



**ComEd**

# **Residential Lighting Discounts Program Evaluation Report**

**FINAL**

**Energy Efficiency / Demand Response Plan:  
Plan Year 8 (PY8)  
(6/1/2015-5/31/2016)**

**Presented to**

**Commonwealth Edison Company**

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***Prepared by:***

**Amy Buege  
Itron, Consulting and Analysis**

**Vanessa Arent  
Itron, Consulting and Analysis**



[www.navigant.com](http://www.navigant.com)

**Submitted to:**

ComEd  
Three Lincoln Centre  
Oakbrook Terrace, IL 60181

**Submitted by:**

Navigant  
30 S. Wacker Drive, Suite 3100  
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
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## TABLE OF CONTENTS

<b>E.Executive Summary</b> .....	<b>1</b>
E.1. Program Savings .....	1
E.2. Program Savings by Bulb Type.....	2
E.3. Impact Estimate Parameters for Future Use .....	3
E.4. Program Volumetric Detail .....	3
E.5. Results Summary .....	4
E.6. Findings and Recommendations.....	5
<b>1. Introduction</b> .....	<b>8</b>
1.1 Program Description.....	8
1.2 Evaluation Objectives .....	8
1.2.1 Impact Questions.....	8
1.2.2 Process Questions.....	8
<b>2. Evaluation Approach</b> .....	<b>10</b>
2.1 Overview of Data Collection Activities.....	10
2.2 Verified Savings Parameters .....	10
2.2.1 Verified Gross Program Savings Analysis Approach.....	11
2.2.2 Verified Net Program Savings Analysis Approach.....	12
2.3 Process Evaluation.....	12
<b>3. Gross Impact Evaluation</b> .....	<b>13</b>
3.1 Tracking System Review .....	13
3.2 Program Volumetric Findings .....	14
3.3 Gross Program Impact Parameter Estimates.....	16
3.4 Verified Gross Program Impact Results.....	18
<b>4. Net Impact Evaluation</b> .....	<b>20</b>
4.1 PY8 Program and Carryover Savings Estimate .....	20
4.2 PY9 Carryover Savings Estimate.....	21
<b>5. Process Evaluation</b> .....	<b>23</b>
5.1 Overview of Process Evaluation .....	23
5.2 High-Level Process Findings .....	23
<b>6. Findings and Recommendations</b> .....	<b>26</b>
<b>7. Appendix</b> .....	<b>31</b>
7.1 Evaluation Research Impact Approaches and Findings.....	31
7.1.1 Evaluation Research Gross Impact Findings.....	31
7.1.1 Evaluation Research Gross Program Impact Results.....	38
7.2 Detailed Process Findings.....	40
7.3 IL TRM Recommendations .....	40
7.4 NTGR Recommendations.....	42

7.5 PJM Data and Findings .....	43
7.6 Attachments .....	44
7.6.1 PY8 In-Store Intercept Survey Instrument.....	44
7.6.2 PY8 NTG Memo .....	45
7.6.3 PY8 Shelf Survey Memo .....	46
7.6.4 PY8 Process Memo .....	47
7.6.5 PY8 In-Store Intercepts Memo.....	48
7.6.6 PY8 Preliminary Impacts Memo.....	49

## LIST OF TABLES AND FIGURES

Figure 3-1. Sales Over Time .....	15
Figure 3-2. Number of Measures Installed by Type .....	16
Table E-1. PY8 Total Program Electric Savings .....	1
Table E-2. PY8 Total Program EEPS Electric Savings (Carryover only).....	2
Table E-3. PY8 Total Program IPA Electric Savings .....	2
Table E-4. PY8 Program Results by Measure .....	2
Table E-5. Impact Estimate Parameters for Future Use .....	3
Table E-6. PY8 Volumetric Findings Detail.....	4
Table E-7. PY8 Verified Net MWh Savings Summary Detail .....	4
Table E-8. PY8 Results Summary.....	5
Table 2-1. Primary Data Collection Activities.....	10
Table 2-2. Additional Resources .....	10
Table 2-3. Verified Savings Parameter Data Sources .....	11
Table 3-1. Tracking Database Bulb Description versus “Lamp_category” Field.....	14
Table 3-2. PY3 – PY8 Volumetric Findings Detail .....	14
Table 3-3. PY8 Volumetric Findings Detail – Bulbs installed in PY8.....	15
Table 3-4. Verified Gross Savings Parameters.....	16
Table 3-5. PY8 Verified Gross Impact Savings Estimates by Measure Type .....	19
Table 3-6. PY8 Verified Gross Impact Savings including Carryover .....	19
Table 4-1. PY8 Verified Net Impact Savings Estimates by Measure Type without Carryover ..	20
Table 4-2. PY8 Verified Net Impact Savings including Carryover .....	21
Table 4-3. PY9 Carryover Savings Estimates by Portfolio.....	22
Table 6-1. Impact Estimate Parameters for Future Use.....	30
Table 7-1. Evaluation Research Gross Savings Parameters .....	32
Table 7-2. PY8 Bulb Sales by Pack Size.....	34
Table 7-3. PY8 Bulb Sales by Type of Retailer.....	34
Table 7-4. Average Delta Watts Value across All Bulbs .....	35
Table 7-5. Installation Rate Estimates by Bulb Type and Retailer .....	35
Table 7-6. Residential HOU and Peak CF Estimates .....	36
Table 7-7. PY8 Energy and Demand Interactive Effects.....	37
Table 7-8. PY8 Carryover Parameter Sources .....	37
Table 7-9. PY8 Carryover Bulb Estimates .....	38
Table 7-10. PY8 Verified Savings Estimate for Carryover Bulbs .....	38
Table 7-11. PY8 Evaluation Research Gross Impact Savings Estimates.....	39
Table 7-12. NTGR by Bulb Type .....	39
Table 7-13. PY8 FR, Spillover, and NTGR Estimates Compared to Prior Program Years .....	40
Table 7-14. Impact Estimate Parameters for Future Use.....	41
Table 7-15. 3-Year Average Res/Non-Res Split for ComEd .....	41
Table 7-16. 3-Year Average Installation Rates for ComEd .....	42
Table 7-17. Multi-Year Average NTGR Available for Future Use.....	42
Table 7-18. NTGR Parameters Available for Future Use.....	43

## E. EXECUTIVE SUMMARY

This report presents a summary of the findings, results, and recommendations from the impact and process evaluation of the PY8<sup>1</sup> Residential Lighting Discounts (Residential Lighting) program. The main goal of this program is to increase the market penetration of energy-efficient lighting within the Commonwealth Edison Company's (ComEd's) service territory by offering incentives for bulbs purchased through various retail channels. The program also seeks to increase customer awareness and acceptance of energy-efficient lighting technologies through the distribution of educational materials. In PY8, the Residential Lighting program offered incentives for the purchase of standard compact fluorescent lamps (CFLs), standard and specialty LEDs, and LED fixtures. The savings from bulbs sold in PY8 were counted under the Illinois Power Agency (IPA) portfolio. Some carryover bulbs from previous years were counted under the Energy Efficiency Portfolio Standard (EEPS).

### E.1. Program Savings

Table E-1 summarizes the gross and net electricity savings from the PY8 Residential Lighting program, including the carryover savings resulting from bulbs sold in PY6 and PY7 that are installed in PY8. As this table shows, the total verified net energy savings including carryover and bulbs attributable to both the EEPS and the IPA portfolios is 313,360 megawatt-hours (MWh).<sup>2</sup> Table E-2 and Table E-3 separate the overall PY8 Residential Lighting program savings into the portions attributable to the EEPS and IPA portfolios (including carryover).

**Table E-1. PY8 Total Program Electric Savings**

Savings Category	Energy Savings (MWh)	Demand Savings (MW)	Summer Peak Demand Savings (MW)	Winter Peak Demand Savings (MW)
Ex-Ante Gross Savings <sup>3</sup>	326,151	NR <sup>4</sup>	NR	NR
Verified Gross Program Savings <sup>5</sup>	381,167	359.3	46.3	58.0
Verified Gross Carryover Savings	95,652	94.2*	10.9	12.7
Verified Gross PY8 Savings	476,819	453.5*	57.2	70.7
Verified Net Program Savings	254,854	240.0	31.0	38.8
Verified Net Carryover Savings	58,506	57.1*	6.8	7.7*
Verified Total PY8 Net Savings	313,360	297.1*	37.8	46.5*

NR = Not Reported

\*Numbers do not sum exactly due to rounding.

Source: ComEd tracking data and Navigant team analysis

<sup>1</sup> The PY8 program year began June 1, 2015 and ended May 31, 2016.

<sup>2</sup> Net savings attributable to the EEPS portfolio are 54,272 MWh and net savings attributable to the IPA portfolio are 259,088 MWh. All EEPS savings are from PY8 carryover.

<sup>3</sup> PY8 Bulb Sales only, excludes carryover.

<sup>4</sup> Estimates of demand and summer and winter peak demand are not reported in the tracking database provided to the evaluation team. Additionally, tracking data only reports gross savings.

<sup>5</sup> PY8 Bulb Sales only, excludes carryover.

**Table E-2. PY8 Total Program EEPS Electric Savings (Carryover only)**

Savings Category	Energy Savings (MWh)	Demand Savings (MW)	Summer Peak Demand Savings (MW)	Winter Peak Demand Savings (MW)
Verified Gross Carryover Savings	87,810	87.2	9.9	11.5
Verified Net Carryover Savings	54,272	53.3	6.3	7.1

Source: ComEd tracking data and Navigant team analysis.

**Table E-3. PY8 Total Program IPA Electric Savings**

Savings Category	Energy Savings (MWh)	Demand Savings (MW)	Summer Peak Demand Savings (MW)	Winter Peak Demand Savings (MW)
Ex-Ante Gross Savings	326,151	NR	NR	NR
Verified Gross Program Savings	381,167	359.3	46.3	58.0
Verified Gross Carryover Savings	7,842	6.9	1.0	1.2
Verified Net Program Savings	254,854	240.0	31.0	38.8
Verified Net Carryover Savings	4,234	3.7	0.5	0.7
Verified Total PY8 Net Savings	259,088	243.7	31.5	39.5

NR = Not Reported

Source: ComEd tracking data and Navigant team analysis.

## E.2. Program Savings by Bulb Type

Table E-4 summarizes the electricity and demand savings (MWh and MW) from the ComEd PY8 Residential Lighting program by bulb type. As this table shows, LEDs (including omnidirectional, directional, and fixtures) now comprise 61 percent of the total verified net savings, and standard CFLs comprise the remaining 39 percent of the savings.

**Table E-4. PY8 Program Results by Measure<sup>6</sup>**

Savings Category	Standard CFL	Omni-Directional LED	Directional/Other LED	LED Fixtures	Total
Ex-Ante Gross Energy Savings (MWh)	157,023	96,317	60,679	12,132	326,151
Verified Gross Energy Savings (MWh)	167,132	122,231	79,621	12,183	381,167
Verified Gross Demand Savings (MW)	159.6	116.2	70.7	12.9	359.3*
Verified Net Energy Savings (MWh)	98,608	89,228	58,124	8,893	254,854*
Verified Net Demand Savings (MW)	94.2	84.8	51.6	9.4	240.0
Gross Verified / Ex-Ante Realization Rates	106%	127%	131%	100%	117%

Source: ComEd tracking data and Navigant team analysis.

\*Numbers do not sum exactly due to rounding.

<sup>6</sup> These tables do not include PY8 carryover savings.

### E.3. Impact Estimate Parameters for Future Use

In the course of our PY8 evaluation, the evaluation team conducted research on parameters used in impact calculations including those in the Illinois TRM. Some of those parameters are eligible for deeming for future program years or for inclusion in future versions of the TRM. The evaluation team’s parameters recommended for future use are shown in the following table.

**Table E-5. Impact Estimate Parameters for Future Use<sup>7</sup>**

Parameter	Value	Data Source
Res/Non-Res Split	95%/5% Standard CFLs	3-year rolling average (PY6-PY8) of Evaluation Research Findings
	98%/2% Omni-Directional LEDs	
	92%/8% Directional LED	
1st Year Installation Rate	76.6% Standard CFL	2-year rolling average (PY7-PY8) of Evaluation Research Findings
	89.9% Omni-Directional LEDs	
	93.5% Directional/Other LEDs	
Leakage	2.2% Standard CFL	3-year rolling average (PY6-PY8) of Evaluation Research Findings
	1.4% Omni-Directional LEDs	
	2.2% Directional/Other LEDs	
NTGR	0.54 Standard CFLs	PY8 Evaluation Research Findings
	0.58 Omni-Directional LEDs	
	0.58 Directional/Other LEDs	

Source: Evaluation Analysis

### E.4. Program Volumetric Detail

The PY8 program incentivized 7,205,656 standard CFLs, 3,896,077 omni-directional LEDs, 1,578,687 directional LEDs, and 302,241 LED fixtures as shown in the following table.

<sup>7</sup> The evaluation research parameter estimates differ from those reported in the PY8 In-store Intercepts Memo and the PY8 NTG Results Memo because the estimates were reweighted using final PY8 bulb sales (allocated sales were used to weight the results reported in the In-Store Intercepts Results Memo).



**Table E-6. PY8 Volumetric Findings Detail**

Participation	Total	Standard CFLs	Specialty CFLs	Omni-Directional LEDs	Directional/Other LEDs	LED Fixtures
PY8 Incentivized Bulbs	12,982,661	7,205,656	0	3,896,077	1,578,687	302,241
PY8 1st Year Installed Bulbs	10,773,575	5,268,776	0	3,702,364	1,500,195	302,241
PY6 Carryover–PY8 Installs	1,359,037	1,174,487	184,551	0	0	0
PY7 Carryover– PY8 Installs	1,539,885	1,432,726	85,219	15,095	6,845	0
Total Installed Bulbs in PY8	13,672,497	7,875,988	269,770	3,717,459	1,507,040	302,241

Source: ComEd tracking data and Navigant team analysis.

The verified net MWh savings associated with bulbs installed in PY8 (by bulb type) are provided in the table below.

**Table E-7. PY8 Verified Net MWh Savings Summary Detail**

Net Verified Savings from Population	Total	Standard CFLs	Specialty CFLs	Omni-Directional LEDs	Directional/Other LEDs	LED Fixtures
PY8 1st Year Installed Bulbs	254,854	98,608	0	89,228	58,124	8,893
PY6 Carryover–PY8 Installs	27,598	23,364	4,234	0	0	0
PY7 Carryover– PY8 Installs	30,908	28,935	1,357	362	255	0
Total Installed Bulbs in PY8	313,360	150,907	5,591	89,590	58,378	8,893

Source: ComEd tracking data and Navigant team analysis.

## E.5. Results Summary

The following table summarizes the key verified savings metrics from PY8.

**Table E-8. PY8 Results Summary**

Key Metrics	Units	EEPS Portfolio	IPA Portfolio	EEPS Carryover	IPA Carryover
Verified Gross Savings	MWh	n/a	381,167	87,810	7,842
Verified Gross Demand Reduction	MW	n/a	359.3	87.2	6.9
Verified Gross Summer Peak Demand Reduction	MW	n/a	46.3	9.9	1
Verified Gross Winter Peak Demand Reduction	MW	n/a	58.0	11.5	1.2
NTGR	#	n/a	0.67 <sup>8</sup>	0.62	0.54
Verified Net Savings	MWh	n/a	254,854	54,272	4,234
Verified Net Demand Reduction	MW	n/a	240.0	53.3	3.7
Verified Net Summer Peak Demand Reduction	MW	n/a	31.0	6.3	0.5
Verified Net Winter Peak Demand Reduction	MW	n/a	38.8	7.1	0.7
Standard CFLs incentivized	#	n/a	7,205,656	n/a	n/a
Omni-directional LEDs incentivized	#	n/a	3,896,077	n/a	n/a
Directional LEDs incentivized	#	n/a	1,578,687	n/a	n/a
LED Fixtures incentivized	#	n/a	302,241	n/a	n/a

Source: ComEd tracking data and Navigant team analysis.

† A deemed value. Source: ComEd\_NTG\_History\_and\_PY8\_Recommendation\_2014-02-28\_Final\_EMV\_Recommendations.xlsx, which is to be found on the IL SAG web site here: <http://ilsag.info/net-to-gross-framework.html>

## E.6. Findings and Recommendations

Overall, the PY8 Residential Lighting program successfully met its goals and objectives. The program exceeded its planning target by over 155,000 bulbs (one percent increase over the program’s target volume) and exceeded its gross energy savings target by 27 percent (gross savings target was 299,013 MWh, versus the program achieved verified gross savings of 381,167 MWh). In addition, the program’s net savings exceeded the PY8 target by 24 percent (the net savings target was 252,729 kWh (which was comprised of 205,529 kWh from IPA PY8 installs and 47,200 kWh from EEPS carryover) and the verified PY8 net savings was 313,360 kWh (which included carryover savings)).

The key evaluation findings and recommendations are presented below. Numbered findings and recommendations in this section are the same as those found in Section 6 of the evaluation report for ease of reference between each section.

### Program Volumetric Findings

**Finding 1.** The total number of bulbs sold during the PY8 Residential Lighting program was estimated to be 12,982,661, which is a six percent increase from the quantity of bulbs sold in PY7. Fifty-six percent of the bulbs sold in PY8 were standard CFLs, 30 percent were omni-directional LEDs, 12 percent were directional LEDs, and two percent were LED fixtures. No specialty CFLs were incentivized through the program

<sup>8</sup> The NTG estimates in this row represent an average NTGR across standard CFLs, directional and omni-directional LEDs, and LED fixtures.

in PY8. This significant decrease in standard CFL sales was planned as it is likely that standard CFLs will be eliminated from the program during PY9.

**Finding 2.** Analysis of PY8 program bulb sales found the average incentive per MWh of energy saved for omni-directional LEDs and directional LEDs is higher than it is for standard CFLs (roughly \$77/net MWh for a standard CFL, \$150/net MWh for an omni-directional LED, \$120/net MWh for a directional LED). The cost per kWh saved will continue to be lower for standard CFLs than for LEDs as these bulbs continue to require greater incentives to encourage market uptake due to their higher non-incentivized market prices. Energy Star 2.0 (ES 2.0) bulbs which are scheduled to hit the market in July 2018 should help decrease the cost per MWh of savings as their retail prices are projected to be significantly lower than existing LEDs and thus will require lower incentive levels.<sup>9</sup>

**Recommendation 1.** ComEd should consider adding the ES 2.0 bulbs to the program to retain a large volume of LED savings while minimizing program spending.

### Barriers to CFL and LED Purchase

**Finding 3.** Customers' primary barriers to purchasing CFLs are aesthetic—their look and fit in fixtures or their light color—and as a result customers reported a low likelihood of purchasing CFLs even if their prices were equal to or lower than the price of other bulb types. Barriers to LED purchases are related to their cost and a lack of awareness or knowledge of this newer technology. The top factors that customers reported had influenced their decision to purchase efficient bulbs were the energy saved by the bulbs, the longevity of the bulbs, and the quality of light they produce.

**Recommendation 2.** Both of the primary LED barriers will be reduced over time, however ComEd's lighting program is currently well positioned to effectively increase the rate at which these barriers are diminished by expanding their program LED offerings and re-examining their educational materials to ensure they are focused on the top influential factors, such as the longevity of the bulb and its impact on the ultimate cost and energy savings of the LED.

### State of the Lighting Market

**Finding 4.** The shelf surveys conducted as part of this evaluation found that the ComEd program incentives are having a significant effect on the retail price of CFLs and LEDs within ComEd service territory. Specifically, these shelf surveys found:

- Program LEDs (omni-directional and directional) are around two-thirds the price of non-program LEDs.
- Over the last two years, the price of a standard LED has decreased by around \$10 and the price of a specialty LED has decreased by \$13 a bulb. In addition, LEDs also comprise a larger proportion of stocked bulbs, however they seem to be replacing space previously occupied by CFLs.
- Program standard CFLs are approximately half the price of non-program standard CFLs and cost less per bulb, on average, than similar incandescent and halogen bulbs.

<sup>9</sup> Further information on Energy Star 2.0 LEDs can be found at: <https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Lamps%20V2%20Cover%20Letter%2012-4-15.pdf>

- The shelf space dedicated to standard incandescent bulbs lamps has been cut in half (22 percent to 11 percent) in the past two years, mostly driven by EISA, but all of this reduction has been met with an increase in halogen bulbs.
- The availability of specialty incandescent bulbs, which are generally not covered by the EISA standards, has increased—specialty incandescent bulbs represent 54 percent of the stocked product (up from 35 percent in the last two years ago). Stocking of halogen specialty bulbs has remained fairly steady (around 20 percent).

**Recommendation 3.** Availability and acceptance of high efficiency specialty bulbs still significantly lag behind standard bulbs (resulting from their exclusion from the EISA standards, their high up-front cost, and customers lack of satisfaction with previous products, primarily CFLs, they have installed). ComEd should review their specialty LED offerings to ensure they are effectively targeting the bulb shapes with the highest potential (based on price differential between efficient and in-efficient bulbs and the estimated quantity of sockets containing inefficient specialty products).

### Awareness of ComEd’s Residential Lighting Program Incentives and Marketing Materials

**Finding 5.** Customer awareness that the bulbs were discounted by ComEd continued to be low (66 percent of PY8 program bulb purchasers surveyed were not aware they were purchasing bulbs discounted by ComEd, in PY7 this rate was 69 percent). However, while participants may be unaware of the ComEd discount, they are noticing the lower CFL and LED prices that the program provides (60 percent of respondents were aware they were buying discounted bulbs (but not necessarily ComEd discounted) and an additional 60 percent of respondents who didn’t know the LEDs were discounted reported that they thought the prices in the store were low for LEDs).

**Finding 6.** Despite paying a higher upfront cost for LEDs, LED purchasers seem to be aware that the longevity and efficiency of LEDs will save them money over the lifetime of the bulb, compared to other bulb types.

**Recommendation 4.** ComEd should re-examine marketing material to see if it can enhance the information on lifetime cost savings to encourage more of non-LED purchasers to make the higher initial investment in LEDs.

Complete findings and recommendations can be found in Section 6.

## 1. INTRODUCTION

### 1.1 Program Description

This report presents a summary of the findings and results from Navigant's impact and process evaluation of the Residential Lighting Discounts (Residential Lighting) program's eighth program year (PY8<sup>10</sup>). The PY8 Residential Lighting program provides incentives to increase the market share of ES-qualified compact fluorescent lamps (CFLs) and light emitting diodes (LEDs) sold through retail sales channels. The program distributes educational materials designed to increase customer awareness and acceptance of energy-efficient lighting technology. The PY8 program accounted for a substantial portion of the Commonwealth Edison Company's (ComEd's) Residential energy efficiency portfolio, making an important contribution to meeting ComEd's energy efficiency goals.

The PY8 Residential Lighting program is delivered upstream (at the retailer level), which minimizes the burden on consumers and lowers barriers to participation, but makes program participant identification (and thus evaluation) more difficult. As a result, it is not possible to match specific purchases in the program tracking data to other characteristics of those bulb purchasers or to specific details on how the bulbs will be used.

During PY8, 20 retailers participated in the program, which resulted in 1,129 retail outlets selling program bulbs within ComEd's service territory. Across the 20 retailers, nearly 570 unique lighting measures<sup>11</sup> were available to ComEd customers.

### 1.2 Evaluation Objectives

The evaluation team identified the following key researchable questions for PY8.

#### 1.2.1 Impact Questions

1. What is the level of gross annual energy (kilowatt-hours [kWh]) and peak demand (summer and winter, kilowatts [kW]) savings induced by the program?
2. What are the net impacts from the program? What is the level of free-ridership associated with this program? What is the level of participant and nonparticipant spillover from the program?
3. Did the program meet its energy and demand goals? If not, why not?
4. What is the researched value for net-to-gross (NTG) ratio?
5. What updates are recommended for the Illinois Technical Reference Manual (TRM)?

#### 1.2.2 Process Questions

1. How aware are customers regarding the ComEd-incented CFL and light-emitting diodes (LEDs) bulb discounts? How effective are the in-store displays and marketing materials?

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<sup>10</sup> The Residential Lighting program began in PY1, however this program was significantly different in those first two years so this PY8 report makes specific references back to PY3.

<sup>11</sup> Unique by manufacturer, model number, and retailer.

2. How aware are customers regarding changes in available lighting products as a result of EISA 2007 implementation? How have customers lighting purchasing decisions been affected by the changes in the options available for purchase?
3. How has this program changed with regard to rapid market changes for energy efficient lighting and upcoming standards changes?
4. What are the key barriers to CFL and LED purchase and how can they be addressed by the program?
5. What is the current level of LED availability and pricing in ComEd territory for common retail channels? How does this compare to similar regions (with or without lighting programs) and how is this changing over time?

## 2. EVALUATION APPROACH

For the Residential Lighting program, the upstream retail-level delivery of the program determined the analytical methods for the evaluation. This delivery approach, while allowing for ease of program implementation and customer participation, increases the complexity of the program evaluation, since the program participants cannot be easily identified.

### 2.1 Overview of Data Collection Activities

The core data collection activities for the PY8 evaluation included in-store intercept surveys and retailer shelf surveys. The full set of data collection activities is shown in the following table.

**Table 2-1. Primary Data Collection Activities**

What	Who	Target Completes	Completes Achieved	When	Comments
In-store Intercept Survey	Retail Lighting Purchasers	800	832 <sup>12</sup>	August – September 2015	Data collection supporting Gross and Net impact assessment and process analysis.
Shelf Surveys	Program Retailers	25	25	October – November 2015	Market Assessment
In Depth Interviews	Program Manager	1	1	April 2016	

**Table 2-2. Additional Resources**

Reference Source	Author	Application	Gross Impacts	Process
Illinois TRM	VEIC	Verified Savings Assumptions	X	

### 2.2 Verified Savings Parameters

Verified gross and net savings (energy and coincident peak demand) resulting from the PY8 Program were calculated using the following algorithms as defined by the Illinois TRM version 4<sup>13</sup>

**Verified Gross Annual  $\Delta kWh$**  = Delta Watts/1000 \* ISR \* (1-Leakage) \* HOU \* IEe

**Verified Gross Annual  $\Delta kW$**  = Delta Watts/1000 \* ISR \* (1-Leakage)

**Verified Gross Annual Summer Peak  $\Delta kW$**  = Gross Annual  $\Delta kW$  \* Summer Peak CF \* IEd

**Verified Gross Annual Winter Peak  $\Delta kW$**  = Gross Annual  $\Delta kW$  \* Winter Peak CF \* IEd

**Where:**

- Delta Watts = Difference between Baseline Wattage (incandescent wattage) and CFL Wattage

<sup>12</sup> Fifty-five percent of the surveys completed were conducted with retail customers who were purchasing one or more ComEd incentivized bulb.

<sup>13</sup> Source: <http://www.ilsag.info/technical-reference-manual.html>

- HOU = Annual Hours of Use
- IEe = Energy Interactive Effects
- Leakage = % of Program Bulbs installed outside of ComEd Service Territory
- Summer Peak CF = Peak load coincidence factor, the percentage of Program Bulbs turned on during summer peak hours (weekdays from 1 to 5 p.m.)
- Winter Peak CF = Peak load coincidence factor, the percentage of Program Bulbs turned on during the PJM Winter Peak hours<sup>14</sup>
- IEd = Demand Interactive Effects (applied to summer Peak kW estimates only<sup>15</sup>)

The following table presents the parameters that were used in the verified gross and net savings calculations and indicates which were examined through evaluation activities and which were deemed.

**Table 2-3. Verified Savings Parameter Data Sources**

Verified Savings Parameters	Data Source	Deemed or Evaluated?
Program Bulbs	PY8 Program Tracking Data	Evaluated
Delta Watts	Illinois TRM v4	Deemed
Installation Rate	Illinois TRM v4	Deemed
Leakage	PY7 Report	Evaluated
Res / Non-Res Split	Illinois TRM v4	Deemed
Hours of Use (HOU)	Illinois TRM v4	Deemed
Summer Peak Coincidence Factor (CF)	Illinois TRM v4	Deemed
Winter Peak Coincidence Factor (CF)	Memo to ComEd <sup>16</sup>	Evaluated
Energy Interactive Effects	Illinois TRM v4	Deemed
Demand Interactive Effects	Illinois TRM v4	Deemed
NTGR†	IL Stakeholder Advisory Group website	Deemed

† A deemed value. Source: "ComEd\_NTG\_History\_and\_PY8\_Recommendations.xls", found on the IL SAG web site: <http://ilsag.info/net-to-gross-framework.html>. Accessed: September 2, 2016.

### 2.2.1 Verified Gross Program Savings Analysis Approach

The evaluation team calculated verified savings by measure for measures with available data. For PY8, the evaluation team calculated verified savings for standard CFLs, omni-directional LEDs, directional LEDs, and LED fixtures. The data used to estimate the verified gross program

<sup>14</sup> The Winter Peak Period is defined by PJM as the period from 6-8 am and 5-7 pm, Central Time Zone, between January 1 and February 28.

<sup>15</sup> Summer interactive effects represent the increased energy savings due to the cooler operating temperatures at which CFLs and LEDs operate and thus a reduction in cooling electric loads. In the winter the cooler operating temperature of efficient bulbs results in an increase in gas heating loads (often referred to as "heating penalties"). Since ComEd is an electric utility these heating penalties have not included in the winter peak kW savings estimates.

<sup>16</sup> "Winter Peak Coincidence Factor Recommendation for Residential Lighting" memo delivered to ComEd on February 2, 2015



savings came from the PY8 program tracking data<sup>17</sup>, the Illinois Statewide Technical Reference Manual for Energy Efficiency Version 4.0 (Illinois TRM v4), and PY8 in-store intercept surveys.

### **2.2.2 Verified Net Program Savings Analysis Approach**

Verified net energy and demand (coincident peak and overall) savings were calculated by multiplying the verified gross savings estimates by a net-to-gross ratio (NTGR). For PY8, the NTGR estimates were 0.59 for standard CFLs and 0.73 for LED bulbs and fixtures. These NTGR estimates were based on past evaluation research and approved through the Illinois Stakeholder Advisory Group (IL SAG) consensus process.

## **2.3 Process Evaluation**

The process evaluation for the PY8 Residential Lighting program focused on the impact of program processes (e.g., the mechanics of how the program was implemented) on consumers who participated in the program, as well as, the current state of the efficient lighting market in ComEd's service territory. In this component of the study, we examined the effectiveness of program marketing, current levels of customer familiarity and use of energy efficient lighting technologies, awareness of ComEd sponsored discounts on high efficiency lighting, key considerations when purchasing household lighting, and remaining barriers to purchasing CFL and LED lighting technologies. The primary data source for the process evaluation was the in-store intercept surveys (n=832).

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<sup>17</sup> The Evaluation Team received the tracking data on July 29, 2016: Res\_Lighting\_PY8\_EOY\_Evaluation\_Data\_Rev0\_07252016.xlsx.

## 3. GROSS IMPACT EVALUATION

This section presents the results of the verified gross impact findings, including a review of the tracking data analyzed and the parameter estimates used to calculate the verified gross savings. The PY8 verified estimates (excluding carryover) are 381,167 MWh for gross energy savings, 359.3 MW for gross demand savings, with 46.3 MW of summer peak demand savings, and 58.0 MW of winter peak demand savings.

### 3.1 Tracking System Review

The Residential Lighting Project Information Database was the upstream lighting database used for the PY8 evaluation. This database contained a record for all retail program bulb sales invoices (by model number and store) that were sold during PY8. The key variables in this database included the retailer store name and address, the bulb description and model number, the number of program bulbs sold, and the rebates paid for these program bulbs, as well as the parameter values used to calculate ex-ante gross energy savings. The database did not include the parameters needed to calculate the ex ante gross demand savings. In previous program years, ComEd provided a cumulative tracking database that included the program's sales since its inception. However, this year's database included only PY8 sales, which avoided the data cleaning steps required in prior years to make sure each year's sales were complementary and non-overlapping. The PY8 analysis dataset was created based on the program tracking database received from ComEd (dated July 25, 2016). This dataset contained 263,900 records, representing 12,982,661 program bulbs sold in PY8.

In prior years, the evaluation team had to match the tracking database with a file created by the implementation contractor called the *Goals Tracker* in order to pick up detailed bulb information not present in the tracking database. This problem was resolved in PY8 as the tracking database has been updated to include all of the necessary program bulb fields.

The Residential Lighting Project Information Database included all of the information needed to calculate and verify the measure-level gross energy savings, but did not include measure-level demand savings or the demand savings calculation parameter input values. The evaluation team recommends continuing to include the energy savings calculation parameter values in the upstream lighting database and adding the measure-level demand savings and the demand savings calculation parameter input values to the database.

The evaluation team also noted that The Residential Lighting Project Information Database included a field called "Lamp\_category" that appears to incorrectly classify program bulbs and is not consistent with the "description" field included in the tracking database. The following table details the inconsistencies observed. Therefore, the evaluation team recommends reviewing the bulb description to "Lamp\_category" mapping to ensure this field is correctly defined and delete the "Lamp\_category" field if it is not being used by ComEd.

**Table 3-1. Tracking Database Bulb Description versus “Lamp\_category” Field**

Tracking Database Bulb Category	Tracking Database Lamp Type	“Lamp_category”	N Records	N Bulbs
LED Omni	A-Lamp	LED MR16 8w (LMRS16)	61	1,108
LED Omni	A-Lamp	LED PAR 20 (LPAR20)	69,770	3,894,969
LED-Directional/Other	7-9 Watt Reflector	LED MR16 20w (LMRL)	2,122	93,385
LED-Directional/Other	Reflector	LED MR16 8w (LMRS16)	48,246	1,110,719
LED Fixture	Retrofit	LED MR16 8w (LMRS16)	87	547

### 3.2 Program Volumetric Findings

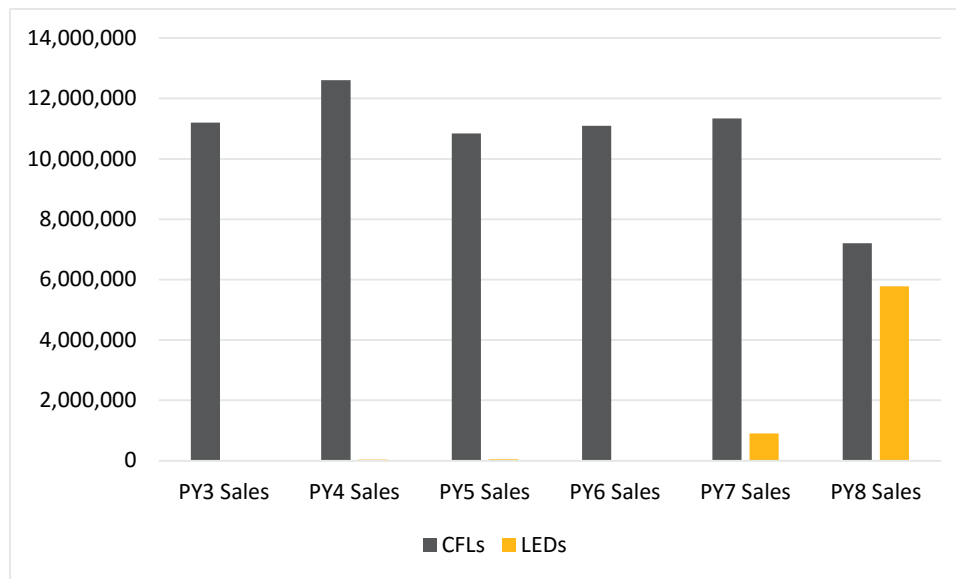
The total number of bulbs sold during the PY8 Residential Lighting program is estimated to be 12,982,661, which is a six percent increase from the bulbs sold in the seventh program year (PY7). There was a dramatic shift in the volumetric sales among the types of bulbs sold through the program from CFLs to LEDs: 56 percent of the bulbs sold in PY8 were standard CFLs compared to 85 percent in PY7, 30 percent were omni-directional LEDs compared to four percent in PY7, 12 percent were directional LEDs compared to three percent in PY7, and two percent were LED fixtures (no fixtures were sold in the program in PY7). Table 3-2 and Figure 3-1 show the volume of bulbs, by bulb type, incentivized through the Residential Lighting program in PY3 through PY8.

**Table 3-2. PY3 – PY8 Volumetric Findings Detail**

Program Year	Standard CFLs	Specialty CFLs	CFL Fixtures	LED Omni-Dir	LED Dir	LED Fixtures	Coupons	Total
PY8 Sales	7,205,656	0	0	3,896,077	1,578,687	302,241	0	12,982,661
PY7 Sales	10,347,580	989,999	0	471,710	427,824	0	0	12,237,113
PY6 Sales	8,965,546	2,125,179	0	0	0	0	0	11,090,725
PY5 Sales	9,633,227	1,197,896	8,767	9,472	18,758	24,268	5,506	10,897,894
PY4 Sales	11,419,752	1,097,670	84,539	2,592	22,327	16,551	5,599	12,649,030
PY3 Sales	9,893,196	1,217,723	86,943	0	0	0	0	11,197,862

Source: ComEd tracking data and Navigant team analysis.

**Figure 3-1. Sales Over Time**



Source: ComEd tracking data and Navigant team analysis.

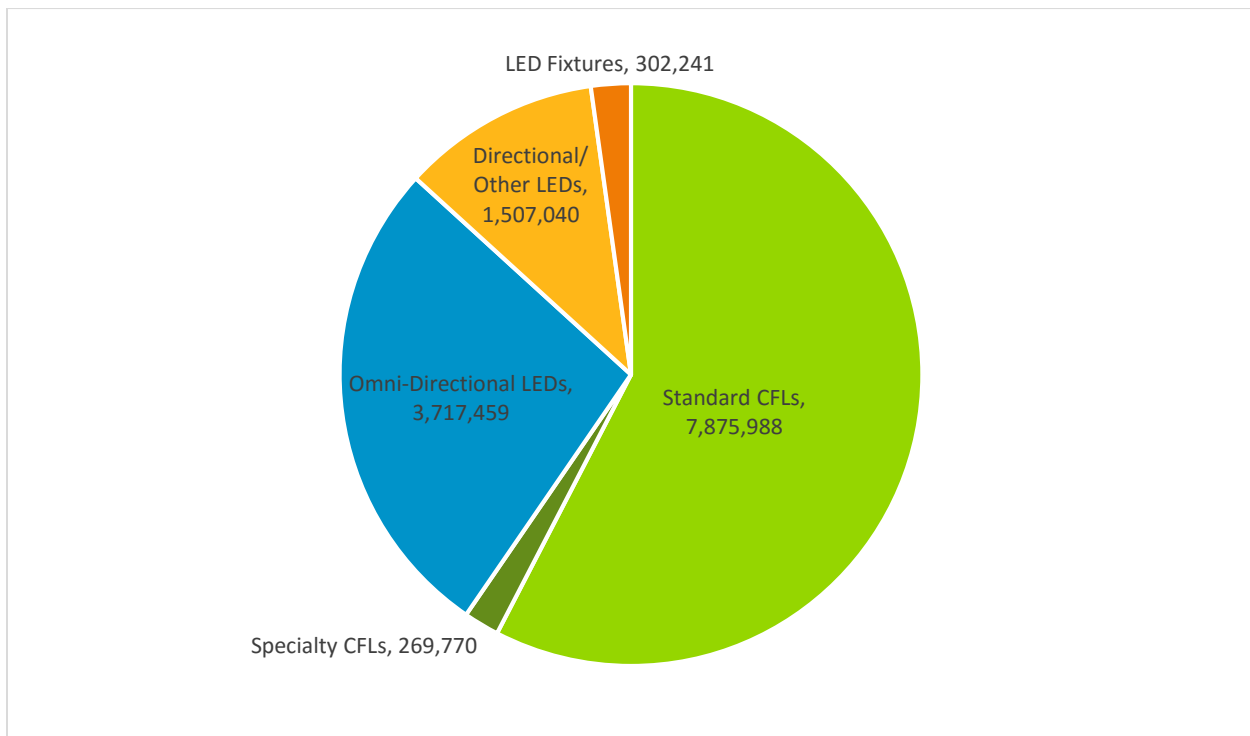
Table 3-3 shows the volume of bulbs incentivized through the Residential Lighting program estimated to have been installed during PY8. This includes bulbs sold in prior program years and installed in PY8 by program bulb type.

**Table 3-3. PY8 Volumetric Findings Detail – Bulbs installed in PY8**

Participation	Total	Standard CFLs	Specialty CFLs	Omni-Directional LEDs	Directional/Other LEDs	LED Fixtures
PY8 Incentivized Bulbs	12,982,661	7,205,656	0	3,896,077	1,578,687	302,241
PY8 1st Year Installed Bulbs	10,773,575	5,268,776	0	3,702,364	1,500,195	302,241
PY6 Carryover–PY8 Installs	1,359,037	1,174,487	184,551	0	0	0
PY7 Carryover– PY8 Installs	1,539,885	1,432,726	85,219	15,095	6,845	0
<b>Total Installed Bulbs in PY8</b>	<b>13,672,497</b>	<b>7,875,988</b>	<b>269,770</b>	<b>3,717,459</b>	<b>1,507,040</b>	<b>302,241</b>

Source: ComEd tracking data and Navigant team analysis.

Figure 3-2. Number of Measures Installed by Type



Source: Evaluation Analysis

### 3.3 Gross Program Impact Parameter Estimates

As described in Section 2, energy and demand savings are estimated using the following formula as specified in the IL TRM v4:

**Verified Gross Annual  $\Delta kWh$**  = Delta Watts/1000 \* ISR \* (1-Leakage) \* HOU \* IEe

**Verified Gross Annual  $\Delta kW$**  = Delta Watts/1000 \* ISR \* (1-Leakage)

**Verified Gross Annual Summer Peak  $\Delta kW$**  = Gross Annual  $\Delta kW$  \* Summer Peak CF \* IE<sub>d</sub>

**Verified Gross Annual Winter Peak  $\Delta kW$**  = Gross Annual  $\Delta kW$  \* Winter Peak CF \* IE<sub>d</sub>

The evaluation team conducted research to validate the parameters that were not specified in the TRM. The final list of parameter estimates used to calculate the PY8 verified gross savings are shown in the following table.

Table 3-4. Verified Gross Savings Parameters

Gross Impact Parameters	Measure	PY8 ComEd Reported (Ex-Ante)	PY8 Verified Savings <sup>18</sup>
Program Bulb Sales <sup>19</sup>	Standard CFLs		7,205,656
	Omni-Directional LEDs		3,896,077

<sup>18</sup> All of the verified NonRes parameters in this table are taken from the IL TRM v4, building type = "Unknown".

<sup>19</sup> In PY8, the Residential Lighting program did not incent specialty CFLs and CFL fixtures.

Gross Impact Parameters	Measure	PY8 ComEd Reported (Ex-Ante)	PY8 Verified Savings <sup>18</sup>
	Directional LEDs		1,578,687
	LED Fixtures		302,241
	All Measures		12,982,661
Delta Watts	Standard CFLs		31.2
	Omni-Directional LEDs		32.3
	Directional LEDs	42.4	48.6
	LED Fixtures	43.9	44.0
	All Measures	33.2	34.0
Installation Rate	Res Standard CFLs	0.747 <sup>20</sup>	0.732
	Res Omni-Directional LEDs		0.95
	Res Directional LEDs		0.95
	Res LED Fixtures	1.00	1.00
	Non-Res Standard CFLs	NR	0.712
	Non-Res LEDs	NA	0.957
Res/NonRes	Standard CFLs	NR	96%/4%
	Omni-Directional LEDs	100%/0%	96%/4% <sup>21</sup>
	Directional LEDs	100%/0%	96%/4%
	LED Fixtures		100%/0%
Leakage	All Measures	NA	3%
	Res Standard CFLs	759 <sup>22</sup>	847
Hours of Use (HOU)	Res Omni-Directional LEDs	759	847
	Res Directional LEDs - Reflector	861	891
	Res Directional LEDs - Globe	639	639
	Res Directional LEDs - Decorative	1,190	1,190
	Res LED Fixtures	861	891
	Non-Res Standard CFLs		3,612
	Non-Res LEDs	NA	3,612

<sup>20</sup> The standard CFL installation rate appears to be the estimated value recommended for future use in the PY7 Final Report. This is not the value that is included in the IL TRM v4 since the IL TRM estimate averages the ComEd and Ameren results for a statewide estimate.

<sup>21</sup> Currently the IL TRM does not include a Res/NonRes split for Omni-Directional LEDs. The evaluation team believes this is an oversight and should be added.

<sup>22</sup> The tracking data uses an HOU estimate of 873 hours which is a weighted average of the Res (759 hours, residential Interior) and NonRes (3,612 hours, nonresidential Unknown) HOU estimates assuming a 96/4 Res/NonRes Split.

Gross Impact Parameters	Measure	PY8 ComEd Reported (Ex-Ante)	PY8 Verified Savings <sup>18</sup>
Interactive Effects (IE)	Energy - Res All Measures		1.06 <sup>23</sup>
	Energy - Non-Res Standard CFLs		1.31
	Energy - Non-Res LEDs	NA	1.31
	Demand - Res All Measures	NR	1.11
	Demand - Non-Res Standard CFLs	NR	1.53
	Demand - Non-Res LEDs	NA	1.53
Summer Peak Coincidence Factor (Summer Peak CF) <sup>24</sup>	Res Standard CFLs	NR	0.081
	Res Omni-Directional LEDs	NR	0.081
	Res Directional LEDs - Reflector	NR	0.094
	Res Directional LEDs - Globe	NR	0.075
	Res Directional LEDs - Decorative	NR	0.121
	Res LED Fixtures	NR	0.094
	Non-Res All Measures	NR	0.66
Winter Peak Coincidence Factor (Winter Peak CF) <sup>25</sup>	Res Standard CFLs	NR	0.116
	Res Omni-Directional LEDs	NR	0.116
	Res Directional LEDs - Reflector	NR	0.134
	Res Directional LEDs - Globe	NR	0.107
	Res Directional LEDs - Decorative	NR	0.173
	Res LED Fixtures - Interior	NR	0.134
Non-Res All Measures	NR	0.55	
Carryover Bulbs	All Measures		2,898,922

† State of Illinois Technical Reference Manual version 4 from <http://www.ilsag.info/technical-reference-manual.html>.

NR = Not Reported

NA = Not Applied

### 3.4 Verified Gross Program Impact Results

The resulting total program verified gross savings is 381,167 MWh for electricity, 359.3 MW for demand, 46.3 MW for summer peak demand, and 58.0 MW for winter peak demand as shown in the following table. These saving estimates are based on deemed parameter estimates from the Illinois TRM v4. The evaluation team verified the quantity of bulbs sold based on the tracking data and found they matched 100 percent with the ex-ante estimates. These tables do not include carryover. PY8 Carryover savings are presented in Table 3-6.

<sup>23</sup> The tracking data uses an WHFe estimate of 1.07, which is a weighted average of the Res (1.06) and NonRes (1.31) WHFe estimates assuming a 96/4 Res/NonRes Split.

<sup>24</sup> The evaluation team recommends that ComEd use the Summer Peak Coincidence Factors in this table for Residential Lighting, dated 2/2/2015.

<sup>25</sup> The evaluation team recommends that ComEd use the Winter Peak Coincidence Factors in this table for Residential Lighting, dated 2/2/2015.

**Table 3-5. PY8 Verified Gross Impact Savings Estimates by Measure Type**

Measure	Ex-Ante Gross MWh Savings	Verified Gross Realization Rate	Verified Gross MWh Savings	Verified Gross Summer Peak MW Savings	Verified Gross Winter Peak MW Savings
Standard CFLs	157,023	106%	167,132	20.1	25.0
Omni-Directional LEDs	96,317	127%	122,231	14.7	18.3
Directional LEDs	60,679	131%	79,621	10.2	12.8
LED Fixtures	12,132	100%	12,183	1.3	1.9
<b>Total</b>	<b>326,151</b>	<b>117%</b>	<b>381,167</b>	<b>46.3</b>	<b>58.0</b>

Source: Evaluation Team analysis.

The PY8 Residential Lighting program is able to claim energy and demand savings from program bulbs purchased during PY6 and PY7, but not installed in a customer’s home until PY8. Table 3-6 below provides estimates of the verified gross savings for all bulbs installed in PY8 including the savings from the carryover bulbs. PY8 carryover savings from PY6 standard CFLs and all PY7 bulbs were attributed to the EEPS portfolio and savings from PY6 specialty CFLs were attributed to the IPA portfolio.

**Table 3-6. PY8 Verified Gross Impact Savings including Carryover**

Measure	Ex-Ante Gross MWh Savings	Verified Gross Realization Rate	Verified Gross MWh Savings	Verified Gross Summer Peak MW Savings	Verified Gross Winter Peak MW Savings
PY8 Bulb Sales	326,151	117%	381,167	46.3	58.0
Carryover bulbs	95,652	100%	95,652	10.9	12.7
<b>Total</b>	<b>421,803</b>	<b>113%</b>	<b>476,819</b>	<b>57.2</b>	<b>70.7</b>

Source: Evaluation team analysis



## 4. NET IMPACT EVALUATION

Verified net energy and demand (coincident peak and overall) savings were calculated by multiplying the verified gross savings estimates by a NTG ratio. In PY8, the NTGR estimates used to calculate the net verified savings for the IPA portfolio were based on past evaluation research and approved through the IL SAG consensus process.<sup>26</sup>

### 4.1 PY8 Program and Carryover Savings Estimate

In PY8, all program bulbs sales (standard and specialty CFLs and omni-directional and directional LEDs) were attributed to the IPA portfolio. The NTGR estimates applied to calculate verified net savings were based on past evaluation research and approved through the IL SAG consensus process: 0.59 for standard CFLs and 0.73 for LEDs (omni-directional, directional, and fixtures). Using these NTGR values, the evaluation team calculated verified net savings of 313,360 MWh, 297.1 MW for demand, 37.8 summer peak MW, and 46.5 winter peak MW as shown in Table 4-1 and Table 4-2.

**Table 4-1. PY8 Verified Net Impact Savings Estimates by Measure Type without Carryover**

Measure	Ex-Ante Net MWh Savings <sup>27</sup>	Verified Net Realization Rate	Verified Net MWh Savings	Verified Net Summer Peak MW Savings	Verified Net Winter Peak MW Savings
Standard CFLs	92,644	106%	98,608	11.8	14.7
Omni-Directional LEDs	70,311	127%	89,228	10.8	13.4
Directional LEDs	44,296	131%	58,124	7.4	9.3
LED Fixtures	8,856	100%	8,893	1.0	1.4
<b>Total</b>	<b>216,107</b>	<b>118%</b>	<b>254,854</b>	<b>31.0</b>	<b>38.8</b>

Source: Evaluation team analysis

Table 4-2 provides estimates of the verified net savings for all bulbs installed in PY8 including the savings from the carryover bulbs. PY8 carryover savings from PY6 standard CFLs and all PY7 bulbs were attributed to the EEPS portfolio and savings from PY6 specialty CFLs were attributed to the IPA portfolio.

<sup>26</sup> ComEd\_NTG\_History\_and\_PY8\_Recommendations.xls, available on the IL SAG website here: <http://ilsag.info/net-to-gross-framework.html>. Accessed: September 2, 2016.

<sup>27</sup> ComEd did not provide the evaluation team with the ex-ante net savings and thus these estimates were derived by multiplying the ex-ante gross savings estimates by the deemed NTG values found on the IL SAG website.

**Table 4-2. PY8 Verified Net Impact Savings including Carryover**

Measure	Ex-Ante Net MWh Savings	Verified Net Realization Rate	Verified Net MWh Savings	Verified Net Summer Peak MW Savings	Verified Net Winter Peak MW Savings
PY8 Sales	216,107	118%	254,854	31.0	38.8
Carryover bulbs	58,506	100%	58,506	6.8	7.7
<b>Total</b>	<b>274,613</b>	<b>114%</b>	<b>313,360</b>	<b>37.8</b>	<b>46.5</b>

Source: Evaluation team analysis

## 4.2 PY9 Carryover Savings Estimate

The evaluation team calculated the PY9 carryover estimate using the Illinois TRM (v4 and v5) and the PY7 and PY8 reports. The energy and demand savings from these PY7 and PY8 late installed bulbs are calculated based on the following parameters:

- Delta Watts – Verified savings estimate from the year of installation (source: Illinois TRM v5)
- Res/Non-Res Split - Evaluation research from the year of purchase (PY7 and PY8 Reports)
- HOU and Peak CF – Verified savings estimate from the year of installation (source: Illinois TRM v5)
- Energy and Demand IE – Verified savings estimate from the year of installation (source: Illinois TRM v5)
- Installation Rate - Verified savings estimate from the year of purchase (source: IL TRM v3 and Illinois TRM v4)
- NTGR – Evaluation research from the year of purchase (source: PY7 and PY8 Reports)

Table 4-3 shows that in PY9 a total of 2,373,351 bulbs (1,317,793 EEPS bulbs and 1,055,558 IPA bulbs) that were purchased during PY7 or PY8, are expected to be installed within ComEd's service territory. The table below provides both the gross and net energy and demand savings from these bulbs attributable to the EEPS and IPA portfolios. Combined across these two portfolios, the total net energy savings estimate is 51,464 MWh, 51.3 MW, 5.8 Summer Peak MW, and 6.6 Winter Peak MW which will be counted in PY9 as Residential Lighting Program carryover savings.

**Table 4-3. PY9 Carryover Savings Estimates by Portfolio**

PY9 Verified Savings Carryover Estimate	EEPS PY7 Bulbs	IPA PY8 Bulbs	Total PY9 Carryover
Carryover Bulbs Installed in PY9	1,317,793	1,055,558	2,373,351
Average Delta Watts	32.2	31.7	n/a
Average Daily Hours of Use	2.5	2.6	n/a
Summer Peak Load Coincidence Factor	0.096	0.102	n/a
Winter Peak Load Coincidence Factor	0.127	0.132	n/a
Installation Rate	10.8%	8.1%	n/a
Energy Interactive Effects	1.06	1.06	n/a
Demand Interactive Effects	1.12	1.12	n/a
Gross kWh Impact per unit	29.9	30.6	n/a
Gross kW Impact per unit	0.032	0.032	n/a
Carryover Gross MWh Savings	48,888	34,397	83,286
Carryover Gross MW Savings	49.6	33.4	83.0
Carryover Gross Peak Summer MW Savings	5.3	4.0	9.3
Carryover Gross Peak Winter MW Savings	6.3	4.4	10.7
Net-to-Gross Ratio	0.63	0.60	n/a
Carryover Net MWh Savings	30,707	20,756	51,464
Carryover Net MW Savings	31.1	20.2	51.3
Carryover Net Summer Peak MW Savings	3.3	2.4	5.8
Carryover Net Winter Peak MW Savings	4.0	2.7	6.6

Source: Evaluation team analysis

## 5. PROCESS EVALUATION

This section includes a description of the process evaluation and findings from the study.

### 5.1 Overview of Process Evaluation

The process evaluation of the PY8 Residential Lighting program assessed the impact of program processes (e.g., the mechanics of how the program was implemented) on select consumers who participated in the program and the current state of the efficient lighting market in ComEd's service territory. In this component of the study, we examined the effectiveness of program marketing, current levels of familiarity and usage of energy efficient lighting technologies, awareness of ComEd sponsored discounts on high efficiency lighting, key considerations when purchasing household lighting, remaining barriers to purchasing CFL and LED lighting technologies, and the current retailer (program and non-program) efficient lighting stocking levels to assess the effect ComEd's program is having on the price of efficient lighting at program stores. The primary data source for the process evaluation were the in-store intercept surveys (n=832) and the shelf surveys (n=25). Memos presenting the complete analysis details and key findings for each of these process related efforts were delivered to ComEd in May and June of 2016. These process memos have been included as attachments to this report (Sections 7.6.3 and 7.6.4). The remainder of this section presents the key process findings from these memos. The reader is encouraged to review the attached memos if further detail is desired.

### 5.2 High-Level Process Findings

**Customer Bulb Type Preference.** From PY7 to PY8 there was a dramatic shift in the purchasing behavior among intercept respondents towards LEDs and away from CFLs and incandescent bulbs. This shift to LEDs is likely closely tied to the high level of LED awareness (85 percent in PY8), the significant increase in program LED offerings<sup>28</sup> and the rapidly declining LED prices.<sup>29</sup> Despite all of this LED activity, only half of customers who were aware of LEDs went on to purchase LEDs primarily due to their cost (price continues to be reported as the largest barrier to LED purchase).

**Prior Usage of High Efficiency Bulbs by Program Participants.** The majority of program participants had prior experience with high efficiency bulbs. Ninety-four percent of program CFL purchasers reported they had previously installed CFLs in their home or business and 73 percent of program LED purchasers reported they had also previously installed LEDs in their home or business.

**Installation of LEDs.** LEDs are most frequently being purchased to replace incandescent bulbs. Over half (56 percent) of survey respondents reported the LEDs would replace incandescent bulbs, 30 percent reported they would replace CFLs, 5 percent reported they would replace other LEDs, and 4 percent reported they would replace Halogen bulbs. Nine percent were unsure what type of bulb they would replace.

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<sup>28</sup> In PY8, more than 200 LED models were incentivized through the program across the four program retailers where intercepts were conducted, compared to 50 LED models in PY7.

<sup>29</sup> *LED Incremental Cost Study Overall FINAL Report*. Prepared by Cadmus for the Electric and Gas Program Administrators of Massachusetts. February 2016. Figure 15, page 44.

**Replacement of Working Bulbs.** The majority of respondents purchasing CFLs and LEDs reported they planned to install these efficient bulbs to replace less efficient bulbs that were still in working order (70 percent of LED purchasers and 50 percent of CFL purchasers reported that some or all of the bulbs they were purchasing would replace bulbs that were still in working order).

**Awareness of ComEd's Residential Lighting Program Incentives.** Customer awareness that the bulbs were discounted by ComEd was low (66 percent of program bulb purchasers were not aware they were purchasing bulbs discounted by ComEd).

**Price Differential.** While roughly a third of program participants did not know they were buying ComEd discounted bulbs, 60 percent of participants did know that the bulbs were discounted. The majority of customers who did not know the bulbs were discounted did think that the CFL and LED in-store prices were low (84 percent reported the CFL prices were low and 60 percent reported the LED prices were low). This indicates that while the participants may be unaware of the ComEd program or discount, they are noticing the low prices (that the program provides) for these efficient bulb types.

**Influence of Incentives.** The ComEd program incentives are having a significant effect on the retail price of CFLs and LEDs within ComEd service territory. On average, program standard CFLs are approximately half the price of non-program standard CFLs and program LEDs (both omni-directional and directional) are around two-thirds the price of non-program LEDs. Additionally, ComEd discounted standard CFLs cost less per bulb, on average, than similar incandescent and halogen bulbs.

**Awareness and Influence of Program Marketing Materials.** The majority of customers surveyed were unaware of in-store efficient lighting information provided by ComEd (63 percent), however customers who had seen this information reported they were highly influential in their decision to purchase efficient lighting. During demonstration events customers reported greater awareness of marketing materials and more frequent interactions with store employees who could offer information on energy efficiency lighting.

**Purchasing Intentions.** The majority of respondents planned to purchase lighting when they entered the store (81 percent) and most of these respondents (93 percent) purchased at least one bulb of the type they reportedly had planned to buy. Lighting purchasers who had not planned to purchase bulbs upon entering the store, primarily purchased LEDs and CFLs (48 percent purchased LEDs only, 34 percent purchased CFLs only, and 19 percent purchased a mix of efficient and non-efficient bulbs). The program appeared to have a rather significant influence on what these customers purchased as program influence was relatively high amongst those who ended up purchase a program bulb (87 percent reported an influence of 6 or higher to either the program bulb price, in-store information, or the bulb placement). Awareness of the discount was also higher amongst those who ended up buying a program bulb (61 percent of those who ended up buying a program bulb were aware of the discount versus only 12 percent who did not end up buying a program bulb).

**Purchasing Influences.** Customers purchasing CFLs and LEDs both reported two of the top three factors influencing their purchase were: the energy used by the bulbs and the longevity of

bulbs. The other top factor reported for CFL purchasers was the price of the CFLs, while for LED purchasers it was the light quality that LEDs produce.

**Barriers to CFL and LED Purchase.** Customers purchasing incandescent or halogen bulbs reported their primary barriers to purchasing CFLs were aesthetic – including their look and fit in fixtures, light color and quality, and flicker (47 percent) or that they needed another kind of bulb (24 percent). Because customers largely disliked CFLs for aesthetic reasons they also reported a low likelihood of purchasing CFLs if their prices were equal to or lower than other bulb types available for purchase. The primary barriers reported to LED purchase included their cost and a lack of awareness or knowledge of LEDs, both are factors that can be overcome through continued program incentives, marketing, and education.

**State of the LED Market:** The cost of a medium screw-based LED has come down substantially in recent years (the average cost of a non-incentivized standard LED in PY6 was nearly \$17 a bulb and is now less than \$7 and the price of a non-incentivized specialty LED has come down from around \$26 a bulb to \$13). LED bulbs are also comprising a larger proportion of the medium-screw based bulbs stocked on program retailer shelves (21 percent in PY8 versus 16 percent in PY6), although they appear to be replacing shelf space previously filled by CFLs, as opposed to reducing the share of incandescent and halogen bulbs.

**State of the CFL Market:** The shelf space program retailers dedicate to CFLs has decreased significantly as LEDs drop in price and awareness of LEDs continues to rise quickly. Since LEDs last longer, generate greater energy savings than CFLs, and are often preferred to CFLs in terms of light quality, they will likely continue to cannibalize the CFL market as the preferred energy efficient bulb technology. Specialty CFL shelf space has declined at a faster rate than standard CFL space, dropping from 29 percent in PY6 to 6 percent in PY9 (standard CFL space dropped from 43 percent to 34 percent during that same period).

**Incandescent Lamp Availability:** The availability of standard incandescent medium screw-based lamps has continued to decrease due to the implementation of EISA 2007. Overall, the share of standard incandescent bulbs has decreased from 22 percent in PY6 to 11 percent in PY8, with the greatest decline being in the 40-watt replacement category where incandescent bulbs fell from 39 percent to 26 percent of the market. At the same time the availability of specialty incandescent bulbs, which are generally not covered by the EISA standards, has increased with specialty incandescent bulbs making up 54 percent of the stocked product (up from 35 percent in PY6).

**Halogen Lamp Availability:** The volume of standard halogen bulbs found on the shelves of program retailers has risen as incandescent bulbs have gone away. Between PY6 and PY8, standard halogens increased from 20 percent of the stocked standard bulbs to 35 percent. The stocking of specialty halogen bulbs in that same time period has remained fairly steady (20 percent compared to 18 percent).

**Specialty Bulb Market:** Availability of high efficiency (CFL and LED) specialty bulbs still significantly lags behind standard bulbs – in part due to the fact that many specialty bulbs are exempt from the EISA standards, their prices are still about double the cost of a standard bulb of the same technology, and customers lack of satisfaction with the products that are available (primarily for CFLs).

## 6. FINDINGS AND RECOMMENDATIONS

This section summarizes the key impact and process findings and recommendations. The PY8 Residential Lighting program planning target was to sell 12,827,609 incentivized CFL and LED bulbs to Residential customers within ComEd's service territory. The program exceeded this goal by selling a total of 12,982,661 CFLs, LEDs, and LED fixtures. These CFL and LED sales led to the program achieving 127 percent of its targeted gross energy savings. Retailer participation in the Residential Lighting program remained stable between PY7 and PY8. In total, there were 20 retail chains participating in the PY8 program, resulting in a total of just over 1,129 individual retail locations where program bulbs could be purchased. As in previous program years, big box, do-it-yourself (DIY), and warehouse stores remained the dominant retail categories (responsible for selling 84 percent of PY8 program bulbs).

### Program Volumetric Findings

**Finding 1.** The total number of bulbs sold during the PY8 Residential Lighting program was estimated to be 12,982,661, which is a six percent increase from the quantity of bulbs sold in PY7. Fifty-six percent of the bulbs sold in PY8 were standard CFLs, 30 percent were omni-directional LEDs, 12 percent were directional LEDs, and two percent were LED fixtures. No specialty CFLs were incentivized through the program in PY8. This significant decrease in standard CFL sales was planned as it is likely that standard CFLs will be eliminated from the program during PY9.

**Finding 2.** Analysis of PY8 program bulb sales found the average incentive per MWh of energy saved for omni-directional LEDs and directional LEDs is higher than it is for standard CFLs (roughly \$77/net MWh for a standard CFL, \$150/net MWh for an omni-directional LED, \$120/net MWh for a directional LED). The cost per kWh saved will continue to be lower for standard CFLs than for LEDs as these bulbs continue to require greater incentives to encourage market uptake due to their higher non-incentivized market prices. Energy Star 2.0 (ES 2.0) bulbs which are scheduled to hit the market in July 2018 should help decrease the cost per MWh of savings as their retail prices are projected to be significantly lower than existing LEDs and thus will require lower incentive levels.<sup>30</sup>

**Recommendation 1.** ComEd should consider adding the ES 2.0 bulbs to the program to retain a large volume of LED savings while minimizing program spending.

### Barriers to CFL and LED Purchase

**Finding 3.** Customers' primary barriers to purchasing CFLs are aesthetic—their look and fit in fixtures or their light color—and as a result customers reported a low likelihood of purchasing CFLs even if their prices were equal to or lower than the price of other bulb types. Barriers to LED purchases are related to their cost and a lack of awareness or knowledge of this newer technology. The top factors that customers reported had influenced their decision to purchase efficient bulbs were the energy saved by the bulbs, the longevity of the bulbs, and the quality of light they produce.

<sup>30</sup> Further information on Energy Star 2.0 LEDs can be found at: <https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Lamps%20V2%20Cover%20Letter%2012-4-15.pdf>

**Recommendation 2.** Both of the primary LED barriers will be reduced over time, however ComEd's lighting program is currently well positioned to effectively increase the rate at which these barriers are diminished by expanding their program LED offerings and re-examining their educational materials to ensure they are focused on the top influential factors, such as the longevity of the bulb and its impact on the ultimate cost and energy savings of the LED.

### State of the Lighting Market

**Finding 4.** The shelf surveys conducted as part of this evaluation found that the ComEd program incentives are having a significant effect on the retail price of CFLs and LEDs within ComEd service territory. Specifically, these shelf surveys found:

- Program LEDs (omni-directional and directional) are around two-thirds the price of non-program LEDs.
- Over the last two years, the price of a standard LED has decreased by around \$10 and the price of a specialty LED has decreased by \$13 a bulb. In addition, LEDs also comprise a larger proportion of stocked bulbs, however they seem to be replacing space previously occupied by CFLs.
- Program standard CFLs are approximately half the price of non-program standard CFLs and cost less per bulb, on average, than similar incandescent and halogen bulbs.
- The shelf space dedicated to standard incandescent bulbs lamps has been cut in half (22 percent to 11 percent) in the past two years, mostly driven by EISA, but all of this reduction has been met with an increase in halogen bulbs.
- The availability of specialty incandescent bulbs, which are generally not covered by the EISA standards, has increased—specialty incandescent bulbs represent 54 percent of the stocked product (up from 35 percent in the last two years ago). Stocking of halogen specialty bulbs has remained fairly steady (around 20 percent).

**Recommendation 3.** Availability and acceptance of high efficiency specialty bulbs still significantly lag behind standard bulbs (resulting from their exclusion from the EISA standards, their high up-front cost, and customers lack of satisfaction with previous products, primarily CFLs, they have installed). ComEd should review their specialty LED offerings to ensure they are effectively targeting the bulb shapes with the highest potential (based on price differential between efficient and in-efficient bulbs and the estimated quantity of sockets containing inefficient specialty products).

### Awareness of ComEd's Residential Lighting Program Incentives and Marketing Materials

**Finding 5.** Customer awareness that the bulbs were discounted by ComEd continued to be low (66 percent of PY8 program bulb purchasers surveyed were not aware they were purchasing bulbs discounted by ComEd, in PY7 this rate was 69 percent). However, while participants may be unaware of the ComEd discount, they are noticing the lower CFL and LED prices that the program provides (60 percent of respondents were aware they were buying discounted bulbs (but not necessarily ComEd discounted) and an additional 60 percent of respondents who didn't know the LEDs were discounted reported that they thought the prices in the store were low for LEDs).



**Finding 6.** Despite paying a higher upfront cost for LEDs, LED purchasers seem to be aware that the longevity and efficiency of LEDs will save them money over the lifetime of the bulb, compared to other bulb types.

**Recommendation 4.** ComEd should re-examine marketing material to see if it can enhance the information on lifetime cost savings to encourage more of non-LED purchasers to make the higher initial investment in LEDs.

**Finding 7.** The majority of customers surveyed in PY8 were unaware of in-store efficient lighting materials provided by ComEd (63 percent), however customers who had seen these materials reported they were highly influential in their decision to purchase efficient lighting. During demonstration events customers reported greater awareness of marketing materials and more frequent interaction with store employees who could offer information on energy efficiency lighting.

**Recommendation 5.** ComEd should re-examine their in-store materials to look for ways to increase customer awareness of in-store program marketing and educational materials.

### Program Tracking Data

**Finding 8.** In PY8, the Residential Lighting program tracking database was updated so that it includes all program bulb information required to calculate program impacts. This makes it no longer necessary to merge the tracking data and the goals tracker spreadsheet, which had been necessary in past program years. This change has reduced the need for manual matches on the part of the evaluation team representing significant time savings. However, the database did not include measure-level demand savings or the demand savings calculation parameter input values.

**Recommendation 6.** Continue to include the energy savings calculation parameter values in the upstream lighting database as well as add the measure-level demand savings and the demand savings calculation parameter input values to the database.

**Finding 9.** The Residential Lighting Project Information Database included a field called “Lamp\_category” that appears to incorrectly classify program bulbs and is not consistent with the “description” field included in the tracking database.

**Recommendation 7.** Review the bulb description for “Lamp\_category” mapping to ensure this field is correctly defined and delete the “Lamp\_category” field if it is not being used by ComEd.

### Verified Gross Impacts

**Finding 10.** The PY8 gross verified energy savings were estimated to be 381,167 MWh (excluding carryover), the entirety of which was attributable to the IPA portfolio. The PY8 gross verified carryover savings were 95,652 kWh, of which the majority (92 percent) were attributable to the EEPs portfolio and the remaining 8 percent were attributable to the IPA portfolio.

### Installation of CFLs and LEDs

**Finding 11.** The lighting market is currently undergoing a dramatic shift from CFLs and incandescent bulbs to LEDs. This shift to LEDs is closely tied to the high level of LED

awareness (85 percent in PY8), the significant increase in program LED offerings,<sup>31</sup> rapidly declining LED prices,<sup>32</sup> and prior experience with LEDs (73 percent of program LED purchasers had an LED installed in their home or business).

**Finding 12.** While LEDs are most frequently being purchased to replace incandescent bulbs (56 percent), nearly a third are replacing CFLs (five percent are replacing LEDs, four percent Halogens, and nine percent an unknown bulb type).

**Finding 13.** The majority of high efficiency bulbs will replace less efficient bulbs that are still in working order (70 percent of LED purchasers and 50 percent of CFL purchasers reported that some or all of the bulbs they were purchasing would replace bulbs that were still in working order).

### **PY9 Carryover Savings Estimate**

**Finding 14.** In PY9, the savings from nearly 2.4 million high efficiency bulbs, purchased during PY7 or PY8, are expected to be installed within ComEd service territory. These bulbs are estimated to yield total net savings of 51,464 MWh, 51.3 MW, 5.8 Summer Peak MW, and 6.6 Winter Peak MW. Estimated net carryover savings for PY9 is 88 percent of PY8 net carryover savings. Approximately 60 percent of the PY9 carryover savings are attributable to the EEPS portfolio (30,707 MWh) and the remaining 40 percent of carryover savings are attributable to the IPA portfolio (20,756 MWh). All EEPS savings come from bulbs purchased in PY7 and all IPA savings come from bulbs purchased in PY8.

### **Impact Estimates for Future Use**

**Finding 15.** During the course of the PY8 study, the evaluation team estimated key parameters used to estimate lighting program impacts. These parameters can be included in future versions of the Illinois Statewide Technical Reference Manual for Energy Efficiency (Illinois TRM) or within the IL net-to-gross ratio (NTGR) framework.

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<sup>31</sup> In PY8, more than 200 LED models were incentivized through the program across the four program retailers where intercepts were conducted, compared to 50 LED models in PY7.

<sup>32</sup> *LED Incremental Cost Study Overall FINAL Report*. Prepared by Cadmus for the Electric and Gas Program Administrators of Massachusetts. February 2016. Figure 15, page 44.

**Table 6-1. Impact Estimate Parameters for Future Use<sup>33</sup>**

Parameter	Value	Data Source
Res/Non-Res Split	95%/5% Standard CFLs	3-year rolling average (PY6-PY8) of Evaluation Research Findings
	98%/2% Omni-Directional LEDs	
	92%/8% Directional LEDs	
1st Year Installation Rate	76.6% Standard CFL	2-year rolling average (PY7-PY8) of Evaluation Research Findings
	89.9% Omni-Directional LEDs	
	93.5% Directional/Other LEDs	
Leakage	2.2% Standard CFL	3-year rolling average (PY6-PY8) of Evaluation Research Findings
	1.4% Omni-Directional LEDs	
	2.2% Directional/Other LEDs	
NTGR	0.54 Standard CFLs	PY8 Evaluation Research Findings
	0.58 Omni-Directional LEDs	
	0.58 Directional/Other LEDs	

<sup>33</sup> The evaluation research parameter estimates differ from those reported in the PY8 In-store Intercepts Memo and the PY8 NTG Results Memo because the estimates were reweighted using final PY8 bulb sales (allocated sales were used to weight the results reported in the In-Store Intercepts Results Memo).

## 7. APPENDIX

### 7.1 Evaluation Research Impact Approaches and Findings

#### 7.1.1 Evaluation Research Gross Impact Findings

The PY8 evaluation research gross savings were calculated using the gross energy and demand savings algorithms shown below. These are the same algorithms used to estimate the evaluation verified estimates (provided in Section 2) and specified within the Illinois TRM v4.<sup>34</sup>

**Verified Gross Annual  $\Delta kWh$**  = Delta Watts/1000 \* ISR \* (1-Leakage) \* HOU \* IEe

**Verified Gross Annual  $\Delta kW$**  = Delta Watts/1000 \* ISR \* (1-Leakage)

**Verified Gross Annual Summer Peak  $\Delta kW$**  = Gross Annual  $\Delta kW$  \* Summer Peak CF \* IEd

**Verified Gross Annual Winter Peak  $\Delta kW$**  = Gross Annual  $\Delta kW$  \* Winter Peak CF \* IEd

#### Where:

- Delta Watts = Difference between Baseline Wattage (incandescent wattage) and CFL Wattage
- HOU = Annual Hours of Use
- IEe = Energy Interactive Effects
- Leakage = % of Program Bulbs installed outside of ComEd Service Territory
- Summer Peak CF = Peak load coincidence factor, the percentage of Program Bulbs turned on during summer peak hours (weekdays from 1 to 5 p.m.)
- Winter Peak CF = Peak load coincidence factor, the percentage of Program Bulbs turned on during the PJM Winter Peak hours<sup>35</sup>
- IEd = Demand Interactive Effects (applied to summer Peak kW estimates only<sup>36</sup>)

Table 7-1 contains the evaluation research gross savings parameter estimates. As shown in the table below, many of the evaluation research parameters, such as installation rate, res/nonres split, and leakage, were based on analysis of customer self-report data collected during the PY8 in-store intercept surveys. The evaluation research estimates of installation rate, res/nonres split, and leakage differ from those reported in the In-store Intercepts Memo delivered on March 19, 2016 because the estimates were reweighted using final PY8 bulb sales (allocated sales were used to weight the results reported in the In-Store Intercepts Results Memo).

A number of these estimates differ from the deemed verified parameter estimates and thus account for the discrepancy between the verified savings and evaluation research savings estimates. The differences include the following:

- The evaluation research installation rates for standard CFLs were 14 percent higher than the deemed estimates included in Illinois TRM v4. For omni-directional and directional

<sup>34</sup> Source: <http://www.ilsag.info/technical-reference-manual.html>

<sup>35</sup> The Winter Peak Period is defined by PJM as the period from 6-8 am and 5-7 pm, Central Time Zone, between January 1 and February 28.

<sup>36</sup> Summer interactive effects represent the increased energy savings due to the cooler operating temperatures at which CFLs and LEDs operate and thus a reduction in cooling electric loads. In the winter the cooler operating temperature of efficient bulbs results in an increase in gas heating loads (often referred to as "heating penalties"). Since ComEd is an electric utility these heating penalties have not included in the winter peak kW savings estimates.

LEDs, the installation rates were found to be six percent and two percent lower, respectively.

- The evaluation research Res/NonRes split found the percent of residential installs was two percent higher than the deemed estimate from the Illinois TRM v4 for standard CFLs and omni-directional LEDs. For directional LEDs the residential installations rate was six percent lower.
- The evaluation research found no leakage for CFLs while the deemed estimate in Illinois TRM v4 was three percent. For omni-directional and directional LEDs the evaluation research estimated leakage was slightly lower than the deemed estimate in the TRM.

**Table 7-1. Evaluation Research Gross Savings Parameters**

Gross Impact Parameters	Population	PY8 Evaluation Research	Source
Program Bulb Sales	Standard CFLs	7,205,656	PY8 Program Tracking data
	Omni-directional LEDs	3,896,077	
	Directional/Other LEDs	1,578,687	
	LED Fixtures	302,241	
	All Bulbs	12,982,661	
Delta Watts	Standard CFLs	31.2	Base Watts: IL TRM v4; Efficient Watts: Tracking Data
	Omni-directional LEDs	32.3	
	Directional/Other LEDs	48.6	
	LED Fixtures	44.0	
	All Bulbs	34.0	
Installation Rate	Res Standard CFLs	83.6%	PY8 In-Store Intercepts
	Res Omni-Directional LEDs	89.3%	
	Res Directional LEDs	93.1%	
	Res LED Fixtures	100.0%	Illinois TRM v4
	Non-Res Standard CFLs	71.2%	
	Non-Res LEDs	95.7%	
Res/Non-Res	Standard CFLs	98%/2%	PY8 In-Store Intercepts
	Omni-directional LEDs	98%/2%	
	Directional/Other LEDs	90%/10%	Illinois TRM v4
	LED Fixtures	100%/0%	
Hours of Use	Res Standard CFLs	847	Illinois TRM v4
	Res Omni-Directional LEDs	847	
	Res Directional LEDs - Reflector	891	
	Res Directional LEDs - Globe	639	
	Res Directional LEDs - Decorative	1190	
	Res LED Fixtures	891	

Gross Impact Parameters	Population	PY8 Evaluation Research	Source
Summer Peak CF	Non-Res All Measures	3,612	Illinois TRM v4
	Res Standard CFLs	0.081	
	Res Omni-Directional LEDs	0.081	
	Res Directional LEDs - Reflector	0.094	
	Res Directional LEDs - Globe	0.075	
	Res Directional LEDs - Decorative	0.121	
	Res LED Fixtures	0.094	
Winter Peak CF	Non-Res All Measures	0.66	Memo to ComEd <sup>37</sup>
	Res Standard CFLs	0.116	
	Res Omni-Directional LEDs	0.116	
	Res Directional LEDs - Reflector	0.134	
	Res Directional LEDs - Globe	0.107	
	Res Directional LEDs - Decorative	0.173	
	Res LED Fixtures - Interior	0.134	
Leakage	Standard CFLs	0.0%	PY8 In-Store Intercepts
	Omni-directional LEDs	1.6%	
	Directional/Other LEDs	2.8%	PY7 Report
	LED Fixtures	3.0%	
Interactive Effects	Energy - Res	1.06	Illinois TRM v4.0
	Demand - Res	1.11	
	Energy - Non-Res	1.31	
	Demand - Non-Res	1.53	
Carryover Bulbs	All Measures	2,898,922	PY7 Report

Source: Evaluation team analysis

The remainder of this section provides details on how each of the evaluation research gross savings parameters, shown in the table above, were estimated.

### 7.1.1.1 PY8 Bulb Sales Estimates

Verified savings and evaluation research program bulb sales estimates were derived from the PY8 tracking databases provided by ComEd. The total number of bulbs sold during the PY8 Residential Lighting program is estimated to be 12,982,661, which is a six percent increase from the bulbs sold in PY7. Fifty-six percent of these were standard CFLs, 30 percent were omni-directional LEDs, 12 percent were directional LEDs, and two percent were LED fixtures. Table 7-2 shows that nearly all standard CFLs were sold in multi-packs (99.9 percent), while LEDs were more likely to be sold in single packs (74.9 percent of omni-directional LEDs and 52.2

<sup>37</sup> Winter Peak Coincidence Factor Recommendation for Commercial Lighting to ComEd from evaluation team, dated 2/10/2015.

percent of directional LEDs were sold in multi-packs). LED fixtures are primarily sold in single units, 24% of LED fixtures were multi-unit packages.

**Table 7-2. PY8 Bulb Sales by Pack Size**

Single vs. Multi-Pack	Standard CFL	Omni-directional LED	Directional LED	LED Fixtures	Total
Single Pack	5,557	976,503	755,366	228,427	1,965,853
Multi-Pack	7,200,099	2,919,574	823,321	73,814	11,016,808
PY8 Total Bulb Sales	7,205,656	3,896,077	1,578,687	302,241	12,982,661
% Multi-Pack	99.9	74.9	52.2	24.4	84.9

Source: Evaluation team analysis

Table 7-3 shows bulb sales by retailer type. Across all bulb types, 89 percent of PY8 bulbs and fixtures were sold at DIY, warehouse or big box stores. DIY stores alone were responsible for half of the overall program bulb sales, selling approximately 50 percent of program CFLs and LEDs and 74 percent of the program LED fixtures.

**Table 7-3. PY8 Bulb Sales by Type of Retailer**

Retailer Type	Standard CFL	Omni-directional LED	Directional LED	LED Fixtures	Total
DIY	3,615,067	1,938,908	733,206	225,163	6,512,344
Warehouse	1,026,196	1,390,769	573,463	74,980	3,065,408
Big Box	1,458,066	382,564	148,844	336	1,989,810
Dollar Store	725,422	4,851	0	0	730,273
Small Hardware	148,545	123,569	110,687	836	383,637
Other <sup>38</sup>	232,360	55,416	12,487	926	301,189
PY8 Total Bulb Sales	7,205,656	3,896,077	1,578,687	302,241	12,982,661

Source: Evaluation team analysis

### 7.1.1.2 PY8 Delta Watts

Displaced watts or “delta watts” is calculated as the difference between the program bulb wattage and baseline incandescent equivalent wattage. Program bulb wattages as specified by the manufacturer were easily obtained from the upstream lighting database. Appropriate baseline wattages are more difficult to establish as this metric depends on various factors including bulb type / shape, directionality, and federal standards.<sup>39</sup> The verified savings delta watts values and the evaluation research delta watts were estimated by applying a custom lumen mapping based on the program bulb type, bulb shape, and directionality (omni-directional, globes, directional, and decorative). This delta watts approach is technology neutral, meaning that lumen ranges for specific bulb types are consistent across technologies.

<sup>38</sup> Includes electronics, discount, and grocery stores.

<sup>39</sup> The Energy Independence and Security Act 2007 (EISA) and the Energy Policy and Conservation Act of 2012 (EPACT).

Using the baseline wattages methods established in the Illinois TRM v4, delta watts was calculated for each program bulb by subtracting the program bulb wattage from the Illinois TRM baseline wattage. Average delta watts values by bulb type are presented in Table 7-4.

**Table 7-4. Average Delta Watts Value across All Bulbs**

	Standard CFLs	Omni-directional LED	Directional LED	LED Fixtures	All PY8 Bulbs
Bulbs Sold	7,205,656	3,896,077	1,578,687	302,241	12,982,661
Average Bulb Wattage	16.5	10.4	8.8	10.6	12.2
Average Delta Watts	31.2	32.3	48.6	44.0	34.0

Source: Evaluation team analysis

### 7.1.1.3 PY8 CFL Installation Rates

Table 7-5 shows the standard CFL, specialty CFL, and LED installation rates broken down by the retailer types where in-store intercepts took place. For additional information about the methods and results of the PY8 installation rate calculations see the In-store Intercepts Memo in Section 7.6.5.

**Table 7-5. Installation Rate Estimates by Bulb Type and Retailer**

Retailer Type	Standard CFLs	Omni-directional LEDs	Directional LEDs	All Bulbs
Big Box	81%	88%	95%	85%
DIY	84%	86%	94%	86%
Warehouse	87%	94% <sup>40</sup>	92%	90%
Retailer Sales Weighted	84%	89%	93%	87%

Source: Evaluation team analysis

### 7.1.1.4 PY8 Program Bulb Leakage Rate

In PY8, the overall leakage rate across bulb types and retailer types was estimated to be 0.8 percent, which has decreased from the PY7 value of three percent. The decline in leakage was primarily driven by program standard CFL purchasers who reported that they planned to install all of their bulbs within the ComEd service territory, and only six program LED bulb purchasers reported they planned to install the program LED bulbs that they were purchasing outside of ComEd service territory.<sup>41</sup> For additional details about the leakage purchases see the In-store Intercepts Memo in Section 7.6.5.

### 7.1.1.5 PY8 Residential/Non-residential Installation Location Split

The percentage of program bulbs being installed in residential versus non-residential locations in PY8 was estimated to be 98/2 for Standard CFLs, 98/2 for omni-directional LEDs, and 90/10

<sup>40</sup> It should be noted that this result is based on a small sample of six intercept survey respondents who purchased Specialty CFLs at a Warehouse store.

<sup>41</sup> The six LED purchasers who reported leakage included three omni-directional LED purchasers who bought 13 bulbs and three directional LED purchasers who bought 7 bulbs.



for directional LEDs<sup>42</sup> based on data collected during the in-store intercept surveys. Respondents who indicated that they were planning to install their purchased program bulbs in a business that was reported to be either an apartment building or a hotel/motel were asked a follow up question about whether the bulbs would be installed in a common area of the building or within an individual unit/room. Those respondents who reported that the program bulbs would be installed within an individual unit/room were classified as Residential installations and assigned Residential HOU and CF estimates.

### 7.1.1.6 PY8 Hours of Use and Peak Coincidence Factor

#### Residential Evaluation Research Estimates

Table 7-6 shows the residential HOU and Peak CF estimates used to calculate the evaluation research impact estimates. These values were taken from IL TRM v4 and are the same as those used to calculate the verified energy and demand savings. The deemed TRM HOU and CF estimates are the results of the PY5/PY6 ComEd Lighting Logger Study.<sup>43</sup>

**Table 7-6. Residential HOU and Peak CF Estimates**

Bulb Type		Evaluation Research				
		Bulb Sales	Annual HOU	Daily HOU	Summer Peak CF	Winter Peak CF
CFL	Standard	7,205,656	847	2.32	0.081	0.116
	Omni-directional	3,896,077	847	2.32	0.081	0.116
LED	Candelabra	288,526	891	2.44	0.094	0.134
	Reflector	1,204,104	639	1.75	0.075	0.107
	Globe	86,057	1190	3.26	0.121	0.173
LED Fixture		302,241	891	2.44	0.094	0.134
Bulb Weighted Average		12,982,661	832	2.28	0.08	0.12

Source: Evaluation team analysis

#### Non-Residential Impact Evaluation Research Estimates

The non-residential HOU and peak CF estimates used to calculate the evaluation research impact estimates were taken from the commercial lighting portion of the Illinois TRM v4.0 (Unknown” building type).

### 7.1.1.7 Interactive Effects

The IE estimates (both energy and demand) used to estimate the verified savings and evaluation research impacts were taken from the Residential and C&I sections of the Illinois TRM v4. The non-residential verified savings estimates were taken directly from the “Miscellaneous” category estimates. Similar to the method used to calculate the Non-residential evaluation research HOU and peak CF estimates, evaluation research energy and demand IE were calculated by taking a weighted average of the business type specific IE estimates using the distribution of business types found during the in-store intercept surveys. Table 7-7 presents these Illinois TRM based IE estimates.

<sup>42</sup> This analysis excluded program bulbs that were reportedly installed in locations outside of ComEd service territory.

<sup>43</sup> The complete PY5/PY6 Lighting Logger Study was included as an Appendix to the PY6 report.

**Table 7-7. PY8 Energy and Demand Interactive Effects**

Sector	Evaluation Research	
	Energy IE	Demand IE
Residential	1.06	1.11
Non-residential	1.31	1.53

Source: Evaluation team analysis

### 7.1.1.8 Carryover Bulb Savings Estimation

The PY8 residential CFL energy and demand savings estimates include savings resulting from bulbs purchased during PY6 and PY7, but that were not installed (i.e., used by the consumer) in the program year during which they were purchased. Similarly, saving from program bulbs purchased in PY8, but not installed in PY8, can be counted in future program years. This section presents the verified savings estimates for the carryover bulbs installed in PY8.

#### PY8 Carryover Savings Estimation

The source for the parameter estimates that go into the energy and demand impact calculations for the PY8 carryover bulbs are provided in Table 7-8.

**Table 7-8. PY8 Carryover Parameter Sources**

Parameter Estimate	Parameter Timing	PY6 Sales	PY7 Sales
Installation Rate	Year of Bulb Purchase	Illinois TRM v2	Illinois TRM v3
Delta Watts	Year of Bulb Installation	Illinois TRM v4	Illinois TRM v4
Res/Non-Res Split	Year of Bulb Purchase	Illinois TRM v2	Illinois TRM v3
HOU and Peak CF	Year of Bulb Installation	Illinois TRM v4	Illinois TRM v4
Energy/Demand IE	Year of Bulb Installation	Illinois TRM v4	Illinois TRM v4
NTGR	Year of Bulb Purchase	PY6 Report	PY7 Report

Source: Evaluation team analysis

Table 7-9 shows that 2,898,922 bulbs sold through the program in PY6 or PY7 were estimated to have been installed in PY8. The number of PY6 bulbs installed in PY8 was calculated based on the third-year installation rate deemed in v2 of the Illinois TRM<sup>44</sup> and the number of PY7 bulbs installed in PY8 was calculated based on the second-year installation rate deemed in v3 of the Illinois TRM.<sup>45</sup>

<sup>44</sup> The Illinois TRM v2 (effective in PY6) was in place at the time the PY6 program bulbs were sold and govern the estimated installation rates for PY6 bulb sales.

<sup>45</sup> The Illinois TRM v3 (effective in PY7) was in place at the time the PY7 program bulbs were sold and govern the estimated installation rates for PY7 bulb sales.

**Table 7-9. PY8 Carryover Bulb Estimates**

Carryover Bulbs	Bulbs Sold in PY6	PY7 Bulbs Sold in PY7
Total Bulbs Sold	11,090,725	12,237,113
Installed During PY6	7,912,071	n/a
Installed During PY7	1,597,802	9,134,352
Installed During PY8	1,359,037	1,539,885
Installed During PY9	n/a	1,317,793
Total Installed	10,868,911	11,992,031
Lifetime Installation Rate	98%	98%

Source: Evaluation team analysis

Table 7-10 provides estimates of energy and demand savings in PY8 resulting from the delayed installation of PY6 and PY7 program bulbs.

**Table 7-10. PY8 Verified Savings Estimate for Carryover Bulbs**

PY8 Verified Savings Carryover Estimate	PY6 Program Bulbs	PY7 Program Bulbs	Total PY8 Carryover
Program Bulbs Installed During PY8	1,359,037	1,539,885	2,898,922
PY8 Carryover Gross Energy Savings (MWh)	46,442	49,210	95,652
PY8 Carryover Gross Demand Savings (MW)	44.6	49.6	94.2
PY8 Carryover Gross Summer Peak Demand Savings (MW)	5.4	5.5	10.9
PY8 Carryover Gross Winter Peak Demand Savings (MW)	6.2	6.5	12.7
Net-to-Gross Ratio	0.59	0.63	0.61
PY8 Carryover Net Energy Savings (MWh)	27,598	30,908	58,506
PY8 Carryover Net Demand Savings (MW)	26.0	31.1	57.1
PY8 Carryover Net Summer Peak Demand Savings (MW)	3.4	3.4	6.8
PY8 Carryover Net Winter Peak Demand Savings (MW)	3.6	4.1	7.7

Source: Evaluation team analysis

### 7.1.1 Evaluation Research Gross Program Impact Results

The total PY8 Residential Lighting program evaluation research gross savings is estimated to be 396,182 MWh, 380.9 MW, 47.2 summer peak MW and 49.9 winter peak MW. Table 7-11 shows evaluation research gross savings by portfolio (EEPS and IPA<sup>46</sup>) and overall, and presents the evaluation research gross realization rates<sup>47</sup> that are associated with these impact estimates.

<sup>46</sup> All PY7 program bulb sales are included in the EEPS portfolio.

<sup>47</sup> The evaluation research gross realization rates are equal to the evaluation research gross savings/verified savings gross estimate.

**Table 7-11. PY8 Evaluation Research Gross Impact Savings Estimates**

	IPA Portfolio	EEPS Portfolio	Total
<b>PY8 Evaluation Research Gross Savings</b>			
Gross MWh Savings	396,182	n/a	396,182
Gross MW Savings	380.9	n/a	380.9
Gross Summer Peak MW Savings	47.2	n/a	47.2
Gross Winter Peak MW Savings	59.9	n/a	59.9
<b>PY8 Evaluation Research Gross Savings Realization Rates</b>			
Gross MWh Savings	121%	n/a	121%
Gross MW Savings	106%	n/a	106%
Gross Summer Peak MW Savings	102%	n/a	102%
Gross Winter Peak MW Savings	103%	n/a	103%

Source: Evaluation team analysis

### 7.1.2 Evaluation Research Net Impact Findings

As shown in Table 7-12, the evaluation research NTGR in PY8 was 0.54 for standard CFLs, 0.58 for omni-directional LEDs, and 0.58 for directional LEDs. The final free ridership, spillover, and NTGR estimates differ from those reported in the PY8 NTG Results Memo delivered on January 29, 2016 because the estimates were reweighted using final PY8 bulb sales (allocated sales were used to weight the results reported in the NTG Results Memo).

**Table 7-12. NTGR by Bulb Type**

Bulb Type	Wt'd Free-Ridership	Spillover Part/Nonpart	Wt'd NTGR
Standard CFLs	0.47	0.004/0.010	0.54
Omni-Directional LEDs	0.49	0.009/0.058	0.58
Directional LEDs	0.45	0.009/0.026	0.58

Source: Evaluation team analysis

Table 7-13, compares the free-ridership, spillover and NTGR estimates for PY8 to those from the previous program years.

**Table 7-13. PY8 FR, Spillover, and NTGR Estimates Compared to Prior Program Years**

Net Impact Parameters	Population	PY2	PY3	PY4	PY5	PY6	PY7	PY8
Free-ridership	Standard CFLs	n/a	n/a	0.47	0.47	0.41	0.38	0.47
	Omni-directional LEDs	n/a	n/a	n/a	n/a	n/a	0.44	0.49
	Directional LEDs	n/a	n/a	n/a	n/a	n/a		0.45
Spillover	Standard CFLs	n/a	n/a	0.02	0.02	0.01	0.02	0.01
	Omni-directional LEDs	n/a	n/a	n/a	n/a	n/a	0.17	0.07
	Directional LEDs	n/a	n/a	n/a	n/a	n/a		0.03
NTGR	Standard CFLs	n/a	n/a	0.55	0.55	0.59	0.64	0.54
	Omni-directional LEDs	n/a	n/a	n/a	n/a	n/a	0.73	0.58
	Directional LEDs	n/a	n/a	n/a	n/a	n/a		0.58

Source: Evaluation team analysis

## 7.2 Detailed Process Findings

Details about the process evaluation methods, results, and findings are provided in the Process Evaluation memo which can be found in Section 7.6.4.

## 7.3 IL TRM Recommendations

As noted in previous evaluation reports, the evaluation team recommends updating a number of parameters in the Illinois TRM annually based on three-year rolling averages of the evaluation primary research based parameter estimates. It should be noted that including a three-year rolling average of research findings in the Illinois TRM reduces volatility that a single year of research could introduce and ensures that the most recent evaluation research estimates are being applied. However, if a significant change is made to the Residential Lighting program that would render the three-year rolling average inappropriate and justifiably warrants a change to the parameter estimate away from a three-year rolling average, this should be considered. The evaluation team’s recommended parameters for the IL TRM are shown in Table 7-14.

**Table 7-14. Impact Estimate Parameters for Future Use**

Parameter	Value	Data Source
Res/Non-Res Split	95%/5% Standard CFLs	3-year rolling average (PY6-PY8) of Evaluation Research Findings
	98%/2% Omni-Directional LEDs	2-year rolling average (PY7-PY8) of Evaluation Research Findings
	92%/8% Directional LED	
1 <sup>st</sup> Year Installation Rate	76.6% Standard CFL	3-year rolling average (PY6-PY8) of Evaluation Research Findings
	89.9% Omni-Directional LEDs	2-year rolling average (PY7-PY8) of Evaluation Research Findings
	93.5% Directional/Other LEDs	
Leakage	2.2% Standard CFL	3-year rolling average (PY6-PY8) of Evaluation Research Findings
	1.4% Omni-Directional LEDs	2-year rolling average (PY7-PY8) of Evaluation Research Findings
	2.2% Directional/Other LEDs	2-year rolling average (PY7-PY8) of Evaluation Research Findings

Source: Evaluation team analysis

In Illinois TRM v4.0, the res/non-res split is deemed at 96 percent/4 percent for standard CFLs “based on a weighted (by sales volume) average of ComEd PY4, PY5, and PY6 and Ameren PY5 and PY6 in-store intercept survey results.”<sup>48</sup> The TRM also recommends that if the installation location of an LED bulb is unknown then it should be classified as a residential bulb, which is guidance that results in all ComEd PY8 LEDs being classified as residential installs. The evaluation team recommends updating the deemed res/non-res split annually based on a rolling three-year average from the most recent evaluation research findings from ComEd and Ameren. It is not possible for the evaluation team at this time to estimate what the statewide deemed res/non-res split would be for Illinois TRM v5.0 (effective June 1, 2016 to correspond to ComEd PY9) due to the lack of Ameren IL data; however, the table below provides three years of evaluation research results for the ComEd program, which could be used to estimate the statewide assumption in the future. PY7 is the first year the evaluation team had enough data to estimate the res/non-res split by LED bulb type. This is shown in Table 7-15.

**Table 7-15. 3-Year Average Res/Non-Res Split for ComEd**

Program Year	Standard CFLs		Omni-directional LEDs		Directional LEDs	
	Bulbs	Res/NonRes	Bulbs	Res/NonRes	Bulbs	Res/NonRes
PY6	8,965,546	95% / 5%				
PY7	10,347,580	94% / 6%	471,710	98% / 2%	427,824	98% / 2%
PY8	7,205,656	98% / 2%	3,896,077	98% / 2%	1,578,687	90% / 10%
3-year Wtd Average	-	95% / 5%	-	98% / 2%		98% / 2%

Source: Evaluation team analysis

<sup>48</sup> Illinois TRM v3 at p. 576

The evaluation team recommends updating the deemed installation rates for CFLs annually based on a rolling three-year average from the most recent evaluation research findings (from both ComEd and Ameren IL when available). This insures the deemed installation rates are reflective of the most recent data available. It is not possible at this time to estimate the statewide deemed installation rate for the Illinois TRM due to the lack of Ameren IL data, however Table 7-16 provides three years of CFL evaluation research results and one year of LED evaluation research results for the ComEd program which can be used to estimate the statewide assumptions.

**Table 7-16. 3-Year Average Installation Rates for ComEd**

Program Year	Standard CFLs		Omni-directional LEDs		Directional LEDs	
	Bulbs	1 <sup>st</sup> Year ISR	Bulbs	1 <sup>st</sup> Year ISR	Bulbs	1 <sup>st</sup> Year ISR
PY6	8,965,546	72.6%	--	--	--	--
PY7	10,347,580	75.2%	471,710	95.0%	427,824	95.0%
PY8	7,205,656	83.6%	3,896,077	89.3%	1,578,687	93.1%
3-year Wtd Average	-	76.6%	-	89.9%	-	93.5%

Source: Evaluation team analysis

## 7.4 NTGR Recommendations

The NTGR for PY8 was deemed for bulbs sold through the IPA portfolio based on past evaluation research and approved through the IL SAG consensus process. Table 7-17 provides up to three years of evaluation research NTGR estimates (PY6-PY8) for standard CFLs and omni-directional and directional LEDs, as well as the two- or three-year weighted NTGR estimates which are available for future use.

**Table 7-17. Multi-Year Average NTGR Available for Future Use**

Program Year	Standard CFLs		Omni-Directional LEDs		Directional LEDs	
	Bulbs	NTGR	Bulbs	NTGR	Bulbs	NTGR
PY6	8,965,546	0.59	--	--	--	--
PY7	10,347,580	0.64	471,710	0.73	427,824	0.73
PY8	7,205,656	0.54	3,896,077	0.58	1,578,687	0.58
3-year Wtd Average	-	0.60	-	0.60	-	0.61 <sup>49</sup>

Source: Evaluation team analysis

Table 7-18 provides the NTGR Parameters available for deeming for future use, based on previous evaluation research.

<sup>49</sup> Only two years of results is available and thus this result is not a 3-year weighted average.

**Table 7-18. NTGR Parameters Available for Future Use**

Value	Data Source
0.54 Standard CFL	
0.58 Omni-directional LEDs	PY8 Evaluation Research Findings
0.58 Directional LEDs	

*Source: Evaluation team analysis*

## 7.5 PJM Data and Findings

ComEd Residential Lighting Program  
 Program Year 8 – June 2015 – May 2016  
 (In a separate memo)



## 7.6 Attachments

### *7.6.1 PY8 In-Store Intercept Survey Instrument*

**7.6.2 PY8 NTG Memo**

**7.6.3 PY8 Shelf Survey Memo**

**7.6.4 PY8 Process Memo**

*7.6.5 PY8 In-Store Intercepts Memo*

*7.6.6 PY8 Preliminary Impacts Memo*