Guidehouse

ComEd LED Streetlighting Impact Evaluation Report

Energy Efficiency / Demand Response Plan: Program Year 2019 (CY2019) (1/1/2019-12/31/2019)

Presented to
ComEd

FINAL

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ComEd LED Streetlighting Impact Evaluation Report

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TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

1. Introduction

This report presents the results of the impact evaluation of ComEd's CY2019 LED Streetlighting 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. CY2019 covers January 1, 2019 through December 31, 2019.

2. Program Description

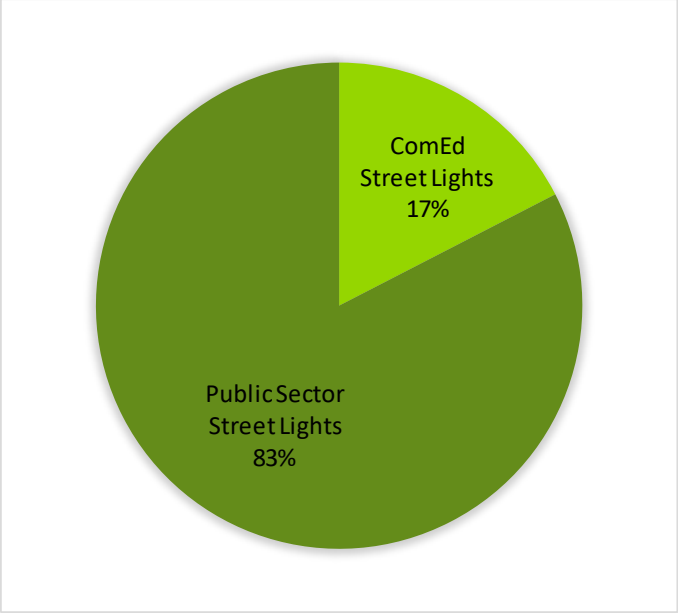
The LED Streetlighting Program, launched in 2014, encourages early retirement of High-Pressure Sodium (HPS), Mercury Vapor (MV), and Metal Halide (MH) streetlighting fixtures and replacement with Light-Emitting Diode (LED) fixtures. Streetlighting fixtures in the program are either ComEd-owned or owned by a public sector entity (e.g., a municipality). The program had 114 unique participants in CY2019 and supported adoption of 122,991 LED streetlights. Table 2-1 shows these allocations broken out by equipment owned by ComEd versus those owned by Public Sector participants.

Table 2-1. CY2019 Volumetric Findings Detail

Participation	ComEd Streetlights	Public Sector Street Lights	Total
Participants	52	62	114
Total Measures	21,076	99,859	120,935
Number of Units	21,076	101,915	122,991
Number of Projects	69	116	185

Source: ComEd tracking data and evaluation team analysis

Figure 2-1. Distribution of Measures Installed by Program Track



Source: ComEd tracking data and evaluation team analysis

3. Program Savings Detail

Table 3-1 summarizes the incremental energy and demand savings the LED Streetlighting Program achieved in CY2019. This program does not generate gas savings.

Table 3-1. CY2019 Total Annual Incremental Electric Savings

Savings Category	Energy Savings (kWh)	Non-Coincident Demand Savings (kW)	Summer Peak* Demand Savings (kW)
Electricity			
Ex Ante Gross Savings	91,409,071	21,242	NR
Program Gross Realization Rate	1.00	1.00	NA
Verified Gross Savings	91,536,753	21,272	0.59
Program Net-to-Gross Ratio (NTG)	1.00	1.00	1.00
Verified Net Savings	91,536,753	21,272	0.59
Converted from Gas†			
Ex Ante Gross Savings	NA	NA	NA
Program Gross Realization Rate	NA	NA	NA
Verified Gross Savings	NA	NA	NA
Program Net-to-Gross Ratio (NTG)	NA	NA	NA
Verified Net Savings	NA	NA	NA
Total Electric Plus Gas			
Ex Ante Gross Savings	91,409,071	21,242	NR
Program Gross Realization Rate	1.00	1.00	NA
Verified Gross Savings	91,536,753	21,272	0.59
Program Net-to-Gross Ratio (NTG)	1.00	1.00	1.00
Verified Net Savings	91,536,753	21,272	0.59

NR = Not reported (refers a piece of data that was not reported, i.e., non-coincident demand savings)
NA = Not applicable (refers a piece of data cannot be produced or does not apply)
* The coincident summer peak period is defined as 1:00-5:00 p.m. Central Prevailing Time on non-holiday weekdays, June through August.
† This program does not generate any Gas savings.
Source: ComEd tracking data and evaluation team analysis

4. Cumulative Persisting Annual Savings

Table 4-1 and Figure 4-1 show the measure-specific and total verified gross savings for the LED Streetlighting Program and the cumulative persisting annual savings (CPAS) for the measures installed in CY2019. Verified net savings for 2019 is 91,536,753 kWh. The electric CPAS lifetimes savings across all measures installed in 2019 is 91,536,753 kWh (Table 4-1). The “historic” rows in each table are the CPAS contribution back to CY2018. The “Program Total Electric CPAS” and the “Program Total Gas CPAS” are the sum of the CY2019 contribution and the historic contribution.

Guidehouse found no gas savings for this program attributable to ComEd and as such electric CPAS is equivalent to total CPAS.

The CPAS table below summarizes savings broken out both by equipment ownership (ComEd vs Public Sector) and baseline lighting technology (mercury vapor as distinct from other HID technology). This division in baseline is necessary because the Illinois TRM (TRM) specifies that mercury vapor lamps are subject to early retirement after a period equal to one-third of the efficient measure's effective useful life. LED streetlights have an EUL of 12 years; therefore, MV lamps are subject to a stepped-baseline that switches from the original equipment, to a lumen equivalent HPS lamp after four years of LED service.

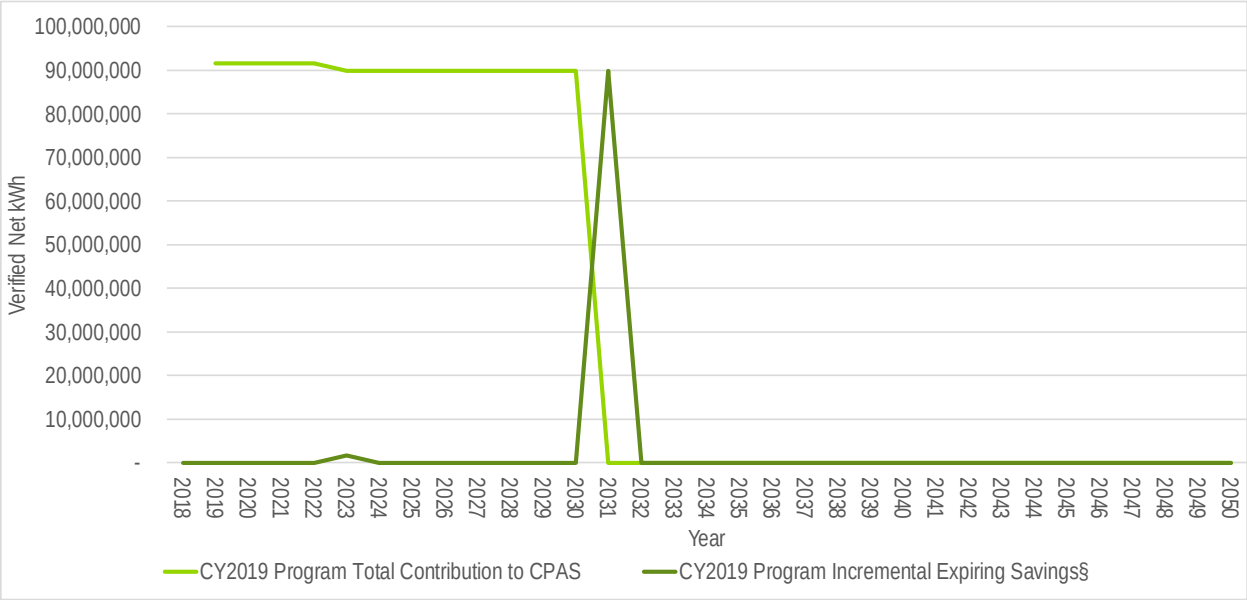
Table 4-1. Cumulative Persisting Annual Savings (CPAS) – Electric

End Use Type	Research Category	EUL	CY2019 Verified Gross Savings (kWh)	NTG*	Lifetime Net Savings (kWh)†	Verified Net kWh Savings 2018	2019	2020	2021	2022	2023	2024	2025	2026
Public Sector Street Lights	LED Street Lighting - Standard Baseline	12.0	75,037,605	1.00	900,451,265		75,037,605	75,037,605	75,037,605	75,037,605	75,037,605	75,037,605	75,037,605	75,037,605
Public Sector Street Lights	LED Street Lighting - Mercury Vapor Baseline	12.0	429,749	1.00	5,077,864		429,749	429,749	429,749	429,749	419,858	419,858	419,858	419,858
ComEd Street Lights	LED Street Lighting - Standard Baseline	12.0	10,906,349	1.00	130,876,193		10,906,349	10,906,349	10,906,349	10,906,349	10,906,349	10,906,349	10,906,349	10,906,349
ComEd Street Lights	LED Street Lighting - Mercury Vapor Baseline	12.0	5,163,049	1.00	48,603,215		5,163,049	5,163,049	5,163,049	5,163,049	3,493,877	3,493,877	3,493,877	3,493,877
CY2019 Program Total Electric Contribution to CPAS			91,536,753		1,085,008,536		91,536,753	91,536,753	91,536,753	91,536,753	89,857,690	89,857,690	89,857,690	89,857,690
Historic Program Total Electric Contribution to CPAS‡						86,043,658	86,043,658	86,043,658	86,043,658	83,238,412	83,238,412	83,238,412	83,238,412	83,238,412
Program Total Electric CPAS						86,043,658	177,580,411	177,580,411	177,580,411	174,775,165	173,096,102	173,096,102	173,096,102	173,096,102
CY2019 Program Incremental Expiring Electric Savings§								-	-	-	1,679,063	-	-	-
Historic Program Incremental Expiring Electric Savings‡§							-	-	-	2,805,246	-	-	-	-
Program Total Incremental Expiring Electric Savings§							-	-	-	2,805,246	1,679,063	-	-	-

End Use Type	Research Category	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Public Sector Street Lights	LED Street Lighting - Standard Baseline	75,037,605	75,037,605	75,037,605	75,037,605								
Public Sector Street Lights	LED Street Lighting - Mercury Vapor Baseline	419,858	419,858	419,858	419,858								
ComEd Street Lights	LED Street Lighting - Standard Baseline	10,906,349	10,906,349	10,906,349	10,906,349								
ComEd Street Lights	LED Street Lighting - Mercury Vapor Baseline	3,493,877	3,493,877	3,493,877	3,493,877								
CY2019 Program Total Electric Contribution to CPAS		89,857,690	89,857,690	89,857,690	89,857,690	-	-	-	-	-	-	-	-
Historic Program Total Electric Contribution to CPAS‡		83,238,412	83,238,412	83,238,412									
Program Total Electric CPAS		173,096,102	173,096,102	173,096,102	89,857,690	-	-	-	-	-	-	-	-
CY2019 Program Incremental Expiring Electric Savings§		-	-	-	-	89,857,690	-	-	-	-	-	-	-
Historic Program Incremental Expiring Electric Savings‡§		-	-	-	83,238,412	-	-	-	-	-	-	-	-
Program Total Incremental Expiring Electric Savings§		-	-	-	83,238,412	89,857,690	-	-	-	-	-	-	-

Note: The green highlighted cell shows program total first year electric savings. The gray cells are blank, indicating values irrelevant to the CY2019 contribution to CPAS.
* A deemed value. Source: is to be found on the Illinois SAG web site here: https://www.ilsag.info/ntg_2019.
† Lifetime savings are the sum of CPAS savings through the EUL.
‡ Historical savings go back to CY2018
§ Expiring savings are equal to CPAS Y_{n-1} - CPAS Y_n
Source: Evaluation team analysis

Figure 4-1. Cumulative Persisting Annual Savings

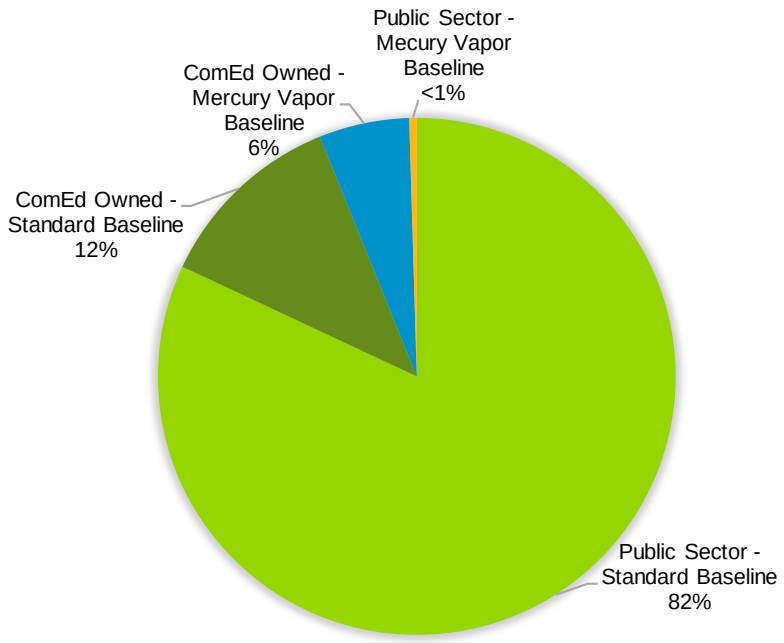


* Expiring savings are equal to CPAS Y_{n-1} - CPAS Y_n .
Source: Evaluation team analysis

5. Program Savings by Measure

The program includes four (4) combinations of measure ownership and baseline, as shown in the following tables. The Public Sector – Standard Baseline measure contributed 80% of the verified program savings, and ComEd owned – Standard Baseline measures contributed the second highest portion of savings, 14% (see Figure 5-1).

Figure 5-1. Verified Net Savings by Measure – Electric



Source: Evaluation team analysis.

Table 5-1. CY2019 Energy Savings by Measure – Electric

End Use Type	Research Category	Ex Ante Gross Savings (kWh)	Verified Gross Realization Rate	Verified Gross Savings (kWh)	NTG*	Verified Net Savings (kWh)	EUL (years)
Public Sector Street Lights	Standard Baseline	74,909,006	1.00	75,037,605	1.00	75,037,605	12.0
Public Sector Street Lights	Mercury Vapor Baseline	429,637	1.00	429,749	1.00	429,749	12.0
ComEd Street Lights	Standard Baseline	10,907,378	1.00	10,906,349	1.00	10,906,349	12.0
ComEd Street Lights	Mercury Vapor Baseline	5,163,049	1.00	5,163,049	1.00	5,163,049	12.0
	Total	91,409,071	1.00	91,536,753	NA	91,536,753	NA

NA = Not applicable
* A deemed value. Source: is to be found on the Illinis SAG web site here: https://www.ilsag.info/ntg_2019.
Source: ComEd tracking data and evaluation team analysis

Table 5-2. CY2019 Non-Coincident Demand Savings by Measure

End Use Type	Research Category	Ex Ante Gross Non-Coincident Demand Reduction (kW)	Verified Gross Realization Rate	Verified Gross Non-Coincident Demand Reduction (kW)	NTG*	Verified Net Non-Coincident Demand Reduction (kW)
Public Sector Street Lights	Standard Baseline	17,407.94	1.00	17,437.83	1.00	17,437.83
Public Sector Street Lights	Mercury Vapor Baseline	99.85	1.00	99.87	1.00	99.87
ComEd Street Lights	Standard Baseline	2,534.83	1.00	2,534.59	1.00	2,534.59
ComEd Street Lights	Mercury Vapor Baseline	1,199.87	1.00	1,199.87	1.00	1,199.87
	Total	21,242.49	1.00	21,272.17	NA	21,272.17

NA = Not applicable
* A deemed value. Source: is to be found on the Illinois SAG web site here: https://www.ilsag.info/ntg_2019.
Source: ComEd tracking data and evaluation team analysis

Table 5-3. CY2019 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)	NTG*	Verified Net Peak Demand Reduction (kW)
Public Sector Street Lights	Standard Baseline	NA	NA	0.59	1.00	0.59
Public Sector Street Lights	Mercury Vapor Baseline	NA	NA	0.00	1.00	0.00
ComEd Street Lights	Standard Baseline	NA	NA	0.00	1.00	0.00
ComEd Street Lights	Mercury Vapor Baseline	NA	NA	0.00	1.00	0.00
	Total	NA	NA	0.59	NA	0.59

NA = Not applicable
* A deemed value. Source: is to be found on the Illinois SAG web site here: https://www.ilsag.info/ntg_2019.
Source: ComEd tracking data and evaluation team analysis

6. Impact Analysis Findings and Recommendations

6.1 Impact Parameter Estimates

Energy savings are estimated using the following two formula as specified in the TRM:

Equation 6-1. Street Light kWh Savings

$$\Delta kWh = (W_{exist} - W_{eff}) * HOURS / 1000$$

Equation 6-2. Street Light Demand Savings

$$\Delta kW = (W_{exist} - W_{eff}) / 1000 * CF$$

The lifetime energy and demand savings are estimated by multiplying the verified savings by the effective useful life for each measure. With the notable exception, previously mentioned, that LED streetlights that replace mercury vapor fixtures are subjected to a stepped baseline shift (from MV to HPS) after one-third of the LED's EUL has occurred.

The EM&V team conducted research to validate the parameters that were not specified in the TRM. The results are shown in the following table.

Table 6-1. Savings Parameters

Gross Savings Input Parameters	Value	Units	Deemed or Evaluated?	Source *
Quantity	Varies	LED Fixture (Heads)	Evaluated	
NTG	Varies per Ownership	%	Deemed	SAG Consensus
Hours of Use	4,303 or 8766	Hours/year	Deemed	TRM v7.0 – Section 4.5.16
Summer Peak Coincidence Factor (CF)	0 or 1 per HOU	NA	Deemed	TRM v7.0 – Section 4.5.16
Gross Savings per Unit, Sampled Non-Deemed Measures	Varies	kWh	Evaluated	
Verified Realization Rate on Ex Ante Gross Savings (Lighting)	Varies	NA	Evaluated	
Effective Useful Life (EUL)	12	Years	Mixture	TRM v7.0 – Section 4.5.16

* TRM is the State of Illinois Technical Reference Manual version 7.0 from http://www.ilsag.info/technical-reference-manual.html. The NTG values can be found on the Illinois SAG web site here: https://www.ilsag.info/ntg_2019.

6.2 Other Impact Findings and Recommendations

The evaluation team developed several recommendations based on findings from the CY2019 evaluation.

Finding 1. The most common updates to verified savings were due to wattages that are entered in to eTrack incorrectly or where counterfactual baseline differs from the reported wattage. The issues identified include:

- Lamp wattage entered as Fixture wattage (baseline lacks ballast factor)
  - One project (LDSB-286), 22 fixtures
  - LED fixture watts reported as an increase from the baseline85), 24 fixtures
  - Lumen equivalent method used to determine counterfactual baseline.
- New fixtures added but with baseline wattage reported as zero.
  - Six projects (LDSB-85, LDSB-98, LDSB-117, LDSB-244, LDSB-284, LDSB-285), 133 fixtures.
  - Guidehouse only made this correction to fixtures with unique geo-codes; i.e., the exact fixture location does not have an associated fixture removal.
- When a new fixture is added, the baseline watts are determined using a lumen equivalent HPS lamp.Less clear cut, but instances with particularly high or low fraction of wattage reduction (i.e., wattage reduction greater than 80% or less than 10%) should be flagged for manual double check that the fixture wattage data was entered correctly.

Recommendation 1. Consider adding an automated or semi-automated data review and screening process to check for outliers.

Finding 2. There is very little correlation between baseline fixture watts and the wattage of the LED used to replace that fixture. For instance, 400W HPS lamps are regularly reported with LED replacements ranging from 39W to 291W; not including one extreme outlier replaced with a 556W LED. The program is in full compliance with the TRM directions to use the as found condition for baseline and efficient wattage. However, the program participants are regularly using the upgrade to adjust system design and lighting intensity. This is a great non-energy benefit; but complicates the data review and QC process.

Recommendation 2a. The program delivery team may want to review the lumen output of the new LED fixtures relative to the fixture being replaced. In instances where the lumen output varies significantly from pre- to post- condition, confirm data entry is accurate.

Recommendation 2b. It would also help if the database had an extra field for project notes, and this field was used to document the intent behind projects that are more complex (e.g., removal, new fixtures, pole relocation, or relamping other than a 1:1 exchange with similar lumen output). This will add transparency and continuity of awareness across the project lifecycle; boosting.

Finding 3. The database field for fixture quantity (number of heads) is underutilized. Instead, multiple fixtures at a single location are reported individually. This makes sense in instances where the fixtures are different type and size (e.g. roadway and walkway lights co-located on a single pole). However, in other instances there are as many as eight measure rows for a given set of coordinates. The risk with the current approach is that it is possible for individual fixtures to be inadvertently entered more than once.

- As an example, LDSB-98 includes 26 instances of fixture removal, which are attributed to 13 unique locations. Each pair of geographic twins not only had the same coordinates, but also the same baseline wattages. A review of the streetview for these locations confirms that each pole only had a single head prior to the project, and each site only has one new head now.

Recommendation 3. Leverage the data field for "number of heads on pole" to avoid repetitious data entry. This will save time on the date entry process and is a more clear-cut to interoperate

7. Appendix 1. Impact Analysis Methodology

LED streetlights are a straightforward lighting measure, with deemed hours of use and lacking any interactive impacts. Therefore, the analysis methodology directly follows the approach outlined in v7.0 of the TRM.

8. Appendix 2. Total Resource Cost Detail

Table 8-1 shows the Total Resource Cost (TRC) cost-effectiveness analysis inputs available at the time of finalizing this 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 the evaluation team later.

Table 8-1. Total Resource Cost Savings Summary

End Use Type	Research Category	Units	Quantity	EUL (years)*	ER Flag†	Verified Gross Electric Energy Savings (kWh)	Verified Gross Peak Demand Reduction (kW)	Verified Gross Gas Savings (Therms)	Gross Heating Penalty (kWh)	Gross Heating Penalty (Therms)	NTG (kWh)	NTG (kW)	NTG (Therms)	Verified Net Electric Energy Savings (kWh)	Verified Net Peak Demand Reduction (kW)	Verified Net Gas Savings (Therms)	Net Heating Penalty (kWh)	Net Heating Penalty (Therms)
Public Sector Street Lights	Standard Baseline	Head	101,269	12.0	No	75,037,605	0.59	0	0	0	1.00	1.00	1.00	75,037,605	0.59	0	0	0
Public Sector Street Lights	Mercury Vapor Baseline	Head	646	12.0	Yes	429,749	0.00	0	0	0	1.00	1.00	1.00	429,749	0.00	0	0	0
ComEd Street Lights	Standard Baseline	Head	14,952	12.0	No	10,906,349	0.00	0	0	0	1.00	1.00	1.00	10,906,349	0.00	0	0	0
ComEd Street Lights	Mercury Vapor Baseline	Head	6,124	12.0	Yes	5,163,049	0.00	0	0	0	1.00	1.00	1.00	5,163,049	0.00	0	0	0
	Total			12.0		91,536,753	0.59	0	0	0	NA	NA	NA	91,536,753	0.59	0	0	0

NA = Not applicable

Note: This program did not include any water related impacts; therefore there is no danger of double counting savings associated with those ripple effects.

* The total of the EUL column is the weighted average measure life (WAML), and is calculated as the sum product of EUL and measure savings divided by total program savings.

† Yes in the Early Replacement (ER) column identifies MV lamps which have a baseline shift to HPS after four years of LED use. See the CPAS tables (Table 4-1) for further context.

Source: ComEd tracking data and evaluation team analysis