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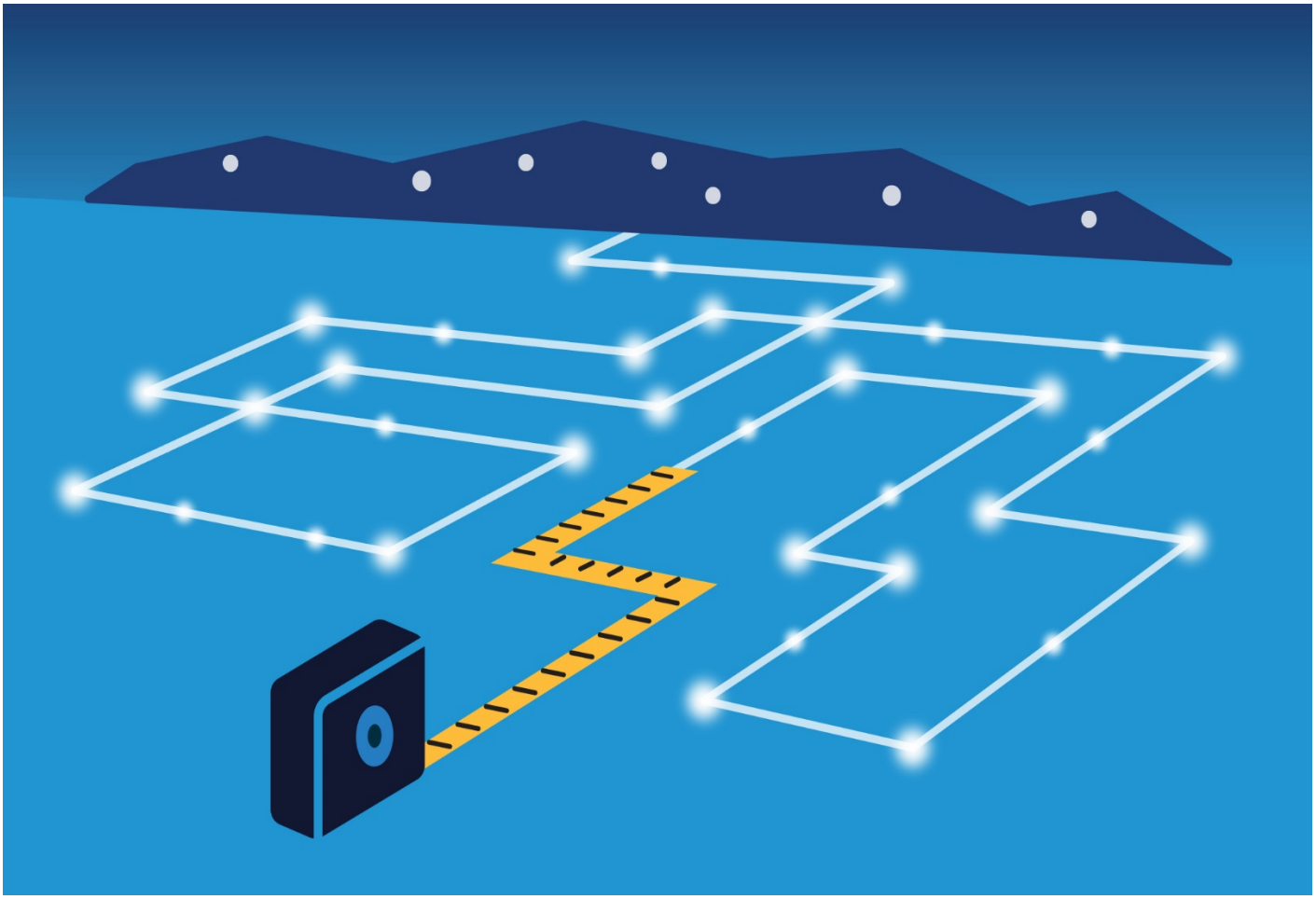

Impact and Process Evaluation of the 2014 Illinois Power Agency Residential Lighting Program: Retail Specialty

Draft

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1. Executive Summary

The Illinois Power Agency (IPA) Residential Lighting Program (hereafter "Residential Lighting Program") has as its aim the eventual transformation of the residential lighting market in Ameren Illinois Company (AIC) service 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, 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 seven years, the program has discounted 21,127,632 energy efficient light bulbs and fixtures.

This report presents results of Opinion Dynamics' evaluation of the Residential Lighting Program during its seventh year of operation (program year 7, or PY7), which ran from June 2014 to May 2015. The PY7 program included providing discounts for the Specialty CFL Retail Program.[1] In addition, AIC offered discounts for the Standard CFL Retail Program and through a Web Store Program, which sells standard CFLs, specialty CFLs and LEDs. In addition, Ameren Illinois Company (AIC) offered discounts for the Standard CFL Retail program. The program is implemented by Leidos and its subcontractors CLEAResult (formerly Conservation Services Group [CSG]) and Energy Federation, Incorporated (EFI).

This report focuses solely on retail sales of specialty CFLs.

1.1 Impact Results

The Residential Lighting Program sold 403,952 specialty CFLs in PY7. Bulbs were sold at participating retail stores. Compared to PY6 sales (850,195), the program sold 52% fewer specialty CFLs in PY7.[2]

The carryover savings method outlined in the Illinois Statewide Technical Reference Manual (TRM) for Energy Efficiency Version 2.0 (IL-TRM V2.0) spreads program savings across the three years customers take to install all of the bulbs they purchase. As a result, PY7 savings come from bulbs customers *installed* in PY7 but which they may have *purchased* in PY5, PY6, or PY7. Because AIC funded all sales in PY5 and PY6, the evaluation team decided to count all carryover savings from these years within the Standard Lighting Program Evaluation. Thus, net energy impacts for the specialty CFL in-store markdowns consist only of savings from bulbs purchased and installed during PY7. As shown in Table 1, the program achieved a net energy impact of 6,022 MWh and a net demand impact of 0.72 MW.

[1] Throughout this report, we use the program definition of standard versus specialty CFLs. A standard CFL is a spiral bulb that does not have any special functions. A specialty CFL has glass covering the spiral, can be dimmed, can function as a 3-way bulb, or has other special functions.

[2] The AIC Residential Lighting Program sold 3,672,388 bulbs in PY7. Nearly all (99%) were standard CFLs sold through retail stores. When looking at bulbs sold through both the IPA and AIC programs, the vast majority of bulbs sold were standard CFLs (90%).

Table 1. PY7 Net Residential Lighting Program Impacts

	Ex Ante Gross	Realization Rate	Ex Post Gross	NTGR	Ex Post Net
Energy Savings (MWh)					
Total MWh	14,237	0.90	12,813	0.47	6,022
Demand Savings (MW)					
Total MW	1.55	0.98	1.52	0.47	0.72

Note: Realization Rate = Ex post Value / Ex ante Value

Ex-post savings are different from ex ante savings due to the following methodological reasons:

- The program savings method uses an In-Service-Rate (ISR) of 1.00 for specialty bulbs, which assumes that 100% of bulbs purchased in PY7 are also installed in PY7. As recommended by the IL-TRM V2.0, we applied ISR values over three years: an ISR at 79.5% in the first year, and the remaining bulb installations distributed over the next two years. As a result, ex post gross energy savings (kWh) are 20.5% lower and ex post gross demand savings (kW) are 20.5% lower than ex ante gross savings due to the application of the carry over savings method.

- The program savings method uses different hours of use (HOU) than the IL-TRM V2.0 recommends. We applied IL-TRM V2.0 HOU for standard and specialty bulb types, which tend to be higher than the values used in the program savings method. As a result, ex post gross energy savings (MWh) and demand savings (MW) are 12.7% higher than ex ante gross savings.

- The program database misclassified several bulbs, resulting in different base wattages for a small portion of bulbs (less than 0.25% of bulbs sold). Combined, ex post gross savings are about .11% higher than ex ante gross savings for both energy (MWh) and demand (MW).

- The program savings method does not use waste heat factors in the ex ante savings calculations. The evaluation team applied the waste heat factors recommended in IL-TRM V2.0 to calculate ex post energy and demand savings. As a result, ex post gross energy savings (MWh) are 6.6% higher and ex post gross demand savings (MW) 12.3% higher than ex ante gross savings.

- The program savings method uses different summer peak coincidence factors than those which IL-TRM V2.0 recommends. Our evaluation team applied the TRM-recommended values to the evaluated demand savings. As a result, ex post gross demand savings (MW) are 15.7% higher than ex ante gross savings.

- The program savings methods does not account for bulbs sold to non-AIC customers. We applied an overall leakage rate of 10.2%, which accounts for AIC-discounted bulbs sold to non-AIC customers as well as bulbs discounted by other utilities but purchased by AIC customers. As a result, ex post gross energy (kWh) and demand (kW) savings are 10.2% lower than ex ante savings.

1.2 Process Results

The Residential Lighting Program ran smoothly in PY7, and the program met its bulb sales goals. A program objective this year was to address the geographic challenges of reaching as many AIC customers as possible. Because AIC territory is large (est. 45,000 square miles) and predominantly rural, many customers live in areas where national big box chain stores are not prominent. To better reach these customers, program administrators increased the program's presence in retail channels that are more often available in

rural communities, which includes farm stores, independent grocery stores, and small hardware stores. In PY7, these retailer types sold 297,922 program-discounted CFLs, which accounted for 13% of all program sales in PY7 compared to 3% in PY6.

The Residential Lighting Program's key marketing tactic in PY7 was placing point-of-purchase (POP) sales materials at participating retail stores. Program administrators worked with manufacturers and retail chains to develop store-specific materials designed to enhance consumer awareness of the AIC discount. To better show customers the value of per-product program savings, certain stores helped to develop POP materials that prominently compared program-incentivized prices with regular retail prices.

The program also uses its website[3] as a marketing tool. In addition to providing an online store for discounted bulbs, the website is intended to increase customer awareness of the retail program. In particular, website materials list the schedule for lighting demonstrations held at participating retailers. The website also provides a zip code-based store search tool that enables customers to identify program stores near their home.

The program employs seven field representatives and assigns each the responsibility for specific stores across AIC territory. Field representatives visit participating retailers on a regular basis to ensure that retail staff properly display products and promotional materials, provide retailer training, and conduct customer demonstrations and promotions. Field representatives held 92 in-store lighting demonstrations to promote the program and educate customers about CFLs.

In addition to territory responsibilities, a senior field representative also performs field leadership duties, including staff development and QA/QC auditing. Through in-store checkups, the objective of the QA/QC process is to ensure that field representatives are correctly implementing key program processes. When needed, the senior field representative provides suggestions to improve the program implementation process. Overall, each representative earned an average composite score above 92% out of 100% across each five-store review cycle, indicating that field staff are implementing the program correctly.

1.3 Recommendations

Within this context, we make the following recommendations for program improvement.

- **Continue working to add additional farm store locations in rural AIC communities, with some refinements.** Experience in PY7 suggested farm stores are important retail locations for rural customers. By increasing the number of farm stores enrolled in the program, the program can enhance rural customer access to discounted bulbs. Continuing these efforts could help the program continue progress towards its goal of reaching all AIC customers. Recognizing that the program faces multiple needs, to reach many customers cost-effectively, and with minimized risk of leakage it may help the program to study ways that the program can optimize its store enrollment decisions. Such an analysis would likely consider bulb sales per customer by location.

- **For specialty bulbs, consider increasing the number of incentives for LEDs.** Between the drop in market prices and the longer life of LEDs, specialty LEDs could be a cost-effective alternative to specialty CFLs. During PY7, the program found that retailers continued to scale back both their CFL

[3] Website: http://www.actonenergy.com/for-my-home/find-energy-efficient-products

shelf space and their participation in specialty CFL programs in favor of LEDs. In PY7, this had little impact on program impact or process given program success earlier in the program year and because retailers provided advance notice about stocking changes. However, these factors may not be true for all years. To minimize risk for future years, the program might consider proactively changing the mix of specialty bulb incentives to include more specialty LEDs and fewer specialty CFLs.

2. Evaluation Approach

The 2014 evaluation of the Residential Lighting Program involved both process and impact assessments. To support the process evaluation, we conducted a review of program materials and tracking data and interviews with program implementation staff. To estimate gross impacts, the evaluation team reviewed the program-tracking data and applied the Illinois Statewide Technical Reference Manual for Energy Efficiency Version 2.0 (IL-TRM). Net impacts applied AIC's IPA filing from Docker 12-0544 for this program to the gross impacts.

2.1 Research Objectives

The main research objectives of the PY7 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 PY7 evaluation tasks. We designed these tasks to answer the following research questions:

Impact-related research questions:

1. What are the estimated program gross energy and demand savings?
2. What are estimated program net energy and demand savings?
3. To what extent are AIC customers purchasing and using energy efficient bulbs incented by programs in neighboring territories? Such bulbs may be considered "leakage into" the AIC[4] territory.

Process-related research questions:

1. Did the program change its design in PY7? If so, how, why, and were those changes advantageous?
2. Was program implementation effective and smooth?
3. What implementation challenges occurred in PY7, and what was done to address them?
4. What is the method of customer outreach? How often does the outreach occur?

[4] The program savings methods already account for the energy savings of standard bulbs sold to non-AIC customers (i.e., leakage out of the AIC territory).

2.2 Evaluation Tasks

Table 3 summarizes the evaluation tasks that we conducted for PY7.

Table 2. Summary of AIC Residential Lighting Evaluation Activities for PY7

Activity	PY7 Impact	PY7 Process	Forward Looking	Details
Program Staff In-Depth Interviews	✓	✓	✓	Gathered detailed information on the step-by-step operational conditions and implementation efforts to gain an understanding of program design and delivery.
Program Materials Review		✓		Reviewed program implementation plan and marketing and outreach materials.
Program Data Review	✓			Verified program-reported savings and input sources.
Impact Analysis	✓		✓	Calculated gross and net impacts for the program. In addition, estimated CFL leakage into AIC territory using spatial (GIS) analysis of incented bulb sales offered by other utilities at retail locations near AIC territory.

This section describes the data collection activities used in the PY7 process and impact evaluations.

2.2.1 Program Staff In-Depth Interviews

To complete the PY7 process evaluation we conducted an in-depth interview with the program implementer, CLEAResult and Leidos. Our main PY7 activities included interviewing implementation staff. 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 Program Materials Review

To complete the PY7 process evaluation we also reviewed key program materials. CLEAResult provided the evaluation team with a list of PY7 participating retail locations, a database of in-store events and trainings, plus accompanying field reports describing each site visit; monthly field reports for PY7, QA/QC scorecards used by CLEAResult staff, and a summary of in-store marketing materials. We reviewed these program materials to evaluate program reach, implementation quality, satisfaction with the program, and to determine whether there were any challenges to program participation.

2.2.3 Program Data Review

The evaluation team reviewed AIC program data, checked the data for accuracy, and recalculated values based on baseline assumptions to ensure that assumptions were computed correctly. See Table 5 for a detailed description of our program data review.

2.2.4 Impact Analysis

Gross Impacts

The evaluation team calculated the program's gross electric and demand savings using the program-tracking database and per-measure savings specified in the Illinois Statewide Technical Reference Manual, Version 2.0 (IL-TRM V2.0). This section presents three key components of gross savings calculations: the ex post electric savings algorithm; the ex post demand savings algorithm; and the key variables used in these calculations, such as assumed base wattage, in-service rate, hours of use, coincidence factors, and net program bulb sales leakage rates.

Electric Savings

As noted above, to calculate program electric savings, we applied the savings algorithm in the IL-TRM V2.0. The TRM carryover savings method accounts for bulbs that are purchased and stored for later use. The method assumes that 2% of program CFLs will never be installed, but that the remaining 98% will be installed over three years. Because AIC funded all program bulb sales in PY5 and PY6, the evaluation team accounted for all carryover savings from those years within the Standard Lighting Program Evaluation. Therefore, IPA program PY7 bulb savings include only savings from sales made in PY7:

$$\text{Realized PY7 Gross kWh Savings } = \Delta \text{ kWh} \times (\text{Units Purchased PY7}|\text{Installed in PY7})$$

Table 4 presents yearly bulb installation rates.

Table 3. Residential CFL In-Service Rates by Years after Purchase

Bulb Type	First Year	Second Year	Third Year	Final
Specialty CFLs[a]	79.5%	10.0%	8.5%	98.0%

[a] Source: IL-TRM V2.0

The TRM savings assumptions vary by customer and bulb type. Based on our PY6 in-store customer intercept interviews, the evaluation team determined that 4% of program-discounted bulbs are installed in commercial spaces, which have greater hours of use and different waste heat factors. The evaluation team thus weighted energy savings estimates 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 PY6 in-store customer research, the evaluation team estimated that 15% of AIC-discounted bulbs were sold to non-AIC customers. Through secondary research that we conducted as part of this PY7 evaluation, we estimated that AIC customers purchased and installed the equivalent of 5% of AIC PY7 sales from other utility programs in Illinois and Missouri. We provide additional details on the study methods in the next section. Based on our estimates of both factors, we applied an overall leakage rate of 10% to gross savings.

To calculate weighted program electric savings, we applied both the residential and commercial savings algorithms outlined in IL-TRM V2.0:

$$Year\ 1\ \Delta\ kWh = LA \times 0.96 \times \left[\frac{(Base\ Watt_{2015} - Bulb\ Watt)}{1000} \times ISR_{res,yr1} \times HOU_{res} \times WHFe_{res}\right]$$

$$+ LA \times 0.04 \times \left[\frac{(Base\ Watt_{2015} - Bulb\ Watt)}{1000} \times ISR_{com,yr1} \times HOU_{com} \times WHFe_{com}\right]$$

Where:

LA = Leakage adjustment equal to one minus the leakage rate, or 1 - %Leakage
Base Watt = EISA complaint base wattage in 2015
Bulb Watt = Actual wattage of installed CFL 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 PY7 purchases that will be installed during the next two years we apply the in-service rate (ISR) for year 2 and year 3:

$$Year\ 2\ \Delta\ kWh = \quad LA \times\ 0.96 \times \left[\frac{(Base\ Watt_{2016} - Bulb\ Watt)}{1000} \times ISR_{res,yr2} \times HOU_{res} \times WHFe_{res}\right]$$

$$+LA \times 0.04 \times \left[\frac{(Base\ Watt_{2016} - Bulb\ Watt)}{1000} \times ISR_{com,yr2} \times HOU_{com} \times WHFe_{com}\right]$$

$$Year\ 3\ \Delta\ kWh = \ LA \times 0.96 \times \left[\frac{(Base\ Watt_{2017} - Bulb\ Watt)}{1000} \times ISR_{res,yr3} \times HOU_{res} \times WHFe_{res}\right]$$

$$+ LA \times 0.04 \times \left[\frac{(Base\ Watt_{2017} - Bulb\ Watt)}{1000} \times ISR_{com,yr3} \times HOU_{com} \times WHFe_{com}\right]$$

Demand Savings

As we did for electric savings, we calculate PY7 realized savings using bulbs purchased across three years, but installed in PY7:

$$\text{Realized PY7 Gross kW Savings } = \Delta \text{ kW} \times (\text{Units Purchased PY7}|\text{Installed in PY7})$$

The evaluation team calculated demand savings using the TRM method. We applied the appropriate savings assumptions based on installation location and assumed that 96% of bulbs purchased are installed in residential locations and 4% in commercial locations. Our weighted savings equation is as follows:

$$Year\ 1\ \Delta\ kW = LA \times\ 0.96 \times \left[\frac{(Base\ Watt_{2015} - Bulb\ Watt)}{1000} \times ISR_{res,yr1} \times WHFd_{res} \times CF_{res}\right]$$

$$+ LA \times 0.04 \times \left[\frac{(Base\ Watt_{2015} - Bulb\ Watt)}{1000} \times ISR_{com,yr1} \times WHFd_{com} \times CF_{com}\right]$$

Where:

LA = Leakage adjustment equal to one minus the leakage rate, or 1 - $\%Leakage_{PY7}$
Base Watt = EISA complaint base wattage in 2015
Bulb Watt = Actual wattage of installed CFL bulb
ISR = First year In-Service Rate
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 PY7 purchases that will be installed during the next two years we apply the ISR for year 2 and year 3 and modify the base wattage for the bulb to be EISA compliant:

$$Year\ 2\ \Delta\ kW = LA \times\ 0.96 \times \left[\frac{(Base\ Watt_{2016} - Bulb\ Watt)}{1000} \times ISR_{res,yr2} \times WHFd_{res} \times CF_{res}\right]$$

$$+ LA \times 0.04 \times \left[\frac{(Base\ Watt_{2016} - Bulb\ Watt)}{1000} \times ISR_{com,yr2} \times WHFd_{com} \times CF_{com}\right]$$

$$Year\ 3\ \Delta\ kW = LA \times\ 0.96 \times \left[\frac{(Base\ Watt_{2017} - Bulb\ Watt)}{1000} \times ISR_{res,yr3} \times WHFd_{res} \times CF_{res}\right]$$

$$+ LA \times 0.04 \times \left[\frac{(Base\ Watt_{2017} - Bulb\ Watt)}{1000} \times ISR_{com,yr3} \times WHFd_{com} \times CF_{com}\right]$$

Summary of Input Sources

Table 5 summarizes data sources for key variables in the ex post gross energy and demand savings estimation. In cases where the evaluation team found that ex post data contained errors, the team adjusted

or corrected the ex post data. While these changes improve accuracy, they cause ex post savings to differ from ex ante savings. Table 5 also notes changes we made to input data and the resulting percentage increase or decrease in estimated savings due to each change, relative to ex ante results.

Table 4. Data and Assumptions Used in Ex post Gross Savings Calculations

Gross Savings Input	Ex Post Savings Data Source	Adjustment Relative to Ex Ante Data	Change in Savings (%)*
Shared Assumptions for All Savings Calculations			
Program Sales	PY7 Program-Tracking Database	No adjustments.	0%
Base Watts	IL-TRM V2.0	Adjusted several baseline wattages given ex-post bulb reclassification.	0.11%
Bulb Watts	PY7 Program-Tracking Database	No adjustments.	0%
Residential vs. Commercial Installations	2014 (PY6) AIC In-Store Customer Interviews	Program assumed all bulbs installed in residential locations. We apply the installation location assumptions (4% commercial, 96% residential).	0%
Demand Savings Calculations (kW)			
Installation Rate	IL-TRM V2.0	Slight change due to adjusting the in-service rate for commercial savings. Added an in-service rate assumption for specialty bulbs.	-20.5%
Waste Heat Demand Factor	IL-TRM V2.0	Slight change from ex ante values given ex-post bulb reclassification and commercial savings. Added the waste heat factor assumption. Ex-ante specialty bulb savings calculations did not use waste heat factors.	12.3%
Summer Peak Coincidence Factor	IL-TRM V2.0	Applied TRM coincidence factor values, which differ from the coincidence factors used in calculating the ex-ante values.	15.7%
Net Leakage	Recommended per PY6 evaluation report and developed with secondary research from this PY7 evaluation	The estimated net leakage rate is -10%. This accounts for AIC-discounted bulbs sold to non-AIC customers (-15 %) and bulbs discounted by other utilities but	-10%

Gross Savings Input	Ex Post Savings Data Source	Adjustment Relative to Ex Ante Data	Change in Savings (%)*
		purchased by AIC customers (+5%). The program's savings calculations did not apply leakage adjustments.	
Energy Savings Calculations (kWh)			
Installation Rate	IL-TRM V2.0	Slight change due to adjusting the in-service rate for commercial savings. Added an in-service rate assumption for specialty bulbs.	-20.5%
Hours of Use	IL-TRM V2.0	Updated hours of use based on new TRM values, bulb reclassification, and application of commercial hours of use.	12.7%
Waste Heat Energy Factor	IL-TRM V2.0	Given ex-post bulb reclassifications, WHF is slightly different than ex ante values due to considering commercial savings.	6.6%
Net Leakage	Recommended per PY6 evaluation report and developed with secondary research from this PY7 evaluation	The program's savings calculations did not apply leakage adjustments to specialty bulbs.	-10%

Note: Each value is the percentage difference between the ex post gross and ex ante gross estimates, due to the input data adjustment and holding all else constant (without the effect of other adjustments and corrections). Because individual percentage changes do not account for overlapping effects (in the order of operations) the totals do not sum to the realization rate.

Bulb Leakage Analysis

The IPA offers energy efficiency programs to help AIC customers reduce their energy usage. However, lighting programs that provide discounts through retailers at the point-of-purchase are generally unable to restrict sales to customers of the sponsoring utility. As a result, customers of nearby utilities may purchase some of the program-discounted bulbs. In effect, these energy savings "leak" out of the sponsoring utility's territory. Retail customers tend to purchase household products at retailers located near their homes; thus, "leakage" to other utilities' customers is likely to be more common at stores near the edge of a given utility's service area.

The overall leakage rate for a given program area includes both leakage out, and leakage into, the sponsoring utility's service area. Through the evaluation of the PY6 program, the evaluation team estimated that customers of other utilities purchased 15% of bulbs sold through the AIC program (i.e., leakage out). To estimate the overall leakage rate for AIC's program, the evaluation team's PY7 research studied the number of bulbs that "leak into" AIC's service area. We evaluated all potential sources of inward leakage. First, there are a number of municipal cooperatives throughout the AIC territory, but none of the municipal cooperatives operates upstream lighting programs. AIC also shares a limited border with municipal electric service

providers in Kentucky; none of these operated upstream programs during the evaluation period. There are also three adjacent utilities in Indiana. These Indiana utilities either (a) did not operate upstream lighting programs during the PY7 timeframe, or (b) did operate programs but are not within close proximity to AIC customers.[5] Next, AIC's service area shares a small border with two utilities in Iowa (MidAmerican Energy Company and Alliant Energy). While these Iowa utilities did offer upstream lighting programs during PY7, their programs are unlikely to constitute a significant source of leakage given the low density of AIC customers in this area; thus, we omitted them from analysis. Finally, there are two utilities that do appear to be notable sources of leakage into AIC: Ameren Missouri (AMO) and Commonwealth Edison (ComEd). ComEd and AMO both operated upstream lighting programs similar to the AIC program during PY7, and are located near sizeable segments of AIC's residential customer population. Thus, it is likely that some AIC customers who live near retailers that participate in ComEd or AMO programs have purchased CFLs at those stores. In other words, it is likely that bulbs discounted by ComEd and AMO have "leaked into" AIC territory.

To estimate leakage into AIC territory from ComEd and AMO, the evaluation team focused on customers living near the edges of AIC service area and relatively near to retailers participating in ComEd or AMO upstream lighting programs. The process diagram in Figure 1 summarizes our overall research methods. Table 6 lists our data sources. The main steps in the analysis were:

- **Identify stores participating in ComEd and AMO upstream lighting programs that are relatively likely to sell bulbs to AIC customers.** We first mapped the location of individual stores participating in either program. We used distance to AIC service area border as a proxy for relative likelihood to sell bulbs to AIC customers. We then either estimated or calculated the number of program-incentivized bulbs sold per retailer location. Sources of store locations, program sales, and assumptions about distance thresholds differed for the two utilities and are discussed in more detail later in this section.

- **Define each store's market area and estimate the population of customers living within the market area.** Approximate the market area using a distance-based buffer around the store location. Use spatial analysis of the market areas and Census data to estimate the total number of households located within each store's market area. This estimate represents the assumed total population of a store's customers. Use spatial analysis of the market areas and AIC customer data to determine the number of AIC customers living in the store's market area.

- **By store, estimate the number of store bulbs sold to AIC customers.** This step assumes that (a) households in the store's market area purchased all of the store's bulb sales and (b) these sales were distributed equally across all customers in the market area.

- **Estimate total leakage into AIC service area.** Sum all estimates of AIC customer bulb purchases at ComEd and AMO stores. Compare total sales by AIC customers at retailers participating in other utilities' upstream lighting programs, to AIC program sales in PY7.

In the rest of this section, we describe our methods and data in more detail.

[5] In previous years when more Indiana utilities ran upstream programs, it is possible that there was greater leakage into AIC territory. It is also possible that there could be leakage in from these utilities in future years if programs resume.

Figure 1. Steps in the Leakage Analysis

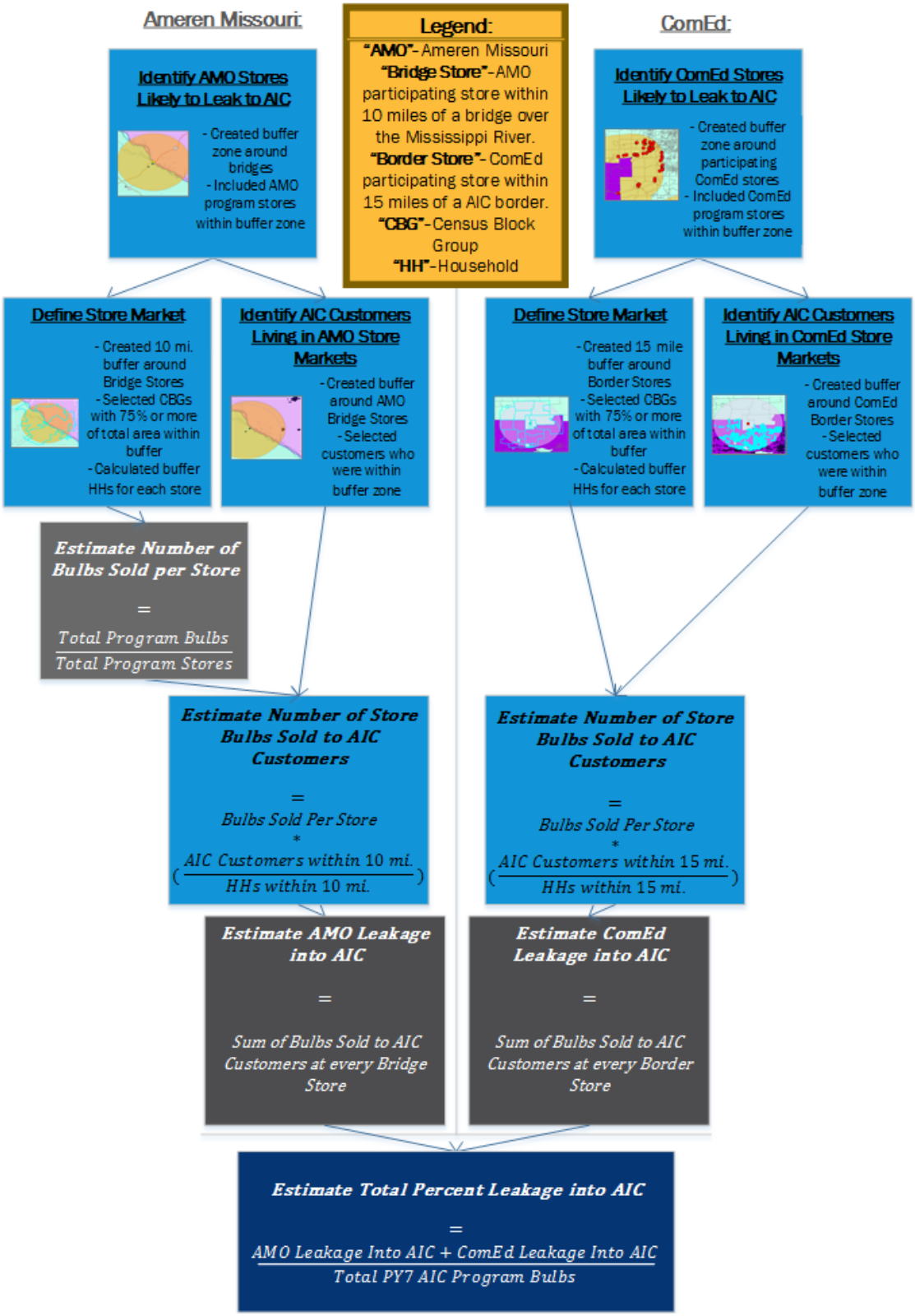


Table 5. Leakage Analysis Data Sources

Data	Source
Base Layer Data for Both Leakage Analyses	
AIC Customers	Geocoded residential service addresses in AIC customer database provided for PY7 portfolio evaluation.
AIC Service Area	Any U.S. Census block group that contains at least one AIC customer address point.
General Household Population Estimates	U.S. Census American Community Survey (2013). 2013 American Community Survey Geodatabase. Number of Households by Census Block Group. (5-Year Average, 2009 to 2013).
Retail Market Assumptions	All households within a store's retail market area are equally likely to purchase the store's bulbs.
ComEd Leakage Analysis	
ComEd Store Locations	Geocoded store addresses found in PY7 ComEd upstream lighting program sales data, cross-checked with ComEd website listings (Accessed October, 2015)
ComEd Program Bulb Sales	Store-level sales counts from ComEd PY7 upstream lighting program sales data
Distance Threshold Assumption	• Included stores within 15 miles of the AIC service area • Included households and AIC customers that are within 15 miles of the included stores
AMO Leakage Analysis	
AMO Store Locations	Geocoded store addresses from on AMO upstream lighting program website (accessed October, 2015)
AMO Program Bulb Sales	Total 2014 program sales from AMO 2014 evaluation report
Mississippi River Bridge Locations	Spatial location of 17 of bridges spanning the Mississippi River and near to population centers in the AIC service area
Distance Threshold Assumption	• Included stores within 10 miles of a selected Mississippi River bridge • Included households and AIC customers that are within 10 miles of the included stores

Estimating Leakage from ComEd

We focused on stores that are within 15 miles of the AIC territory border ("ComEd leakage-in stores"), and the AIC customers living near each of those stores (Figure 2). We developed the 15-mile distance threshold using professional judgement about the maximum distance a typical customer would travel during shopping trips that include light bulb purchases. Implicit in this distance choice is our assumption that travel across the service areas is relatively easy, to the point that customers do not differentiate between stores in different service areas (or are not aware of utility service area borders). Through our geographic analysis, we estimated that 3% of all AIC customers (n=27,551) live near enough to a ComEd participating retailer to potentially purchase ComEd-discounted bulbs.

We requested and received from ComEd PY7 sales data for each store that participated in its upstream lighting program. We identified 117 participating stores within the 15-mile distance from AIC service area.

We estimated bulb leakage from these ComEd program stores to AIC customers as a share of each ComEd store's sales, where the share was equal to the proportion of a store's customer base assumed to be AIC customers (i.e., a population-derived share). The population share for each store *i* equals the total number of nearby AIC customers[6] divided by the total number of nearby households living within this zone:

$$\%Customers_{AIC,i} = Customers_{AIC,i} / Population_i$$

Where:

$Customers_{AIC,i}$ = Total number of AIC customer address points within the 15-mile buffer around an individual store *i*, and

$Population_i$ = Population estimate for all Census block groups that substantially intersect the 15-mile buffer around store *i*, [7]

To estimate how many of a store's bulbs were purchased by AIC customers, we multiplied the total number of bulbs sold at each store ($Sales_i$) times $\%Customers_{AIC,i.}$ Total leakage from ComEd into AIC equals the sum of the per-store leakage estimates from all included ComEd stores *i*=1, …, n:

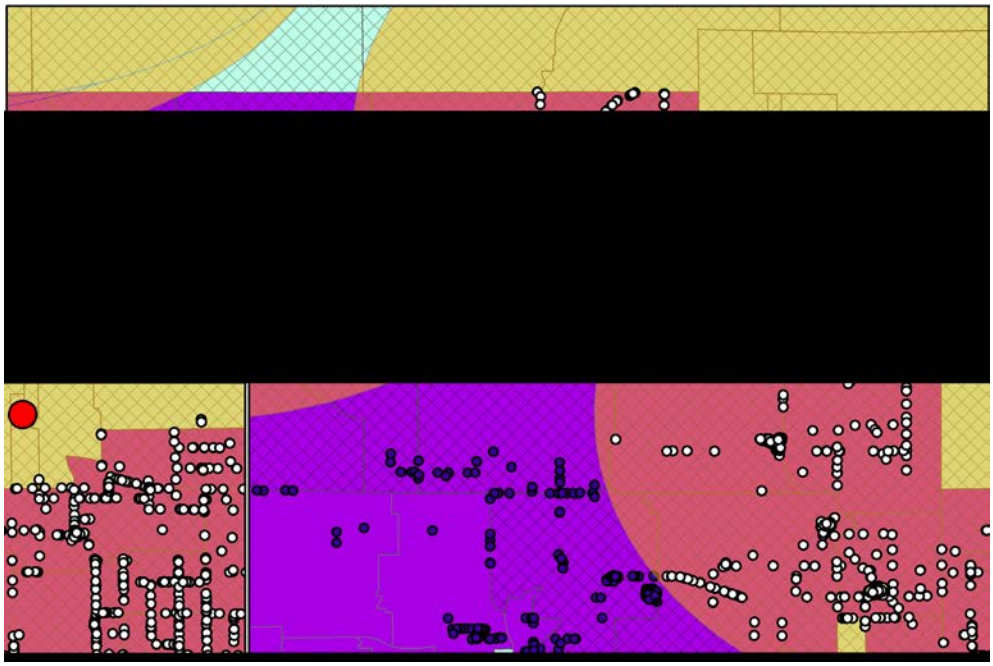
$$LeakageIn_{ComEd} = \Sigma(\%Customers_{AIC,i} * Sales_i)$$

Figure 2 depicts an example of this spatial analysis. In the figure, a representative ComEd participating retailer is shown as a red point. The store is within 15 miles of the AIC service area (purple). The yellow 15-mile buffer around the ComEd store models the store's assumed customer base, and the white dots are geocoded AIC customer addresses.

[6] Customer address locations based on geocoded addresses from PY7 AIC customer database.

[7] We base the total surrounding household population estimates for each store on 2009-2013 American Community Survey estimates at the Census block group level. Making use of the AIC customer map in Figure 2, one can see that AIC customers tend to be clustered in various parts of, rather than evenly distributed throughout each Census block group. This implies that the total household distribution within these block groups is also clustered rather than evenly distributed. Even population distribution is a critical assumption in "areal weighted interpolation," or the process of using proportional area to allocate a total block group population count to the part of the block group that falls within a store buffer zone (e.g., Qui et al., 2012). Although complex methods of spatial allocation are available to account for clustering, they involve making additional subjective assumptions and require using complex mathematical regressions. For the purposes of this simple analysis, we defined the store market area as the total population of all Census block groups for which at least 75% of the block group area intersects the 15-mile buffer around a store. Reference: https://desktop.arcgis.com/en/desktop/latest/guide-books/extensions/geostatistical-analyst/what-is-areal-interpolation.htm

Figure 2. Finding the Percent of the Total Population that are AIC Customers



Note: CBG= Census Block Group.

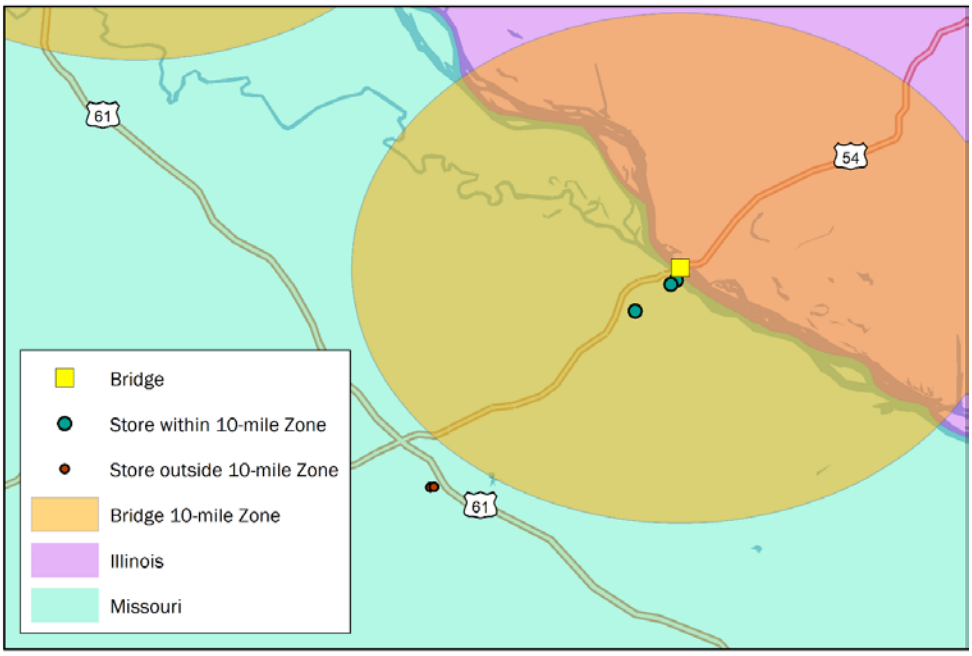
Estimating Leakage from Ameren Missouri

The AMO analysis proceeded much the same as the ComEd analysis, with some modifications. The first type of modification pertained to assumptions about proximity of AMO participating stores to AIC customers and the access to shopping opportunities across utility service areas. The Mississippi River divides AMO and AIC territory and is a natural barrier that reduces leakage between the two utilities. However, households living near one of several major bridges regularly cross the river for work and shopping. To acknowledge that retail patterns in this region are different from those near the ComEd border, we modified our analysis in two key ways:

- We assumed that only AMO stores near a major bridge would be susceptible to leakage to AIC customers. Thus, we limited the analysis to stores located within 10 miles of one of 17 Mississippi River bridges ("AMO leakage-in stores"), as seen in Figure 3 below. There were 200 stores that met this criterion for leakage into AIC.

- To acknowledge the greater hurdle of traveling to stores across a bridge (relative to stores that are not located across a river) we reduced the area of analysis from 15 miles to 10 miles surrounding these AMO leakage-in stores.

Figure 3. Locating ComEd Stores within 10 Miles of Mississippi River Bridges



Based on these assumptions, we estimated that 9% of all AIC customers (n=83,877) live close enough to an AMO participating retailer near a Mississippi River bridge. There was no overlap among the AIC customers included in the ComEd and AMO analyses.

We were unable to obtain store level sales data from AMO and instead used publicly available sales data that reported territory-wide sales of bulbs discounted by AMO (Program Year 2013[8]). The modification is an added step to equally distribute the program-level AMO sales data across all AMO stores (total AMO program bulbs divided by the number of stores participating in the AMO program, as shown in Figure 1). [9]

We estimated bulb leakage from these AMO program stores to AIC customers as a share of each AMO store's sales, where the share was equal to the proportion of a store's customer base assumed to be AIC customers (i.e., a population-derived share). The population share for each store *i* equals the total number of nearby AIC customers divided by the total number of nearby households living within this zone:

[8] Nexant and The Cadmus Group, Inc. 2014. Ameren Missouri LightSavers Impact and Process Evaluation: Program Year 2013. Retrieved from https://www.efis.psc.mo.gov/mpsc/commoncomponents/viewdocument.asp?DocId=935842418.

[9] This method assumes that each store sells the same number of bulbs, which we know is an incorrect assumption. However, to estimate total leakage in from AMO, we combine estimated sales at multiple stores to estimate total sales at all stores within a reasonable driving distance of AIC territory. This combined result will average out some of the over and under estimates of sales at individual locations, reducing the error of the overall estimate. Though this method is not ideal, it is the best that is possible without store level sales data.

$$\%Customers_{AIC,i} = Customers_{AIC,i} / Population_i$$

Where:

$Customers_{AIC,i}$ = Total number of AIC customer address points within the 10-mile buffer around an individual store *i*, and

$Population_i$ = Population estimate for all Census block groups that substantially intersect the 10-mile buffer around store *i*, [10]

To estimate how many of this store's bulbs were purchased by AIC customers, we multiplied the total number of bulbs sold at each store ($Sales_i$) times $\%Customers_{AIC,i.}$. We calculated $LeakageIn_{AMO}$ as:

$$LeakageIn_{AMO} = \Sigma(\%Customers_{AIC,i} * Sales_i)$$

Overall Leakage Estimate

We combined the total bulb leakage estimates into an overall leakage rate ($\%Leakage_{PY7}$) using the following formula:

$$\%Leakage_{PY7} = (\%LeakageOut_{PY6}) - \left(\frac{LeakageIn_{ComEd} + LeakageIn_{AMO}}{Units_{PY7}}\right)$$

Where:

$LeakageIn_{ComEd}$ = Number of ComEd-discounted bulbs sold to AIC customers,
$LeakageIn_{AMO}$ = Number of AMO-discounted bulbs sold to AIC customers,
$\%LeakageOut_{PY6}$ = Percent of AIC program sales leaking out, estimated in PY6, and
$Units_{PY7}$ = Total PY7 bulbs sold through AIC program.

We applied $\%Leakage_{PY7}$ in the PY7 to the ex post gross savings calculations.

Net Impacts

To estimate net program savings for standard bulbs, the evaluation team used a net-to-gross ratio (NTGR) of 0.47. This value is the result of the PY5 Lighting Impact evaluation, and mirrors the values from the program tracking data.

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[10] We base the total surrounding household population estimates for each store on 2009-2013 American Community Survey estimates at the Census block group level. Making use of the AIC customer map, one can see that customers tend to be clustered in various parts of each Census block group, rather than evenly distributed throughout each Census block group. This implies that the total household distribution within these block groups is also clustered rather than evenly distributed. Even population distribution is a critical assumption in "areal weighted interpolation," or the process of using proportional area to allocate a total block group population count to the part of the block group that falls within a store buffer zone. Since assuming even population distribution is incorrect in this study area (and in fact, rarely is for any case), we chose not to use areal allocation. Although complex methods of spatial allocation are available to account for clustering, they involve making additional subjective assumptions. For purposes of this simple analysis, we defined the store market area as the total population of all Census block groups for which at least 75% of the block group area intersects the 15-mile buffer around a store.

2.3 Sources and Mitigation of Error

Table 7 summarizes the possible sources of error associated with data analysis conducted for the Residential Lighting Program evaluation.

Table 6. Possible Sources of Error

Research Task	Possible Survey Error		Non-Survey Error
	Sampling	Non-Sampling	
Gross Savings Calculations	No	N/A	Data processing error
Net Savings Calculations	No	N/A	Data processing error
Leakage Analysis			• Spatial projection errors inherent in any GIS mapping task • Uncertainty in modeling assumptions • Data processing error

The main source of error is data processing error. The evaluation team took of the following steps to mitigate this error:

- Gross Impact Calculations: To calculate gross impacts, we applied calculations specified in the IL-TRM V2.0 to the participant data from the tracking database. To minimize data processing error, the evaluation team had a secondary team member review all calculations for accuracy.
- Net Impact Calculations: We applied the prospective deemed NTGR to estimate the program's net impacts. To minimize data processing error, the evaluation team had a separate team member review all calculations to verify they were performed accurately.
- Leakage Analysis: Our data analytics team conducted a thorough review of all data used in the error to standardize formatting and to fill in gaps in the data using secondary research. We utilized the most up-to-date versions of mapping software, and relied on recent map address data to geo-locate addresses.

3. Evaluation Findings

3.1 Process Assessment

3.1.1 Program Design and Implementation

The Residential Lighting Program ran smoothly in PY7. As in prior years, the program met its bulb sales goals within budget.

During PY7, CLEAResult acquired AIC's existing program implementation contractor, APT. After the acquisition, CLEAResult continued implementing both the Specialty and Standard CFL programs. In-depth interviews with program administrators indicate that, aside from several higher-level staffing changes, the acquisition had relatively little impact on lighting program implementation and success during the program year.

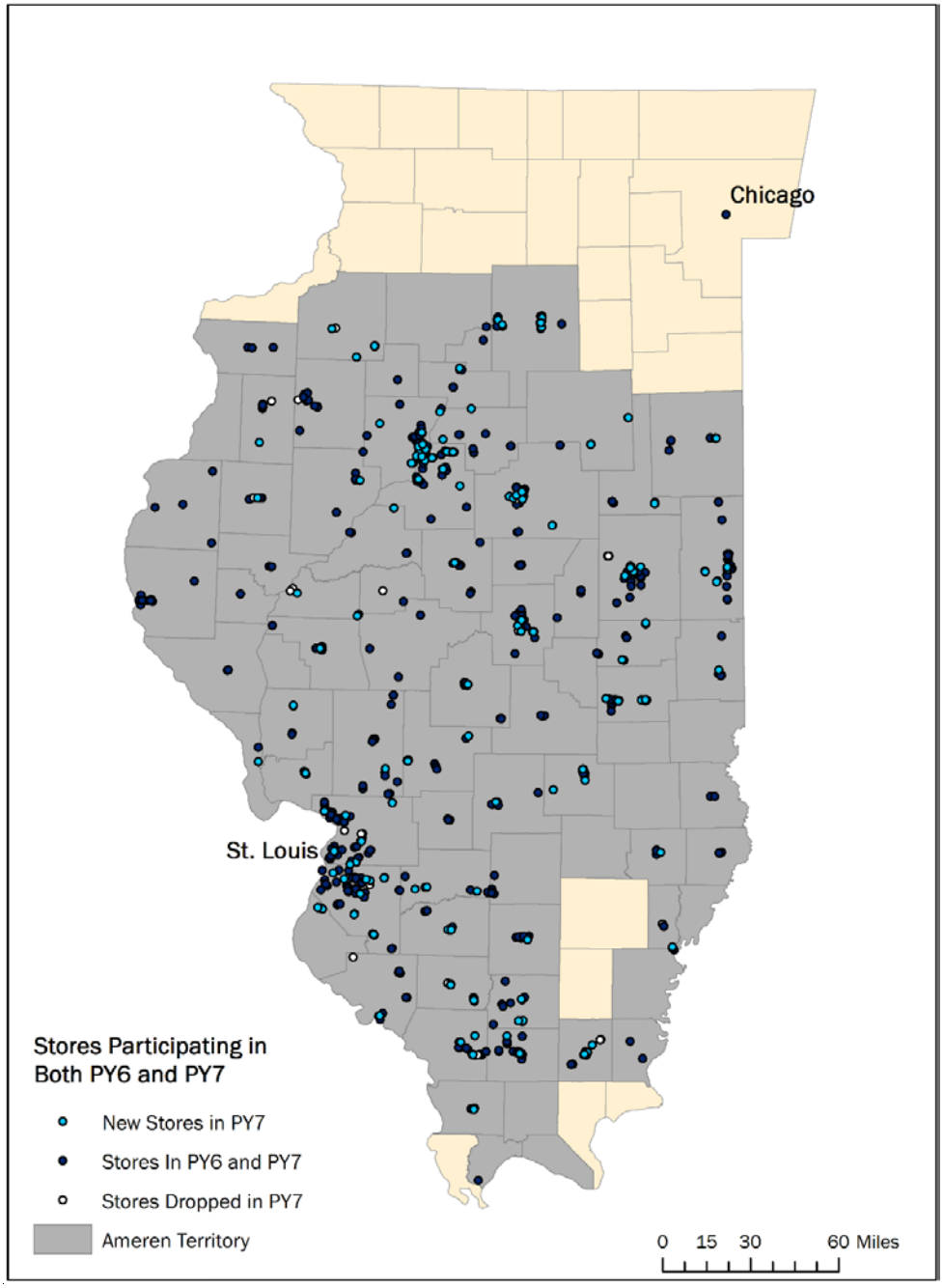
Program design remained largely similar to the PY6 design. For example, field representatives remained an integral part of program implementation. CLEAResult employs seven AIC field representatives who are each responsible for visiting specific participating retail stores across AIC territory. Representatives regularly visit their assigned retailers to ensure that products and promotional materials are displayed properly, to train store staff (e.g., sales associates, cashiers, managers), and to conduct in-store lighting demonstrations that educate lighting customers. The field representative supervisor reviews other staff work using Quality Assurance scorecards, and all retail visits are documented in a database. As the staff directly interacting with AIC customers at the point of purchase, field staff provide feedback on the PY7 retail implementation process, customer awareness and satisfaction with the PY7 program, and potential markets for future incentive programs.

Program administrators did make two adjustments designed to address two existing and emerging challenges of the lighting marketplace. The first challenge was the rapid change in the availability, pricing, and consumer awareness of LED bulb technology. Changes in the LED market have induced rapid changes in the market for other efficient lighting products. For example, retailers have reduced shelf space devoted to CFLs and discontinued promotions of some CFL products ahead of schedule; in reaction, program administrators must change the products discounted through the program. Administrators addressed this challenge by ensuring that field staff were prepared to provide enhanced education and training to retail staff, such as training on new products and opportunities to promote energy efficiency. Program administrators also 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.

The second challenge that administrators continued to address during PY7 was ensuring that rural AIC customers have access to lighting discounted through the program. Rural communities tend not to have many of the larger big box stores that have traditionally participated in the program. While rural customers have access to program-discounted lighting through an AIC-funded web store, administrators believe that rural customers are less likely to purchase light bulbs online (i.e., at the AIC web store). Thus, administrators expanded retail partnerships with stores typically more prevalent in rural communities: independent hardware stores; independent groceries; and farm stores, which are big-box retailers focused on farm life

and industry. In PY7, administrators established new partnerships for a net addition of 10 farm stores, as seen in below.[11]

Figure 4. Program Stores in PY6 and PY7



[11] Between PY6 and PY7, the program dropped five farm stores of one chain and added 15 of another. Across all store types, the program added 73 net new stores in PY7.

The program also added 21 additional independent grocery and hardware stores. Some stores dropped from the program as well. Across all store types, the program had 754 stores participating in PY6 and 795 in PY7, for a net increase of 41 participating stores. Associated program sales in this store category outpaced program-wide average growth in sales, and now account for 13% of retail program sales (Table 8).

Table 7. Bulbs Sold at Independent Hardware, Independent Grocery, and Farm Stores (IHIGFS)

Bulb Sales Category	PY6	PY7	% Change from PY6 to PY7
Bulbs Sold at IHIGFS	87,874	297,922	**239%**
Total Program Bulbs Sold	2,570,131	2,332,705	**-9%**
Bulbs Sold at IHIGFS as a Percent of Total Program Bulbs Sold	3%	13%	**10%[a]**

[a] Indicates an absolute percentage-point change (13% - 3%).
Note: To make comparisons between years, this table includes sales of both standard and specialty bulbs

By participating in the program, independent retailers were able to offer competitively priced efficient lighting products and make use of program marketing materials to gain customer attention. Program manager feedback and the relatively large growth in sales within this category, relative to program-wide growth (Table 8), suggests this expansion is working smoothly and productively. Given the strong sales performance of discounted bulbs in farm supply stores, program administrators plan to continue expanding the program in this channel in PY8.

We also evaluated the extent to which the new program store locations address the program's stated need to provide better rural customer access to lighting discounted through the program. From PY6 to PY7, the program added stores to 67 zip codes in the AIC service area, of which 9 zip codes had no participating stores in PY6. The program dropped stores located in 32 zip codes between PY6 and PY7. Most of these zip codes had other participating stores, but eight no longer had any participating stores.[12,13] The new PY7 stores are distributed evenly throughout most of AIC's service area (Figure 5). About one-third of the AIC customer population lives in a zip code in which the program added at least one store during PY7 (about 311,000 customers out of roughly 964,000 AIC customers).

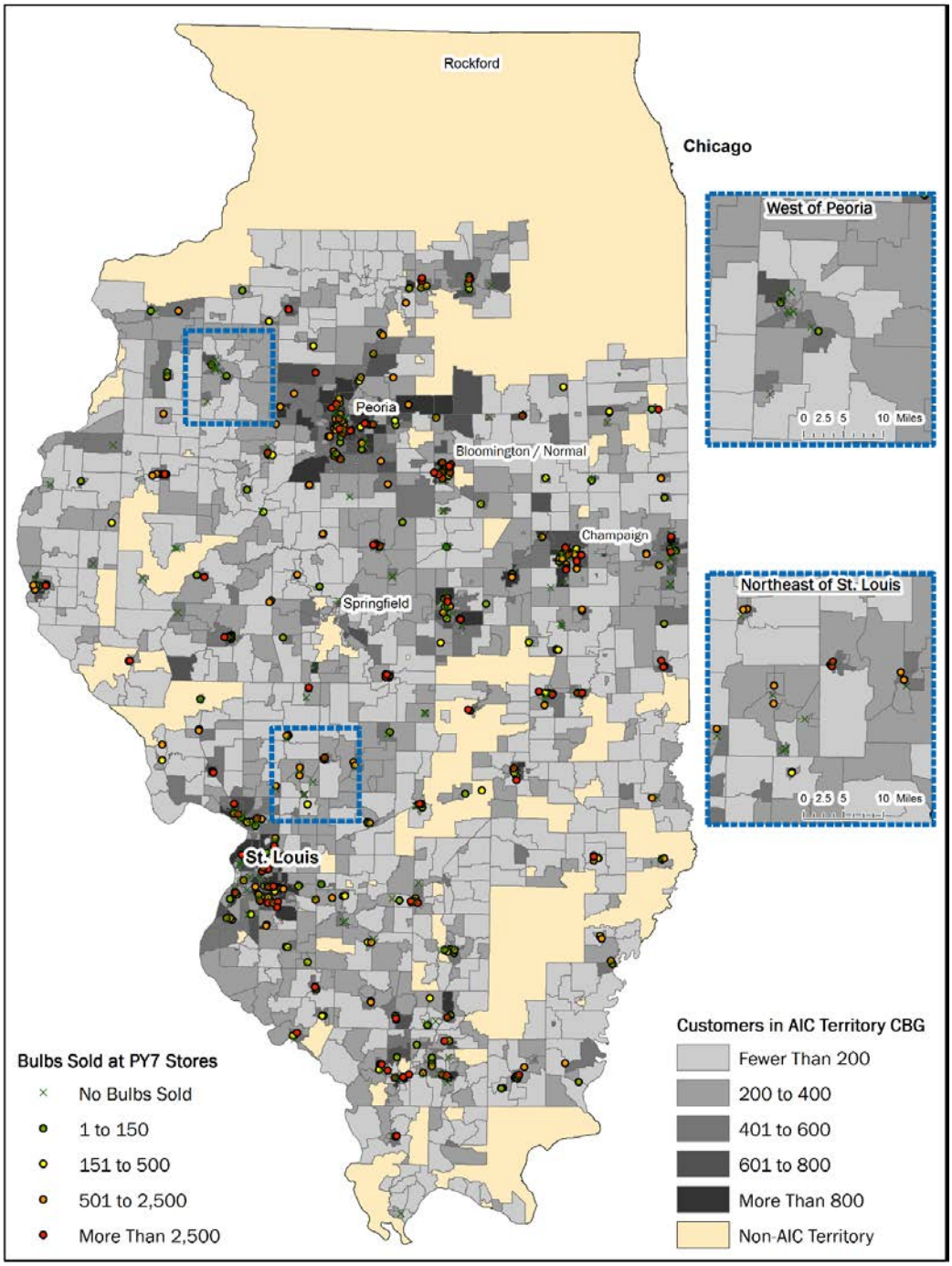
When considering the characteristics of the areas where stores were added in PY7, we found that the new PY7 stores are not located in areas that had a greater need for additional stores. Figure 5 shows the distribution of stores across the AIC service area and their corresponding program sales volumes. Several trends are apparent. First, stores selling the largest volumes of discounted lighting are fairly evenly distributed throughout the AIC service area, indicating success in providing access throughout a very large service area. Second, stores tend to be clustered in areas with dense AIC customer populations, suggesting that the program is effectively serving urban and suburban customers. Third, however, is the fact that retail

[12] Program administrators change the retailers and locations that participate in the program for a variety of reasons including low sales, retailer decisions, and management of leakage. The purpose of this analysis is to provide a territory-wide overview of participating store locations relative to customer types and not an analysis of why administrators added or dropped particular store locations.

[13] There are 817 zip codes in Illinois that contain at least one AIC customer based on our geocoding of customer addresses. The resulting service area used throughout this evaluation may under-represent actual AIC territory, since not all ratepayer addresses could be geocoded.

coverage in many rural, low-AIC population areas remains sparse. The blue callout boxes in Figure 5 illustrate a single case where rural store location and sales may need improvement, and a single case where rural store location and sales seem to give effective coverage of the area. While we have not analyzed the presence of non-participating retailers that could be brought into the program, it appears that the program still has room to expand its rural retailer approach. We understand the program has continued these efforts in PY8, a strategy that is supported by this analysis.

Figure 5. PY7 Bulb Sales by Store and AIC Customer Density by Census Block Group



Notes: CBG = Census Block Group. Store sales include standard and specialty bulbs.

3.1.2 Program Data

Program administrators tracked all of the necessary information to calculate savings using IL-TRM V2.0 methods. However, the program did not actually use all of the savings assumptions provided in the TRM and instead used different savings assumptions to calculate program savings. In the Impact Assessment, we provide greater detail on the specific assumptions that were incorrect and the impact of these differences on ex ante savings.

3.1.1 Program Marketing, Outreach, and Training

Point-of-purchase (POP) sales materials were the Residential Lighting Program's primary form of customer outreach. These materials are placed to draw customer attention to discounted products. The various POP labels and signs are consistently branded with a blue and red background, the AIC and ActOnEnergy logos, and text reading "Special Discounts: Ameren Illinois Electric Customers," increasing the potential for brand recognition across products and retail locations. Multiple shapes and sizes of labels are available, which facilitates the placement of POP materials at many of the locations that retailers display bulbs in stores (e.g., shelves, pallets, end caps, counter displays). Some retailers created dual-language (Spanish and English) signs. Bilingual materials improve program reach to Spanish-speaking households in AIC territory. Program staff have also worked with select big box retailers to develop custom POP materials that identify qualifying products by SKU, the ENERGY STAR® label, pricing, and/or the amount of the AIC rebate. Program administrators reported being pleased about these collaborations because they strengthened relationships with retail chains. Field reports indicate that retail staff are displaying these in-store materials correctly and prominently, and that products are correctly priced.

Field representatives' visits to participating stores are the second key way that the program reaches customers. During a visit, staff complete one or more activities including customer outreach, staff training, and product and POP marketing adjustments. Representatives made 9,948 in-store visits during PY7. Representatives visit individual retail locations at store-specific frequencies based on retailer type and sales volume. Field staff visited discount (30% of visits), big box (24%), and DIY (19%) stores most frequently. The store visits allow staff to ensure that POP materials are displayed neatly and correctly, to adjust product placement, and to replace damaged or removed signs. Representatives visit grocery stores (11% of visits), independent hardware stores (7%), drug stores and other stores (8%) less frequently given lower sales volumes.

During typical store visits, representatives provided employee training to sales associates, store managers, cashiers, lighting department staff, and bookkeepers. Representatives train store staff on CFLs and how to best promote them; they also briefly describe how the program works from the consumer's standpoint. Staff provided multiple training modules per store visit. Each training module is designed to be "relevant and actionable."[14] The modules cover a variety of topics including industry and program updates, program

[14] May 2015 Field Report

markdowns, AIC program objectives, product recognition, the features and benefits of discounted products, POP materials, ENERGY STAR®, the Energy Independence and Security Act, and other topics.[15]

Representatives provided customer lighting demonstrations during 11% of store visits. Field reports generally suggest that demonstrations and informal discussions run smoothly and reach multiple customers during each visit. Staff discuss bulb features, details of the discount program, and in some cases refer customers to the AIC website for more information on the web store or other energy efficiency programs for their home or business.

To help customers identify participating retail locations near their homes, the program advertises the program online. This website allows customers to search for participating retailers by store name, zip code, and type of lighting product discount. The website also advertises the program's in-store lighting demonstration schedule. Field reports show that program staff frequently direct in-store customers to the AIC website for more information and to identify additional savings opportunities via AIC's other residential and commercial program. Field staff reported interacting with one customer who used the website before she visited the retail store; this customer brought information she had found online about bulb types and program bulb prices. However, she also described the website as "vague" with respect to what she could expect at the point of purchase.

In addition to territory responsibilities, one of the seven field representatives also performs 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 impact program success. The field leader checks whether the representative's use of merchandising and POP materials is correct and tidy, evidence of ongoing store training and customer demonstrations, and indicators that the representative is building positive relationships with store staff and training them correctly. Overall, each representative earned an average composite score above 92% out of 100% across each five-store review cycle, indicating that overall field staff are implementing the program correctly. Where needed, narrative comments and suggestions were listed, which provided clear and actionable steps that staff could take to implement program activities more effectively.

3.2 Impact Assessment

3.2.1 Program Data Verification

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. For all products, we found that the count of bulbs sold was based correctly on the total number of bulbs sold, accounting for bulbs sold in multi-packs. We identified four types of errors in the program's database and savings calculations:

- For 11 products (37,314 bulbs, or 9% of bulb sales), we found inconsistencies between the bulb description and the bulb type classification listed in program-tracking data. These cases were either specialty CFL bulbs misclassified as standard CFLs, or specialty bulbs with misclassified categories

[15] Source: CLEAResult program data

(e.g., specialty A-Line misclassified as specialty Post Light). We corrected these classifications for the final evaluation results.

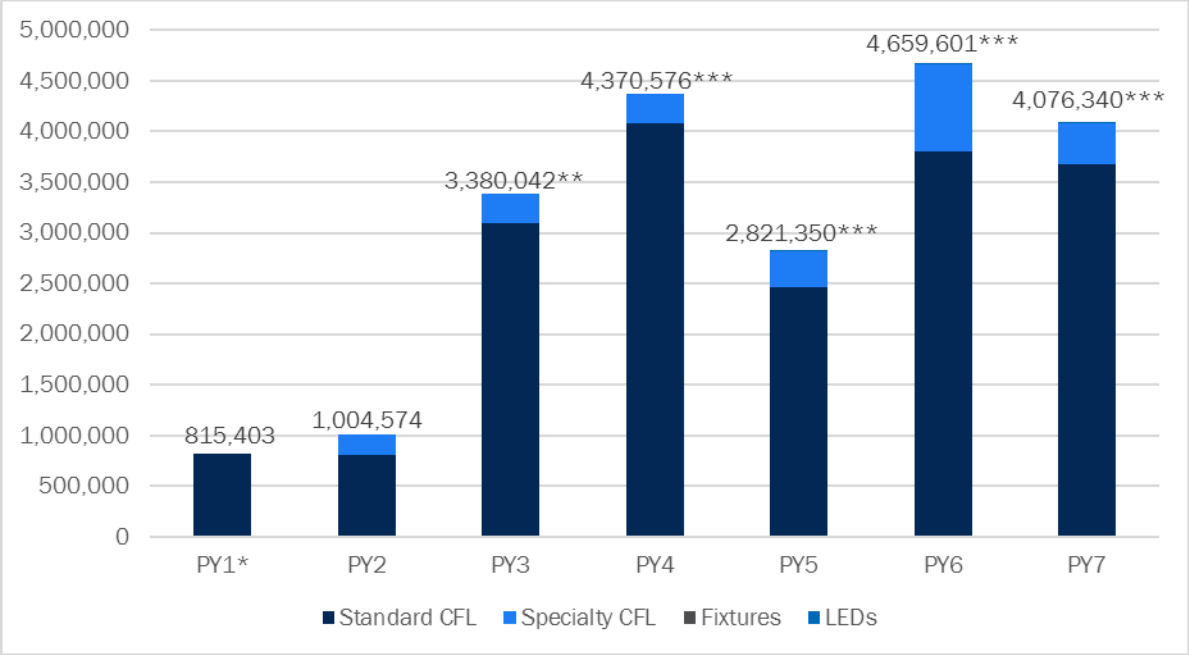
- We identified an error in the conversion between watts and kilowatts for globe bulbs sold through the in-store markdown. The program savings assumptions used a conversion factor of 1220 W = 1 kW. In our impact analysis, we used the correct conversion factor of 1,000 W = 1 kW. This change affected 10.7% of bulbs.

- We also examined the program data to ensure that the appropriate base wattage was used to calculate program savings for each product. As recommended by IL-TRM V2.0, the program used a lumens-based approach to calculate savings. However, some of the underlying assumptions regarding hours of use, waste heat factors, and in-service rates did not align with the TRM-recommended values. The program database also misclassified a small portion of bulbs, causing changes to the baseline wattages of affected bulbs. We provide a detailed list of differences between the program-tracked values and the TRM values in the Evaluation Methods section (Section 2, above).

3.2.2 Program Participation

The IPA and AIC lighting programs sold 4,076,340 bulbs in PY7 (of which the IPA program sold 403,952 bulbs). Figure 6 shows program sales from PY1 through PY7. PY7 sales are 12.5% lower overall than in PY6, and specifically IPA program specialty CFL bulb sales are 53% lower than PY6 specialty CFL bulb sales. PY7 specialty CFL sales were higher than the sales volumes in all recent program years except for PY6.

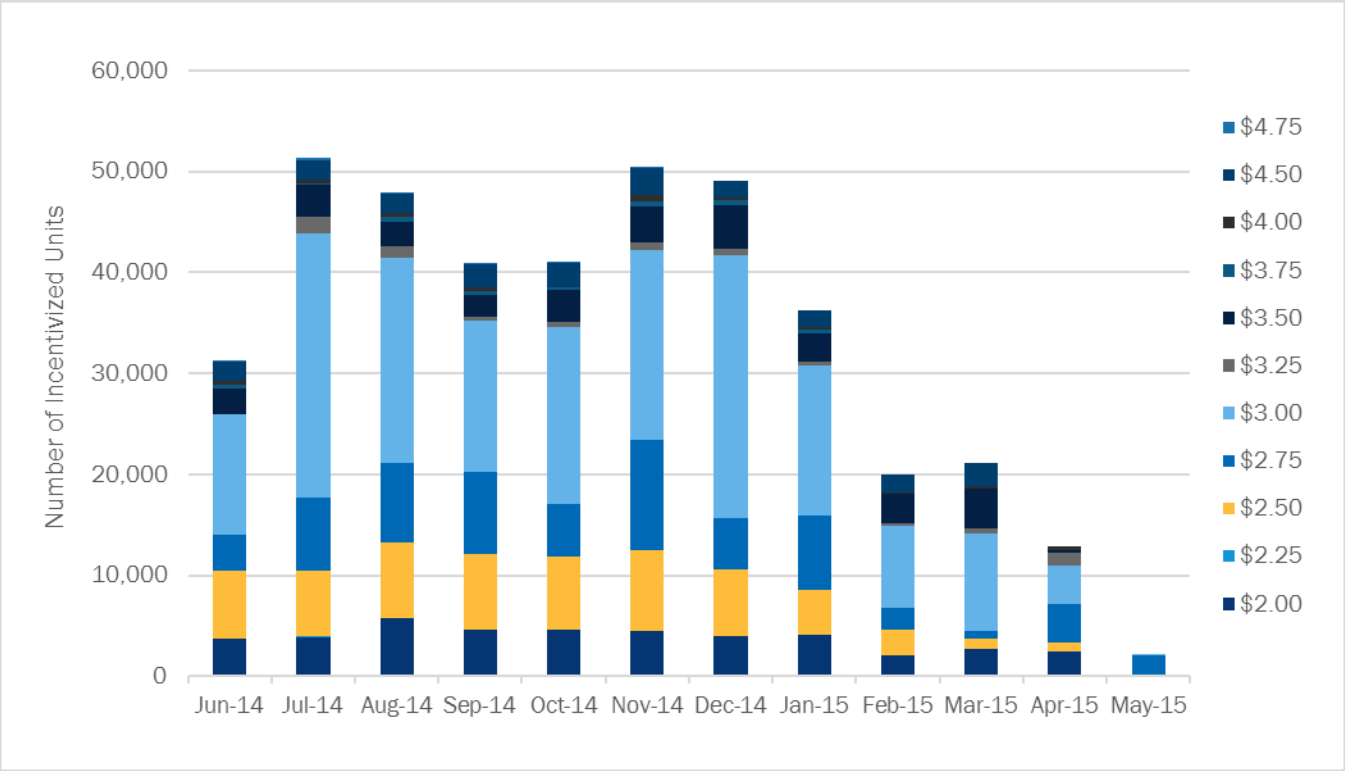
Figure 6. Total Bulbs Sold PY1 to PY7



* We do not have a record of the number of CFLs sold by type for PY1.
** In PY7, in-store specialty CFLs are reported in a separate report.
*** Indicates LEDs were sold but the quantity is too small for the bar to be visible.

Figure 7 shows monthly bulb sales for the program, broken down by incentive amount. Two main trends are evident from the figure. First, bulb sales vary by month, with noticeably fewer sales per month during the last four months of the program year. Second, the mix of bulbs by discount amount varies over the course of the program year. To avoid budget overages, program administrators scaled back the program during the final months.

Figure 7. Specialty Bulb Type Sales by Month and Incentive Amount



As in PY6, interior reflector bulbs are the most frequently purchased specialty bulb. In PY7, Candelabra bulbs were the second most frequently purchased bulb.

Table 8. Program Sales by Bulb Shape

Specialty Bulb Type	Number of Bulbs Sold	Percent of Bulbs Sold
Interior Reflector	201,840	50.0%
Candelabra	70,110	17.4%
A-Line	54,238	13.4%
Globe	52,193	12.9%
Three-Way	18,005	4.5%
Exterior Reflector	4,559	1.1%
High Output Spiral	2,286	0.6%
Dimmable Spiral	721	0.2%

Most of the specialty CFLs sold in PY7 were in either the 310-749 or the 750–1,049 lumens range (Table 10). EISA regulations do not affect specialty bulbs.

Table 9. Program Bulb Sales by Wattage

Lumens Range	Number of Bulbs Sold	Percent of Bulbs Sold
310-749	191,965	48%
750-1,049	177,607	44%
1,050-1,489	10,450	3%
1,490-2,599	22,114	5%
2,600+	1,364	<1%
2,600+[a]	452	<1%

[a]68 Watt Bulbs

Sales by Store Category

As in past years, DIY stores and big box retailers sell the majority of program-discounted bulbs (Table 11). CLEAResult added more farm store retailers to the lighting program during PY7; the evaluation team classifies farm stores as a type of big box retailer.

Table 10. PY7 Bulb Sales by Retailer Type

Store	Bulbs	% of Sales
DIY	167,469	41%
Big Box[a]	158,402	39%
Independent Hardware	34,896	9%
Discount	26,402	7%
Grocery Store	16,783	4%
Total	**403,952**	**100%**

[a]Includes Warehouses and Farm Stores.

3.2.3 Leakage into AIC Territory

In PY6, the evaluation team conducted in-store interviews with customers at participating retailers and found that 15% of program-discounted bulbs were purchased by customers of another utility (Illinois Rural Electric, Southwestern Electric, AMO, or others). This rate is the percentage of discounted bulbs that leaked out of AIC territory (leakage out).

Based on our PY7 analysis of leakage into AIC territory, we estimate that AIC customers purchased 195,523 bulbs discounted by other utility programs, which equates to 5% of bulbs sold by AIC. This figure is slightly larger than the 4% leakage in rate estimated in the evaluation of the PY6 program. Of the bulbs leaking into the AIC service area, we estimate that 10% (19,377) leaked in from the ComEd lighting program upstream retailers. This amount is consistent with the relatively small number of AIC customers within 15 miles of participating ComEd participating stores (27,551 or 3% of AIC customers).[16]

The remaining 90% of bulbs leaking into the AIC service area (176,147) come from the AMO upstream lighting program. The greater percentage of bulbs leaking into AIC from AMO compared to ComEd is due the larger number of AIC customers living close to the AMO border. Ten percent of AIC customers (83,877) live within 10 miles of a participating AMO store that has Mississippi River bridge access.[17] The higher leakage in from the AMO program also reflects the concentration of participating retailers in the greater St. Louis area. About 44% of all AMO upstream lighting program retailers are located in close proximity to AIC customers, whereas only about 9% of ComEd upstream lighting program retailers are located in close proximity to AIC customers.[18]

We recommended an overall leakage rate that combines leakage out (15%) as well as leakage in (5%). Based on our estimates of both factors, we estimate an overall leakage rate of 10% (15% - 5%).

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[16] The ComEd upstream lighting program incentivized 12,237,113 bulbs in PY7. Our estimate of bulbs leaking out of ComEd into AIC constitutes 0.016% of the total bulbs incentivized by the ComEd program.

[17] The AMO upstream lighting program incentivized 3,509,926 bulbs in 2013. Our estimate of bulbs leaking out of AMO into AIC constitutes 5% of the total bulbs incentivized by the AMO program.

[18] These figures reflect a total of 1,296 retailers participating in the ComEd upstream lighting program and 452 retailers participating in the AMO upstream lighting program.

3.2.4 Gross Impacts

Table 12 outlines the ex ante and ex post gross savings for the PY7 Residential Lighting Program. Because some bulbs sold are stored for later use, an installation adjustment factor is required to calculate the gross savings achieved in PY7. We used the IL-TRM V2.0 method, which banks savings from PY7 sales for application in future years. The ex post gross savings achieved in PY7 and shown in Table 12 are the result of sales made in PY7 and installed in PY7.

Table 11. PY7 Residential Lighting Program Gross Impacts

Sales Year – Install Year	Energy (MWh)		Demand (MW)	
	Ex Ante	Ex Post	Ex Ante	Ex Post
PY7 – Year 1 Gross Savings	14,237	12,813	1.55	1.52
PY7 Achieved Gross Realization Rate	0.90		0.98	

Notes: Realization Rate = Ex post Value / Ex ante Value.

Assumed PY7 installations of specialty bulbs sold in prior years are credited to the AIC program's impact and therefore not counted in this report.

Ex post gross savings are different than ex ante gross savings due to the following methodological reasons:

- The program savings method uses an In-Service-Rate (ISR) of 1.00 for specialty bulbs, which assumes that 100% of bulbs purchased in PY7 are also installed in PY7. As recommended by the IL-TRM V2.0, we applied ISR values over three years: an ISR at 79.5% in the first year, and the remaining bulb installations distributed over the next two years. As a result of applying the carry over savings method, ex post gross energy savings (kWh) are 20.5% lower and ex post gross demand savings (kW) are 20.5% lower than ex ante gross savings.
- The program savings method uses different hours of use (HOU) than the Statewide TRM recommends. We applied IL-TRM V2.0 for standard and specialty bulb types, which tend to be higher than the values used in the program savings method. As a result, ex post gross energy savings (MWh) and demand savings (MW) are 12.7% higher than ex ante gross savings.
- The program database misclassified several bulbs, resulting in different base wattages for a small portion of bulbs (less than 0.25% of bulbs sold). Combined, ex post gross savings are about 0.11% higher than ex ante gross savings for both energy (MWh) and demand (MW).
- The program savings method does not use waste heat factors in the ex ante savings calculations. The evaluation team applied the waste heat factors recommended in IL-TRM V2.0 to calculate ex post energy and demand savings. As a result, ex post gross energy savings (MWh) are 6.6% higher and ex post gross demand savings (MW) 12.3% higher than ex ante gross savings.
- The program savings method uses different summer peak coincidence factors than those which IL-TRM V2.0 recommends. Our evaluation team applied the TRM-recommended values to the evaluated demand savings. As a result, ex post gross demand savings (MW) are 15.7% higher than ex ante gross savings.
- The program savings methods does not account for bulbs sold to non-AIC customers. We applied an overall leakage rate of 10%, which accounts for AIC-discounted bulbs sold to non-AIC customers as

well as bulbs discounted by other utilities but purchased by AIC customers. As a result, ex post gross energy (kWh) and demand (kW) savings are 10% lower than ex ante savings.

Appendix A contains additional details about the savings assumptions we used to calculate program savings. It also contains an attached document that provides, for each product sold through the program, the program tracking data we received and assumptions the program used to calculate ex ante savings compared to the final corrected data and assumptions we used to calculate ex post savings.

Table 13 provides the savings values from sales made in PY7 that are realized in PY7 and the savings that will carry over to PY8 and PY9 due to their later installation. As discussed earlier, IL-TRM V2.0 assumes that consumers will install 98% of purchased CFLs within three years and that they will never install the remaining 2% of bulbs.

Table 12. Yearly Gross Impact of PY7 Residential Lighting Sales by Assumed Installation Year

Measure	Energy (MWh)			Demand (MW)		
	PY7	PY8	PY9	PY7	PY8	PY9
Specialty CFLs	12,813	1,612	1,370	1.52	0.19	0.16

3.2.5 Net Impacts

To calculate PY7 net ex post savings for specialty bulbs, we applied the program NTGR estimated in the PY5 evaluation (0.47) to the gross ex post MWh and MW estimates (Table 14).[19]

Table 13. PY7 Residential Lighting Program Net Energy Impacts

Net Energy Impacts	Net Energy (MWh)		Net Demand (MW)	
	Ex Ante	Ex Post	Ex Ante	Ex Post
Residential Lighting Program	6,264	6,022	0.68	0.72
PY7 Net Savings Realization Rate	0.96		1.05	

Note: Realization Rate = Ex post value / Ex ante value.

The Residential Lighting Program's realization rate for net energy savings is 0.96, and its realization rate for net demand savings is 1.05. The differences between ex ante and ex post net savings are due to the reasons cited above in the discussion of gross savings.

[19] The 0.44 NTGR comes from a draft memo reporting results of in-store customer intercepts. In our final PY5 report, we provided an updated and revised NTGR of 0.47.

4. Conclusions and Recommendations

The Residential Lighting Program ran smoothly in PY7. The program met its goals within budget and implemented several process improvements. The program had realization rates greater than 1.00 net demand savings, and realization rates near 1.00 for net energy savings.

We conducted several studies that provide information about program implementation in AIC territory. Our leakage study indicates that AIC customers are likely to purchase a significant number of bulbs discounted by other utility programs. These purchases equate to 5% of AIC program sales. However, our PY6 evaluation found that 15% of AIC-discounted bulbs are purchased by non-AIC customers. This greater rate of bulb leakage out compared to leakage in is due to the presence of municipal utilities through AIC territory, which do not run lighting programs.

Our informal analysis of the rural and independent retail store category suggests that these types of retailers offer potential for increasing sales of program-discounted lighting, particularly in areas without existing program presence. However, access to retailers appears to remain sparse in some of the more rural areas of AIC territory.

Within this context, we make the following recommendations for program improvement.

- **Continue working to add additional farm store locations in rural AIC communities, with some refinements.** Experience in PY7 suggested farm stores are important retail locations for rural customers. By increasing the number of farm stores enrolled in the program, the program can enhance rural customer access to discounted bulbs. Continuing these efforts could help the program continue progress towards its goal of reaching all AIC customers. Recognizing that the program faces multiple needs--to reach many customers cost-effectively and with minimized risk of leakage—it may help the program to study ways that the program can optimize its store enrollment decisions. Such an analysis would likely consider bulb sales per customer by location.

- **For specialty bulbs, consider increasing the number of incentives for LEDs.** Between the drop in market prices and the longer life of LEDs, specialty LEDs could be a cost-effective alternative to specialty CFLs. During PY7, the program found that retailers continued to scale back both their CFL shelf space and their participation in specialty CFL programs in favor of LEDs. In PY7, this had little impact on program impact or process given program success earlier in the program year and because retailers provided advance notice about stocking changes. However, these factors may not be true for all years. To minimize risk for future years, the program might consider proactively changing the mix of specialty bulb incentives to include more specialty LEDs and fewer specialty CFLs.

Appendix A– Gross Impact Assumptions

In this appendix, we provide details on the savings assumptions for each quantity used to estimate gross electric and demand savings. The appendix also contains an attached Excel file that provides, for each product sold through the program, the program tracking data we received and assumptions the program used to calculate ex ante savings compared to the final corrected data and assumptions we used to calculate ex post savings.

Base Wattage – EISA Compliance

Specialty bulbs are not affected by EISA legislation.

Hours of Use (HOU)

IL-TRM V2.0 provides different HOU assumptions for different bulb types and installation locations (Table 15). For the 96% of bulbs assumed sold to residential customers, we applied the residential HOU assumptions, and for the 4% of bulbs assumed sold to commercial entities we applied the commercial HOU assumptions. The TRM also provides HOU assumptions for A-Line LEDs in residential settings, which we used as inputs to the residential HOU assumption.

Table 14. IL-TRM V2.0 Hours of Use Assumptions

Bulb Type	Program Tracked	Residential	Commercial
Dimmable Spiral	882	897	3,198
Three-Way	882	897	3,198
A-Line	963	938	3,198
High Output Spiral	923	938	3,198
Interior Reflector	923	938	3,198
Globe	1,193	1,240	3,198
Candelabra	1,306	1,328	3,198
Exterior Reflector	1,768	1,825	4,903

Source: IL-TRM V2.0

Waste Heat Factors

IL-TRM V2.0 provides different WHFe values for bulbs installed in a variety of installation locations (Table 16). For electric savings, we used a WHFe of 1.06 for the 96% of bulbs installed in residential locations and

1.24 for the 4% installed in commercial locations.[20] Bulb types that customers would normally install in exterior locations (bug light and exterior reflectors) take on a value of 1.00 because these bulbs do not affect the heated areas of a building.

For demand savings, we used a WHFd of 1.11 for the 96% of bulbs assumed installed in residential locations and 1.46 for the 4% assumed installed in commercial locations (Table 17). As with electric savings, bulbs that we assume are installed in exterior locations take on a value of 1.00 because they do not affect the heated areas of a building.

Table 15. Waste Heat Factor of Energy Savings by Bulb Type

Bulb Type	Program Tracked	Ex-Post Residential	Ex-Post Commercial
	WHFe	WHFe	WHFe
A-Line	1.0	1.06	1.24
Candelabra	1.0	1.06	1.24
Dimmable Spiral	1.0	1.06	1.24
Exterior Reflector	1.0	1.00	1.00
Globe	1.0	1.06	1.24
High Output Spiral	1.0	1.06	1.24
Interior Reflector	1.0	1.06	1.24
Three-Way	1.0	1.06	1.24

Source: IL-TRM V2.0

[20] IL-TRM V2.0 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 TRM guidelines and chose the WHFe for miscellaneous buildings.

Table 16. Waste Heat Factor of Demand Savings by Bulb Type

Bulb Type	Program Tracked	Ex-Post Residential	Ex-Post Commercial
	WHFd	WHFd	WHFd
A-Line	1.0	1.11	1.46
Candelabra	1.0	1.11	1.46
Dimmable Spiral	1.0	1.11	1.46
Exterior Reflector	1.0	1.00	1.00
Globe	1.0	1.11	1.46
High Output Spiral	1.0	1.11	1.46
Interior Reflector	1.0	1.11	1.46
Three-Way	1.0	1.11	1.46

Source: IL-TRM V2.0

Coincidence Factors

IL-TRM V2.0 provides different peak coincidence factors based on installation location. For the 96% of bulbs assumed sold to residential customers, we applied the residential factors, and for the remaining 4% we applied commercial factors (Table 18).

Table 17. IL-TRM V2.0 Coincidence Factor Assumptions

Bulb Type	Program Tracked	Ex-Post Residential	Ex-Post Commercial
A-Line	0.102	0.095	0.66
Three-Way	0.087	0.081	0.66
Dimmable Spiral	0.087	0.081	0.66
Interior Reflector	0.102	0.095	0.66
High Output Spiral	0.102	0.095	0.66
Globe	0.125	0.116	0.66
Candelabra	0.131	0.122	0.66
Exterior Reflector	0.178	0.184	0

PY7 Ameren Lighting Additional

Appendix B– Other Cost Effectiveness Inputs

Heating Penalty Methods

Efficient lighting products generate less waste heat compared to baseline lighting products. When customers replace baseline products with more efficient lighting, they must use more space heating to compensate for the "lost" heat from lighting. The heating penalty represents this increased gas usage for space heating.[21] The penalty is used in the analysis of program cost effectiveness. IL-TRM V2.0 provides different algorithms to calculate the heat penalty for residential and commercial installations.

For residential homes:

$$Year\ 1\ \Delta\ Therms = \left[\frac{(Base\ Watt_{2015} - Bulb\ Watt)}{1000} \times ISR_{res,yr1} \times HOU_{res} \times HF_{res} \times 0.03412\right] \Big/ \eta Heat$$

Where:

Base Watt = EISA complaint base wattage in 2015
Bulb Watt = Actual wattage of installed CFL bulb
ISR = First year In-Service Rate
HOU = Hours of Use
HF = Heating Factor or percentage of light savings that must be heated
0.03412 = Conversion factor from kWh to Therms
ηHeat = Efficiency of heating system.

For commercial facilities:

$$Year\ 1\ \Delta\ Therms = \frac{(Base\ Watt_{2015} - Bulb\ Watt)}{1000} \times ISR_{com,yr1} \times HOU_{com} \times IFTherms_{com}$$

Where:

Base Watt = EISA complaint base wattage in 2015
Bulb Watt = Actual wattage of installed CFL bulb
ISR = First year In-Service Rate
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 average program heat penalty, we apply both the residential and the commercial savings algorithms and calculate their weighted average, where weights are the probability of a bulb being installed in each respective location. Our weighted savings equation is:

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

$$Year\ 1\ \Delta\ Therms = LA \times 0.96 \times \left[\frac{(Base\ Watt_{2015} - Bulb\ Watt)}{1000} \times ISR_{res,yr1} \times HOU_{res} \times HF_{res} \times 0.03412\right] \Big/ \eta Heat$$

$$+ LA \times\ 0.04 \times \left[\frac{(Base\ Watt_{2015} - Bulb\ Watt)}{1000} \times ISR_{com,yr1} \times HOU_{com} \times IFTherms_{com}\right]$$

Where:

Res = Residential values
Com = Commercial values

To calculate the heating penalty for PY7 purchases that will be installed during the next two years we simply apply the in-service rate (ISR) for year 2 and year 3 and modify the base wattage for the bulb to be EISA complaint:

$$Year\ 2\ \Delta\ Therms\ Heat\ Penalty$$
$$= LA \times 0.96 \times \left[\frac{(Base\ Watt_{2016} - Bulb\ Watt)}{1000} \times ISR_{res,yr2} \times HOU_{res} \times HF_{res} \times 0.03412\right] \Big/ \eta Heat$$

$$+ LA \times 0.04 \times \left[\frac{(Base\ Watt_{2016} - Bulb\ Watt)}{1000} \times ISR_{com,yr2} \times HOU_{com} \times IFTherms_{com}\right]$$

$$Year\ 3\ \Delta\ Therms\ Heat\ Penalty$$
$$= LA \times 0.96 \times \left[\frac{(Base\ Watt_{2017} - Bulb\ Watt)}{1000} \times ISR_{res,yr3} \times HOU_{res} \times HF_{res} \times 0.03412\right] \Big/ \eta Heat$$

$$+ LA \times 0.04 \times \left[\frac{(Base\ Watt_{2017} - Bulb\ Watt)}{1000} \times ISR_{com,yr3} \times HOU_{com} \times IFTherms_{com}\right]$$

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. IL-TRM V2.0 provides different factors based on installation location.

Table 18. Heating Penalty Factors for Calculating Gas Heat

Bulb Type	Ex-Post Residential	Ex-Post Commercial
	Heating Factor (HF)	Lighting-HVAC Integration Factor
A-Line	0.49	0.014
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
Three-Way	0.49	0.014

Heating Penalty Results

Table 20 shows the gas-heating penalty that results from the additional space heating needed when efficient lighting is installed.

Table 19. Gas Heating Penalty

Measure	Heating Penalty (Therms)		
	PY7	PY8	PY9
Specialty CFLs	-261,068	-32,839	-27,913

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