: ComEd tracking data and Navigant team analysis

Figure 7-3 shows energy savings by program year. The program has grown from 460,000 kWh in PY7 to 17,452,138 kWh savings in PY9 as large increase in program savings.

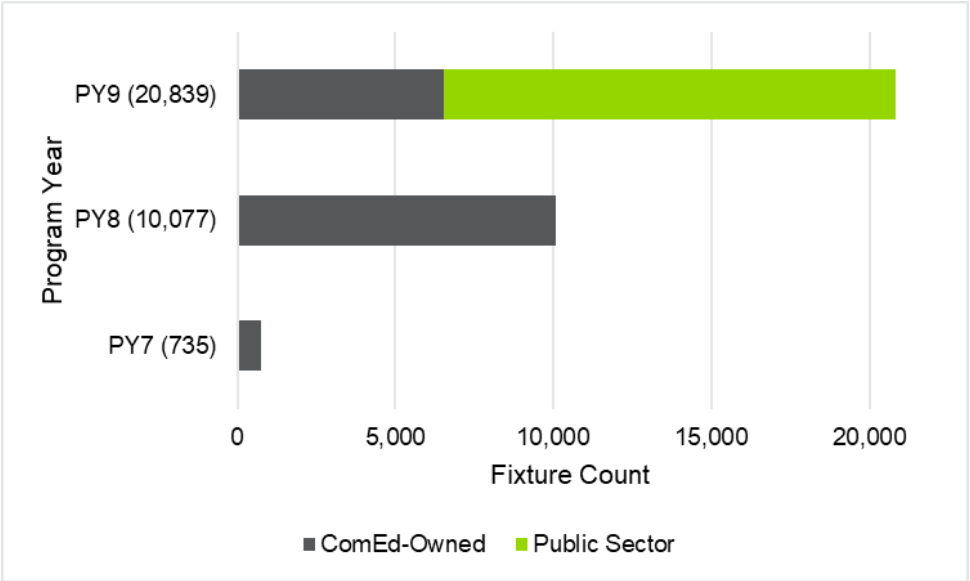
Figure 7-3. Energy Savings by Program Year



Source: ComEd tracking data and Navigant team analysis

Figure 7-4 shows the number of fixtures retrofitted by program year. The program has grown from retrofitting 735 fixtures in PY7 to 20,839 fixtures in PY9. This massive increase has been in line with ComEd's goals and the program is aiming to incentivize an additional 20,000 retrofitted fixtures in 2019.

Figure 7-4. Fixture Count by Program Year



Source: ComEd tracking data and Navigant team analysis

8. APPENDIX 3. TRC DETAIL

Table 8-1, below, the Total Resource Cost (TRC) variable table, only includes cost-effectiveness analysis inputs available at the time of finalizing this 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. Details on EULs in this table are subject to change and are not final.

Table 8-1. TRC Savings Summary

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	LED Installations	Each	14,303	12	12,954,935	NA	12,954,935	2,047
	Total		14,303		12,954,935		12,954,935	2,047

The 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.