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Impact and Process Evaluation of the 2015 Illinois Power Agency Residential Lighting Program

Final

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CADMUS

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Table of Contents

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Table of Tables

Table of Figures

1. Executive Summary

The aim of the Illinois Power Agency (IPA) Residential Lighting Program is the eventual transformation of the residential lighting market in Ameren Illinois Company (AIC) territory. The objective of the program is to increase residential customers' awareness and use of ENERGY STAR® (ES) lighting products by providing discounts and by undertaking marketing and outreach efforts at participating retailers and community events and on the AIC website. The discounts offered by the program and its retail and manufacturing partners bring the cost of ES lighting closer to that of less-efficient options. They encourage customers who are reluctant to pay full price for ES lighting to choose energy-efficient over standard lighting. During its 8 years, the program has discounted 24,672,057 energy-efficient light bulbs and fixtures. The Residential Lighting Program is implemented by CLEAResult and Energy Federation, Incorporated (EFI).

This report presents the results of Opinion Dynamics's evaluation of the Residential Lighting Program during its eighth year of operation (Program Year 8 [PY8]), which ran from June 2015 to May 2016.

Program Impacts

The Residential Lighting Program sold a total of 3,544,171 bulbs in PY8 at participating retail stores. While exceeding all of it PY8 goals for bulb sales and energy savings, this reflects a 13% decrease from PY7. While a large majority of bulbs sold were standard CFLs (80%), the program drastically boosted sales of LEDs from less than 1% in previous years to 20% of bulbs sold in PY8. Table 1 shows bulb sales by shape and technology.

Table 1. Residential Lighting Program Bulb Sales by Type

Bulb Type	Bulbs Sold	Percentage of Total Sales
CFL Standard	2,838,498	80%
LED Omnidirectional	612,346	17%
LED Downlights	93,327	3%
Total	**3,544,171**	**100%**

The carryover savings method outlined in the Illinois Statewide Technical Reference Manual for Energy Efficiency Version 4.0 (IL-TRM V4.0) spreads program savings across the 3 years that customers take to install all of the bulbs that they purchase. As a result, PY8 savings come from bulbs *installed* in PY8 but that could have been *purchased* in PY6, PY7, or PY8. As shown in Table 2, the program achieved a net energy impact of 76,783 MWh and a net demand impact of 9.76 MW.

Table 2. PY8 Residential Lighting Program Net Impacts

	Ex Ante Gross	Realization Rate	Ex Post Gross	Net-to-Gross Ratio (NTGR)	Ex Post Net
Energy Savings (MWh)					
Total MWh	N/A	N/A	127,688	0.63/0.73[a] 0.47[b]	76,783
Demand Savings (MW)					
Total MW	N/A	N/A	16.2	0.63/0.73[a] 0.47[b]	9.76

Note: Program staff provided only ex ante net savings.
[a] NTGR = 0.63 for CFLs and 0.73 for LEDs for PY8 purchases installed in PY8.
[b] NTGR = 0.47 for all PY6 and PY7 purchases installed in PY8.

Program implementers track progress toward their net savings goals using per-unit values for each product type discounted through the program. We applied these net per-unit values to bulb quantities in the sales data extract to represent ex ante net kWh savings. Program implementers also tracked gross energy and demand savings using TRM-based assumptions for internal purposes but did not use these estimates as the official measure of progress towards program goals. The TRM-based formulas produce different saving estimates than the per-unit method. For consistency purposes and because official program goals were based on savings estimated using per-unit values, we use per-unit savings to represent ex ante savings. The program did not have gross energy or demand per-unit values; therefore, it was not possible for us to calculate gross and demand realization rates as part of this evaluation.

Key Findings and Recommendations

The Residential Lighting Program ran smoothly in PY8, exceeding all of its goals for bulb sales and energy savings. Total bulb sales decreased by 13% from PY7 as the program shifted its focus toward LED products, which are generally more expensive and require larger discounts than their CFL counterparts. Still, the more-efficient LED technology typically yields slightly more savings per bulb, which helps compensate for the decrease in total sales. The shift resulted in the program boosting sales of LEDs from less than 1% in previous years to 20% of bulbs sold in PY8. The types of LEDs were also diversified to include downlights and other shapes besides A-lamp.

Based on the results of the PY8 Residential Lighting Evaluation, the evaluation team offer the following key findings and recommendations for the program moving forward:

- **Key Finding #1:** Our stocking study and in-store intercept results indicate that the lighting market is transforming and moving away from CFLs to LEDs. LEDs are the most common product on retailer shelves and more customers purchased LEDs than any other light bulb technology. LEDs are the most prominent technology and are taking up shelf space formerly occupied by CFLs as well as incandescents. Results from our in-store interviews show that 62% of customers purchased at least one energy-efficient bulb (CFL or LED), and 42% purchased at least one less-efficient bulb (incandescent or halogen). A greater percentage of customers purchased an LED than any other bulb type (36%).

  - **Recommendation:** Although the lighting market is transforming and shifting to LEDs, it is important to continue discounts for LEDs given the presence of less efficient halogens and lower quality LEDs. Customers are willing to pay a somewhat higher price for LEDs, but they are also attracted to lower-cost, lower-quality LEDs. The new ES 2.0 standards, which go into effect January 2017, lower the requirements for LEDs to be ES certified. As a result, costs of ES LEDs should drop and help push some of the low-quality products off retailer shelves. However, it is not yet clear that will happen, or whether retailers will still reserve shelf space for non-ES bulbs that undercut ES bulb pricing. LED discounts are important to continue the transformation of the lighting market. Quality is a concern for market transformation to continue. Many consumers had a bad experience with the first generation of CFLs, which slowed adoption. The program could help ensure that there is not a repeat experience with LEDs and continued discounts on ES LEDs will help.

    While it is important to continue LED discounts, as the lighting market continues to transform, the program may need to consider transitioning from a mass market approach that discounts every bulb type to one that targets customers who lag behind in efficient bulb use. Program administrators discontinued the online store after PY7 but may want to consider bringing it back and target marketing the store to select customers. The evaluation team is currently conducting a

lighting penetration and saturation study that will provide results that could help select customer types to target.

- **Key Finding #2.** The LED specialty market lags behind the standard market. Low-cost, less-efficient specialty bulbs are more readily available and consumers are more likely to purchase them. Though specialty LEDs are increasingly available (42% of specialty products were LEDs in PY8 compared to 21% in PY6) the majority of customers still buy less-efficient bulbs (i.e., incandescents and halogens). In fact, we found through our in-store intercepts that customers purchased less efficient specialty bulbs at a higher rate in PY8 than in PY6 (74% compared to 65%). Our stocking study results show that the specialty market is still a challenging one in terms of price. Without program discounts, quality specialty LEDs were much more expensive in PY8 than less-efficient products, CFLs, or lower-quality LEDs.
  - **Recommendation:** The program should increase its focus on specialty LEDs. ES specialty LEDs cost significantly more than less-efficient bulbs or low-quality specialty LEDs and without program discounts, customers will continue to purchase these low cost alternatives. Program administrators should consider more-aggressive goals for specialty bulbs.
- **Key Finding #3:** The contract between AIC and the program implementer sets net savings goals using per-unit values for different bulb types. It was not clear how these per-unit values were determined. Our evaluated per-unit values ended up being greater than those used to set program goals. However, this may not be the case in future years.
  - **Recommendation:** To ensure greater certainty when planning, we recommend that the program implementer work with the evaluation team to develop per-unit values based on TRM assumptions.

2. Evaluation Approach

2.1 Research Objectives

The main research objectives of the PY8 evaluation were to estimate gross and net program savings and to assess program processes. In Section 2, we describe the details and logic behind our PY8 evaluation tasks. We designed these tasks to answer the following research questions:

Impact-related research questions:

1. What were the estimated gross energy and demand savings from this program?
2. What were estimated net energy and demand savings from this program?
3. What was the estimated impact of the program on energy-efficient lighting purchases? How many customers would have purchased a less-efficient bulb if the program had not discounted bulbs?
4. What was participant spillover from the program? How many customers purchased non-discounted energy-efficient bulbs due to the program?
5. What percentage of bulbs were purchased by non-AIC customers? What percentage of bulbs were purchased for use in commercial settings?

Process-related research questions:

1. Did the program change its design in PY8? If so, how and why and were those changes advantageous?
2. Was program implementation effective and smooth?
3. What screw-in lighting products were available for AIC customers to purchase? How has this changed over time? What was the availability of less-efficient lighting products compared to efficient products (i.e., incandescent and 2007 Energy Independence and Security Act [EISA]-compliant halogen bulbs versus CFLs and LEDs)? How does the pricing of efficient products compare to the pricing of less-efficient products?
4. What types of bulbs do AIC customers purchase? What is the market share for the different bulb technologies in the presence of program discounts?
5. How well is the program promoted at participating stores? Are customers aware of the discounts?
6. In what areas could the program improve to increase its overall effectiveness? What could the program do to assist customers in understanding energy-efficient lighting options and how to achieve higher energy savings?

2.2 Evaluation Tasks

Table 3 summarizes the evaluation tasks that we conducted for PY8, which are described in detail below.

Table 3. Summary of IPA Residential Lighting Program Evaluation Activities for PY8

Activity	PY8 Impact	PY8 Process	Forward Looking	Details
Program Staff In-Depth Interviews	✓	✓	✓	Conducted two interviews with program staff to gain detailed information on the step-by-step operational conditions and implementation efforts to gain an understanding of program design and delivery.
Program Data Review	✓			Verified program-reported savings.
Program Materials Review		✓		Reviewed program implementation plan and marketing and outreach materials.
In-Store Customer Intercept Interviews	✓	✓	✓	Interviewed 853 customers purchasing lighting products at 25 participating retail stores. Asked questions used to estimate program free-ridership (FR), spillover, leakage, and residential versus commercial usage of program lighting. Also used the interviews to assess lighting preferences, barriers to ES lighting purchases, and program awareness and satisfaction.
Lighting Shelf-Stocking Study	✓	✓	✓	Conducted a stocking study of lighting products on shelves at 10 participating retail locations to collect information on lighting product availability and pricing and the presence of marketing materials in stores.

2.2.1 Program Staff In-Depth Interviews

We conducted two in-depth interviews with staff involved in the management and implementation of the Residential Lighting Program. We conducted an interview with the AIC staff member who oversees the Residential Lighting Program and an interview with the program manager at CLEAResult, which implements the program. We used structured interview questions to guide the interviews in which we asked staff about their roles and responsibilities, program goals, marketing, data management, and quality assurance practices.

2.2.2 Review of Program Data and Materials

The evaluation team conducted an extensive review of all available program data and materials, including marketing materials, field reports, and tracking databases.

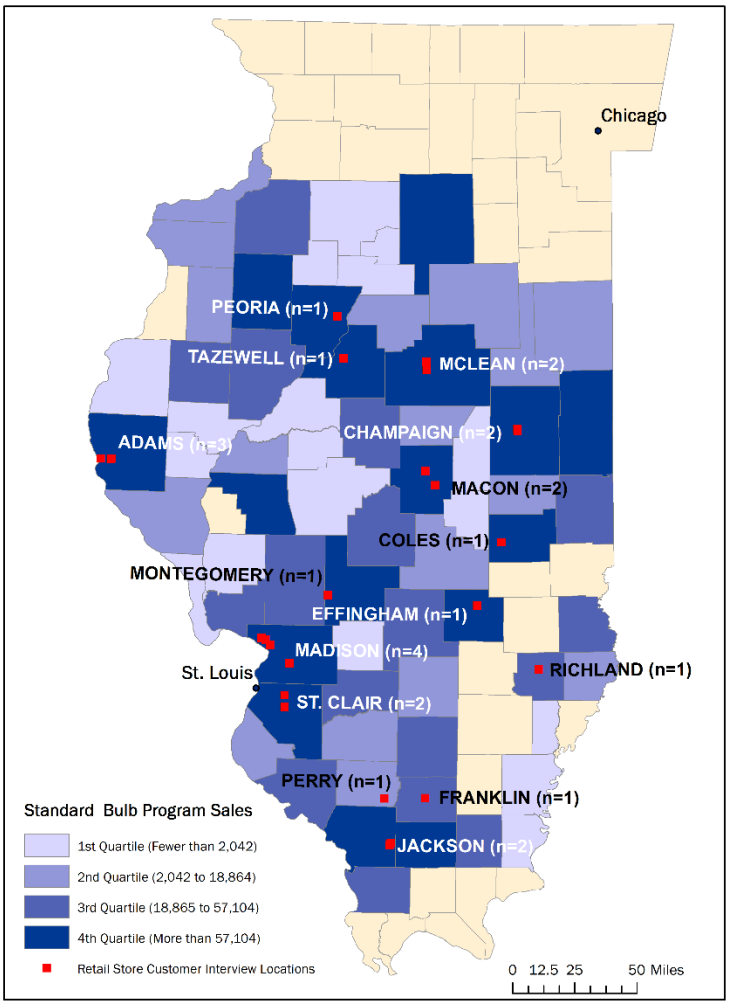
2.2.3 In-Store Customer Intercept Interviews

Evaluators conducted interviews with 853 customers purchasing lighting at 25 participating retail locations between February and April 2016, spending 3 days at each location. Interviews took place at a selection of do-it-yourself (DIY), warehouse, and big box retailers.[1] We had to use a convenience sample of stores for budgetary reasons and to ensure that retailers would allow access to their customers. The selection of customers was not random. Despite these constraints, we selected a sample of stores that represented a large percentage of program sales and customers across AIC territory.

[1] Together, these retailers accounted for 69% of all bulbs sold.

Figure 1 shows intercept locations and the number of bulbs sold in each county in AIC territory. Our sample stores are located in counties where the most program bulbs were sold.

Figure 1. In-Store Customer Interview Locations



To gain entry to the stores, we accompanied the program field representative who was conducting a lighting demonstration. The program representative helped the interviewer gain permission to return to the store and conduct additional interviews in the 2 days following the in-store demo. We conducted 20% of the interviews during in-store demonstrations. Because such demonstrations alter the shopping environment and purchases during the demonstrations may not be representative of customer purchases throughout the year, we report the results separately for demonstration and non-demonstration hours, where appropriate. We conducted interviews on the days of the week and during hours when residential customers are more likely to shop: Fridays, Saturdays, Sundays, and Mondays between 9 am and 5 pm. We attempted to interview all customers purchasing lighting, including CFLs and LEDs discounted through the program, CFLs and LEDs not discounted, and incandescent and halogen light bulbs.

We instructed the field interviewers to station themselves in the lighting aisle of the store and to approach customers after they had made their purchase decision and were preparing to leave the aisle. Interviewers asked customers to complete a short survey in exchange for a $10 gift card to that particular retail store that

they could use that day. Interviewers recorded customers' answers using an electronic tablet. We asked only questions that were relevant to the types of bulbs customers were purchasing.

Table 4 contains a summary of the total number of completed intercept interviews by store type and the number of storefronts associated with each store type in which we completed intercept interviews. The 25 retail locations where we completed interviews sold 17% of all bulbs discounted through the program.

Table 4. Completed In-Store Intercept Interviews by Store Type

Store Type	Locations	Completed Interviews
Big Box	15	501
DIY	7	280
Warehouse	3	72
Total	**25**	**853**

One of the objectives of the study was to estimate the percentage of program-discounted bulbs that were sold to non-AIC customers, so the sample store locations were an important factor to consider during store selection. We considered the stores' locations relative to the border of AIC territory and attempted to select stores that were representative of the locations of the overall population of participating stores. Due to the multiple factors that we had to consider when selecting stores, the locations and sales of the final sample of stores is slightly different from the overall population. We applied a location-based weight when estimating leakage so that our sample matches the overall population of bulb sales. Table 5 compares the locations and sales of the 25 stores where we conducted intercepts with all participating stores.

Table 5. Retailer Distance from Non-AIC Territory

Distance from AIC Territory Boundary	Intercept Stores	All Participating Stores		
	% of Stores	% of Bulb Sales	% of Stores	% of Bulb Sales
Within 5 miles	48%	47%	42%	40%
5–10 miles	28%	29%	27%	27%
10–15 miles	16%	16%	21%	26%
15+ miles	8%	7%	10%	7%
Total	**100%**	**100%**	**100%**	**100%**

2.2.4 Lighting Shelf-Stocking Study

We conducted a lighting shelf-stocking study at 10 of the 25 stores where we interviewed customers. We conducted two shelf studies at each of the five retailers that were part of the study. We completed the inventory on the first of the 3 days on-site while the in-store demonstration event was taking place.

For each lighting product discounted through the program or that could be purchased instead of a discounted product, we recorded a number of key characteristics, including bulb type, pack size, specialty features, and price. We also collected information on the presence and focus of all lighting marketing materials in the store. Appendix E contains a copy of the shelf-stocking instrument.

2.2.5 Impact Analysis

Gross Impacts

Electric Savings

The evaluation team calculated gross electric and demand savings for PY8 using the program-tracking database and applying algorithms and savings assumptions based on the Illinois Statewide Technical Reference Manual Version 4.0 (IL-TRM V4.0). The IL-TRM V4.0 outlines a carryover savings method to account for bulbs that are purchased and stored for later use. The method assumes that 2% of program bulbs will never be installed, but the remaining 98% will be installed within 3 years. As a result, PY8 savings come from bulbs *installed* in PY8 but that could have been *purchased* in PY6, PY7, or PY8:

$$\text{Realized PY8 Gross kWh Savings} = \Delta\text{kWh} \times (\text{Units Purchased PY8 and Installed in PY8} + \text{Units Purchased PY7 and Installed in PY8} + \text{Units Purchased PY6 and Installed in PY8})$$

First-year installation rates vary by bulb type, with lower installation rates for standard CFLs compared to specialty CFLs (see Table 6).

Table 6. Residential In-Service Rates

Bulb Type	First Year	Second Year	Third Year	Final
CFL Standard	73.2%	13.4%	11.4%	98.0%
CFL Specialty	73.2%	13.4%	11.4%	98.0%
LED Omni-Directional	95.0%	1.6%	1.4%	98.0%
LED Downlights	95.0%	1.6%	1.4%	98.0%

Source: IL-TRM V4.0.

The savings assumptions in the IL-TRM V4.0 vary depending on the customer and bulb type purchased. Based on the in-store customer intercept interviews, the evaluation team determined that 6% of program-discounted bulbs are installed in commercial spaces, which have greater hours of use and different waste heat factors (see Section 3.2.3 for more details on this intercept study result). To estimate energy savings, the evaluation team weighted the savings by the number of bulbs installed in residential homes and commercial spaces.

Due to the upstream nature of the program, AIC cannot limit the sales of program-discounted bulbs to AIC customers. At the same time, AIC customers can go to retailers in neighboring jurisdictions and purchase utility-discounted bulbs. Through our in-store customer research conducted in PY8, the evaluation team estimated that 13% of AIC-discounted bulbs were sold to non-AIC customers. Through secondary research that we conducted in PY7, the evaluation team estimated that AIC customers purchased and installed the equivalent 5% of AIC PY7 sales from other utility programs in Illinois, Indiana, and Missouri. Based on our estimates of both factors, we applied an overall leakage rate of 8% to gross savings (see Section 3.2.4 for additional details about the methods we used to estimate leakage).

To calculate weighted program electric savings, we applied both the residential and commercial savings algorithms outlined in the IL-TRM V4.0. We applied the appropriate savings assumptions based on installation

location and assumed that 94% of bulbs purchased are installed in residential locations and 6% in commercial locations. Our weighted savings equation is as follows:

$$Year\ 1\ \Delta\ kWh = \mathrm{LA} \times\ 0.94 \times \left[\frac{(Base\ Watt - Bulb\ Watt)}{1000} \times ISR_{res,yr1} \times HOU_{res} \times WHFe_{res}\right]$$

$$+ \mathrm{LA} \times 0.06 \times \left[\frac{(Base\ Watt - Bulb\ Watt)}{1000} \times ISR_{com,yr1} \times HOU_{com} \times WHFe_{com}\right]$$

Where:

LA = Leakage adjustment equal to (1 − leakage rate) or (1 − %Leakage)
0.94 = Residential install rate
0.06 = Commercial install rate
Base Watt = EISA-compliant base wattage
Bulb Watt = Actual wattage of installed bulb
ISR = First year in-service rate
HOU = Hours of use
WHFe = Waste heat factor for energy savings
Res = Residential values
Com = Commercial values

We provide more detail on the savings assumptions for each quantity in Appendix A.

Similarly, to calculate savings for PY8 purchases that will be installed during the next 2 years, we simply apply the in-service rate (ISR) for year 2 and year 3:

$$Year\ 2\ \Delta\ kWh = \ LA \times 0.94 \times \left[\frac{(Base\ Watt - Bulb\ Watt)}{1000} \times ISR_{res,yr2} \times HOU_{res} \times WHFe_{res}\right] +$$

$$LA \times 0.06 \times \left[\frac{(Base\ Watt - Bulb\ Watt)}{1000} \times ISR_{com,yr2} \times HOU_{com} \times WHFe_{com}\right]$$

$$Year\ 3\ \Delta\ kWh = LA \times 0.94 \times \left[\frac{(Base\ Watt - Bulb\ Watt)}{1000} \times ISR_{res,yr3} \times HOU_{res} \times WHFe_{res}\right] +$$

$$LA \times 0.06 \times \left[\frac{(Base\ Watt - Bulb\ Watt)}{1000} \times ISR_{com,yr3} \times HOU_{com} \times WHFe_{com}\right]$$

Demand Savings

As we did for electric savings, we calculate PY8 ex post demand savings using bulbs purchased across 3 years, but installed in PY8:

$$\text{Realized PY8 Gross kW Savings } = \Delta\ \text{kW} \times (\text{Units Purchased PY8 and Installed in PY8} + \text{Units Purchased PY7 and Installed in PY8} + \text{Units Purchased PY6 and Installed in PY8})$$

The evaluation team calculated demand savings using the method outlined in the IL-TRM V4.0. We applied the appropriate savings assumptions based on installation location and assumed that 94% of bulbs purchased are installed in residential locations and 6% in commercial locations. Our weighted savings equation is as follows:

$$Year\ 1\ \Delta\ kW = LA \times 0.94 \times \left[\frac{(Base\ Watt - Bulb\ Watt)}{1000} \times ISR_{res,yr1} \times WHFd_{res} \times CF_{res}\right] +$$

$$LA \times 0.06 \times \left[\frac{(Base\ Watt - Bulb\ Watt)}{1000} \times ISR_{com,yr1} \times WHFd_{com} \times CF_{com}\right]$$

Where:

LA = Leakage adjustment equal to (1 − leakage rate) or (1 − %Leakage)
0.94 = Residential install rate
0.06 = Commercial install rate
Base Watt = EISA-compliant base wattage
Bulb Watt = Actual wattage of installed bulb
ISR = First year ISR
WHFd = Waste heat factor for energy savings
CF = Coincidence factor
Res = Residential values
Com = Commercial values

We provide more detail on the savings assumptions for each quantity in Appendix A.

Similarly, to calculate savings for PY8 purchases that will be installed during the next 2 years, we simply apply the ISR for year 2 and year 3:

$$Year\ 2\ \Delta\ kW = LA \times 0.94 \times \left[\frac{(Base\ Watt - Bulb\ Watt)}{1000} \times ISR_{res,yr2} \times WHFd_{res} \times CF_{res}\right] +$$

$$LA \times 0.06 \times \left[\frac{(Base\ Watt - Bulb\ Watt)}{1000} \times ISR_{com,yr2} \times WHFd_{com} \times CF_{com}\right]$$

$$Year\ 3\ \Delta\ kW = LA \times 0.94 \times \left[\frac{(Base\ Watt - Bulb\ Watt)}{1000} \times ISR_{res,yr3} \times WHFd_{res} \times CF_{res}\right] +$$

$$LA \times 0.06 \times \left[\frac{(Base\ Watt - Bulb\ Watt)}{1000} \times ISR_{com,yr3} \times WHFd_{com} \times CF_{com}\right]$$

Net Impacts

The evaluation team applied net-to-gross ratios (NTGRs) approved by the Illinois Stakeholder Advisory Group (SAG) to PY8 program savings. The CFL NTGR comes from in-store customer intercept interviews that we conducted for AIC in PY6. Because AIC did not discount LEDs in PY6 (when we last conducted in-store customer interviews), we lack an AIC-specific NTGR for LEDs. For LEDs, the estimate comes from the PY7 evaluation of the Commonwealth Edison Residential Lighting Program. Table 7 summarizes the NTGRs used in the net impact analysis.

Table 7. SAG-Approved PY8 NTGRs

Measure Type	Electric NTGR
CFLs	0.63
LEDs	0.73

Note: PY8 savings will include carryover savings for bulbs that were purchased in PY6 and PY7 but not installed until PY8. For these bulbs, we use the SAG-approved NTGR (0.47) for the year the bulbs were purchased of 0.47.

Summary of Input Sources

Table 8 summarizes the data sources for key variables in the ex post gross and net energy and demand savings estimation.

Table 8. Summary of Ex Post Gross and Net Energy and Demand Savings Assumptions and Sources

Parameter	Source of Savings Assumption
Program Sales	PY8 Sales Data
Base Watts	2015 IL-TRM 4.0
CFL Watts	PY8 Sales Data (Measure Descriptions)
Residential vs. Commercial Installations	PY8 In-Store Intercepts
Leakage Out	PY8 In-Store Intercepts
Leakage In	PY7 Residential Lighting Evaluation Analysis
Hours of Use	2015 IL-TRM 4.0
Installation Rate	2015 IL-TRM 4.0
Waste Heat Energy Factor	2015 IL-TRM 4.0
Waste Heat Demand Factor	2015 IL-TRM 4.0
Summer Peak CF	2015 IL-TRM 4.0
NTGR	PY7 ComEd In-Store Intercepts for LEDs sold in PY8 PY6 AIC In-Store Intercepts for CFLs sold in PY8 PY5 AIC In-Store Intercepts for bulbs sold in PY6 or PY7

2.3 Sources and Mitigation of Error

Table 9 provides a summary of the possible sources of error associated with data collected for the Residential Lighting Program evaluation. We discuss each item in detail below.

Table 9. Possible Sources of Error

Research Task	Survey Error		Non-Survey Error
	Sampling	Non-Sampling	
In-Store Customer Intercepts	• N/A, convenience sample	• Measurement error • Non-response and self-selection bias • External validity	• Data processing error
Lighting Shelf-Stocking Study	• N/A, convenience sample		
Gross Savings Calculations	• N/A	• N/A	• Data processing error
Net Savings Calculations	• N/A	• N/A	• Data processing error

The evaluation team took a number of steps to mitigate potential sources of error throughout the planning and implementation of the PY6 evaluation.

Survey Error

- **Sampling Error**
  - For the in-store customer intercepts and lighting shelf-stocking survey, the evaluation team had to use a convenience sample of store locations. Because a convenience sample is a non-probability-based sample, traditional sampling theory does not apply. For this reason, the evaluation team did not estimate a precision level for these results or conduct tests of statistical significance. However, where possible, the team did attempt to address potential coverage bias by selecting stores that reflect the overall population of participating stores. For the estimate of program leakage in which the location of the store relative to the AIC border was a critical factor, we weighted the survey results by store location. For survey estimates that represented all program sales (e.g., FR), we applied a sales-based weight so that customers who purchased more bulbs and retail channels that sold more bulbs had a greater weight.
- **Non-Sampling Error**
  - **Measurement Error:** We addressed the validity and reliability of customer survey data through multiple strategies. First, we relied on the experience of the evaluation team to create questions that, at face value, appear to measure the idea or construct that they are intended to measure. We reviewed the questions to ensure that we did not ask double-barreled questions (i.e., questions that ask about two subjects, but with only one response) or loaded questions (i.e., questions that are slanted one way or another). We also checked the logical flow of the questions so as not to confuse respondents, which would decrease reliability. Key members of the evaluation team, as well as AIC and ICC staff, reviewed all survey instruments.

    We also used well-trained and experienced field staff to minimize interviewer error during the in-store customer intercept interviews. We have worked with the same staff on several in-store lighting customer interview projects. They understand the purpose of the study and the lighting technologies involved and are experienced in interviewing customers in a retail environment. We

downloaded and checked data throughout the fielding period to identify and correct problems in real time rather than at the end of the study.

- **Non-Response and Self-Selection Bias:** The field staff who conducted the in-store customer intercepts have years of experience conducting these types of interviews and encouraging customers to complete them. Customers received a $10 gift card to the retail store where they were shopping to encourage their participation. Providing an incentive and encouragement to participate helps reduce the degree to which certain types of customers are more likely to "self-select" for participation, which would introduce non-response bias.

- **External Validity:** We addressed external validity (the ability to generalize any findings to the population of interest) through the development of an appropriate research design. For example, the in-store intercepts had to use a convenience sample, which affects the generalizability of the results. Given the high costs of such a study, it is not possible to conduct interviews throughout the entire program year and at all participating retailers. Faced with these limitations, we employed other strategies to increase the external validity of the results. We conducted interviews at several types of retailers and on weekends and weekdays to capture a variety of customer types. We also conducted interviews at retailers and locations that sold the most bulbs through the program so that the results applied to a large proportion of program sales.

- **Data Processing Error:** The evaluation team addressed processing error by using established data cleaning and analysis quality control processes and procedures. Experienced project managers oversaw the work of analytic staff and conducted checks of their work to catch any data processing errors. We also had analytic code for many data cleaning and processing tasks that flag errors.

Non-Survey Error

- Data Processing Error

  - **Gross Savings Calculations:** We applied the IL-TRM V4.0 calculations to the participant data in the tracking database to calculate gross impacts. To minimize data processing error, a separate member of the evaluation team reviewed all calculations to verify accuracy.

  - **Net Savings Calculations:** We applied the prospective deemed NTGR determined by the PY6 evaluation to estimate net impacts of the program in PY8. To minimize data processing error, a separate member of the evaluation team reviewed all calculations to verify accuracy.

3. Detailed Findings

The Illinois Power Agency (IPA) Residential Lighting Program aims to transform the residential lighting market in Ameren Illinois Company (AIC) territory by increasing customers' awareness and use of ENERGY STAR® (ES) lighting. The program partners with retailers and lighting manufacturers to sell ES CFL and LED products at discounted prices to bring costs closer to those of less-efficient lighting options. These discounts encourage customers who are reluctant to pay full price for ES lighting to choose energy-efficient options over the traditional alternatives. The program also employs marketing and outreach efforts at participating retailers, at community events, and on the AIC website. Most products are sold at participating retailers throughout the AIC territory.

Launched in August 2008, the program is implemented by CLEAResult and Energy Federation, Incorporated (EFI). During the program's 8 years of operation, it has discounted 24,672,057 energy-efficient light bulbs and fixtures. This evaluation reviews the program's performance in Project Year 8 (PY8), which began in June 2015 and ended in May 2016.

3.1 Process Findings

3.1.1 Program Design and Implementation

The Residential Lighting Program ran smoothly in PY8. As in prior years, the program met its goals in terms of bulb sales and energy savings. The program design remained largely similar to the PY7 design. For example, field representatives remained an integral part of program implementation. CLEAResult employs seven field representatives who are each responsible for visiting specific participating retail stores across AIC territory. Representatives regularly visited their assigned retailers to ensure that products and promotional materials were displayed properly, to train store staff (e.g., sales associates, cashiers, managers), and to conduct in-store lighting demonstrations that educate customers. Field staff visited each retail location at least once a month, with the top-selling locations receiving weekly visits. The field representative supervisor reviewed other staff work using quality assurance scorecards, and all retail visits were documented in a database.

The lighting market continues to change at a rapid pace, which presents some challenges for program implementation. For example, retailers have shifted shelf space from CFLs to LEDs and discontinued promotions of some CFL products ahead of schedule. In response, the program administrators must change the products discounted through the program but are somewhat limited in the products that can be substituted for contractual reasons. Program administrators have independent goals for each bulb type (standard CFLs, standard LEDs, specialty LEDs) and cannot shift budget or sales goals from one bulb type to another. If a retailer stops carrying a standard CFL that the program discounted, the administrator must find another standard CFL to discount to reach the CFL goals. To meet this challenge, program administrators worked closely with retailers to obtain advance notice of the retailers' pricing and stocking decisions. Administrators believe that this retailer cooperation is the result of having developed a positive working relationship with retail partners during past program years.

Program administrators added Target, a big box chain, and Krogers, a grocery chain, to the program in PY8 to reach additional customers. During their store visits, field representatives found that the pricing on participating products at the grocery chain were often incorrect. Because of low sales and the time that field representatives had to spend ensuring correct prices, program administrators decided to drop this grocery chain from the program in PY9.

3.1.2 Program Data

The program-tracking data included all of the information necessary to calculate ex post savings using the method outlined in the IL-TRM V4.0. Program administrators track progress toward their net savings goals using per-unit values for each product type discounted through the program. The program does not have gross per-unit values; therefore, it was not possible for us to calculate a gross realization rate as part of this evaluation. The net per-unit values were used to set savings goals in the CLEAResult contract but may not reflect the per-unit savings that would result from application of the IL-TRM V4.0 savings assumptions.[2] As we show in the Section 3.2.6, the ex post net per-unit savings are slightly higher than the ex ante net savings.

3.1.3 Program Marketing, Outreach, and Training

In PY8, the Residential Lighting Program was promoted primarily through point-of-purchase (POP) sales materials at participating retail stores, which were redesigned prior to the start of the program year. Figure 2 provides an example of the PY8 in-store marketing.

Figure 2. Example of Redesigned POP Marketing

Our in-store stocking study found Ameren-sponsored promotional materials present at all 10 of the participating stores we visited. In addition, we found that 7 of the 10 locations featured program bulbs on promotional off-shelf displays, such as endcap displays at the end of aisles or by the registers. Table 10 provides a breakdown of the types of Ameren-sponsored informational materials present at the retailers we visited.

[2] Program administrators also estimated savings using TRM assumptions for tracking purposes, but these values were not the official program savings values.

Table 10. Ameren-Sponsored In-Store Informational Materials Present

Informational Materials Present	Number of Retailers (n=10)
Information on CFL Bulbs	8
Information on LED Bulbs	7
Information on Discounts	7
Information on Proper CFL Disposal	1
Explanation of Lumens	2
Information on EISA Regulations	2

Field representatives' visits to participating stores were the second key way that the program reached customers. During a visit, staff completed one or more activities, including customer outreach, staff training, and product and POP marketing adjustments. During typical store visits, representatives provided employee training to sales associates, store managers, cashiers, lighting department staff, and bookkeepers. Representatives trained store staff on efficient lighting and how to best promote the bulbs; they also briefly described how the program works from the consumer's standpoint.

Field representatives conducted a total of 13 customer lighting demonstrations a month. Each representative conducted two demonstrations per month, with the exception of the Senior Field Representative, who conducted only one due to his additional quality assurance/quality control (QA/QC) responsibilities. The events were held at stores with the most customers. During the demonstration, field representatives discussed bulb features and details of the discount program and, in some cases, referred customers to the AIC website for more information about other energy efficiency programs for their home or business.

The in-store intercepts that the evaluation team conducted show the effectiveness of the in-store lighting demonstrations. Customers who purchased light bulbs during a lighting demonstration were somewhat more likely to purchase an efficient bulb than a less-efficient bulb. During an event, 71% of customers purchased CFLs or LEDs compared to 61% of customers when an event was not taking place. Table 11 shows that the lift in efficient bulb sales was almost entirely due to increased LED purchases.

Table 11. Comparison of Bulb Purchases with and without Promotional Events

Efficiency	Bulb Type	Event		No Event	
		Customers	Percentage	Customers	Percentage
Higher	LEDs	73	42%	232	34%
	CFLs	51	29%	180	27%
	Halogen	27	16%	127	19%
Lower	Incandescent	39	23%	179	26%
	Total	**174**	**110%**	**679**	**106%**

Note: The table presents the number of customers who purchased each type of bulb. Percentages are greater than 100% because some customers purchased more than one type of bulb.

Customers who purchased program-discounted bulbs during lighting events were only slightly more likely to know that the bulbs were discounted (61% compared to 57%) than those who purchased bulbs when an event was not present. Customers were much more likely to know that AIC was the source of the discount if they

made their purchase during an event (43% compared to 19%) (see Table 12).[3] These numbers are considerably lower than what we found in PY6, when 77% of all customers who purchased program-discounted bulbs were aware of the discount and 57% were aware that AIC was the discount sponsor. It is possible that redesigned POP materials were less noticeable or that there was a change in POP material placement since PY6.

Table 12. Awareness of Lighting Discounts

	Event (n=93)	No Event (n=242)
Aware of Discount	61%	57%
Aware AIC Is Discount Sponsor	43%	19%

Note: Excludes customers who did not purchase program-discounted bulbs

To help customers identify participating retail locations near their homes, the program advertised online. This website allowed customers to search for participating retailers by store name, zip code, and type of lighting product discount. The website also advertised the program's in-store lighting demonstration schedule.

In addition to territory responsibilities, one of the seven field representatives also performed field leadership duties, including staff development and QA/QC auditing. The QA/QC procedure is a series of in-store checkups to ensure that each representative is correctly implementing key processes and actions that affect program success. The field leader checks whether the representative's use of merchandising and POP materials is correct and tidy, for evidence of ongoing store training and customer demonstrations, and for indicators that the representative is building positive relationships with store staff and training them correctly.

3.1.4 Retail Stocking and Sales of Energy-Efficient Lighting

The results of our retailer shelf inventory and in-store customer interviews show a changing lighting market and the growing prominence of LEDs. LEDs are the most common product on retailers' shelves and in customer shopping carts.

Data from the shelf surveys indicate that energy-efficient lighting products are the dominant lighting technology on retailer shelves, especially in the general service product category. In PY8, LEDs and CFLs made up 73% of general service products and 57% of specialty products. The market share of incandescent light bulbs is decreasing, especially for general service lighting products affected by EISA, while the percentage of EISA-compliant halogen products has remained relatively stable.

Lighting Product Stocking

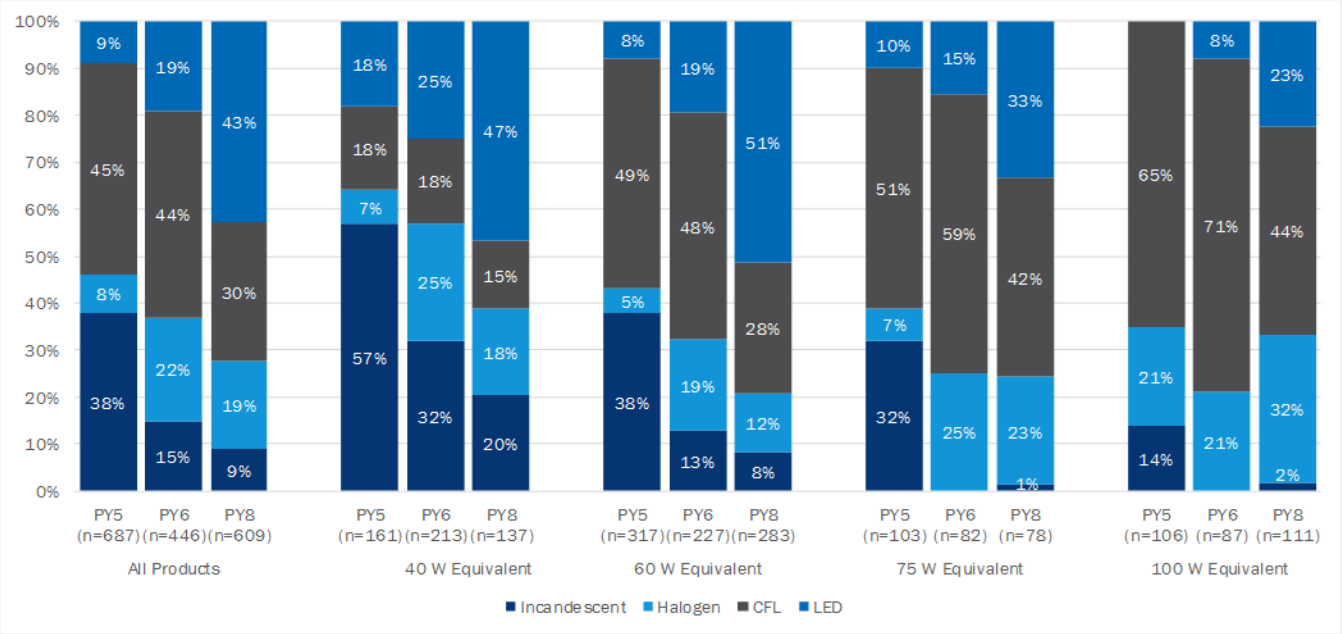
The evaluation team conducted an inventory of each lighting product discounted through the program or that could be purchased instead of a discounted product at 10 of the 25 participating retailers where we conducted in-store intercepts. All store visits took place from February to April 2016. We compared the results with a similar inventory that we conducted in PY5 and PY6. The results show that energy-efficient lighting products take up the majority of retailer shelf space, especially in the general service product category. LEDs are the most-prominent technology and are replacing CFLs as well as incandescents (see Figure 3). The percentage

[3] These results reflect customer awareness of marketing, not the discount's impact on purchase behavior. Customers who are unaware of the discount can still be price sensitive and influenced by the lower price.

of LED products more than doubled between PY6 and PY8. The share of EISA-compliant halogens more than doubled from PY5 to PY6 but decreased slightly from PY6 to PY8.

We found very few 100-watt and 75-watt equivalent general service incandescents on retailer store shelves. However, incandescents do represent 8% of 60-watt equivalent products and 20% of 40-watt equivalent products stocked. Halogens have not taken over, but they are more likely to be present in the higher-wattage categories. We found tremendous growth in the availability of LEDs across all wattage categories, but especially in the lower-wattage ranges. Although CFL availability decreased across all standard wattage categories, CFLs remain the dominate technology for 75-watt and 100-watt equivalent products, whereas LEDs are the dominant product among 40-watt and 60-watt bulbs.

Figure 3. Standard Lighting Products on Shelves (Affected by EISA Legislation)

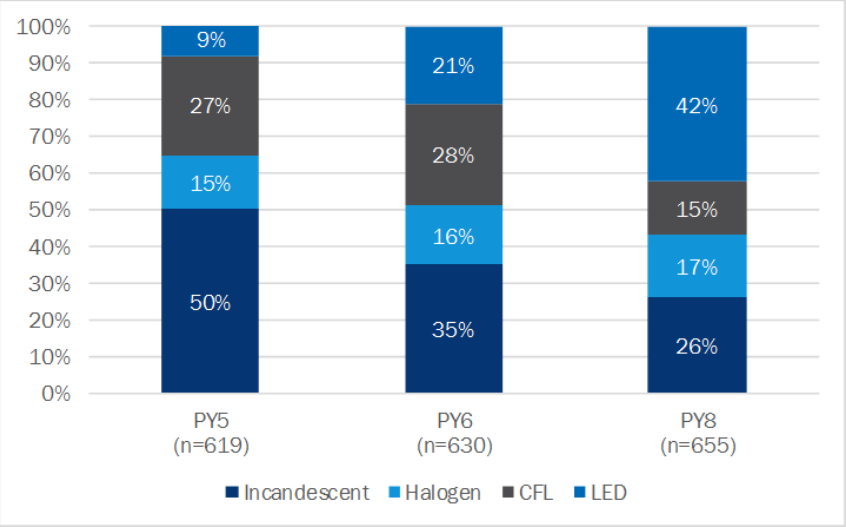


Note: The numbers ("n") in this figure represent the number of unique products (i.e. skus) and not counts of packages or bulbs. We completed shelf studies at 10 retailers in PY5, 8 in PY6, and 10 in PY8. While the overall number of products differs as a result, the types of retailers included in the three studies were similar so that the relative distribution of product types can be compared.

In contrast to general service bulbs, the stocking of specialty bulbs is not affected by EISA, and specialty incandescents are more available on store shelves, representing 26% of all specialty products in PY8 (see Figure 4). However, product stocking has changed considerably. Half of specialty products stocked in PY5 and one-third in PY6 were incandescents. Like general service bulbs, LEDs are now the most common product stocked. The percentage of specialty LEDs doubled between PY6 and PY8 (21% compared to 42%), while the percentage of CFLs dropped by nearly half, 28% to 15%, during that time. Shelf space devoted to halogen products has remained relatively constant since PY5.[4]

[4] While we recorded the lumens and wattage of all specialty products, it is difficult to present the results by lumen range for specialty bulbs as we did for standard bulbs. The baseline wattages vary by bulb type (globe, reflector, candelabra, etc.) for different lumen ranges. We could provide these results for each specialty bulb type, but there is no meaningful way to group all specialty products by lumen range.

Figure 4. Specialty Lighting Products on Shelves



Note: The numbers ("n") in this figure represent the number of different types of products and not counts of bulbs.

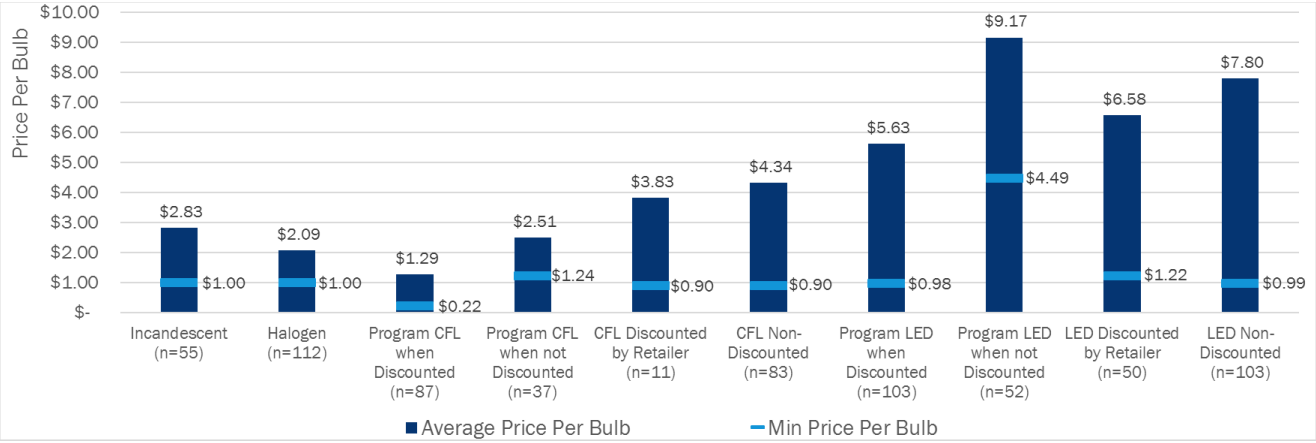
Lighting Product Pricing

As part of the shelf-stocking study, the evaluation team collected pricing information for all products inventoried. For discounted products, we recorded the regular retailer price, where available, and the discounted price. We also noted whether the program or the retailer/manufacturer provided the discounts. Figure 5 compares average and minimum pricing of standard products across all bulb technologies. For CFLs and LEDs, we provide price estimates for four types of pricing. Two of the prices are for products that the program discounts; the figure shows the average and minimum discounted price of program CFLs and LEDs and what these products would cost if they were not discounted by the program. Retailers also provide discounts on CFLs and LEDs. We provide the average and minimum prices for products discounted by retailer and for the remaining non-discounted CFLs and LEDs.

The results show that CFLs are priced comparably to incandescents and halogens (see Figure 5). The least expensive non-discounted CFL was $0.10 less per bulb than the least expensive incandescent or halogen. With the program discounts, the least expensive CFL cost $0.78 less than the least expensive incandescent or halogen. Perhaps due to the scarcity of incandescents in the market, the average incandescent bulb cost more than the average halogen bulb or CFL, both with and without program discounts.

Our results show that there are some low-cost LEDs on the market as well. The least expensive retailer-discounted LED was $1.22 per bulb, while the least expensive non-discounted LED was $0.99. These LEDs are typically lower quality. The program restricts its discounts to ES LEDs that had an average non-discounted price of $9.17 per bulb, which is considerably higher than non-discounted, less-efficient bulbs or CFLs. The program discount brought the average price down to $5.63. However, on some products, the program discount brought the price down to $0.99 so that the least expensive program-discounted LED was close to the pricing of incandescents and halogens but still more than the least expensive program-discounted CFL.

Figure 5. Average Price of Standard Light Bulbs

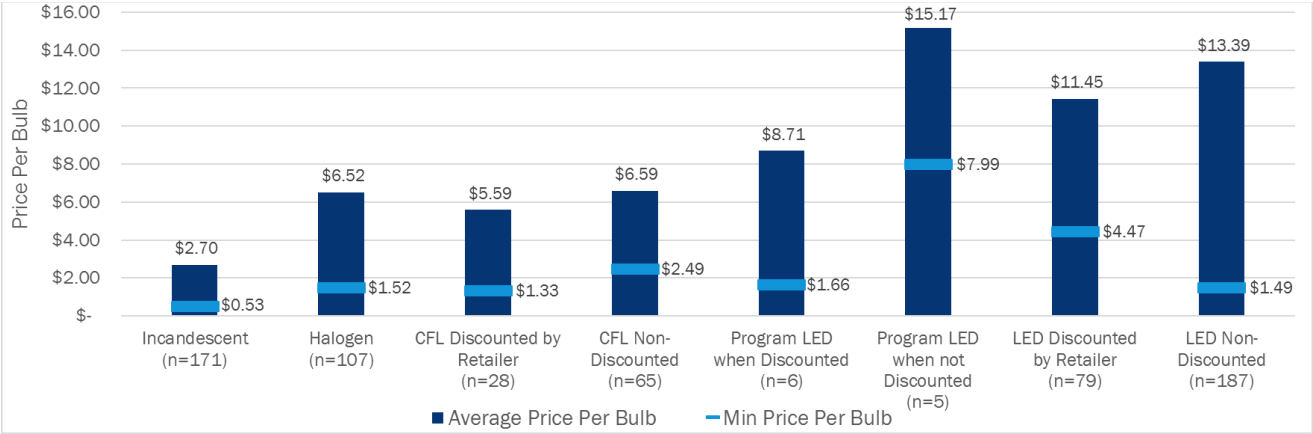


Note: The non-discounted prices for program CFLs and LEDs were not available for all products in stores, so the number of products used to estimate the program-discounted price is not the same as the number of products used to estimate the non-discounted price. If we limit the comparison to the products for which we have both the discounted and non-discounted prices, the average discounted price is $1.22 for standard program CFLs and $5.54 for standard program LEDs.

Figure 6 provides a comparative pricing analysis for specialty products. The program did not discount any specialty CFLs in PY8, but we did find a few retailer-sponsored discounts of specialty CFLs. The program was also nearing its budget on specialty LEDs and had discontinued discounts at most retailers. The results show that, without program discounts, quality specialty LEDs were much more expensive in PY8 than less-efficient products, CFLs, or lower-quality LEDs.

Incandescent specialty bulbs were less expensive than all other products in terms of both their minimum and average pricing. This is true of products with and without discounts. The least expensive specialty incandescent was $0.53 compared to $1.52 for halogens and $2.49 for CFLs. With retailer discounts, the lowest price specialty CFL was $1.33. Average pricing shows even greater differences between specialty incandescents and halogens and CFLs. Pricing of specialty LEDs was quite varied due to the presence of program and retailer discounts, as well as some lower-quality, less-expensive LEDs on the market. The least expensive non-discounted LED was $1.49 per bulb, but this is not a comparable product in terms of quality to the LEDs that the program discounts. The average price of program-discounted specialty LEDs was $15.17. After the discount, the average price was $8.71, with the least expensive LED costing $1.66. Retailers also discounted specialty LEDs. The average retailer-discounted LED was $11.45 and the least expensive bulb was $4.47.

Figure 6. Average Price of Specialty Light Bulbs



Note: The non-discounted price for program LEDs was not available for all products in stores, so the number of products used to estimate the discounted price is not the same as the number of products used to estimate the non-discounted price. If we limit the comparison to the products for which we have both the discounted and non-discounted prices, the average specialty program LED discounted price is $10.12.

Lighting Purchases

The shelf-stocking study provided information about what retailers are stocking and showed that they are stocking more LED products than any other bulb type. The in-store interviews provided information about what customers were buying and also showed the shift to LEDs. A greater percentage of customers purchased an LED than any other bulb type.

Overall, 62% of customers purchased at least one energy-efficient bulb (CFL or LED), and 42% purchased at least one less-efficient bulb (incandescent or halogen).[5] More than a third of customers (36%) purchased at least one LED (see Table 13). Customers purchased program-discounted LEDs to an equal degree as non-program LEDs. Just over a quarter of customers purchased at least one CFL (27%). Considerably more customers purchased program-discounted CFLs compared to non-program CFLs (22% vs. 4%). Customers are still purchasing incandescents and halogens. Just over one-quarter of customers (26%) purchased traditional incandescent products, while just under one-fifth of customers (18%) purchased EISA-compliant halogens. Most incandescent purchases were specialty products (81%), while most halogens were standard bulbs (73%).

Although a greater percentage of customers purchased LEDs than CFLs, the average CFL purchaser bought slightly more than twice as many CFLs than the average LED purchaser. Customers purchased an average of 7.4 CFLs compared to 3.5 LEDs, 4.3 halogens, and 4.3 incandescents. As a result, a greater percentage of bulbs purchased were CFLs than LEDs (39% compared to 24%). Customers purchased twice as many program-discounted CFLs as non-program CFLs on average (8.0 vs. 4.0), which suggests that the program increases CFL sales volume. There is no such difference between the number of program and non-program LEDs purchased.

[5] Customers purchased more than one bulb type, so the percentages do not sum to 100%. Only 3% of customers purchased both energy-efficient and less-efficient bulbs.

Table 13. Bulb Types Purchased

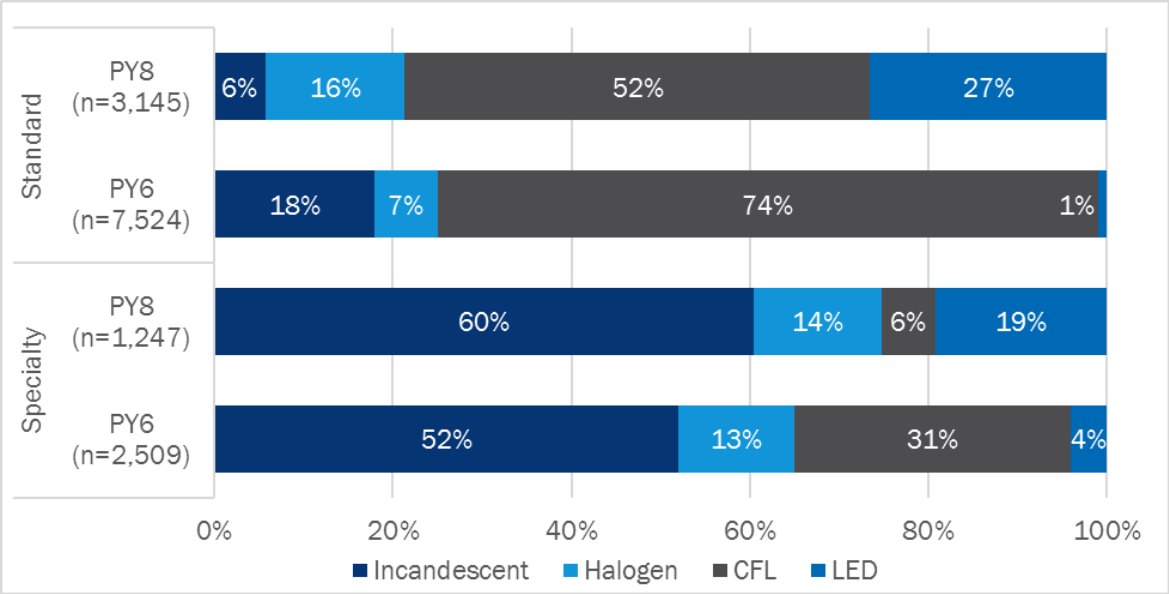
Bulb Type	Customers[a]		Bulbs		
	#	%	#	%	Average[b]
LEDs	304	36%	1,073	24%	3.5
Program LEDs	161	19%	540	12%	3.4
Non-Program LEDs	157	18%	533	12%	3.4
CFLs	231	27%	1,715	39%	7.4
Program CFLs	195	23%	1,562	36%	8.0
Non-Program CFLs	38	4%	153	3%	4.0
Halogens	155	18%	668	15%	4.3
Incandescents	219	26%	934	21%	4.3
Total	**853**	**107%**	**4,391**	**100%**	**5.1**

[a] Numbers sum to more than the number of completed interviews and percentages total more than 100% because some customers purchased more than one type of bulb. The total, 853, is the total number of customers interviewed.
[b] Mean bulb quantity purchased among customers who purchased at least one of the respective bulb type

The shift to LEDs from CFLs is apparent when we compare results from the in-store intercepts that we conducted in PY8 with those we conducted in PY6. Looking just at standard lighting products, there is little change in the purchase of energy-efficient bulbs relative to less-efficient products: 79% of standard bulbs purchased were energy efficient (i.e., LEDs or CFLs) in PY8 compared to 75% in PY6 (see Figure 7). However, of the efficient bulbs purchased, a much greater percentage were LEDs in PY8 compared to PY6. In PY6, only 1% of standard lighting products purchased were LEDs compared to 27% in PY8.

The change to LEDs is also happening in the specialty lighting market, though less-efficient bulbs (i.e., incandescents and halogens) continue to dominate the specialty market. In fact, a smaller percentage of specialty bulbs purchased were energy efficient in PY8 than in PY6 (25% compared to 35%). However, a much greater percentage of specialty bulbs purchased were LEDs in PY8 than in PY6 (19% compared to 4%). As manufacturers discontinue their production of specialty CFLs in favor of LEDs and the Residential Lighting Program dropped its discounts, only 6% of specialty bulbs purchased in PY8 were CFLs compared to 31% in PY6.

Figure 7. Comparison of Bulb Types Purchased in PY6 and PY8



Customer purchases by retailer varied considerably.[6] Customers shopping at warehouse and DIY stores were more likely to purchase LEDs than customers shopping at big box stores (68% and 48% vs. 24%) and less likely to purchase incandescents (0% and 20% vs. 30%). Warehouse stores did not stock any incandescents, which suggests that customers will buy less-efficient bulbs when they are available. Substantially more of the bulbs sold at warehouse and big box stores were program discounted than at DIY stores (69% and 54% vs. 31%). Most of this difference is because program-discounted CFLs comprised only 8% of bulbs sold at DIY stores. Table 14 provides a complete breakdown of bulb purchases by retail channel.

[6] Because our sample of stores overrepresents some retailers and underrepresents others, when we present overall sales results, we weighted the data by retail channel sales so results better reflect total sales across our sample frame.

Table 14. Bulb Types Purchased by Retail Channel

Bulb Type	DIY		Big Box		Warehouse	
	Customers[a]	Bulbs	Customers[a]	Bulbs	Customers[a]	Bulbs
LEDs	48%	44%	24%	13%	68%	44%
Program LEDs	17%	20%	16%	8%	33%	18%
Non-Program LEDs	32%	25%	9%	5%	38%	26%
CFLs	20%	20%	31%	47%	31%	54%
Program CFLs	8%	11%	29%	46%	29%	52%
Non-Program CFLs	13%	9%	2%	1%	1%	2%
Halogens	19%	15%	21%	17%	3%	3%
Incandescents	20%	21%	32%	24%	0%	0%
Total	107%	100%	107%	100%	101%	100%

[a] Numbers and percentages sum to more than the number of completed interviews and 100% because some customers purchased more than one type of bulb.

While the program discounts only ES-labeled LEDs, non-ES LEDs are also available for customers to purchase. More than a quarter of customers purchasing LED products purchased non-ES-rated LED options (29%). When customers purchased ES LEDs, they were twice as likely to purchase LEDs discounted through the program. Non-ES LEDs typically cost less than ES LEDs. The program discount helps bring the price of ES LEDs down, which likely encourages some customers to purchase them instead of non-ES LEDs (see Table 15).

Table 15. LED Purchases by ENERGY STAR Certification Status

Bulb Type	Customers[a]		Bulbs	
	#	%	#	%
ES LEDs	226	74%	774	72%
Program LEDs	161	53%	540	50%
Non-Program LEDs	73	24%	234	22%
Non-ES LEDs (Non-Program)	87	29%	299	28%
Total	304	103%	1,073	100%

[a] Numbers and percentages sum to more than the number of completed interviews and 100% because some customers purchased more than one type of bulb.

3.2 Impact Assessment

3.2.1 Program Data Verification

For PY8, program administrators provided two parallel components of program-tracking data: a raw sales data extract to be treated as final PY8 sales data and a goal-tracking worksheet that included per-unit net energy savings assumptions drawn from CLEAResult's contractual statement of work (SOW). The SOW savings apply a deemed value to each of three primary product categories: standard CFLs, standard LEDs, and specialty LEDs.

We verified program participation by examining the product sales data for product eligibility and time of sale. Our review of the program-tracking data found that all product sales were made during the eligible time period

for eligible products (June 1, 2015–May 31, 2016). We also cross-checked bulb specifications with product descriptions and corrected for some small discrepancies.

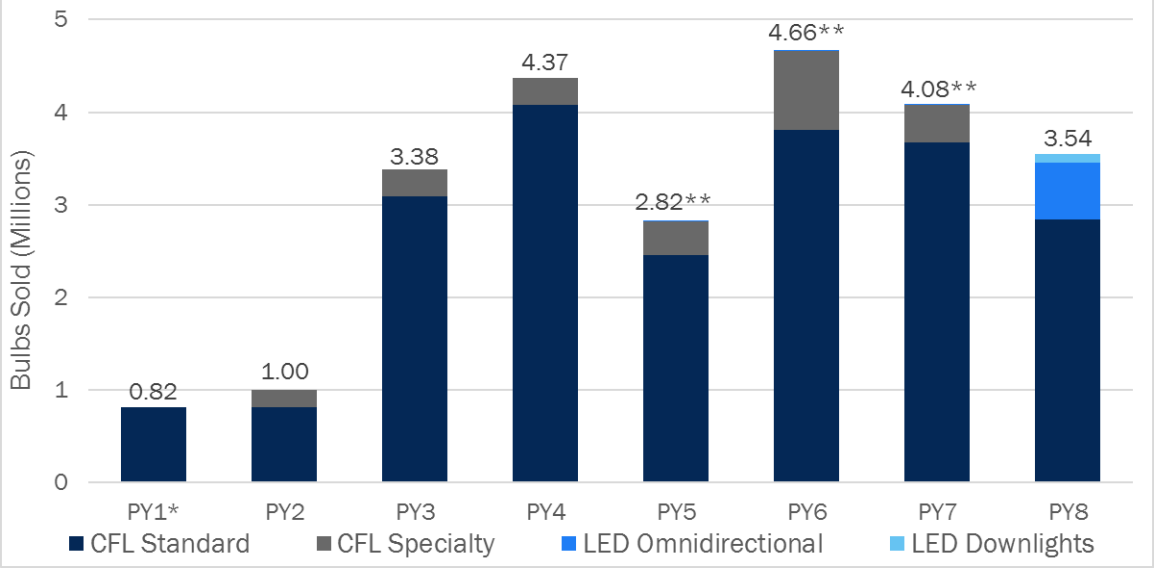
Program implementers track progress toward their net savings goals using per-unit values for each product type discounted through the program. We applied these net per-unit values to bulb quantities in the sales data extract to represent ex ante net kWh savings. Program implementers also tracked gross energy and demand savings using TRM-based assumptions for internal purposes but did not use these estimates as the official measure of progress towards program goals. The TRM-based formulas produce different saving estimates than the per-unit method. For consistency purposes and because official program goals were based on savings estimated using per-unit values, we use per-unit savings to represent ex ante savings. The program did not have gross energy or demand per-unit values; therefore, it was not possible for us to calculate gross and demand realization rates as part of this evaluation.

The IL-TRM V4.0 categorizes LEDs differently than the definitions used by the program. The program uses the same standard and specialty categories that the TRM uses for CFLs. However, for LEDs, the TRM uses two different categories: omnidirectional and downlights. Omnidirectional LEDs include A-lamps and other bulbs, such as globes and candelabras, that are classified as specialty bulbs for CFLs. Downlights are primarily reflectors and any bulb that is labeled "directional." We used the IL-TRM V4.0 LED categories to report counts of bulbs sold and to calculate ex post savings. Therefore, our bulb counts and savings by category will not match the categories and counts reported by the program.

3.2.2 Program Participation

The Residential Lighting Program sold a total of 3,544,171 bulbs in PY8 at participating retail stores. This reflects a 13% decrease from PY7. While a large majority of bulbs sold were standard CFLs (80%), the program drastically boosted sales of LEDs from less than 1% in previous years to 20% of bulbs sold in PY8. Figure 8 shows program sales from PY1 through PY8. The figure shows increasing sales of bulbs until PY4, a significant drop in PY5 due to a reduction in program goals, a rebound to the increasing sales trajectory pattern in PY6, and subsequent decreases as the program prioritizes higher-cost products.

Figure 8. Total Bulbs Sold, PY1–PY8



* We do not have a record of the number of CFLs sold by type for PY1.
** Indicates LEDs were sold but the quantity is too small for the bar to be visible.

Table 16 provides additional detail on the shifting landscape of program-discounted bulb sales since PY6. While the majority of bulbs sold in PY8 were standard CFLs (as in previous years), the program no longer discounted specialty CFLs. The program sold LEDs only through the online store in PY6 and PY7 and sold a very small number. LEDs comprised 20% of bulbs sold in PY8, of which the large majority (82%) were omnidirectional LEDs.[7]

Table 16. Bulb Sales by Type, PY6–PY8

	PY6		PY7		PY8	
Bulb Type	**#**	**%**	**#**	**%**	**#**	**%**
CFL Standard	3,808,439	82%	3,671,575	90%	2,835,395	80%
CFL Specialty	850,445	18%	404,285	10%	0	0%
LED Omnidirectional	717	0%	480	0%	612,346	17%
LED Downlights	0	0%	0	0%	93,327	3%
Total	**4,659,601**	**100%**	**4,076,340**	**100%**	**3,544,171**	**100%**

Sales by Store Category

As in past years, the majority of program-discounted bulbs were sold at big box retailers and DIY stores. Overall, the program maintained its well-established mix of retailers from previous years, but did introduce 28 small independent grocers and dropped its online store offering in PY8 (see Table 17).

[7] Most of the omnidirectional bulbs were A-lamp bulbs (87%). Only 13% were what the program classified as specialty LEDs (10% candelabra, 3% globe, < 1% 3-way).

Table 17. Bulb Sales by Retailer Type

Retailer Type	PY6		PY7		PY8	
	Bulbs	% of Sales	Bulbs	% of Sales	Bulbs	% of Sales
Big Box[a]	2,504,400	54%	2,296,820	56%	2,014,277	57%
DIY	1,377,808	30%	1,128,519	28%	1,004,652	28%
Discount	479,644	10%	324,801	8%	279,838	8%
Drug Store	64,320	1%	37,512	1%	45,500	1%
Grocery Store	77,091	2%	165,248	4%	66,856	2%
Independent Grocery	N/A	N/A	N/A	N/A	17,080	< 1%
Independent Hardware	155,048	3%	122,345	3%	115,968	3%
Online Store	1,290	< 1%	1,095	< 1%	N/A	N/A
Total	**4,659,601**	**100%**	**4,076,340**	**100%**	**3,544,171**	**100%**

[a] Includes warehouse retailers.

Standard CFLs in the 750–1,049 lumens range accounted for the majority of bulbs sold in PY8 (80% of CFLs and 64% of all bulbs) (see Table 18). These bulbs are equivalent to 60-watt incandescents. A smaller number of CFLs (10% of CFLs and 8% of all bulbs) were 100-watt incandescent equivalents in the 1,490–2,599 lumens range. Among LEDs, 66% of bulbs were 60-watt equivalent omnidirectional in the 750–1,059 lumens range. Most downlight products sold were in lower lumen ranges, with 97% of directional LEDs under 1,000 lumens.

Table 18. Program Bulb Sales by Type and Wattage

Lumen Range	LEDs		CFLs	
	Number Sold	% of Sales	Number Sold	% of Sales
Omnidirectional /Standard	**612,346**	**87%**	**2,838,498**	**100%**
< 310	49,684	7%	0	0%
310–749	68,934	10%	166,049	6%
750–1,049	465,627	66%	2,259,690	80%
1,050–1,489	10,114	1%	113,164	4%
1,490–2,599	17,987	3%	296,492	10%
> 2,600	0	0%	3,103	0%
Downlight/Specialty	**93,327**	**13%**	**0**	**0%**
< 600	6,678	1%	0	0%
600–950	84,194	12%	0	0%
950–1,400	1,846	0%	0	0%
> 1,400	609	0%	0	0%
Total	**705,673**	**100%**	**2,838,498**	**100%**

3.2.3 Residential versus Commercial Installations

As part of the in-store customer intercept interviews, we asked customers if they intended to install the bulbs in a home or business. If a business, we further asked for the type of business and, if a rental property, inquired as to whether the bulbs would be installed in a common area or a tenant unit. We classified bulbs that would be installed in tenant units as residential installations. For customers who said that they would install the bulbs in both their home and business, we evenly divided the bulbs between the two locations. Overall, we found that 94% of discounted bulbs would be installed in residential locations and 6% in commercial locations (see Table 19). Commercial customers were more likely to purchase CFLs than LEDs.

Table 19. Bulb Installation Location

Location	CFLs	LEDs	Total
Residential	93%	97%	94%
Commercial	7%	3%	6%

3.2.4 Program Leakage

As an upstream program that provides automatic discounts of light bulbs at the POP, there is no way for the program to restrict retailer lighting sales to AIC customers. As a result, some of the bulbs sold through the program are likely purchased by non-AIC customers (program leakage). To estimate program leakage, we asked customers purchasing program-discounted products for the name of the utility that provides electricity to the location where they said that they would install the program bulbs. The location of the retailer relative to non-AIC territory should affect the leakage rate. Therefore, we constructed and applied weights based on the distance of each store from AIC territory borders. This approach is consistent with the approach applied to develop a program leakage rate in the past evaluations.

We found that 13% of discounted bulbs were purchased by non-AIC customers. Analysis of leakage by retailer distance from the border shows that, generally, the farther the retailer is located from the border, the lower the leakage rate (see Table 20).

Table 20. Percent of Program Bulb Purchases by Non-AIC Customers by Retailer Distance from the Border

Retailer Distance from AIC Border	n	% Leakage Out
Within 5 miles	172	18%
5–10 miles	96	10%
10–15 miles	39	14%
15+ miles	23	0%
Total	**330**	**13%**

Table 21 lists the electric providers of customers who purchased program bulbs. The percentages represent the percentage of program bulbs purchased by these customers, so the overall leakage rate is the percentage of discounted bulbs that leaked out of AIC territory.

Table 21. Electric Utility Provider of Program Bulbs Purchasers

Utility	Percent
Ameren Illinois[a]	87%
Corn Belt Electric	2%
Egyptian Electric	1%
Commonwealth Edison	1%
Other[b]	9%
Total	100%

[a] "Ameren Illinois" includes CIPS, CILCO, and Home Field.

[b] "Other" includes SEIEC, REA, Shelby Electric, and SWECI.

In addition to sales of program bulbs to non-AIC customers, previous research has explored the potential for AIC customers to purchase bulbs discounted by neighboring utilities. The PY7 evaluation estimated that AIC customers purchased the equivalent of 5% of AIC's total program sales that are discounted by nearby utilities. Based on our estimates of both leakage out and leakage in, we estimate an overall leakage rate of 8%.

3.2.5 Gross Impacts

Table 22 outlines the ex post gross savings for the PY8 Residential Lighting Program. As noted earlier, the program uses net per-unit savings values to set program goals and track performance and does not have gross per-unit values.[8] Therefore, it is not possible for us to calculate ex ante gross savings or calculate a gross realization rate. Program administrators also did not calculate the demand savings results from the sale of program-discounted bulbs.

Because some bulbs sold are stored for later use, an installation adjustment factor or ISR is required to calculate the gross savings achieved in PY8. We used the method outlined in the IL-TRM V4.0 that banks savings from a portion of sales for application in future years. The ex post gross savings achieved in PY8 therefore include a combination of bulb sales from PY6, PY7, and PY8 that were installed in PY8. Appendix A contains additional details about the savings assumptions we used to calculate program savings.

[8] The program conducts internal tracking of gross savings using TRM-based savings assumptions. To maintain consistency across gross and net savings as well as energy and demand savings, we only report savings using the per-unit savings method, which the program used to set program goals.

Table 22. PY8 Residential Lighting Program Gross Impacts

Sales Year / Install Year	Energy (MWh)		Demand (MW)	
	Ex Ante	Ex Post	Ex Ante	Ex Post
PY6 / Year 3	N/A	18,992	N/A	2.4
PY7 / Year 2	N/A	17,494	N/A	2.2
PY8 / Year 1	N/A	91,203	N/A	11.7
Total PY8 Gross Savings	N/A	127,688	N/A	16.2
PY8 Achieved Gross Realization Rate	N/A		N/A	

Note: Realization Rate = Ex Post Value / Ex Ante Value.

Table 23 provides the savings values from sales made in PY8 that are claimed in PY8 and the savings that will carry over to PY9 and PY10 due to their later installation. As discussed earlier, the IL-TRM V4.0 method assumes that 98% of CFLs will be installed within 3 years and 2% of bulbs will never be installed.

Table 23. PY8 Residential Lighting Sales Gross Impacts, PY8–PY10

Measure	Energy (MWh)			Demand (MW)		
	PY8	PY9	PY10	PY8	PY9	PY10
CFL Standard	69,436	13,109	11,143	9.14	1.76	1.49
LED Omnidirectional	17,193	279	246	2.00	0.03	0.03
LED Downlights	4,574	74	65	0.57	0.01	0.01
Total	91,203	13,463	11,454	11.71	1.80	1.53

3.2.6 Net Impacts

PY8 ex post net savings is comprised of sales from PY6, PY7, and PY8. To calculate ex post net savings, we applied NTGRs approved by the SAG for each program year to the sales made in that year. We applied the SOW net per-unit savings to bulb quantities in the sales data extract to represent ex ante net kWh savings. There were no per-unit kW savings.[9]

Table 24. PY8 Residential Lighting Program Net Energy Impacts

Sales Year / Install Year	Net Energy (MWh)		Demand (MW)	
	Ex Ante	Ex Post	Ex Ante	Ex Post
PY6 / Year 3	N/A	8,926	N/A	1.11
PY7 / Year 2	N/A	8,222	N/A	1.01
PY8 / Year 1	N/A	59,634	N/A	7.63
Total PY8 Net Savings	48,141	76,783	-	9.76
PY8 Achieved Net Realization Rate	1.59		-	

[9] The program conducts internal tracking of kW savings using TRM-based savings assumptions. To maintain consistency across gross and net savings as well as energy and demand savings, we only report savings using the per-unit savings method, which the program used to set program goals.

Note: Realization Rate = Ex Post Value / Ex Ante Value.

The Residential Lighting Program's realization rate for PY8 net energy savings is 1.59. One reason that ex ante savings are less than ex post savings is that the program did not track and claim PY6 and PY7 bulb sales installed during PY8 (22% of the difference in savings is due to unclaimed carryover savings). Because the program did not provide information about the source of the per-unit values used to estimate savings, it is not possible to determine why ex post net savings is larger than ex ante net beyond the application of carryover savings.

Table 25 shows per-unit net ex ante and ex post energy savings by bulb type. The ex post values are greater than the ex ante values, as would be expected given the net realization rate of 1.59. As noted earlier, the program classified LEDs using the categories that have traditionally been used for CFLs (i.e., standard and specialty), whereas the evaluation team used the LED classifications from the IL-TRM V4.0 (i.e., omnidirectional and downlight). The groupings overlap but are not exactly the same.

Table 25. Deemed Energy Savings Comparison for PY8 Sales

Measure	Ex Ante Net kWh Savings per Bulb	Ex Post Net kWh Savings per Bulb
CFL Standard	11.64	15.41
LED Standard/ Omnidirectional	17.13	20.50
LED Specialty/Downlights	34.71	35.78

Note: LED standard bulbs is an ex ante savings classification and is limited to A-lamps. Omnidirectional LEDs are the equivalent ex post savings category and includes A-lamps and specialty LEDs. LED specialty bulbs is an ex ante savings classification and includes all specialty bulbs (i.e., any bulb that is not A-lamp). Downlight LEDs are the equivalent ex post savings category and include only reflector LEDs.

4. Conclusions and Recommendations

The Residential Lighting Program ran smoothly in PY8, exceeding all of its goals for bulb sales and energy savings. Total bulb sales decreased by 13% from PY7 as the program shifted its focus toward LED products, which are generally more expensive and require larger discounts than their CFL counterparts. Still, the more-efficient LED technology typically yields slightly more savings per bulb, which helps compensate for the decrease in total sales. The shift resulted in the program boosting sales of LEDs from less than 1% in previous years to 20% of bulbs sold in PY8. The types of LEDs were also diversified to include downlights and other shapes besides A-lamp.

Based on the results of the PY8 Residential Lighting Evaluation, the evaluation team offer the following key findings and recommendations for the program moving forward:

- **Key Finding #1:** Our stocking study and in-store intercept results indicate that the lighting market is transforming and moving away from CFLs to LEDs. LEDs are the most common product on retailer shelves and more customers purchased LEDs than any other light bulb technology. LEDs are the most prominent technology and are taking up shelf space formerly occupied by CFLs as well as incandescents. Results from our in-store interviews show that 62% of customers purchased at least one energy-efficient bulb (CFL or LED), and 42% purchased at least one less-efficient bulb (incandescent or halogen). A greater percentage of customers purchased an LED than any other bulb type (36%).

  - **Recommendation:** Although the lighting market is transforming and shifting to LEDs, it is important to continue discounts for LEDs given the presence of less efficient halogens and lower quality LEDs. Customers are willing to pay a somewhat higher price for LEDs, but they are also attracted to lower-cost, lower-quality LEDs. The new ES 2.0 standards, which go into effect January 2017, lower the requirements for LEDs to be ES certified. As a result, costs of ES LEDs should drop and help push some of the low-quality products off retailer shelves. However, it is not yet clear that will happen, or whether retailers will still reserve shelf space for non-ES bulbs that undercut ES bulb pricing. LED discounts are important to continue the transformation of the lighting market. Quality is a concern for market transformation to continue. Many consumers had a bad experience with the first generation of CFLs, which slowed adoption. The program could help ensure that there is not a repeat experience with LEDs and continued discounts on ES LEDs will help.

    While it is important to continue LED discounts, as the lighting market continues to transform, the program may need to consider transitioning from a mass market approach that discounts every bulb type to one that targets customers who lag behind in efficient bulb use. Program administrators discontinued the online store after PY7 but may want to consider bringing it back and target marketing the store to select customers. The evaluation team is currently conducting a lighting penetration and saturation study that will provide results that could help select customer types to target.

- **Key Finding #2.** The LED specialty market lags behind the standard market. Low-cost, less-efficient specialty bulbs are more readily available and consumers are more likely to purchase them. Though specialty LEDs are increasingly available (42% of specialty products were LEDs in PY8 compared to 21% in PY6) the majority of customers still buy less-efficient bulbs (i.e., incandescents and halogens). In fact, we found through our in-store intercepts that customers purchased less efficient specialty bulbs at a higher rate in PY8 than in PY6 (74% compared to 65%). Our stocking study results show that the specialty market is still a challenging one in terms of price. Without program discounts, quality

specialty LEDs were much more expensive in PY8 than less-efficient products, CFLs, or lower-quality LEDs.

- **Recommendation:** The program should increase its focus on specialty LEDs. ES specialty LEDs cost significantly more than less-efficient bulbs or low-quality specialty LEDs and without program discounts, customers will continue to purchase these low cost alternatives. Program administrators should consider more-aggressive goals for specialty bulbs.

- **Key Finding #3:** The contract between AIC and the program implementer sets net savings goals using per-unit values for different bulb types. It was not clear how these per-unit values were determined. Our evaluated per-unit values ended up being greater than those used to set program goals. However, this may not be the case in future years.

  - **Recommendation:** To ensure greater certainty when planning, we recommend that the program implementer work with the evaluation team to develop per-unit values based on TRM assumptions.

Appendix A. Gross Impact Assumptions

In this appendix, we provide details on the savings assumptions used to estimate ex post gross electric and demand savings.

Base Wattage – EISA Compliance

The baseline wattages in the IL-TRM V4.0 are based on the lumen output and the year the bulb is installed, as shown in Table 26. For example, as of June 2012, EISA-compliant halogen bulbs are the baseline wattage for standard bulbs that produce between 1,490 and 2,600 lumens, thus dropping the base wattage from 100 to 72 watts.

Table 26. Baseline Wattages for Calculation of Gross Savings after EISA

Lumen Range	Pre-EISA 2007 Base Wattage	Post-EISA 2007 Base Wattage	Post-EISA 2020 Base Wattage
250–309	25	25	25
310–749	40	29	11.8
750–1,049	60	43	20
1,050–1,489	75	53	28.2
1,490–2,600	100	72	45.4
2,601–2,999	150	150	150
3,000–5,279	200	200	200
5,280–6,209	300	300	300

The program-tracking data provided the lumens per bulb, and the evaluation team was able to match and verify the program-tracked base wattages using Table 26.

Hours of Use

For the 94% of bulbs sold to residential customers, we applied the residential HOU assumptions, and for the 6% of bulbs sold to commercial entities we applied the commercial HOU assumptions from the IL-TRM V4.0 (see Table 27). The TRM provides different HOU assumptions for different bulb types. For commercial HOU, one value is provided for exterior installations and another is given for installations that could be either indoors or outdoors. We applied the latter assumption to exterior downlight bulbs and the former to all other bulb types.

Table 27. Illinois Statewide Technical Reference Manual Version 4.0 Hours of Use Assumptions

Bulb Type	Program Tracked	Residential	Commercial
CFL			
Standard	2,838,498	847	3,612
LED			
Omnidirectional (A-lamp)	534,289	847	3,612
Omnidirectional (CMB/CSB)	58,374	847	3,612
Omni-directional (G25/G16C)	19,126	847	3,612
Omni-directional (3-way)	557	847	3,612
Downlight (BR/R)	89,486	891	3,612
Downlight (PAR)	3,340	891	3,612
Downlight (Exterior)	501	891	4,903

Waste Heat Factors

The IL-TRM V4.0 provides different waste heat factor values for different installation locations. For energy savings, we used a waste heat factor of 1.06 for the 94% of bulbs that were installed in residential locations and 1.31 for the 6% that were installed in commercial locations.[10] For demand savings, we used a waste heat factor of 1.11 for the 94% of bulbs that were installed in residential locations and 1.53 for the 6% that were installed in commercial locations. Bulb types that customers would normally install in exterior locations take on a value of 1.00 because these bulbs do not affect the heated areas of a building. Table 28 outlines waste heat factor assumptions by installation location and bulb type.

[10] The TRM provides a large variety of waste heat factors for commercial installations based on building type. Because we do not know the installation locations of bulbs sold to commercial customers, we followed the TRM guidelines and chose the WHFe for miscellaneous buildings.

Table 28. Illinois Statewide Technical Reference Manual Version 4.0 Waste Heat Factor Assumptions

Bulb Type	Program Tracked	Residential		Commercial	
		WHFe	WHFd	WHFe	WHFd
CFL					
Standard	2,838,498	1.06	1.11	1.31	1.53
LED					
Standard	534,289	1.06	1.11	1.31	1.53
Reflector (BR/R)	89,486	1.06	1.11	1.31	1.53
Reflector (PAR)	3,340	1.06	1.11	1.31	1.53
Reflector (Exterior)	501	1.00	1.00	1.00	1.00
Specialty (CMB/CSB)	58,374	1.06	1.11	1.31	1.53
Specialty (G25/G16C)	19,126	1.06	1.11	1.31	1.53
Specialty (3-way)	557	1.06	1.11	1.31	1.53

Coincidence Factors

The IL-TRM V4.0 provides peak CFs based on bulb type and installation location. For the 94% of bulbs sold to residential customers, we applied the residential factors and, for the remaining 6%, we applied the commercial factors (see Table 29). For residential installs, the TRM provides CFs by bulb type for standard, specialty, and reflector CFLs. However, among LEDs, residential CF is specified only for standard and select reflector bulb types. Therefore, residential CFs for specialty and reflector CFLs were applied to respective LED bulb type in cases where the value was not specified for LEDs. For bulbs installed in commercial locations, the TRM provides one CF for interior installation and one for exterior regardless of bulb type.

Table 29. Illinois Statewide Technical Reference Manual Version 4.0 Coincidence Factor Assumptions

Bulb Type	Program Tracked	Residential	Commercial
CFL			
Standard	2,838,498	0.081	0.660
LED			
Standard	534,289	0.081	0.660
Reflector (BR/R)	89,486	0.091	0.660
Reflector (PAR)	3,340	0.094	0.660
Reflector (Exterior)	501	0.273	0.000
Specialty (CMB/CSB)	58,374	0.121	0.660
Specialty (G25/G16C)	19,126	0.075	0.660
Specialty (3-way)	557	0.078	0.660

Appendix B. Inputs for Future Planning

As part of the in-store lighting customer interviews, we conducted research to update key inputs to the algorithm used to calculate Residential Lighting Program savings. The inputs include a program ISR and NTGR.

In-Service Rate

As part of the in-store customer interviews, we asked customers who were purchasing program-discounted bulbs to estimate the number of bulbs that they expected to install within 6 months. Their responses serve as a first-year ISR. Using the carryover method outlined in IL-TRM V4.0, we assume that 98% of all bulbs will be installed within 3 years of purchase with 55% of bulbs remaining after the first year installed in year two and 45% installed in year three. For standard CFLs, this approach results in 77% of bulbs being installed in the first year, 12% of the bulbs installed in year two, and 9% installed in year three. We found a greater first-year installation rate for omnidirectional LEDs with 90% installed in the first year, leaving 4% in year two and 4T installed in year three (see Table 30).

Table 30. Residential In-Service Rates

Bulb Type	First Year	Second Year	Third Year	Final
Standard CFLs	77%	12%	9%	98%
Omnidirectional LEDs	90%	4%	4%	98%

Net-to-Gross Ratio

As part of the in-store lighting customer interviews, we conducted research to update key inputs to the algorithm used to calculate Residential Lighting Program savings. We provide additional details on the calculation of the NTGR below.

Key Findings

The NTGR includes FR and participant and non-participant spillover (see Equation 1 below).

Equation 1. NTGR Ratio

$$NTGR = 1 - FR + Participant\ Spillover + Non\text{-}Participant\ Spillover$$

The estimated FR rate was the same for CFLs and LEDs: 0.38. Our analysis did not identify participant spillover for either bulb type. However, we did detect non-participant spillover: 0.01 for CFLs and 0.07 for LEDs. The overall program NTGR is 0.64 (0.63 for CFLs, 0.69 for LEDs), as seen in Table 31.

Table 31. Residential Lighting Program NTGR

Concept	CFLs	LEDs	Overall
FR	0.38	0.38	0.38
Participant Spillover	0.00	0.00	0.00
Non-Participant Spillover	0.01	0.07	0.02
NTGR	**0.63**	**0.69**	**0.64**

Methodology

Opinion Dynamics developed a NTGR for the program using the algorithm outlined in the IL-TRM V5.0. We used the in-store customer interviews to estimate program FR and spillover. We describe the methods used for FR and spillover below, and provide results for both.

Free-Ridership

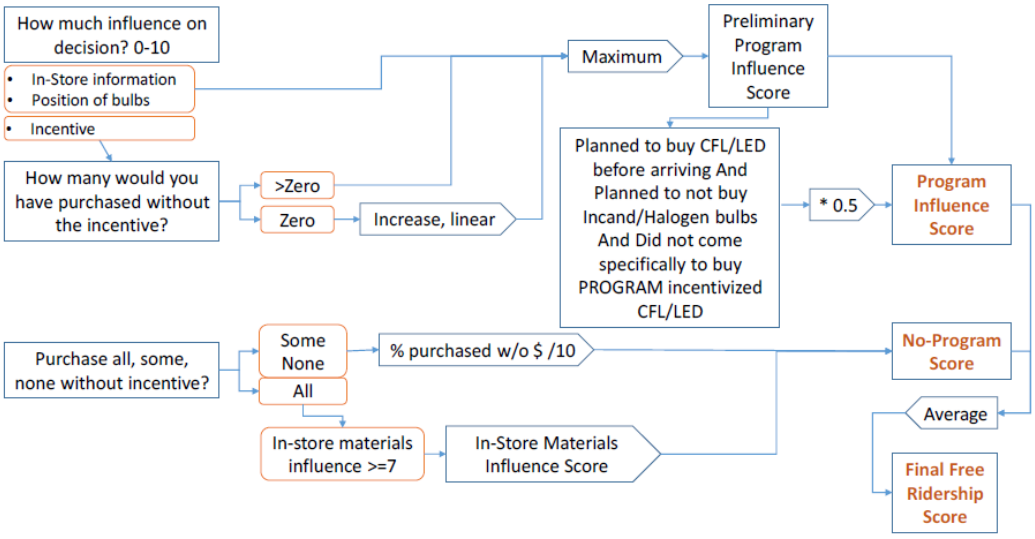
FR represents the portion of participants who would have purchased program bulbs in the absence of the program. The Residential Lighting Program encourages customers to purchase efficient lighting by reducing the purchase price so that it is closer to that of less-efficient alternatives. The program also educates consumers about the benefits of efficient lighting. The final FR score accounted for both avenues of program influence.

As prescribed in the IL-TRM V5.0, Opinion Dynamics calculated FR as the average of two distinct scores: a program influence score and a no-program score.

- **The program influence score** captures the maximum level of program influence, reported by a survey respondent, of the Residential Lighting Program on his or her decision to purchase program-discounted bulbs on the day of the survey. Program influence can take a number of forms, such as the monetary incentive provided to decrease the cost of high-efficiency bulbs, program-sponsored educational materials that explain the benefits of efficient lighting, in-store product placement of efficient bulbs, and program bulb recommendations provided by retail store personnel.
- **The no-program score** is used to estimate how many program bulbs a survey respondent would have purchased in the absence of the Residential Lighting Program.

Figure 9 provides a visual diagram of the FR estimation approach.

Figure 9. FR Calculation Diagram



Source: IL-TRM V5.0.

Using the algorithm outlined in the figure above, we estimated FR for each survey respondent and then combined the scores in proportion to the number of program-discounted bulbs each respondent purchased.

We estimated FR separately for CFLs and LEDs. Due to a very small number of observations (n=2), we were unable to develop a separate FR estimate for directional LEDs. We combined the FR estimates for directional LEDs and omnidirectional LEDs for a single LED FR estimate. We developed a program-level FR estimate by weighting the results by program sales, bulb type, and retail channel.

As we discussed in Section 2.2.3, to gain entry to the stores to conduct the interviews, part of the first day of data collection at each store was done in conjunction with a program lighting demonstration. We conducted interviews for an additional 2 days at each store when there was no demonstration. The combined FR rate for CFLs and LEDs during the demonstration was 0.27, compared to 0.38 when a demonstration was not present.[11] The lower FR rate during demonstration hours shows that lighting demonstrations are effective at encouraging customers who would have purchased less-efficient bulbs to purchase CFLs or LEDs instead. The difference in FR rates is slightly greater for LEDs than CFLs, suggesting that the demonstrations may have had greater influence on LED sales than CFLs (see Table). Because of the relatively small number of hours that demonstrations take place relative to all of the hours that participating retailers are open, we use the FR estimate from interviews conducted during non-demonstration hours to calculate the program NTGR because this better represents the normal store environment.

Table 7. Free-Ridership by Bulb Type and Demonstration vs. Non-Demonstration Hours

	CFLs		LEDs		Total	
Day Type	n	FR Rate	n	FR Rate	n	FR Rate
All hours	161	0.37	124	0.33	281	0.36
Demonstration hours	33	0.28	41	0.22	73	0.27
Non-demonstration hours[a]	128	0.38	83	0.38	208	0.38

Note: A small number of customers purchased both CFLs and LEDs. These customers are counted only once in the total column though they are represented in both the CFL and LED columns. Therefore the number of CFL and LED customers is greater than the total number of customers.

[a] We use this estimate in the calculation of overall lighting program NTGR.

Participant Spillover

Participant spillover results from purchases of non-discounted CFL and LED products by program participants who were influenced by the program interventions. As part of the in-store interviews, we asked participants who were purchasing non-discounted lighting products in addition to discounted products about their reasons for purchasing a mix of program and non-program bulbs, as well as the influence of the program on their decision to purchase non-discounted products. Using a 0–10 scale, where 0 is not influential and 10 is extremely influential, respondents who gave a rating of greater than 5 met the definition of "program influenced." Based on these responses, no participants purchased spillover bulbs.

Non-Participant Spillover

Non-participant spillover results from purchases of non-discounted CFLs and LED products by non-participants who were influenced by the program interventions. As part of the in-store interviews, we asked customers who

[11] Our FR estimate is based on interviews with 439 customers who purchased a total of 5,843 bulbs after excluding interviews conducted with non-AIC customers. Sampling theory does not apply to this study because we had to use a convenience sample to select the stores to include and the time frame of the study. Therefore, it is not appropriate to estimate a precision level for these results or conduct tests of statistical significance.

were purchasing only non-discounted efficient lighting products but who were aware of the program interventions why they were purchasing non-program bulbs instead of program-discounted bulbs, as well as about the influence of the program on their decision to purchase non-discounted products. Based on these responses, we found evidence of non-participant spillover. We employed a three-step process to estimate non-participant spillover:

- **Step 1: Estimate the amount of non-participant spillover in the survey sample.** Using the in-store survey results, we identified the non-participant survey population and the total number of program-influenced non-discounted bulbs (spillover bulbs) purchased. Using a 0–10 scale, where 0 is not influential and 10 is extremely influential, respondents who rated the influence of the program as greater than 5 met the definition of "program influenced." We developed a per-customer bulb average by dividing total spillover bulbs by the non-participant survey population.

- **Step 2: Extrapolate non-participant spillover to the population.** We estimated the number of non-participating customers across the population of AIC customers and developed an estimate of total spillover bulbs purchased. We multiplied the average number of spillover bulbs per customer from Step 1 by the total population of non-participants.

- **Step 3: Estimate non-participant spillover rate.** We divided the population estimate of total spillover bulbs from Step 2 by the total number of bulbs discounted by the program in PY8 (from program-tracking data).

Table 32 summarizes the results of the analysis. Overall, 161 of the 679 customers interviewed during the non-demonstration period (24%) purchased non-program CFLs or LEDs.[12] Of these customers, only 11 reported that they were both aware of *and* influenced by the program interventions. The 11 participants purchased a total of 50 light bulbs: 16 CFLs and 34 LEDs.

When we extrapolate the results to the AIC customer base, we estimate that out of the population of 1,039,533 customers, 246,487 purchased at least one non-discounted CFL or LED. However, we estimate that far fewer—16,841—purchased non-discounted CFLs or LEDs *and* were influenced by the program. Based on the average number of bulbs purchased by our spillover sample respondents, we estimate that these 16,841 customers purchased a total of 87,875 CFLs and LEDs. Dividing those spillover bulbs by the total number of bulbs discounted by the program in PY8 results in a non-participant spillover estimate of 0.03. The non-participant spillover rate is considerably higher for LEDs compared to CFLs (0.07 vs. 0.01), but because CFLs make up 80% of total sales, the overall estimate is heavily weighted toward the CFL spillover rate.

Table 32. Non-Participant Spillover Analysis

	CFLs		LEDs		Total	
Calculation Input	Sample	Population	Sample	Population	Sample	Population
Total customers	679	1,039,533	679	1,039,533	679	1,039,533
Non-participating customers purchasing non-discounted CFLs/LEDs	35	53,584	128	195,965	161	246,487
Non-participating customers purchasing non-discounted CFLs/LEDs influenced by the program	3	4,593	8	12,248	11	16,841

[12] Similar to the estimation of FR, we removed customers with whom we completed interviews during the demonstration period from the analysis.

Calculation Input	CFLs		LEDs		Total	
	Sample	Population	Sample	Population	Sample	Population
Average number of spillover bulbs per customer	5.3		4.3		5.2	
Total number of spillover bulbs	16	24,496	34	52,053	50	87,865
Total number of PY8 program-discounted bulbs[a]	2,838,498		705,673		3,544,171	
Spillover Rate	**0.01**		**0.07**		**0.02**	

[a] Non-downlight specialty LEDs are omitted from these sums because key information was not collected from customers purchasing these bulb types.

Appendix C. Other Cost-Effectiveness Inputs

Heating Penalty Methods

The heating penalty represents the increase in gas usage because of the additional space heating needed due to the reduction of waste heat generated by the more-efficient lighting.[13] The penalty is used in the analysis of program cost-effectiveness. The IL-TRM V4.0 provides different algorithms to calculate the heat penalty for residential and commercial installations.

For residential homes:

$$Year\ 1\ \Delta\ Therms = LA \times 0.94 \times \left[\frac{(Base\ Watt - Bulb\ Watt)}{1000} \times ISR_{res,yr1} \times HOU_{res} \times HF_{res} \times 0.03412\right] \Big/ \eta Heat$$

Where:

LA = Leakage adjustment equal to (1 − leakage rate) or (1 − %Leakage)
0.94 = Residential install rate
Base Watt = EISA-compliant base wattage
Bulb Watt = Actual wattage of installed bulb
ISR = First year ISR
HOU = Hours of use
HF = Heating factor or percentage of light savings that must be heated
0.03412 = Conversion factor from kWh to Therms
ŋHeat = Efficiency of heating system.

For commercial facilities:

$$Year\ 1\ \Delta\ Therms = LA \times 0.06 \times \frac{(Base\ Watt - Bulb\ Watt)}{1000} \times ISR_{com,yr1} \times HOU_{com} \times IFTherms_{com}$$

Where:

LA = Leakage adjustment equal to (1 − leakage rate) or (1 − %Leakage)
0.06 = Commercial install rate
Base Watt = EISA-compliant base wattage
Bulb Watt = Actual wattage of installed bulb
ISR = First year ISR
HOU = Hours of use
IFTherms = Lighting-HVAC integration factor for gas-heating impacts; this factor represents the increased gas space heating requirements due to the reduction of waste heat rejected by the efficient lighting

To calculate the weighted program heat penalty, we apply both the residential and commercial savings algorithms outlined in the IL-TRM V4.0 and multiply them by the probability of being installed in each location. Our weighted savings equation is:

[13] We follow the direction of the IL-TRM V4.0 and assume all homes are gas heated because we do not have information on the heating fuel of customers' homes. Thus, we calculate only a gas-heating penalty.

$$Year\ 1\ \Delta\ Therms = LA \times 0.94 \times \left[\frac{(Base\ Watt - Bulb\ Watt)}{1000} \times ISR_{res,yr1} \times HOU_{res} \times HF_{res} \times 0.03412\right] \Big/ \eta Heat$$

$$+ LA \times 0.06 \times \left[\frac{(Base\ Watt - Bulb\ Watt)}{1000} \times ISR_{com,yr1} \times HOU_{com} \times IFTherms_{com}\right]$$

Where:

LA = Leakage adjustment equal to (1 − leakage rate) or (1 − %Leakage)
Base Watt = EISA-compliant base wattage
Bulb Watt = Actual wattage of installed bulb
ISR = First year ISR
HOU = Hours of use
WHFe = Waste heat factor for energy savings
Res = Residential values
Com = Commercial values

To calculate the heating penalty for PY8 purchases that will be installed during the next 2 years, we simply apply the ISR for year 2 and year 3 and modify the base wattage if necessary:

$$Year\ 2\ \Delta\ Therms\ Heat\ Penalty$$
$$= LA \times 0.94 \times \left[\frac{(Base\ Watt - Bulb\ Watt)}{1000} \times ISR_{res,yr2} \times HOU_{res} \times HF_{res} \times 0.03412\right] \Big/ \eta Heat +$$
$$LA \times 0.06 \times \left[\frac{(Base\ Watt - Bulb\ Watt)}{1000} \times ISR_{com,yr2} \times HOU_{com} \times IFTherms_{com}\right]$$

$$Year\ 3\ \Delta\ Therms\ Heat\ Penalty$$
$$= LA \times 0.94 \times \left[\frac{(Base\ Watt - Bulb\ Watt)}{1000} \times ISR_{res,yr3} \times HOU_{res} \times HF_{res} \times 0.03412\right] \Big/ \eta Heat +$$
$$LA \times 0.06 \times \left[\frac{(Base\ Watt - Bulb\ Watt)}{1000} \times ISR_{com,yr3} \times HOU_{com} \times IFTherms_{com}\right]$$

Heat Penalty-Related Factors

The heating factors represent the increased gas space heating needed due to the reduction of waste heat generated by the more-efficient lighting. The IL-TRM V4.0 provides different factors based on installation location.

Table 33. Heating Penalty Factors for Calculating Gas Heat

Bulb Type	Ex Post Residential	Ex Post Commercial
	Heating Factor	Lighting-HVAC Integration Factor
Standard		
Standard	0.49	0.014
Specialty		
A-lamp	0.49	0.014
Bug Light	0.00	0.000
Candelabra	0.49	0.014
Dimmable Spiral	0.49	0.014
Exterior Reflector	0.00	0.000
Globe	0.49	0.014
High-Output Spiral	0.49	0.014
Interior Reflector	0.49	0.014
Post Light	0.49	0.014
Three-Way	0.49	0.014
LEDs		
A-lamp	0.49	0.014

Heating Penalty Results

The gas-heating penalty that results from the additional space heating needed due to the reduction of waste heat generated by more-efficient lighting is shown in Table 34.

Table 34. Gas Heating Penalty

Measure	Heating Penalty (Therms)		
	PY6	PY7	PY8
CFL Standard	−1,469,236	−275,321	−234,058
LED Omnidirectional	−342,161	−5,596	−4,917
LED Specialty	−57,406	−4,146	−3,528
LED Downlights	−87,599	−6,388	−5,437
Total	**−1,956,401**	**−291,450**	**−247,940**

Appendix D. Program Savings by Funding Source

PY8 savings for the Residential Lighting Program are comprised of bulbs sold in PY6, PY7, and PY8 and installed in PY8. The program was entirely funded by AIC in PY6, both AIC and the IPA in PY7, and entirely by the IPA in PY8. Tables Table 35 and Table 36 provide PY8 gross and net savings by the year the bulbs were sold and the funding source.

Table 35. PY8 Gross Impacts by Bulb Sales Year and Funding Source

Program Year	AIC (8-103)		IPA		Total	
	kWh	kW	kWh	kW	kWh	kW
PY6	18,992	2.37	-	-	18,992	2.37
PY7	15,882	1.96	1,612	0.19	17,494	2.15
PY8	-	-	91,203	11.71	91,203	11.71
Total	**34,874**	**4.33**	**92,814**	**11.90**	**127,688**	**16.23**

Table 36. PY8 Net Impacts by Bulb Sales Year and Funding Source

Program Year	AIC (8-103)		IPA		Total	
	kWh	kW	kWh	kW	kWh	kW
PY6	8,926	1.11			8,926	1.11
PY7	7,465	0.92	758	0.09	8,222	1.01
PY8			59,634	7.63	59,634	7.63
Total	**16,391**	**2.03**	**60,392**	**7.72**	**76,783**	**9.76**

Appendix E. Data Collection Instruments

Ameren Illinois P

Ameren Illinois P

Ameren Illinois P

Ameren Illinois P

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