



# ComEd Residential Lighting Discounts Impact Evaluation Report

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

Presented to  
Commonwealth Edison Company

**DRAFT**

*March 2, 2018*

***Prepared by:***

Amy Buege  
Itron, Consulting and Analysis

Ethan Barquest  
Itron, Consulting and Analysis



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



## ComEd Residential Lighting Discounts Impact Evaluation Report

### Submitted to:

ComEd  
Three Lincoln Centre  
Oakbrook Terrace, IL 60181

### Submitted by:

Navigant Consulting, Inc.  
150 N. Riverside, Suite 2100  
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  
Patrcia.Plympton@Navigant.com

Disclaimer: This report was prepared by Navigant Consulting, Inc. ("Navigant") for ComEd based upon information provided by ComEd and from other sources. Use of this report by any other party for whatever purpose should not, and does not, absolve such party from using due diligence in verifying the report's contents. Neither Navigant nor any of its subsidiaries or affiliates assumes any liability or duty of care to such parties, and hereby disclaims any such liability.

## TABLE OF CONTENTS

1. Introduction .....	1
2. Program Description .....	1
3. Program Savings.....	2
4. Program Savings by Measure.....	3
5. Impact Analysis Findings and Recommendations .....	5
5.1 Impact Parameter Estimates.....	5
5.2 Other Impact Findings and Recommendations.....	7
6. Appendix 1. Impact Analysis Methodology .....	7
6.1 Verified Gross Program Savings Analysis Approach Estimates.....	7
6.2 Verified Net Program Savings Analysis Approach.....	7
7. Appendix 2. Impact Analysis Detail.....	7
7.1 Program Volumetric Detail .....	7
7.2 Differences in Evaluation Methods .....	8
7.2.1 Differences in Parameter Values.....	8
7.2.2 Application of Residential and Non-Residential splits .....	9
8. Appendix 3. TRC Detail.....	9

## LIST OF TABLES AND FIGURES

Figure 2-1. Distribution of PY9 Measures Sold by Type* .....	2
Table 2-1. PY9 Volumetric Findings Detail .....	1
Table 3-1. PY9 Total Annual Incremental Savings .....	2
Table 3-2. PY9 Total Annual Incremental EEPS Savings .....	2
Table 3-3. PY9 Total Annual Incremental IPA Savings .....	3
Table 3-4. PY9 Total Annual Incremental Savings, Carryover Broken Out.....	3
Table 4-1. PY9 Energy Savings by Measure .....	4
Table 4-2. PY9 Demand Savings by Measure.....	4
Table 4-3. PY9 Summer Peak Demand Savings by Measure.....	5
Table 4-4. PY9 Winter Peak Demand Savings by Measure .....	5
Table 5-1. Verified Gross Savings Parameters.....	6
Table 7-1. PY3 – PY9 Volumetric Findings Detail .....	8
Table 7-2. PY9 Ex-Ante vs Verified Parameter Values When Different .....	8

## 1. INTRODUCTION

This report presents the results of the impact evaluation of ComEd's PY9 Residential Lighting Discounts Program. It presents a summary of the energy and demand impacts for the total program and broken out by relevant measure and program structure details. PY9 covers June 1, 2016 through December 31, 2017.

## 2. PROGRAM DESCRIPTION

The primary goal of this program is to increase the market penetration of energy-efficient lighting within ComEd's service territory by providing 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 PY9, the Residential Lighting Discounts Program offered incentives for the purchase of standard compact fluorescent lamps (CFLs), standard, reflector and specialty LEDs, and LED fixtures.

The PY9 program incentivized just over 20 million high efficiency lamps and fixtures. This included 2,625,479 standard CFLs, 11,905,275 omni-directional LEDs, 3,309,608 directional LEDs, 1,388,782 specialty LEDs, and 831,268 LED fixtures as shown in the following table and figure. While not all these bulbs were installed in PY9 (the TRM deems installation rates for years one, two and three), the overall quantity of bulbs installed in PY9 (20,901,070) exceeded the number of bulbs sold in PY9 due to the addition of carryover installations from bulbs sold in PY7 and PY8.

**Table 2-1. PY9 Volumetric Findings Detail**

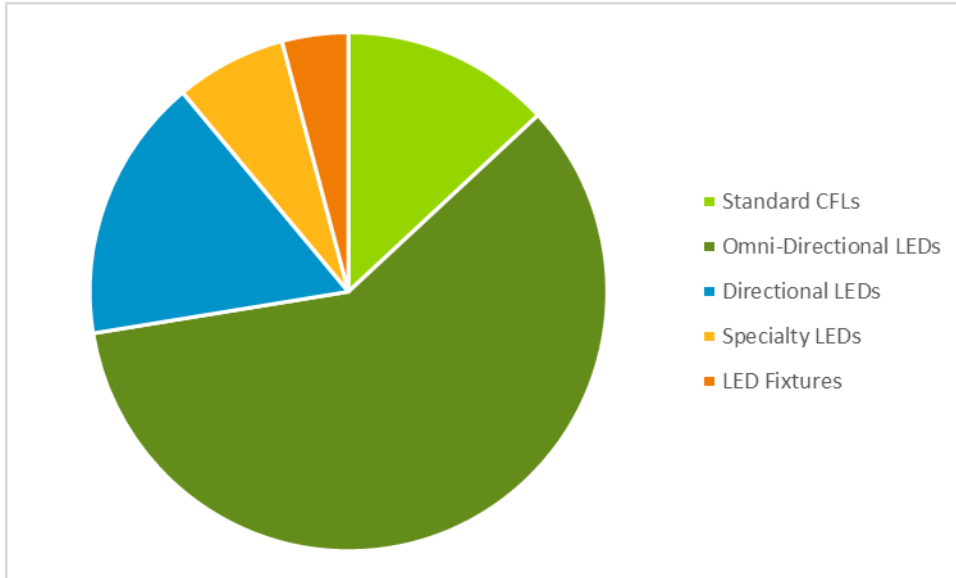
Participation	Total	Standard CFLs	Omni-Directional LEDs	Directional LEDs	Specialty LEDs	LED Fixtures
PY9 Incentivized Bulbs	20,060,412	2,625,479	11,905,275	3,309,608	1,388,782	831,268
PY9 1st Year Installed Bulbs	18,527,719	1,919,750	11,313,345	3,145,054	1,319,732	829,838
PY7 Carryover – PY9 Installs	1,317,793	1,298,595*	13,208	5,990	0	0
PY8 Carryover – PY9 Installs	1,055,558	968,728	61,792	25,038	†	0
Total Installed Bulbs in PY9	20,901,070	4,187,073	11,388,345	3,176,082	1,319,732	829,838

Source: ComEd tracking data and Navigant team analysis.

\*PY7 carryover - The standard CFL quantity includes specialty CFLs sold in PY7.

† PY8 carryover – The directional LED category includes specialty LEDs sold in PY8 as they were not broken out in previous years.

**Figure 2-1. Distribution of PY9 Measures Sold by Type\***



Source: Evaluation Analysis  
 \* Excluding PY9 carryover

### 3. PROGRAM SAVINGS

Table 3-1 summarizes the incremental energy and demand savings the Residential Lighting Discounts Program achieved in PY9.

**Table 3-1. PY9 Total Annual Incremental Savings**

Savings Category	Energy Savings (MWh)	Demand Savings (MW)	Peak Demand Savings (MW)
Ex Ante Gross Savings	832,334	NR	NR
Program Gross Realization Rate	99.5%	N/A	N/A
Verified Gross Savings	828,200	795.8	96.7
Program Net-to-Gross Ratio (NTGR)	0.60	0.60	0.60
Verified Net Savings	494,484	474.9	57.8

Source: ComEd tracking data and Navigant team analysis.

**Table 3-2. PY9 Total Annual Incremental EEPS Savings**

Savings Category	Energy Savings (MWh)	Demand Savings (MW)	Peak Demand Savings (MW)
Ex Ante Gross Savings	48,888	NR	NR
Program Gross Realization Rate	100%	N/A	N/A
Verified Gross Savings	48,888	49.6	5.3
Program Net-to-Gross Ratio (NTGR)	0.63	0.63	0.63
Verified Net Savings	30,707	31.1	3.3

Source: ComEd tracking data and Navigant team analysis.

**Table 3-3. PY9 Total Annual Incremental IPA Savings**

Savings Category	Energy Savings (MWh)	Demand Savings (MW)	Peak Demand Savings (MW)
Ex Ante Gross Savings	783,446	NR	NR
Program Gross Realization Rate	99%	N/A	N/A
Verified Gross Savings	779,312	746.2	91.4
Program Net-to-Gross Ratio (NTGR)	0.60	0.59	0.60
Verified Net Savings	463,776	443.8	54.5

Source: ComEd tracking data and Navigant team analysis.

**Table 3-4. PY9 Total Annual Incremental Savings, Carryover Broken Out**

Savings Category	Energy Savings (MWh)	Demand Savings (MW)	Summer Peak Demand Savings (MW)	Winter Peak Demand Savings (MW)
Ex Ante Gross Savings w/ ISR and WHF	749,049	NR	NR	NR
Ex Ante Gross Carryover - PY7 EEPS	48,888	NR	NR	NR
Ex Ante Gross Carryover - PY8 IPA	34,397	NR	NR	NR
Ex Ante Total Gross	832,334	NR	NR	NR
Program Gross Realization Rate	99.5%	NR	NR	NR
Verified Gross Program Savings - PY9 sales	744,915	713	87	115
Verified Gross Carryover Savings - PY7 EEPS	48,888	49.6	5.3	6.3
Verified Gross Carryover Savings - PY8 IPA	34,397	33.4	4	4.4
Verified Gross Savings	828,200	795.8	96.7	126.0
Program Net-to-Gross Ratio (NTGR)	0.60	0.60	0.60	0.60
Verified Net Program Savings	443,020	423.6	52.1	68.6
Verified Net Carryover Savings - PY7 EEPS	30,707	31.1	3.3	4.0
Verified Net Carryover Savings - PY8 IPA	20,756	20.2	2.4	2.7
Verified Net Savings	494,484	474.9	57.8	75.2

Source: ComEd tracking data and Navigant team analysis.

## 4. PROGRAM SAVINGS BY MEASURE

The program includes five lighting measures as shown in the following table. The standard LED and directional LED measures contributed the most savings. This table also shows carryover savings resulting from bulbs purchased in PY7 and PY8 but installed in PY9.

**Table 4-1. PY9 Energy Savings by Measure**

Enduse Type	Research Category	Ex Ante Gross Savings (MWh)	Verified Gross Realization Rate	Verified Gross Savings (MWh)	NTGR *	Verified Net Savings (MWh)	Technical Measure Life	Persistence	Effective Useful Life (EUL)†
Lighting	Standard CFL	60,152	98%	58,991	0.57	33,625	4.9	N/A	4.9
Lighting	Standard LED	405,204	99%	403,106	0.58	233,801	9.8	N/A	9.8
Lighting	Directional LED	176,419	101%	177,701	0.60	106,621	9.9	N/A	9.9
Lighting	Specialty LED	59,925	100%	59,707	0.60	35,824	9.8	N/A	9.8
Lighting	LED Fixtures	47,349	96%	45,409	0.73	33,149	10.1	N/A	10.1
Lighting	Carryover	83,285	100%	83,286	0.62	51,464	N/A	N/A	N/A
	Total	832,334	100%	828,200	0.60	494,484	N/A	N/A	N/A

Source: ComEd tracking data and Navigant team analysis.

\* A deemed value. Source: ComEd\_NTG\_History\_and\_PY9\_Recommendations\_2016-02-26\_Final.xlsx, which is to be found on the IL SAG web site here: <http://ilsag.info/net-to-gross-framework.html>.

† EUL is a combination of technical measure life and persistence.

**Table 4-2. PY9 Demand Savings by Measure**

Enduse Type	Research Category	Ex Ante Gross Demand Reduction (MW)	Verified Gross Realization Rate	Verified Gross Demand Reduction (MW)	NTGR*	Verified Net Demand Reduction (MW)
Lighting	Standard CFL	NR†	N/A	58.1	0.57	33.1
Lighting	Standard LED	NR	N/A	395.1	0.58	229.2
Lighting	Directional LED	NR	N/A	166.9	0.60	100.1
Lighting	Specialty LED	NR	N/A	50.4	0.60	30.3
Lighting	LED Fixtures	NR	N/A	42.4	0.73	30.9
Lighting	Carryover	NR	N/A	83.0	0.62	51.3
	Total	NR	N/A	795.8	0.60	474.9

Source: ComEd tracking data and Navigant team analysis.

\* A deemed value. Source: ComEd\_NTG\_History\_and\_PY9\_Recommendations\_2016-02-26\_Final.xlsx, which is to be found on the IL SAG web site here: <http://ilsag.info/net-to-gross-framework.html>.

† NR = "Not Reported", as only ex ante savings are reported in the Lighting Discounts tracking data.

**Table 4-3. PY9 Summer Peak Demand Savings by Measure**

Enduse Type	Research Category	Ex Ante Gross Peak Demand Reduction (MW)	Verified Gross Realization Rate	Verified Gross Peak Demand Reduction (MW)	NTGR*	Verified Peak Net Demand Reduction (MW)
Lighting	Standard CFL	NR†	N/A	6.2	0.57	3.5
Lighting	Standard LED	NR	N/A	46.6	0.58	27.1
Lighting	Directional LED	NR	N/A	22.0	0.60	13.2
Lighting	Specialty LED	NR	N/A	7.2	0.60	4.3
Lighting	LED Fixtures	NR	N/A	5.4	0.73	4.0
Lighting	Carryover	NR	N/A	9.3	0.62	5.8
	Total	NR	N/A	96.7	0.60	57.8

Source: ComEd tracking data and Navigant team analysis.

\* A deemed value. Source: ComEd\_NTG\_History\_and\_PY9\_Recommendations\_2016-02-26\_Final.xlsx, which is to be found on the IL SAG web site here: <http://ilsag.info/net-to-gross-framework.html>.

† NR = "Not Reported", as only ex ante savings are reported in the Lighting Discounts tracking data.

**Table 4-4. PY9 Winter Peak Demand Savings by Measure**

Enduse Type	Research Category	Ex Ante Gross Peak Demand Reduction (MW)	Verified Gross Realization Rate	Verified Gross Peak Demand Reduction (MW)	NTGR*	Verified Peak Net Demand Reduction (MW)
Lighting	Standard CFL	NR†	N/A	8.9	0.57	5.1
Lighting	Standard LED	NR	N/A	60.7	0.58	35.2
Lighting	Directional LED	NR	N/A	28.8	0.60	17.3
Lighting	Specialty LED	NR	N/A	9.6	0.60	5.8
Lighting	LED Fixtures	NR	N/A	7.3	0.73	5.3
Lighting	Carryover	NR	N/A	10.7	0.62	6.6
	Total	NR	N/A	126.0	0.60	75.2

Source: ComEd tracking data and Navigant team analysis.

\* A deemed value. Source: ComEd\_NTG\_History\_and\_PY9\_Recommendations\_2016-02-26\_Final.xlsx, which is to be found on the IL SAG web site here: <http://ilsag.info/net-to-gross-framework.html>.

† NR = "Not Reported", as only ex ante savings are reported in the Lighting Discounts tracking data.

## 5. IMPACT ANALYSIS FINDINGS AND RECOMMENDATIONS

### 5.1 Impact Parameter Estimates

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

**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 \* IEed

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

**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>1</sup>
- IEd = Demand Interactive Effects (applied to summer Peak kW estimates only<sup>2</sup>)

The lifetime energy and demand savings are estimated by multiplying the verified savings by the effective useful life for each measure.

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

**Table 5-1. Verified Gross Savings Parameters**

Verified Savings Parameters	Deemed* or Evaluated?
Program Bulbs	Evaluated
Delta Watts	Deemed
Installation Rate	Deemed
Leakage	Evaluated
Res / Non-Res Split	Deemed
Hours of Use (HOU)	Deemed
Summer Peak Coincidence Factor (CF)	Deemed
Winter Peak Coincidence Factor (CF)	Evaluated
Energy Interactive Effects	Deemed
Demand Interactive Effects	Deemed
NTGR†	Deemed

\* State of Illinois Technical Reference Manual version 2.0 from <http://www.ilsag.info/technical-reference-manual.html>.

† NTGR Source: ComEd\_NTG\_History\_and\_PY9\_Recommendations\_2016-02-26\_Final.xlsx, found on the IL SAG web site.

The evaluation team determined the overall PY9 gross energy (kWh) realization rate of 99.5%. The small difference between the ex ante claimed savings and the verified savings resulted from a few minor discrepancies between the ex ante parameters that were applied and the parameters the evaluation team believes should have been applied in accordance with the IL TRM v5. Table 7-2 lists these discrepancies. An additional difference stemmed from the method in which the residential/nonresidential split was applied, essentially an “order of operations” issue that led to a small difference in the resulting savings estimates. The ex ante savings were calculated by applying residential/nonresidential “blended” parameter estimates, whereas the verified savings were calculated by applying distinct residential and non-residential parameter values and then the final residential and non-residential savings estimates were combined using the residential/nonresidential split as a weight. Further detail on this is provided in

<sup>1</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>2</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.

Section 7.2.2. As the 99.5% realization rate indicates, the magnitude of these differences was extremely small.

## 5.2 Other Impact Findings and Recommendations

The evaluation research findings and recommendations (based on the PY9 primary data collection activities) are provided in separate memos.

## 6. APPENDIX 1. IMPACT ANALYSIS METHODOLOGY

### 6.1 Verified Gross Program Savings Analysis Approach Estimates

The evaluation team calculated verified savings by measure for measures with available data. For PY9, the evaluation team calculated verified savings for standard CFLs, omni-directional LEDs, directional LEDs, specialty LEDs, and LED fixtures. The data used to estimate the verified gross program savings came from the PY9 program tracking data<sup>3</sup>, the Illinois Statewide Technical Reference Manual for Energy Efficiency Version 5.0 (Illinois TRM v5), and PY9 in-store intercept surveys.

### 6.2 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 PY9, the NTGR estimates were 0.57 for standard CFLs, 0.58 for Standard LEDs, 0.6 for specialty and directional LEDs, and 0.73 for LED fixtures. These NTGR estimates were based on past evaluation research and approved through the Illinois Stakeholder Advisory Group (IL SAG) consensus process.

## 7. APPENDIX 2. IMPACT ANALYSIS DETAIL

### 7.1 Program Volumetric Detail

The total number of bulbs sold during the PY9 Residential Lighting Discounts Program is estimated to be 20,060,412, which is a 55 percent increase from the bulbs sold in the eighth program year (PY8), however PY9 was an 18-month program year and with normalization, the increase is three percent. In PY9, the shift in sales to LEDs from CFLs continued and CFLs were discontinued from the program in March of 2017. The remainder of the changes from PY8 to PY9 presented below are on the 12-month "normalized" sales numbers. Thirteen percent of the bulbs sold in PY9 were standard CFLs compared to 56 percent in PY8, 59 percent were omni-directional LEDs compared to 30 percent in PY8, 23 percent were directional or specialty LEDs compared to 12 percent in PY8, and four percent were LED fixtures compared to two percent in PY8. Table 7-1 shows the volume of bulbs, by bulb type, incentivized through the Residential Lighting Discounts program in PY3 through PY9.

<sup>3</sup> The Evaluation Team received the final PY9 tracking data on February 14, 2018: Res\_Lighting\_PY9\_EOY\_Evaluation\_Data\_Rev3\_02142018.xlsx.

**Table 7-1. PY3 – PY9 Volumetric Findings Detail**

Program Year	Standard CFLs	Specialty CFLs	CFL Fixtures	LED Omni-Dir	LED Dir	LED Specialty	LED Fixtures	Coupons	Total
PY9 Sales	2,625,479	0	0	11,905,275	3,309,608	1,388,782	831,268	0	20,060,412
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.  
Prior to PY9 LED specialty bulbs were included in the LED Directional category.

## 7.2 Differences in Evaluation Methods

### 7.2.1 Differences in Parameter Values

Differences between the PY9 ex ante and verified gross savings parameters are shown in the following table. It is these differences, along with the application of the residential and nonresidential split described in the section below that led to RR that were slightly less than 100%.

**Table 7-2. PY9 Ex-Ante vs Verified Parameter Values When Different**

Gross Impact Parameters	Measure	PY9 Ex Ante	PY9 Verified
Leakage	All Measures	NR	2.2%
Hours of Use (HOU)*	Res LED Fixtures - Interior	882	891
	Res LED Fixtures - Exterior	2465	2475
Interactive Effects (IE)	Energy – Res Exterior Fixtures	1.06	1
	Demand - Non-Res Exterior Fixtures	1.36	1
Summer Peak Coincidence Factor (Summer Peak CF) <sup>4</sup>	Res Standard CFLs	NR	0.071
	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 Interior Fixtures	NR	0.091
	Res LED Exterior Fixtures	NR	0.273
	Non-Res All Measures – Excluding Exterior Fixtures	NR	0.58
Non-Res Exterior Fixtures	NR	0	

<sup>4</sup> The evaluation team recommends that ComEd use the Summer Peak Coincidence Factors in this table for Residential Lighting, dated 2/2/2015.

Gross Impact Parameters	Measure	PY9 Ex Ante	PY9 Verified
Winter Peak Coincidence Factor (Winter Peak CF) <sup>5</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 and Exterior	NR	0.134
	Non-Res All Measures – Excluding Exterior Fixtures	NR	0.55
	Non-Res Exterior Fixtures	NR	0

\* Ex Ante Values are reported as a weighted value based on the residential and nonresidential split. Res HOU Ex Ante values were calculated using an assumed nonres HOU of 3612. The actual res ex ante HOU values used may be slightly different.

‡ State of Illinois Technical Reference Manual version 5 from <http://www.ilsag.info/technical-reference-manual.html>.

NR = Not Reported

### 7.2.2 Application of Residential and Non-Residential splits

As part of calculating savings for the residential lighting program, four percent of lamps sold in the upstream program are assumed to be installed in non-residential locations. Ex Ante savings values are calculated using blended savings parameters based on the 96%/4% split of program lamps in residential and non-residential spaces. These blended values are then used for in a single equation to calculate Ex Ante value. As we've spoken with ComEd about in past years, this method presents a mathematical order of operations issue, and thus a more accurate way to calculate savings from lamps installed in residential and non-residential locations is to calculate residential and non-residential savings separately and then combine the savings using the 96%/4% split. The evaluation team applied the latter method in determining program impacts and which also led to a non-100% RR (although the magnitude of this application of the residential and nonresidential split is very small).

## 8. APPENDIX 3. TRC DETAIL

[We will add this section in the second draft.]

<sup>5</sup> The evaluation team recommends that ComEd use the Winter Peak Coincidence Factors in this table for Residential Lighting, dated 2/2/2015.