Ameren Missouri
Lighting Impact and Process Evaluation:
Program Year 2015

Final May 13, 2016

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Executive Summary

Ameren Missouri engaged Cadmus and Nexant (the Cadmus team) to perform annual process and impact evaluations of the Lighting program for a three-year period from 2013 through 2015.[1] This annual report covers the impact and process evaluation findings for Program Year 2015 (PY15), the period from January 1, 2015, through December 31, 2015, the final year in the three-year cycle.

Program Description

The Lighting program's design seeks to increase sales of energy-efficient lighting products through a variety of retail channels. Ameren Missouri works with CLEAResult (formerly Applied Proactive Technologies), the Lighting program implementer, to provide a per-unit discount for eligible compact fluorescent lamps (CFLs), light emitting diodes (LEDs), and lighting occupancy sensors. In addition to reducing prices, CLEAResult relies on its relationships with participating retailers to place discounted lighting in prominent locations within stores and to locate Ameren Missouri signage and marketing materials nearby. Energy Federated Incorporated (EFI) also assists in markdown program implementation by maintaining the implementer tracking system (which transmits data to the Ameren Missouri Vision database) and selling discounted lighting products through an online store.

The Lighting program primarily operates through a point-of-sale markdown system at major chain retailers and through an online website. In addition to the markdown channel, the Lighting program includes two other channels: coupons and social marketing distribution (SMD). The coupon channel is available to retailers without a point-of-sale system (i.e., a computer software system that tracks all purchases). For these retailers, Ameren Missouri provides coupons that customers complete at the register to receive a discount. Through the SMD channel, Ameren Missouri distributes free 13W CFLs and 23W CFLs to low-income customers through partnerships with area food banks and related community organizations.

Table 1 shows PY15 total participation by the program's three distribution channels. As in PY14 and PY13, the overwhelming majority of program participation occurred through the markdown channel.

Table 1. PY15 Participation Summary

Lighting Program Channel	PY15 Participation (Bulbs)	Percent of Participation
Markdown	1,840,674	90.5%
Coupon	5,409	0.3%
Online	3,675	0.2%
SMD	183,178	9.0%
Total	**2,032,936**	**100%**

[1] In PY14, Ameren Missouri changed the name of the program from LightSavers (used in PY13) to the Lighting program.

Key Impact Evaluation Findings

The PY15 evaluation included empirical research as well as updates to research conducted in the PY13 and PY14 evaluations. Primary research in PY15 included a home inventory study, and development of an Ameren Missouri-specific wattage baseline that accounts for the gradual disappearance from the market of non-compliant Energy Independence and Security Act of 2007 (EISA) regulated incandescents. The latter research element was informed by a shelf stocking study of local retailers that was similar in design to the study conducted in PY14 (the study involved visiting a sample of stores to identify whether or not EISA impacted bulbs were still available).

To update previous research, the Cadmus team applied PY15 sales data to derive leakage (i.e., upstream bulbs purchased by non-Ameren Missouri customers) and cross-sector sales (i.e., upstream bulbs purchased by nonresidential customers), originally estimated through store intercept surveys in PY13. Based on our analysis, leakage dropped in PY15, from 3.9% to 1.8%, and nonresidential sales increased, from 9% to 15.5%. The Cadmus team determined the increase in nonresidential sales was not representative of a significant portion of program sales, since the result is based on a survey of only big box locations from PY13, whereas the PY15 program saw a larger percentage of sales through non-big box locations. To account for this discrepancy, the team relied on an average nonresidential sales rate for recent similar programs, from a recent meta-analysis of evaluation reports. That rate, 6.6%, was applied to the non-big box sales, resulting in overall cross sector sales of 9.8%.

To evaluate the net savings, we applied the elasticities from the PY14 demand elasticity model with PY15 sales and price shifts to estimate free ridership at 19%. The team updated the market effects model developed in PY13 to determine spillover and market effects with information from the PY15 home lighting inventory. In addition, the team modified the model to account for high efficiency bulb turnover. The model showed lighting spillover of 4% and market effects of 5%. We also estimated nonparticipant (non-lighting) spillover from a PY15 general population survey—equivalent to 1.3% of program savings.

In PY14, the team did not have updated saturation results to model spillover and market effects. Therefore, the team estimated the likely spillover and market effects based on sales volume, and stated that the estimates would be adjusted in PY15 based on updated saturation results. This report includes an adjustment to the PY15 energy savings and the net annual lifetime benefits to account for overage in PY14.

Gross Impacts

Since EISA rules affecting 23W and 18W CFLs went into effect in 2012 and 2013, respectively, equivalent incandescent bulbs were already largely absent from the market in PY14. The PY15 blended baseline for each measure did move downward toward the post-EISA baseline, but the incremental change was minor. The PY14 baseline for 12W LEDs was only slightly offset from the post-EISA baseline, so the Cadmus team assumed a full post-EISA baseline for this measure for PY15, with minimal impact on per-unit savings. While EISA regulations also impact certain reflector bulbs, Cadmus applied the overall

wattage mapping to estimate baselines and efficient bulb wattages for this group. We conducted a detailed review of reflector baselines and determined that baselines are a mix of incandescent and halogen bulbs.

Table 2, below, presents *ex ante*, *ex post* energy savings, and realization rates. Overall, per-unit, *ex post* savings and realization rates increased since last year's evaluation. This increase was the result of an increased in-service rate based on the home inventory study results, decreased leakage, and an increase in the percentage of bulbs going to non-residential applications. These changes more than made up for lower baseline wattages on EISA-impacted bulbs. The 13W CFL, which generates the majority of program savings, ran counter to the overall trend and showed a reduced gross per-unit savings and realization rate in PY15 relative to PY14 because of the more recent phase out of equivalent 60 W incandescent bulbs. The reduced baseline wattage also impacted the per-unit savings for the SMD bulbs (13W and 23W), which had lower realization rates. These major factors are explained further here:

- **Increased In-Service Rate.** Through the home inventory study, the Cadmus team calculated the percentage of high-efficiency bulbs installed in sockets versus in storage. This rate was 79%, down from the 82% found in the PY13 home inventory study. This rate forms the basis for the calculation of the installation rate for markdown bulbs. (The SMD in-service rate is based on a survey of SMD participants conducted in PY13.) .
- **Reduced Leakage Rate.** The leakage rate is the percentage of program bulbs purchased by non-Ameren Missouri customers. In PY13, Cadmus determined the leakage rate based on the geographic location of each store. In PY15, we used the same rates by store type but weighted with PY15 sales. Because in early 2015 the program eliminated discounts for standard CFLs in big-box stores, which have the highest leakage rates, the overall program leakage dropped from 3.9% in PY13 to 1.8% in PY15.
- **Nonresidential Applications**. Because nonresidential bulbs have higher hours of use, we assess savings for the percentage of Lighting program bulbs that are installed in nonresidential applications (such as a small business) separately. The percentage of nonresidential bulb sales increased in PY15. This calculation relies on the same geographic weighting used to determine leakage (described above), and was similarly updated with PY15 sales. Less reliance on the big box mass merchandise stores resulted in a greater concentration of big box sales in stores that experience a higher rate of nonresidential sales, according to the PY13 survey results. Because the non-residential calculation relies on a sample of only big box stores, the evaluated percentage of nonresidential sales increased from 9% in PY14 to 15.5% in PY15. For that reason, Cadmus applied the evaluated value only to big box sales, and applied a value of 6.6%, based on secondary research for nonresidential sales rates across the country, for non-big box sales. The weighted average of the two rates was 9%.
- **Baseline Wattage.** Four program measures (13W, 18W, and 23W CFLs, and 12W LEDs) are affected by federal EISA legislation that established maximum wattages by lumen range for standard (general purpose) bulbs, effectively prohibiting standard incandescent bulbs. For each annual evaluation since EISA went into effect in 2012, the Cadmus team has calculated a blended pre- and post-EISA baseline wattage that accounted for the gradual phase-out of the incandescent bulbs in the marketplace on a quarterly basis.

EISA rules affecting 13W CFLs took effect in 2014, meaning the phase-out of 60W incandescents was just beginning last year. As a result, the 60W pre-EISA baseline wattage made up a majority of the PY14 blended baseline wattage value for 13W CFLs. By PY15, most stores were no longer selling standard 60W incandescents and the blended baseline wattage was almost entirely composed of the post-EISA value. As a result, the baseline wattage dropped from 53.6 in PY14 to 43.5, half a watt above the post-EISA value, for PY15.

Since EISA rules affecting 23W and 18W CFLs went into effect in 2012 and 2013, respectively, equivalent incandescent bulbs were already largely absent from the market in PY14. The PY15 blended baseline for each measure did move downward toward the post-EISA baseline, but the incremental change was minor. The PY14 baseline for 12W LEDs was only slightly offset from the post-EISA baseline, so the Cadmus team assumed a full post-EISA baseline for this measure for PY15, with minimal impact on per-unit savings. While EISA regulations also impact certain reflector bulbs, Cadmus applied the overall wattage mapping to estimate baselines and efficient bulb wattages for this group. We conducted a detailed review of reflector baselines and determined that baselines are a mix of incandescent and halogen bulbs.

Table 2. PY15 Summary: *Ex Ante* and *Ex Post* Program Gross per Unit Savings Comparison

Measure	Verified Number of Measures	*Ex Ante* Gross kWh Savings/Year/ Measure	*Ex Post* Gross kWh Savings/ Year/ Measure	Realization Rate
Upstream Markdown				
CFL - 13W (60W incand equiv)	1,205,401	31.5	28.2	90%
CFL - 18W (75W incand equiv)	16,724	37.4	33.9	91%
CFL - 23W (100W incand equiv)	35,031	51.2	52.6	103%
CFL - High Wattage Bulbs	270	113	174.5	154%
CFL - Reflector	8,333	44.1	56.9	129%
CFL - Specialty Bulbs	3,703	44.1	49.0	111%
LED - 10.5W Downlight E26	239,733	54.5	55.6	102%
LED - 12W Dimmable	297,399	48	37.1	77%
LED - 15W Flood Light PAR30 Bulb	4,144	35	67.4	192%
LED - 18W Flood Light PAR38 Bulb	8,419	32	81.8	256%
LED - 8W Globe Light G25	30,589	32	33.9	106%
Occupancy Sensor	12	217	28.4	13%
SMD				
CFL - 13W (60W incand equiv)	100,470	31.5	20.5	65%
CFL - 23W (100W incand equiv)	82,708	51.2	33.3	65%

Table 3 compares the realization rate for each measure category's per-unit savings for PY15 to the PY13 and PY14 realization rates.

Table 3. Per Unit Savings Realization Rates for PY13, PY14, and PY15

Bulb Type and Wattage	2015	*2014*	*2013*
Upstream and Coupon Bulbs			
CFL - 13W	90%	*120%*	*97%*
CFL - 18W	91%	*96%*	*133%*
CFL - 23W	103%	*93%*	*96%*
CFL - High Wattage	154%	*123%*	*126%*
CFL – Reflector	129%	*89%*	*104%*
CFL - Specialty	111%	*103%*	*92%*
LED - 10.5W Downlight E26	102%	*88%*	*91%*
LED - 12W Dimmable	77%	*71%*	*126%*
LED - 15W Flood Light PAR30	192%	*157%*	*n/a*
LED - 18W Flood Light PAR38	256%	*209%*	*n/a*
LED - 8W Globe Light G25	106%	*91%*	*165%*
Occupancy Sensor	13%	*13%*	*17%*
SMD Bulbs			
CFL - 13W	65%	*86%*	*85%*
CFL - 23W	65%	*67%*	*84%*

Net Impacts

To estimate PY15 net-to-gross (NTG) ratios, the Cadmus team used the following formula:

NTG = 1.0 – Free Ridership + Participant Spillover + Nonparticipant Spillover + Market Effects

To estimate free ridership this year, we used the price elasticities from the PY14 evaluation and applied PY15 sales data and retail prices, finding decreased levels of overall lighting free ridership (19%) compared to last year (25%). The drop in the free ridership rate is not surprising, since Ameren Missouri reduced the availability of discounted bulbs from PY14 distribution channels that had the highest free ridership. . We also conducted a new nonparticipant spillover analysis at the portfolio level, and used PY15 marketing expenditures and program-specific implementation budgets to allocate spillover savings to each program. We determined nonparticipant non-lighting spillover—equivalent to 1.3% of program savings.

In PY15, the Cadmus team conducted inventories at 100 randomly sampled residential customer homes to determine CFL saturations and, subsequently, to model lighting specific spillover and market effects. The inventory found no change in overall saturation, but did find higher storage rates, and evidence of CFL and LED turnover. Cadmus updated the model to reflect this turnover and higher storage rates

which resulted in spillover and market effects of 4% and 5% respectively. Table 4 shows contributing net savings elements.

Table 4. PY15 Net Impact Summary[1]

Delivery Channel	Ex Post Gross Savings (MWh/yr)	Free Ridership	Nonparticipant Non-Lighting Spillover	Lighting-Specific Spillover	Market Effects	NTG Ratio	Net Savings (MWh/yr)
Markdown/ Coupon	63,506	22.1%	1.3%	4.0%	5.0%	88.2%	56,010
SMD	4,820	N/A	N/A	N/A	N/A	100%	4,820
Lighting Program	**68,326**	**20.5%**	**1.2%**	**3.7%**	**4.6%**	**89.0%**	**60,830**

[1]May not sum exactly due to rounding.

As shown in Table 5, the program achieved 98% of its proposed net energy savings target for PY15 (62,371 MWh) as well as 264% of its proposed net demand savings target (1,875 kW). Ameren Missouri's residential tariff, approved by the Missouri Public Service Commission (MPSC) before the beginning of this program cycle in PY13, set the yearly targets for energy and demand savings.

Table 5. Lighting Net Savings Comparisons

Metric	MPSC-Approved Target[1]	*Ex Ante* Gross Savings Utility Reported [2]	*Ex Post* Gross Savings Determined by EM&V[3]	*Ex Post* Net Savings Determined by EM&V[4]	Percent of Goal Achieved[5]
Energy (MWh)	62,371	77,539	68,326	60,830	98%
Demand (kW)	1,875	5,600	5,618	4,944	264%

[1] http://www.ameren.com/-/media/missouri-site/Files/Rates/UECSheet191EEResidential.pdf

[2] Calculated by applying tracked program activity to Ameren Missouri's 2012 Technical Resource Manual (TRM) savings values.(https://www.efis.psc.mo.gov/mpsc/commoncomponents/viewdocument.asp?DocId=935658483)

[3] Calculated by applying tracked program activity to Cadmus' evaluated savings values.

[4] Calculated by multiplying Cadmus' evaluated gross savings and NTG ratio, which accounts for free ridership, participant spillover, nonparticipant spillover, and market effects.

[5] Compares MPSC Approved Target and *Ex Post* Net Savings Determined by EM&V.

PY14 Net Savings Adjustment

Using the updated saturation results from the 2015 home lighting inventory, the Cadmus team adjusted the PY14 net savings estimate. Since the PY14 report is filed and closed, we report the savings adjustment in this PY15 report. Table 6 presents these results.

Table 6. Adjustment for PY14 Overage Applied to PY15 Results

Delivery Channel	*Ex Post* Gross Savings (MWh/yr)	Free Ridership	Participant Spillover	NPSO	Market Effects	NTG Ratio	Net Savings (MWh/yr)
PY14 Original Values							
PY14 Markdown	153,642	25.9%	14.0%	1.2%	10.0%	99.3%	152,581
PY14 SMD + Occ Sens	3,199	0.0%	0.0%	0.0%	0.0%	100%	3,199
Total	**156,841**						**155,780**
PY14 Adjusted Values							
PY14 Markdown	153,642	25.9%	4.0%	1.2%	5.0%	84.3%	**129,535**
PY14 SMD + Occ Sens	3,199	0.0%	0.0%	0.0%	0.0%	100%	3,199
Total	**156,841**						**132,734**
Net Savings Adjustment							***-23,046****
PY15 Values							
PY15 Markdown	63,506	22.1%	4.0%	1.3%	5.0%	88.2%	56,010
PY15 SMD	4,820	0.0%	0.0%	0.0%	0.0%	100%	4,820
Total	**68,326**						**60,830**
PY15 Energy Savings After PY14 Adjustment							**37,783**

* Value differs due to rounding.

Key Process Evaluation Findings

The PY15 evaluation focused on the impacts of program changes in 2015. Key process findings for the PY15 program year are these:

- **Limited Incentive Changes for LEDs.** Retail prices for LEDs continued to fall during 2015, reaching a level where the minimum incentive approved in the program plan—$4.00 per LED bulb—resulted in a price to customers that was too low for some retailers to accept and more expensive than the implementer believed necessary to promote sales. The implementer removed most LED standard and specialty bulbs from retailers in February and March of 2015 until Ameren Missouri could refile a lower minimum incentive with the MPSC. Ameren Missouri filed updated minimum incentives, which the MPSC approved in August, allowing the program to reintroduce LEDs. However, according to implementers, to make up for lost sales time, and to counter the increase of non-ENERGY STAR LEDs (priced near the discounted price of the program bulbs) the implementer did not set LED incentives as low as it had intended earlier in the year. As a result of these changes, average incentives for LED bulbs did not drop below $4.00. The PY15 cost per net kWh for most LED measures was lower or equal to PY14 levels.
- **Shift in Distribution Channels.** To avoid excessive free ridership, standard CFLs were removed from big-box stores in January of 2015. Since big-box sales of standard CFLs have historically

been the vast majority of program savings, this shift resulted in reduced sales of standard CFLs, reduced program sales overall, and reduced savings compared to PY14. Although they continued to participate and to play an important role, big box stores contributed 60% of program sales, far less than in PY13 and PY14. The non-big-box stores were able to generate greater sales than expected, so sales for the year were just over 1.8 million.

- **Increase in LED Sales.** LED sales have increased each year since PY13, and PY15 followed that pattern. LED sales increased from 7% of program sales to over 30% of sales, and grew from 261,031 bulbs to 580,284 bulbs. The 10.5W downlight LED was the most popular of the LED measures, at 408,598 in sales. The program continued to heavily promote specialty LEDs in participating retailers, despite reducing discounts for specialty CFLs. LEDs were more popular with both customers and retailers and achieved slightly higher savings.
- **Disappearance of Incandescent Bulbs.** In PY14, the shelf survey found that standard incandescent bulbs were available in 10% to 70% of participating stores over the course of the year, by wattage, with 60W bulbs being the most common. However, in PY15, the shelf survey found that in non-big-box stores, all incandescents bulbs including 60W bulbs had almost completely disappeared from non-big-box stores. A review of online inventory of participating big-box retail locations found that incandescents were also almost totally absent from these stores as of December 2015.
- **Stagnation in CFL saturation.** The home inventory study showed that saturation of CFLs has been stagnant over the past two years, although storage rates and purchases for installations outside the home have increased. Although the installed percentage of high –efficiency bulbs has not changed, the mix of bulbs has shifted to a higher concentration of LEDs. In PY15, the implementer reduced incentives for specialty CFLs because they were less cost-effective than the implementer had anticipated and due to lack of interest from retailers. In addition, retailers reported to the program implementer that they planned to reduce the number of CFL models they stock, especially specialty CFLs, in favor of LEDs. LEDs are almost price-competitive with specialty CFLs and are more popular with customers.
- **Appearance of non-ENERGY STAR LEDs.** In PY15, retailers began stocking increasing numbers of models of LEDs that are produced by major brands but do not meet certain ENERGY STAR criteria related to lumens, direction of light output, measure life, quality control and other features. These bulbs are cheaper to produce and so are price-competitive with discounted program bulbs, even though they are not eligible for the discount.

Key Conclusions and Recommendations

Based on the impact and process evaluation findings for the Lighting program, the Cadmus team offers the following conclusions and recommendations.

Conclusion 1. The complete phase-out of incandescent bulbs could make future program planning easier. Perhaps the most dramatic and obvious change in the market during PY15 was the near-complete absence of standard incandescent bulbs. In-store shelf surveys, as well as our online inventory

review, showed that neither big-box nor smaller stores are currently offering standard incandescent bulbs. This will make it easier to establish a wattage baseline and predict the savings from high-volume measures in PY16 – PY18. New EISA regulations take effect in 2020 that increase required bulb efficiency to be equivalent to that of CFLs. Non-ENERGY STAR LEDs could be considered an alternative to program-incented ENERGY STAR LEDs, and these market changes should be monitored.

Recommendation 1a. Future evaluations should not track the presence of incandescent bulbs in the marketplace and instead should adopt the corresponding halogen wattage as the baseline for EISA impacted bulbs.

Recommendation 1b. A future program should create more distinction between CFLs and LEDs. Inputs to gross and net savings calculations, such as hours of use, product wattage, free ridership, saturation, and other inputs, should be estimated separately for CFLs and LEDs. This was not possible in past studies because of the low number of LEDs in the marketplace, but LEDs are gaining market share fast enough that in the near future studies should be better able to distinguish between the two.

Conclusion 2. Several market trends will make it difficult for the program to operate cost-effectively as currently designed going forward. The product that has historically driven sales since the program inception—the standard CFL—will have a lower savings per unit due to the phase-out of incandescents and a higher free ridership because regular retail prices have dropped and customers are more familiar with the technology. LEDs have proven popular with customers, and prices are falling, making the bulbs less expensive to promote. However, the increase in non-ENERGY STAR LEDs will force a program to discount these bulbs more aggressively than it otherwise might. And, as with CFLs, the lower overall retail price and increased awareness may increase free ridership.

Recommendation 2. Future portfolio plans will need to take into account that the Lighting program is unlikely to drive the level of savings that it has in the past. This may impact the design of other programs that have been carried by the strong performance of the lighting program in generating cost-effective savings. In addition, it will be important to revisit the design of the Lighting program and adjust it to meet changing market conditions. A key revision might be to adopt bulb models that meet the new ENERGY STAR Lamps Specification 2.0, which will go into effect Jan. 2, 2017. These bulbs have the same savings benefits as other ENERGY STAR bulbs, so from an efficiency perspective, there is no reason to exclude these bulbs.

Conclusion 3. Non-big-box chains were able to generate sufficient sales for the program to operate at levels within range of PY13 and PY14 when sales were driven almost entirely by big-box locations. The program cycle from PY13 to PY15 made the transition from heavy reliance on big-box stores to greater inclusion of smaller and alternative channels, such as discount retailers. The performance in PY15 suggests that these stores could continue to play a significant role in the future.

Recommendation 3. Future programs should continue to incorporate a diverse set of retail partners, and can expect smaller stores to make a significant contribution to program performance.

PY14 Recommendation Tracking

The Cadmus team presents recommendations for program improvement each year for Ameren Missouri's consideration. Table 7 presents Ameren Missouri's response to the recommendations from PY14.

Table 7. Ameren Missouri Responses to PY14 Recommendations

Lighting PY14 Recommendation	Ameren Missouri Response	Explanation
Anticipate that a slow phase out will "float" the baseline wattage above the "post-EISA" value for 40W and 60W at least one to two years after EISA implementation.	Partially Implemented.	Ameren Missouri reduced sales of 60W equivalent CFLs to avoid high free ridership. To track the actual wattage baseline, Ameren Missouri provided Cadmus with shelf stocking report.
To maintain market momentum and guarantee the program gets as much benefit from bulbs as possible, the program should consider marketing campaigns specifically focused on LEDs.	Implemented.	The program focused on promoting and educating customers on LEDs in the fourth quarter of PY15 in anticipation of an all LED program for 2016-2018.
The program should be selective when promoting LEDs. CFLs still account for over 70% of program sales and offer by far the most cost-effective savings. LEDs should not be promoted in a way that would shift CFL sales to LEDs. Instead, focus LED sales where it aligns with retailer's marketing approach, such as DIY stores that want to preserve a wide array of LED options on their shelves, and minimize the number of CFLs.	Not Implemented.	The program removed CFLs from big box stores in 2015, while continuing to offer LEDs. LED sales increased due to reduced retail prices for 2015.
Continue to work with discount retailers to increase uptake at discount retail stores.	Implemented.	The implementers added several discount retail locations and coordinated with stores to use Ameren Missouri in-store marketing.

Introduction

Ameren Missouri engaged Cadmus and Nexant (the Cadmus team) to perform a process and impact evaluation of the Lighting program for a three-year period. This annual report covers the impact and process evaluation findings for Program Year 2015 (PY15), the period from January 1, 2015, through December 31, 2015, the final year in the three-year cycle.

For 2015, the Cadmus team assessed gross and net savings impacts and evaluated program processes. For the gross savings analysis, we conducted primary research to inform the baseline wattage and installation rate, and we updated research from PY13 and PY14 to determine the leakage and cross-sector installation rate (the percentage of program bulbs going to residential versus nonresidential applications). To determine the baseline for EISA-impacted general purpose bulbs, Cadmus conducted retailer shelf surveys similar to PY14. The retailer shelf survey monitored the presence of EISA-impacted incandescent bulbs in participating retailer locations to update the wattage baseline for EISA-impacted program measures.

To update the in-service rate, Cadmus used a new first-year installation rate calculated from on-site inventories of 100 homes in the Ameren Missouri service territory, and then applied 2015 sales data for markdown and coupon bulbs.

Cadmus adjusted the leakage rate and the estimated percentage of bulbs going to residential applications by updating the store intercept survey results from 2013. Cadmus weighted the PY13 sample results by PY15 sales instead of PY13 sales, to reflect the PY15 model and retailer mix. We also modified the approach to determine cross-sector sales rate to account for the fact that the PY13 sample included only big box retailers, but a greater percentage of program sales occurred in non-big box stores in PY15.

To calculate net savings, Cadmus updated our evaluation of the free ridership rate for 2015. We applied the elasticities calculated in 2014 to sales and retail price changes in 2015 to determine free ridership. We determined the estimation and allocation of the nonparticipant spillover through a new general population survey and 2015 marketing expenditures. In addition, we updated the estimated CFL and LED saturations and storage levels and incorporated this data into our model to calculate lighting spillover and market effects.

For the process evaluation, the Cadmus team conducted interviews of Ameren Missouri program staff and implementer staff. The process evaluation evaluated program changes implemented in 2015 as well as changes in the market. These changes included the following:

- Eliminating standard CFLs from big-box stores, and reducing specialty CFL models and incentives on available models.
- Temporarily removing all LEDs.
- Elimination of occupancy sensors.
- An increased focus on discount retail.

- A reduced bulb distribution through the Social Marketing Distribution (SMD) channel.
- Measuring the persistence of standard incandescent bulbs in the marketplace
- Measuring the saturation of energy efficient bulbs in home
- Evaluating customer lighting preferences
- Evaluating customer lighting storage and disposal habits

Through the home lighting inventory, Cadmus developed an updated snapshot of key characteristics of the residential lighting market, including the average number and type of sockets per home, the penetration and saturation of various lighting products by home and by room type, and bulb storage rates.

Program Description

The Lighting program's design seeks to increase sales and customer awareness of ENERGY STAR®-qualified, residential lighting products. The program partners with retailers to increase the availability of qualifying lighting products and provides price discounts to encourage increased sales. Specifically, the Lighting program encourages the purchase of new technologies such as LEDs and specialty CFLs, in addition to standard CFLs. The program offers incentives through several brick-and-mortar retailers and through an online store.

In addition to discounts, the Lighting program relies on various promotional techniques—improved product placements, off-shelf merchandising opportunities, and in-store demonstrations—to encourage adoption of higher-efficiency lighting and increase customer awareness of the benefits from high-efficiency bulbs.

The Lighting program primarily operates through a point-of-sale markdown system at major chain retailers and through an online website. The coupon channel is available to retailers without a point-of-sale system (i.e., a computer software system that tracks all purchases). For these retailers, Ameren Missouri provides coupons that customers complete at the register to receive a discount. The program also uses an SMD channel, through which Ameren Missouri provides CFLs at no charge to low-income customers via partnerships with community organizations.

About the Target Market

Working through local and national chain lighting retailers, the Lighting program targets Ameren Missouri residential customers. While the program generates the most sales through its large, national retailer partners, program and implementer staff seek to include local retailers, regional chains, and small hardware stores that are themselves Ameren Missouri customers and that often serve Ameren Missouri residential customers in more rural locations.

Through its SMD channel, the program targets hard-to-reach low-income segments of the residential customer market. The program also targets this market through the discount retail chains that participate in the markdown channel.

The online store, accessible directly and linked on the Ameren Missouri website, offers another shopping option for customers. This channel ensures availability to customers unable to physically access a retail partner.

About the Program Implementers

Ameren Missouri contracted with CLEAResult (which purchased the previous implementer, Applied Proactive Technologies, in 2015) and Energy Federation Incorporated (EFI) to implement the Lighting program for program years of 2013, 2014, and 2015. These implementers conduct these activities:

- The CLEAResult team's experience in managing upstream lighting programs includes administering Ameren Missouri's Lighting program (formerly the Lighting and Appliance Program) for the past four years and administering similar programs for other utilities across the country.
- EFI processes program incentive payments and manages the online store that sells discounted CFLs and LEDs.

Program Activity

The overwhelming majority of PY15 sales came through brick-and-mortar retailers participating in the point-of-sale (POS) markdown program, which conforms with the program design. After the markdown program, distributions of 13W and 23W CFLs through the SMD program served as the second-largest contributor of savings, followed by product sales through the online store, and, finally, CFL sales through the coupon program. Discount stores provided the greatest contribution to the markdown sales.

Table 8. Participation by Channel

Lighting Element	PY15 Participation	Percentage of Participation
Markdown and Online	1,844,349	90.7%
Coupon	5,409	0.3%
SMD	183,178	9.0%
Total	**2,032,936**	**100%**

Despite the removal of standard CFLs from big-box stores very early in the year, standard CFLs continued to make up the bulk of program sales in PY15. Specialty CFLs, less cost-effective and less popular than other measures, made up a lower percentage of program net savings in PY15 than in PY14, at just 2% of net savings compared to 7% in PY14. LEDs, on the other hand, were a significant contributor to program savings for the first time. Net savings from LEDs increased from just under 7% in PY14 to 39% of net savings in PY15. Occupancy sensors were phased out early in the year and made a negligible contribution to savings.

Evaluation Methodology

The Cadmus team identified the following impact and process evaluation objectives for the Lighting program in PY15.

Impact Evaluation Priorities

- Determine measure-specific savings, total gross savings, net energy savings, and generated demand reductions.
- Determine the saturation rate for high-efficiency bulbs in Ameren Missouri service territory, for average households and for specific room types.
- Determine the energy efficient bulb installation rate
- Determine baseline per-unit wattages by measure, adjusted on a quarterly basis and accounting for the persistence of 100W, 75W, 60W, and 40W incandescent bulbs in the market.
- Estimate the program NTG ratio.

Process Evaluation Priorities

- Document changes to key program design and implementation aspects in 2015, including incentive levels, numbers and types of retail partners, frequency of promotional activities, and staffing levels.
- Assess the impacts of those changes on overall program performance.
- Define the target market, market segment imperfections, and market demands, per requirements of the Missouri Code of State Regulations.[2]

Table 9 lists the evaluation activities conducted in PY15 to achieve these objectives, followed by brief summaries of each activity.

[2] State of Missouri. "Administrative Rules: Missouri Code of State Regulations." Revised January 2016. Available online: http://www.sos.mo.gov/adrules/csr/csr.asp

Table 9. PY15 Process and Impact Evaluation Activities and Rationale

	Process	Impact	Rationale
Data Tracking Review	•	•	Ensure information was collected to inform the impact analysis. Provide ongoing support to ensure all necessary program data are tracked accurately; identify gaps for EM&V purposes.
Home Inventory Survey	•	•	Inventoried lighting sockets and bulbs, and surveyed homeowners, in randomly selected Ameren Missouri homes to update key market characteristics.
EISA Shelf Study	•	•	Survey participating retail locations to determine the persistence of incandescent bulb types no longer manufactured (per EISA), and adjust the wattage baseline to more accurately reflect customer options.
Stakeholder Interviews	•		Interview utility staff and implementer staff to provide insights into program design, effectiveness of marketing, delivery, satisfaction, free ridership, and spillover.
Leakage Analysis		•	Apply PY15 sales to existing analysis to update inputs to savings algorithms for PY15.
In-service Rate Analysis		•	Apply PY15 sales to existing analysis to update inputs to savings algorithms for PY15.
Demand Elasticity Modeling		•	Assess impacts of price changes, marketing, and product placement on sales to estimate free ridership.
NTG Analysis		•	Assessed NTG ratio using input from other analyses.
Cost-Effectiveness		•	Analyzed the cost-effectiveness of PY15 using Ameren Missouri avoided costs and utilizing DSMore.

Data Tracking Review

The Cadmus team reviewed the data content for working tracking databases and final, year-end reports of program activity. Data systems and sources accessed to facilitate the evaluation activities included these:

- Ameren Missouri Vision database, Lighting and EMV/Lighting reports
- CLEAResult Shelf Survey results, provided by staff
- Select Ameren Missouri and CLEAResult reports, provided by staff

Unlike in PY13 and PY14, online sales data, SMD distribution data, and pricing data were available through the Vision database. CLEAResult completed the shelf surveys based on the sample provided by Cadmus and provided results to Ameren Missouri program staff who distributed them to Cadmus staff. Cadmus requested other data and reports from Ameren Missouri staff on an *ad hoc* basis, such as a sample frame of 10,000 residential Ameren Missouri customers for the home inventory study, a

complete list of markdown and coupon participating retail locations with address and ID to inform the process evaluation, and descriptive data.

Program Staff Interviews

The Cadmus team conducted two staff interviews in 2015, one with two Ameren Missouri program staff members and one with two CLEAResult program staff members. Prior to the interviews, we prepared an interview guide that addressed changes in program design, current performance, and ideas for midstream course corrections to improve the program. Appendix C provides a copy of the stakeholder interview guide.

Baseline Wattage Methods

Cadmus used different approaches to determine the wattage baseline for different program bulbs, depending on the function of the bulb. For reflectors and specialty bulbs, we used the lumen-equivalent incandescent wattage as determined by a wattage map (see Appendix B. Lumen-Equivalent Wattage). However, for general purpose bulbs, we used a combination of methods designed to account for changes in the market due to EISA regulation, and changes in program sales channels. This section describes our approach for determining the baseline wattage for general purpose program bulbs.

CFL and LED substitutes for general purpose, medium screw base, 40W, 60W, 75W, and 100W incandescent lamps, (commonly referred to as standard bulbs) are by far the highest-volume measures in the Lighting program. Starting in 2012, EISA prohibited manufacture of standard incandescent bulbs according to a step-wise three-year schedule, by establishing a maximum wattage allowed by lumen range for standard bulbs. (The maximum wattage levels are generally equal to the wattage of a lumen-equivalent halogen bulb.)

The Residential Lighting chapter of the Uniform Methods Project (UMP): Methods for Determining Energy Efficiency Savings for Specific Measures, a standard reference for evaluation methodology, recommends adopting the lumen-equivalent halogen wattage for general purpose bulbs impacted by EISA.[3] However, retail sale of standard incandescents has been phasing out gradually as retailers sell off existing stock, so in some areas, lumen-equivalent incandescent bulbs have continued to be the lowest-cost alternative. Cadmus has monitored the continuing availability of standard incandescent bulbs in order to weight the baseline appropriately between the two baseline options (incandescent or halogen) as the market transitions. Table 10 shows affected measure categories, and the baseline alternatives.

[3] Apex Analytics. The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures, Chapter 21: Residential Lighting Evaluation Protocol. 2015. Available at: http://www.nrel.gov/extranet/ump/pdfs/ump-res-lighting-clean.pdf.

Table 10. Program Measure Categories Impacted by EISA Regulations

Impacted Program Measure Category*	Equivalent Incandescent Bulb Wattage	Equivalent Halogen Bulb Wattage
CFL - 13W (	40W	29W
CFL - 13W (	60W	43W
CFL - 18W	75W	53W
CFL - 23W	100W	72W
LED - 12W	60W	43W

*Measure categories encompass multiple bulb models, which have a range of wattages. For example, the 13W CFL measure category typically includes bulbs with wattages ranging from 10 to 17W.

Taking into account primary research from PY14 and the increased participation of non-big box stores in PY15, the Cadmus team used different approaches to determine the baseline wattage for each of the following standard program bulbs:

- 12W LEDs;
- 13W, 18W, and 23W CFLs sold through big box stores; and
- 13W, 18W, and 23W CFLs sold through non big-box stores.

12W LEDs

The Cadmus team conducted a shelf survey in PY14 that found that the retailers selling the great majority of 12W LEDs through the program had already phased out all incandescent stock as of the end of 2014. Therefore, the Cadmus team set the baseline wattage for 12W LEDs to 43W, the wattage of a lumen-equivalent halogen bulb.

The program also sold a small number of standard LEDs with lumen equivalence to 75W and 100W incandescent bulbs. These were evaluated a part of the 12W LED category, since the program does not have any other standard LED measure categories. The baseline for these bulbs was set at the lumen-equivalent halogen wattage: 53 watts for bulbs with lumen equivalence to 75W incandescents, and 72 watts for bulbs with lumen equivalence to 100W incandescents.

The average baseline wattage for the measure category was 43.4 watts.

Big Box Standard CFLs

The program sold 13W, 18W, and 23W standard CFLs through big box stores for only the month of January in 2015. For these bulbs, the Cadmus team created a weighted average of incandescent and halogen baseline wattages, based on the percentage of program sales in stores still offering lumen-equivalent incandescents. To determine the percentage of sales in stores selling incandescents, the team used data from a December 2014 on-site survey of incandescent sales in sample of participating stores. The team used shelf study results from December 2014 because this was the closest available data to model the presence of incandescent bulbs in participating stores in January 2015. The PY14 survey was similar to the shelf survey conducted in July, September and November 2015, which is

described below. Specific details of the PY14 study are discussed in the PY14 Lighting Program evaluation report.[4]

The December 2014 sales weights and resulting blended baseline wattages, by measure category, are shown in Table 11.

Table 11. Baseline Wattage for Big Box Sales (PY15)

Measure	Q4 PY14 Weighting (Incandescent/ Halogen)	Blended Baseline Wattage
100W Equivalent CFL	4%/ 96%	73.1
75W Equivalent CFL	4%/ 96%	53.9
60W Equivalent CFL	51%/ 49%	51.7
40W Equivalent CFL	44%/ 56%	33.8

Non-Big Box Standard CFLs

To evaluate the baseline wattage for the standard CFLs sold through non-big box retailers, the Cadmus team worked with CLEAResult to conduct a quarterly shelf survey to determine the availability of incandescent bulbs in participating non-big box retailers. The team selected a sample of 55 participating non-big-box stores, representing 51% of the non-big-box program sales of standard 13W, 18W, and 23W CFLs in PY15, as shown in Table 12.

Table 12. Non-Big-Box Sales of 13W, 18W, and 23W CFLs, PY15

	Bulb Sales	% of Total
Sample stores	578,308	51%
All non big-box stores	1,132,609	

CLEAResult representatives conducted the survey at or near the end of each quarter during PY15, with the exception of the first quarter (Q1).[5] In July (Q2), September (Q3), and November 2015 (Q4), a CLEAResult representative visited each location in the sample. The representative searched the lighting aisles for 100W, 75W, 60W, and 40W standard incandescent bulbs (not three-way, reflector, or other bulb types exempted from EISA legislation); bulbs did not need to be the same brand or model. If at least 10 bulbs were available for sale for a given wattage,[6] the representative indicated on the survey

[4] Cadmus. *Ameren Missouri Lighting Impact and Process Evaluation: Program Year 2014*. Presented to Ameren Missouri, May 2015.

[5] The Cadmus team devised the updated methodology in consultation with CLEAResult, Ameren staff, and staff from the Missouri Public Service Commission Auditors in June 2015. Therefore, the team did not collect data for Q1.

[6] The Cadmus team chose the 10-bulb minimum to ensure that enough bulbs were available to provide customers with a visible incandescent choice. We recognize it may be preferable to quantify sales by bulb type or to base the analysis on percentage of shelf space allocated to incandescents. Because of limited evaluation

form that incandescents of that wattage were available. The required count was based on bulbs, not packages. Therefore, three four-packs would represent 12 bulbs and more than satisfy the required number of bulbs. Table 13 shows an example of a completed data collection form.

Table 13. Example of Completed EISA-Impacted Bulbs Shelf Survey Form

		Incandescent bulbs available? (More than 10 bulbs)			
Store Location	Date of Visit	100W (Y/N)	75W (Y/N)	60W (Y/N)	40W (Y/N)
Retailer 1	6/29/2015	N	N	N	Y
Retailer 2	6/29/2015	N	N	N	N
Retailer 3	7/9/2015	N	N	Y	N

For each measure, the percentage of sales in stores where lumen-equivalent incandescent bulbs were available served as the weight for the incandescent baseline, and the percentage of sales where incandescent bulbs were not available served as the halogen baseline weight.

However, the survey results showed that the incidence of incandescent bulbs was negligible, and the weight was essentially 0%. Table 14 shows the actual percentages of sales in sample stores that also sold equivalent incandescents. Therefore, we applied a lumen-equivalent halogen baseline for all 13W, 18W, and 23W CFLs sold through non big-box retailers.

Table 14. Non-Big-Box Sales of 13W, 18W, and 23W CFLs in Stores with Lumen-Equivalent Incandescents

Program Measure	Q2 (Jul. 2015)	Q3 (Sept. 2015)	Q4 (Nov. 2015)
23W CFL	0.00%	0.00%	0.00%
18W CFL	0.00%	0.00%	0.00%
13W CFL	0.75%	0.15%	0.27%

The team then created a PY15 sales-weighted average of the big-box and non-big-box baselines to apply to program measure counts for the savings evaluation. Table 15 presents the final baseline for each standard CFL measure.

budgets, this was not possible for PY15; however, we determined our method to be an improvement over past methods that simply assumed incandescents were the baseline option for six months after EISA standards were implemented.

Table 15. Final Baselines for EISA-Impacted CFL Measures

Program Measure	Percent Sales in Big-Box Stores	Big-Box Baseline	Non-Big-Box Baseline	Blended Baseline
23W CFL	67%	73.1	72.0	72.8
18W CFL	37%	53.9	53.0	53.3
13W CFL	7%	50.5	43.0	43.5

Home Inventory Study

In July and August of 2015, the Cadmus team conducted 100 on-site inventories of residential Ameren Missouri customers. The inventory study updated information the team collected in PY13 and provided data for new estimates of key market characteristics such as bulb type distribution by room, sockets per home, and bulbs in storage. In addition, the team used these data to update the high-efficiency bulb saturation in medium screw base sockets and the in-service rate for high-efficiency bulbs.

The team scheduled 100 site visits from a sample frame of 10,000 residential customers chosen at random from Ameren Missouri's customer records database. The sample included both single-family and multifamily households. This sample size resulted in an expected sampling error of ±8.2% at the 90% confidence level.

The Cadmus team used tablet-based electronic forms to collect a detailed inventory of all lighting equipment, including interior and exterior lights, stored bulbs, and any bulbs purchased in 2015 that were disposed of or given away.

During visits, representatives also asked residents to complete a written survey composed of 28 questions that addressed lighting and program awareness, purchasing habits, and customer demographics (used to weight the inventory results). Wherever possible, the questions were unchanged from a similar survey included in the PY13 home inventory to allow for comparison across years.

Appendix C provides the survey guide.

Engineering Analysis

To calculate lighting savings from CFLs and LEDs, the Cadmus team used the algorithms presented below. These algorithms were applied to each quarter of sales data, incorporating the changing wattage baseline for standard bulbs.

Equation 1

$$\Delta kWh_{RES} = \frac{\left[\left(Watt_{Base} - Watt_{EE}\right) * Hours_{RES} * WHF_{RES}\right] * \%RES * ISR * (1 - LKG)}{1{,}000}$$

Equation 2

$$\Delta kWh_{NRES} = \frac{\left[\left(Watt_{Base} - Watt_{EE}\right) * Hours_{NRES} * WHF_{NRES}\right] * (1 - \%RES) * ISR * (1 - LKG)}{1{,}000}$$

Where:

$Watts_{EE}$	=	The average program bulb wattage
$Watts_{Base}$	=	The lumen-equivalent wattage of replaced bulbs
$Hours_{RES/NRES}$	=	Average daily HOUs for residential or nonresidential applications
%Res	=	The percentage of program bulbs installed in residential applications
ISR	=	The installation rate (NRES is assumed to be the same as RES)
LKG	=	The leakage rate (bulbs sold to customers outside Ameren Missouri's service area)
$WHF_{RES/NRES}$	=	HVAC interaction factors (adjustments for HVAC interactive effects)

The Gross Impact Evaluation Results Section further explains the methodology used and presents the results.

Interactive Effects or Waste Heat Factor

The waste heat factor (WHF) was calculated in PY13, and Cadmus did not update these calculations for PY15. To estimate the WHF, the Cadmus team used a simulation model populated with a customer's typical home characteristics (identified from Ameren Missouri's recent potential study) to estimate how heating and cooling needs changed when converting incandescent lights to efficient CFLs or LEDs. Specifically, we used BEopt™ Version 2.0 to model energy simulations needed for estimating WHF_e (energy) and WHF_d (demand) in residential homes.[7]

The WHF depends on many influences, but the major considerations include the following:

- The length of the respective heating and cooling seasons (areas with long cooling seasons and low saturations of electric heating tend to have higher WHF_e values).
- Electric heating saturation.

[7] Developed by National Renewable Energy Laboratory, BeOpt uses the Energy Plus V8.0 simulation engine to generate hourly projected energy consumption, based on typical TMY3 weather data.

- Cooling saturation.
- Electric resistance versus heat-pump electric heating.

We used Equation 3 to determine the WHF_e.

Equation 3. Waste Heat Factor for Energy

$$\frac{\Delta\ Lighting\ kWh + \Delta Cooling\ kWh + \ \Delta Heating\ kWh}{\Delta\ Lighting\ kWh} = WHFe$$

The WHF_d value depends on cooling saturation and cooling efficiency. We used Equation 4 to determine the WHF_d.

Equation 4. Waste Heat Factor for Demand

$$\frac{Average\ \Delta\ Lighting\ kW@\ Peak\ Period + Average\ \Delta Cooling\ kW\ @\ Peak\ Period}{Average\ \Delta\ Lighting\ kW\ @\ Peak\ Period} = WHFd$$

Where:

- A value of 1.0 would mean no net interaction between heating, cooling, and lighting.
- A value of less than 1.0 would mean a net reduction in total energy savings due to the higher heating load offsetting the lower cooling load.
- A value of more than 1.0 would mean a net increase in energy savings due to the lower cooling load offsetting the higher heating load.

Net-to-Gross Ratio Analysis

The Cadmus team calculated the program net-to-gross (NTG) ratio using the following formula:

$$NTG\ = \ 1 - \ Free\ ridership\ + Non\ Participant\ Non - lighting\ Spillover + Lighting\ Specific\ Spillover + \ Market\ Effects$$

Free riders are customers who would have purchased the marked-down lighting independently of the program. They account for some program costs but none of its benefits and decrease program net savings. We estimated free ridership through the demand elasticity model, described in detail in the next section.

Nonparticipant Spillover is additional savings generated when customers undertake additional energy-efficient measures or activities without financial assistance due to their experience participating in a given program, being exposed to program educational activities or marketing, or other program influences on the market.

Lighting Specific Spillover is additional lighting sales created by program marketing, education and increased product stocking in the current program year that do not receive program incentives.

Market effects are systemic changes to standard business practices, caused by program activities; they tend to persist long after program interventions have ended. The potential for demand-side management (DSM) programs to cause structural changes when intervening in a given market has become increasingly apparent as the following has occurred:

- Program delivery models have evolved (e.g., more have become upstream-focused programs); and
- Energy-efficiency investments have grown dramatically.

Demand Elasticity Modeling to Estimate Free Ridership

For PY15, the Cadmus team did not conduct a primary analysis using the demand elasticity model used in prior years to determine free ridership levels for the lighting program. This decision was made because of changes to the program, which limited sales to channels that typically have infrequent price changes and therefore provided fewer observation with which to estimate price elasticities.

Instead, Cadmus applied the elasticities estimated in the PY14 by bulb type and distribution channel. The PY14 model was chosen because it was the most comparable to the PY15 program, there was substantial price variation, and all retail distribution channels are included in the model.

Demand elasticity modeling uses sales and promotion information to:

- Quantify relationships of prices and promotions to sales;
- Determine the likely level of sales without the program's intervention (baseline sales); and
- Estimate free ridership by comparing modeled baseline sales with actual sales.

After applying the estimated PY14 variable coefficients, we used the resulting model to predict sales that would have occurred *without* the program's price impact and promotional activity and sales that would have occurred *with* the program (and which should be close to actual sales with a representative model). We then calculated free ridership using the following formula:

$$FR\ Ratio = \left(\frac{Sales\ with\ Program - Model\ Predicted\ Sales\ without\ Program}{Sales\ with\ Program}\right)$$

The Net Impact Evaluation Results section provides our full methodology and results.

Nonparticipant Spillover

Cadmus evaluated nonparticipant spillover at the portfolio level, using a survey approach to determine the level of energy efficient purchases and behaviors in the general population that resulted from Ameren Missouri marketing, outreach and education. The survey was designed to identify which actions were not already accounted for in other ways, and so, for example, it does not include lighting purchases. The full survey and analysis methodology is presented in the Nonparticipant Non-Lighting Spillover section later in this report.

Lighting Specific Spillover and Market Effects Analysis

To assess lighting spillover and market effects, Cadmus updated the model used in PY13 and PY14. The Cadmus team's Lighting spillover and market effects model relies on information from two research efforts:

- The home lighting inventory (discussed previously in this section); and
- Retail lighting inventories (rather than sales data) at one to three big box stores for each chain in Ameren Missouri's service territory (both participating and nonparticipating stores). During these inventories (conducted to estimate lighting stocking practices),[8] the team collected data from five participating and two nonparticipating retail chains, representing the available big box store chains in Ameren Missouri's territory.

After comparing saturation rates from the PY15 home lighting inventory to the baseline values from the PY13 home lighting inventory, the Cadmus team attributed the total change in saturation to the following factors:

- Direct program bulbs (from tracking system);
- Free ridership (from the price response model);
- Naturally occurring (assumed to be equal to free ridership);
- Participant spillover; and
- Market effects.

The team used the proportion of energy-efficient retailer inventory to attribute the increase in energy efficient bulbs that are in excess of program sales to spillover and market effects after removing estimated naturally occurring sales. The Net Impact Evaluation Results section provides the full analysis.

NTG for SMD

As in PY13 and PY14, we applied a 1.0 NTG for the SMD portion of the program, because these bulbs are given to low-income customers free of charge through channels that do not offer lighting products outside the program.

Cost-Effectiveness Analysis

Using the final PY15 *ex post* gross and net savings estimates for the Lighting program, as presented in this report, Morgan Marketing Partners (MMP) determined the program's cost-effectiveness using DSMore.[9] MMP also calculated measure-specific cost-effectiveness. As shown in the Cost-Effectiveness Results section, we assessed cost-effectiveness using the five standard perspectives produced by DSMore:

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[8] All participating and nonparticipating retailers analyzed for this study listed individual store inventories online via an "in store" search option.

[9] A financial analysis tool designed to evaluate the costs, benefits, and risks of DSM programs and services.

- Total Resource Cost
- Utility Cost
- Societal Cost Test
- Participant Cost Test
- Ratepayer Impact Test

Impact CSR Summary

According to the Missouri Code of State Regulations (CSR),[10] demand-side programs that are part of a utility's preferred resource plan are subject to ongoing process and impact evaluations that meet certain criteria. Specifically, the CSR requires that impact evaluations of a demand-side program satisfy the requirements listed in Table 16. The table also indicates the data our team used to satisfy these impact CSR evaluation requirements for the Efficient Products program. We provide a summary of the process CSR requirements in Table 26 at the end of the Process Evaluation section.

[10] State of Missouri. "Administrative Rules: Missouri Code of State Regulations." Revised January 2016. Available online: http://www.sos.mo.gov/adrules/csr/csr.asp

Table 16. Summary Responses to CSR Impact Evaluation Requirements

CSR Requirement	Method Used	Description of Program Method
Approach: The evaluation must use one or both of the following comparisons to determine the program impact:		
Comparisons of pre-adoption and post-adoption loads of program participants, corrected for the effects of weather and other intertemporal differences	X	The program compares the pre-adoption load based on assumed baseline technology with the post-adoption load based on program technology, and estimates hours of use (based on metered data adjusted for time of year) and waste-heat impact (based on equipment simulation).
Comparisons between program participants' loads and those of an appropriate control group over the same time period		
Data: The evaluation must use one or more of the following types of data to assess program impact:		
Monthly billing data		
Hourly load data		
Load research data		
End-use load metered data	x	Metered lighting hours of use by room in a sample of homes in the program area during 2013-2014.
Building and equipment simulation models	x	Use simulation modeling to determine the waste-heat impact of efficient lighting
Survey responses	x	Surveyed residents on purchasing practices and date of purchase of efficient technology to determine installation rates.
Audit and survey data on:		
Equipment type/size efficiency	x	Evaluation team conducted an audit of all lighting in sample of homes in program area.
Household or business characteristics	x	Evaluation team collected household characteristics from homes participating in lighting audit: home type, own/rent home
Energy-related building characteristics		

Process Evaluation Findings

This section provides the Cadmus team's process evaluation findings for Ameren Missouri's Lighting program. We organize the findings into four sections: Program Design, Program Operations, Marketing, and Process CSR Summary.

Program Design

The Lighting program's design seeks to achieve energy savings in two ways—by increasing the use of high-efficiency light bulbs over lower-efficiency baseline options and by educating consumers about energy-efficient lighting options. To do so, the program provides:

- POS discounts for high-efficiency light bulbs through major retail chains;
- coupon discounts for smaller retailers in less urban parts of the service territory;
- free distributions of CFLs to low-income populations; and
- promotional events to demonstrate and educate customers about different lighting technologies.

Although this basic program design remained unchanged for PY15, the implementer made significant changes to the distribution channels for POS discounts. In past years, the implementers worked with the big-box retailers to sell high volumes of program-sponsored standard CFLs, which produced the majority of program savings. However, as of PY15, these retailers stocked standard CFLs without program support. To limit free ridership, the implementers removed the program-sponsored standard CFLs from big-box retailers in January 2015.

In addition, the program stopped selling the most popular program-sponsored LEDs in big-box stores early in the year because of a pricing issue resulting from the continued rapid drop in the retail price for LEDs. Those measures were ultimately re-introduced in August of 2015. These changes are described in more detail in the following sections.

Measures

In 2015, CLEAResult offered all of the same measures as in 2014. Also, as in PY13 and Py14, the standard 13W CFL (60W incandescent-equivalent) was the most important product, accounting for 59% of program gross savings. Table 17 shows the percentage of sales by measure for 2015.

Although these standard bulbs, especially the 13W CFLs, continued to provide the majority of program savings in PY15, removing standard CFLs (13W, 18W, and 23W) from the big-box retailers reduced the volume of CFL sales compared to other measures. LED sales increased in 2015, despite not being offered in most stores from February through August. The most popular LED model was the 10.5 downlight (a flood light), available in a package that included a trim kit.

The PY13 evaluation found that occupancy sensors had only a 17% realization rate, which dropped to 13% in 2015. Occupancy sensors were largely phased out in PY14 and only available in January of PY15 as the program closed out the PY14 memoranda of understanding (MOUs).

Table 17. Participation and Savings by Measure

Bulb Type	Measure	Participation (PY15)	% Gross Savings (PY15)
Standard CFLs	CFL - 13W (including SMD)	1,305,871	53%
	CFL - 18W	16,724	1%
	CFL - 23W (including SMD)	117,739	7%
Specialty CFLs	CFL - High Wattage Bulbs (28W+)	270	0%
	CFL – Reflector	8,333	1%
	CFL - Specialty Bulbs	3,703	0%
LED	LED - 10.5W Downlight	239,733	20%
	LED - 12W Dimmable	297,399	16%
	LED - 15W Flood Light PAR30 Bulb	4,144	0%
	LED - 18W Flood Light PAR38 Bulb	8,419	1%
	LED - 8W Globe Light	30,589	2%
N/A	Occupancy Sensor	12	0%
	Program	**2,032,936**	**100%**

Incentives

CLEAResult changed incentive levels throughout the year to adjust for the continued decline in the price of LEDs and changes in the distribution of various other measures. LED incentives, in particular, changed several times over the year. CLEAResult removed LEDs from most retailers in February and March of 2015, because retail prices dropped below the level expected when the program plan was filed with the Missouri Public Service Commission (MPSC). At the beginning of PY15, the program filing approved by the MPSC allowed for a minimum incentive of $4.00 for LEDs. However, given retail prices at that point in the year, the $4.00 minimum incentive resulted in a price to the customer that was lower than retailers wanted to offer. (Too-low prices can affect the store brand, lead to disruptions in inventory stocking, and cause other disruptions in store operations.)

By August 2015, the MPSC approved reducing the incentive to $1.50, which allowed the implementers to reintroduce LEDs into big-box and other retailers. However, by this point in the year, the implementers decided not to drop incentives as low as their original intent for two reasons. The most important reason was that after several months of no big box sales of LEDs, the implementers wanted to drive higher sales volume in the last months of the year.

However, a second reason was that the implementers noticed a new trend in the market—an increase in non-ENERGY STAR LEDs. These bulbs are produced by major manufacturers but do not meet the criteria for the ENERGY STAR label. They are not eligible for program discounts, but because they are cheaper to produce, retailers can offer them at prices that are competitive with the program-discounted bulbs. Implementers hoped to forestall the competition from these new products by keeping incentives at a higher level.

As a result of these two factors, as well as the early-year sales, average incentives for LEDs over the year did not drop below the $4.00 threshold.

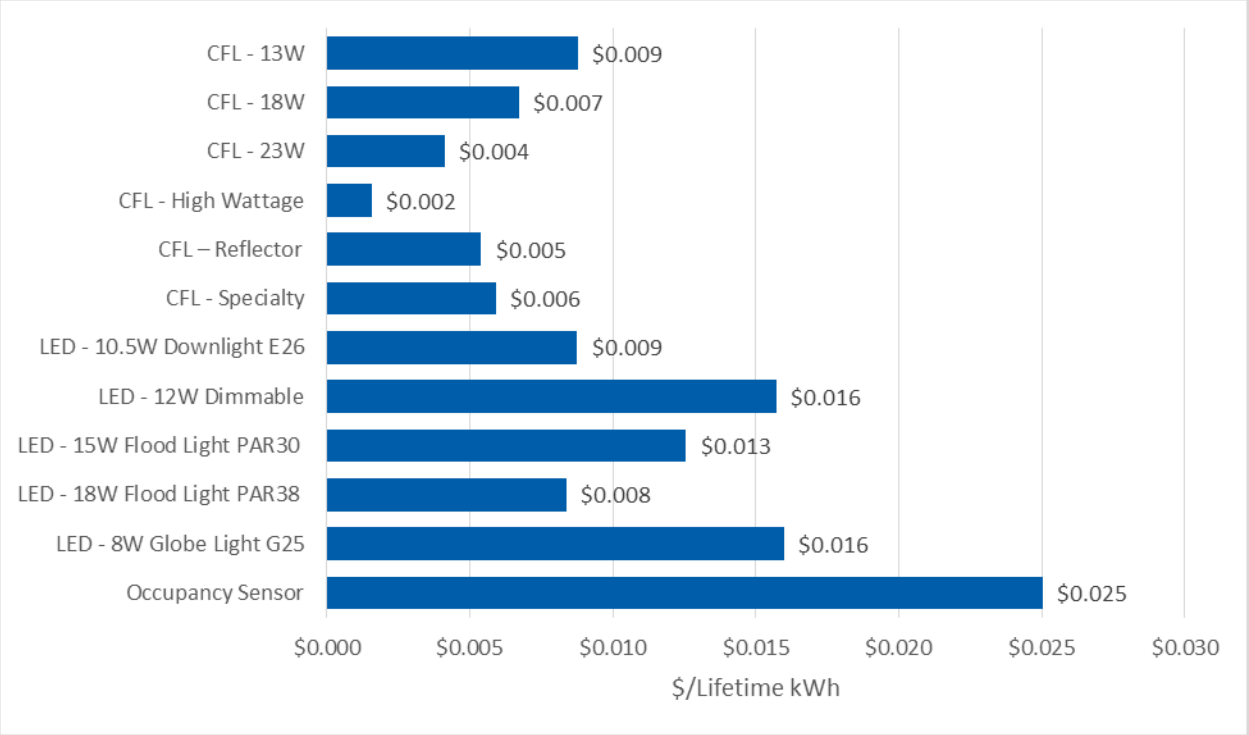
Table 18 shows average per-bulb rebates for each measure in 2015 by quarter, and in 2014.

Table 18. Program Incentives by Product

Bulb Type	Measure	Average Per-Unit Incentive				
		Q1 2015	Q2 2015	Q3 2015	Q4 2015	2014
Standard CFL	CFL - 13W (60W incand equiv)	$1.50	$1.58	$1.62	$1.40	$1.05
	CFL - 18W (75W incand equiv)	$1.35	$1.07	$1.28	$1.31	$1.18
	CFL - 23W (100W incand equiv)	$1.21	$1.11	$1.32	$1.30	$1.20
	CFL - High Wattage Bulbs	$1.50	$1.50	$1.50	$1.50	$1.64
Specialty CFL	CFL - Reflector	$1.54	$1.57	$1.73	$2.41	$1.79
	CFL - Specialty Bulbs	$1.51	$1.52	$1.62	$1.72	$1.86
LED	LED - 10.5W Downlight E26 Light Bulb	$5.82	$5.05	$5.10	$5.09	$5.70
	LED - 12W Dimmable Light Bulb	$5.07	$2.50	$4.93	$4.55	$6.61
	LED - 15W Flood Light PAR30 Bulb	$6.65	$5.04	$5.00	$5.00	$7.43
	LED - 18W Flood Light PAR38 Bulb	$5.52	$5.00	$5.00	$5.00	$7.05
	LED - 8W Globe Light G25 Bulb	$6.40	$5.28	$5.02	$5.18	$5.17
N/A	Occupancy Sensor	$5.00	N/A	N/A	N/A	$5.00

Considering the higher incentives required to move the product, LEDs remained far less cost-effective than CFLs in PY15. Figure 1 gives the average dollars per net kWh for each measure in PY15.

Figure 1. Incentive Dollars Per Unit Energy Saved ($/Lifetime Net kWh/Unit)[1]



[1]This figure uses the present value of net savings over the life of the measure, accounting for bothresidential and nonresidential per-unit savings and measure life.

Non-ENERGY STAR LEDs

The Cadmus team has seen this same pattern in other lighting programs, and it appears to be a national phenomenon. According to research the Cadmus team conducted independent of this evaluation, until the end of summer 2015, the majority of mainstream LED bulb manufacturers (e.g., GE, Philips, and Sylvania) have almost exclusively adhered to the high performance standards set by the ENERGY STAR program. In mid-2015, these manufacturers began to introduce new LED products without ENERGY STAR certification. These “value-line” bulbs, as the industry has dubbed them, do not meet ENERGY STAR standards for LEDs through four key performance characteristics. Table 19 below compares what is found in an ENERGY STAR-certified LED bulb to new value-line bulbs. (Note that value-line LEDs still typically meet or exceed requirements for ENERGY STAR CFLs.)

Table 19. ENERGY STAR Certified LED Bulbs vs. Value-line LED Bulbs

Key Characteristics	ENERGY STAR certified LEDs	Value-line LEDs
Lumens (for 60 watt equivalent)	800	750 - 800
Light distribution	Omni-directional (270-320 degrees)	Not omni-directional (<270 degrees)
Lifetime	25,000 hours	5,000 – 20,000 hours
Features	Easy to find dimmable, damp rated, wet rated, suitable for enclosed fixture bulbs	Not available as dimmable, damp rated, wet rated, suitable for enclosed fixture bulbs
Quality control	Third-party tested	No third-party oversite

The differences between the two types of LED bulbs are minimal when viewed from a product's packaging. Value-line bulbs tend to have a similar, or slightly lower, wattage than comparable certified bulb, meaning there is also little difference between the bulbs from an efficiency perspective.

Cadmus found that major retailers are planning to stock these bulbs in larger numbers. Wal-Mart, for example, has announced value-line LEDs will replace CFLs in its stores. CLEAResult confirmed this, reporting that some retailers participating in the Lighting program plan to continue stocking these non-ENERGY STAR bulbs in greater numbers in the coming months.

ENERGY STAR has introduced a Lamp Specification 2.0 that will take effect January 2, 2017 that allows for a 15,000-hour lifetime and 260-degree minimum for omni-directional bulbs, which will encompass some of the value-line LEDs.

Upstream Markdown Delivery Channel

The program's principle delivery channel is the POS markdown system, whereby discounts incorporated into a store's register system are applied when a customer completes a transaction. Stores then submit the required documentation for bulk reimbursement of these discounts. To participate, stores must be able to meet the terms of the memorandum of understanding (MOU) with the implementer and be located in zip codes where at least 70% of the residents have Ameren Missouri-owned meters. In PY15, the implementer issued MOUs for the full 12 months of the program year, an increase from six-month MOUs offered in PY14, as a way to increase participation from retailers, given the reduced scope of the program. In PY15, 471 store front locations participated in the markdown program, compared to 476 in PY14.

Markdown Partners

As shown in Table 20, the Cadmus team evaluated retailers grouped into six retail markets. The majority of retailers that participated in PY13 and PY14 continued in the program in PY15. Several discount retailers had joined the program in PY14, and although some of these chains dropped locations in PY15, other chains joined or increased participating locations. Overall, the number of stores held fairly steady at 208 discount locations, similar to the number in PY14.

Sales at discount stores increased to 42.9% of total retail sales. In PY15, the implementers focused on achieving high sales in discount retailers, where they expected free ridership to be much lower than in the big-box stores that had driven the program in PY13 and PY14. Some of these discount retailers have only recently added lighting to their product mix, and some would not offer lighting at all except through the program.

The biggest changes to the PY15 program's markdown channel were the permanent removal of standard CFLs from big-box stores in January of PY15, and the temporary removal of most LEDs measures from most stores in February of PY15. The implementers removed the standard CFLs in January 2015 to avoid high free ridership rates, though the big-box stores continued to offer program specialty and reflector CFLs.

CLEAResult removed LEDs measures from most stores beginning in February due to the incentive obstacles described in the previous section; these measures were re-introduced to all stores in August and September of 2015.

According to program and implementer staff, although store-level big-box staff were dissatisfied with the changes in the program, corporate level staff, responsible for decisions related to program participation, were understanding and continued to work closely with the program throughout the year. CLEAResult staff reported that the smaller stores continue to be very satisfied with the program because of the increased traffic and the opportunity to offer new and different products that they otherwise would not sell.

Table 20. Markdown Store Locations and Percentage of Program Sales

	Storefront Locations			Percent of Markdown Sales		
Retail Markets	**2015**	**2014**	**2013**	**2015**	**2014**	**2013**
Club Stores	12	*11*	*11*	11.7%	*20.4%*	*28.4%*
Discount Retail	208	*209*	*98*	42.9%	*13.5%*	*3.0%*
DIY	39	*54*	*47*	21.0%	*26.3%*	*32.3%*
Drug/Grocery	161	*161*	*150*	19.1%	*5.4%*	*3.3%*
Mass Merchandise	50	*41*	*49*	5.1%	*34.1%*	*32.3%*
Online	N/A	*N/A*	*N/A*	0.1%	*0.3%*	*0.8%*
Grand Total	**471**	***476***	***357***			

Upstream Coupon Delivery Channel

For small stores that lack the infrastructure to accommodate a POS system, Ameren Missouri offers a coupon discount system in which booklets of coupons are left on the shelf near the product or at the register. After a customer fills out the coupon at the store, the store applies the discount; after accumulating sufficient coupons, the store submits them to EFI for reimbursement. (EFI also maintains an online store offering program bulbs.)

Stores that offer program coupons must meet two eligibility requirements—be an Ameren Missouri customer and be located in a zip code where at least 60% of the residents have Ameren Missouri-owned meters. The required concentration of Ameren Missouri-owned meters is less for coupon stores than for POS stores (at least 70%) because coupon stores have historically demonstrated negligible leakage out of Ameren Missouri's territory. The customer base for coupon stores typically travels only a short distance to the store, which reduces the likelihood of leakage.

Ameren Missouri offered coupons for 13W CFL, 18W CFL, 23W CFL, and high-wattage CFL. Coupon sales accounted for 5,832 bulbs in 2014, or 0.15% of participation. According to CLEAResult, roughly 78 locations participated in the coupon program during 2015.

Social Marketing Distribution

Through the SMD channel, the Lighting program provides energy-efficient CFLs (13W and 23W) to community organizations to distribute to low-income Ameren Missouri customers in the communities they serve. Although CLEAResult has worked with several types of organizations, it primarily works with food banks and community organizations that can distribute bulbs door to door. The implementer did not recruit community organizations to participate in the SMD channel in PY15. Staff noted the 2013 evaluation found that the SMD in-service rate (ISR) was lower than other channels, which made SMD more expensive than the markdown or online channels. However, the SMD channel remained open, and a description of the program was available on the website. Eligible organizations could submit requests directly to the implementer.

The number of bulbs distributed through the SMD channel increased from 105,360 in PY14 to 183,178 in PY15.

Program Operations

This section describes the Cadmus team's assessment of various Lighting program management and delivery aspects; it contains feedback drawn from program stakeholder and retailer interviews.

Progress Toward Goals

Ameren Missouri must meet portfolio-wide regulatory targets set by the MPSC for energy and demand savings for the three-year cycle. These three-year portfolio requirements are broken into annual program level targets for energy and demand savings to better track program performance.

Table 21 shows the annual targets and the three-year energy and demand savings targets based on Ameren Missouri's filing from 2013 and Ameren Missouri's progress against those goals. The savings targets in the filing decrease year to year from 2013 to 2015 in anticipation of a more rapid phase-out of incandescent bulbs and increasing saturation of CFLs in the marketplace. Program energy and demand savings also decrease year after year, both as an absolute value and as a percentage, but these still exceed the annual targets.

Table 21. Lighting Three-Year Savings Targets and Achievement

	Energy (MWh)			Demand (kw)		
Program Year	MPSC-Approved Target	*Ex Post* Net Savings (MWh)	Percent of Target Achieved	MPSC-Approved Target	*Ex Post* Net Savings (kw)	Percent of Target Achieved
PY13	121,258	279,127	230%	3,647	21,057	577%
PY14	96,837	155,702	161%	2,911	12,287	422%
PY15*	62,371	60,830	98%	1,875	4,944	264%
3-Year Cycle	**280,466**	**495,659**	**177%**	**8,433**	**38,288**	**454%**

* Does not include PY14 spillover and market effects adjustment

The Lighting program has exceeded its annual target for the past two years and was able to meet its three-year goal as of the end of PY14. Therefore, going into PY15, the implementer and Ameren Missouri staff agreed on informal performance metrics to guide implementation during the year. These metrics and the end-of year performance are noted in Table 22.

Table 22. Non-contract Performance Metrics for Implementer for PY15

Metric	PY15 Performance
2.0 million CFL distribution, including SMD	1,452,640 CFLs distributed, including 183,178 SMD bulbs
1.4 million in non-big-box sales	1,175,892 measures sold through non big-box channels
450,000 in LED sales	580,284 LEDs sold through markdown and coupon channels

According to CLEAResult staff, these metrics were designed to continue operating the Lighting program at a similar level to PY13 and PY14 in order to maintain operational momentum going into PY16. In particular, Ameren Missouri staff wanted to maintain a presence in current market channels, strengthen relationships with discount retailers, build awareness in the marketplace for LEDs, and continue social marketing distribution.

The program also used key performance indicators (KPIs) to monitor program implementation throughout the year. KPIs for 2015 were these:

- 180 promotional events
- At least 90% or of payments to industry processed within 21 business days

CLEAResult conducted 200 promotional events in 2015. According to its staff, CLEAResult processed payments to manufacturer and retailer partners within 21 days of receiving the invoice, on average.

Program Management

In PY15, CLEAResult continued to implement the Lighting program with EFI as a subcontractor. There was no turnover in key staff. The CLEAResult team, EFI and Ameren Missouri staff have well-established working relationships. According to both CLEAResult and Ameren Missouri staff, frequent communication occurred over the year, involving scheduled weekly calls and informal calls on an almost

daily basis. Neither side reported any concerns with communication, data sharing, or general operation of the program.

Ameren Missouri performed quality control on the program using two methods during the year:

- Ameren Missouri staff reviewed all invoices from CLEAResult against manufacturer records from EFI. This process eventually will be automated through the Vision database that Ameren Missouri has developed to manage efficiency program data.
- Ameren Missouri program staff visited participating store locations with a CLEAResult representative. They reviewed products, prices, signage, and staff awareness of the program. Ameren Missouri staff made quarterly trips to the field, visiting five to six stores during each trip.

In mid-2014, Ameren Missouri launched the Vision database, which houses all of its residential and commercial efficiency program data in one location. During PY15, CLEAResult and Ameren Missouri refined the upload mechanisms to populate the Vision database. According to Ameren Missouri staff, the data for markdown sales, coupon sales, and online sales were uploaded on a daily or weekly basis by EFI. CLEAResult uploaded SMD distributions on a monthly basis as an Excel file and uploaded pricing data to inform the lighting evaluation periodically.

All uploads done by EFI used customized templates designed by the database administrators. These data were used throughout the year and checked against implementer invoices. According to Ameren Missouri staff, these templates worked smoothly. Data uploads for SMD were finalized shortly after the end of year, with no difficulties.

After the end of the year, the CLEAResult team worked extensively with the database administrators to correct issues with the pricing data, which were not uploading correctly to the Vision database. Out of more than 1.5 million records, a few thousand had not been corrected at the time that the Cadmus team completed the updates to the demand elasticity model that predicts free ridership. These records were later corrected by CLEAResult but not in time to be incorporated into the final evaluation analysis. Cadmus considers that the missing data had a negligible impact on free ridership results.

Ameren Missouri staff reported that after a full year of using the Vision database, there were positive impacts on data sharing and program management. For example, staff reported that it was easier to monitor data consolidated across programs, such as the number of lightbulbs distributed through the Lighting, Home Energy Analysis, Low Income, and Efficient Products programs. It was also easier to share data across multiple staff and have staff use more timely data, because there were fewer data systems that individuals needed to access to review program data. Finally, all staff were using the same data, which had already been verified before uploading to Vision, improving reporting accuracy and limiting the need for data cleaning and revisions.

Marketing

Partner retailers serve as primary outreach channel for the Lighting program. The marketing and outreach efforts, overseen by the program implementer, serve two purposes—educating customers about the availability and benefits of the products and engaging with market actors to deliver the message. The Cadmus team did not conduct a comprehensive marketing review for this evaluation, but did gather some information through staff interviews.

CLEAResult conducted the following in-store activities in support of the program:

- **In-store promotions:** Approximately two per year for each participating big-box location.
- **In-store meetings:** Periodic meetings to discuss Lighting program details with sales associates and to provide a manual with the certified product list and rebate information.
- **Weekly visits:** Certain big-box stores received weekly visits from field representatives, who checked stock levels, prices, and program signage, and who answered questions from store staff members and customers.

Although marketing efforts by CLEAResult staff did not change in PY15, the change in the delivery channels for various measures meant marketing efforts had a different impact than in PY13 and PY14. In those years, the most critical outcome of marketing efforts by program staff was to achieve and maintain prominent placement for standard CFLs in big box stores. Since big box stores no longer offered Ameren Missouri discounts on standard CFLs after January 2015, field representatives from CLEAResult continued to work with big-box stores to maximize the visibility of other program measures through product and signage placement. Field representatives were able to introduce some new signage, including what the industry refers to as a "Llama" sign, a small standing banner sign placed in the lighting aisle. However, the end-caps, pallet displays, wing stacks, and other secondary product placements that drove standard bulb sales were not as widely used for these lower-volume measures, according to implementer staff.

Figure 2. Image of "Llama" Sign

Field representatives did propose the same signage and product placement strategies to small stores that they used in larger stores. According to CLEAResult staff, although there was less opportunity for strategic placement or extra signage in smaller stores, it was also more significant for the store when it did happen. The few pallet displays in smaller stores, for example, typically offered a brand new product the store had not previously sold, such as a specialty LED. There were also some instances of end-caps, wing stacks, register displays, and prominent signage, particularly in some of the discount chains. In smaller stores, the main constraints on this type of marketing is the limited physical space available in the store, and the competition from non-lighting products.

In-store promotions were also possible in smaller stores, though less frequently than in big-box stores. CLEAResult staff reported they held in-store promotional events in the two largest grocery and drug store chains participating in the program. According to the implementer, discount retailers were not well-suited to promotional events because the stores did not have capacity to stock a large volume of product to meet the increased sales volume caused by the promotion, the way larger stores could.

Ameren Missouri marketing supported the program efforts in a key way in PY15, through the personal energy report that the utility distributes to residential customers. Ameren Missouri staff coordinated with CLEAResult to include mention of ongoing sales or special discounts at participating retailers in the personal energy reports, increasing traffic and sales in those stores. These reports were particularly useful in driving sales through the online store.

The number of stores remained nearly unchanged in PY15 (471 locations), and CLEAResult did not change the number of field staff for PY15. As shown in Table 23, CLEAResult conducted 200 promotions in 2015, surpassing its KPI.

Table 23. Promotional Events and Impact*

Quarter	Events	Customers Impacted	Retail Sales Associates Impacted
Quarter 1	50	1,369	176
Quarter 2	59	1,966	170
Quarter 3	56	1,425	157
Quarter 4	35	1,139	107
2015	**200**	**5,899**	**610**

*Data provided by CLEAResult

Process CSR Summary

Table 24. Summary Responses to CSR Process Evaluation Requirements

CSR Requirement Number	CSR Requirement Description	Summary Response
1	What are the primary market imperfections common to the target market segment?	The rapid pace of change in the lighting sector means customers continue to face an information barrier. The PY15 resident survey indicates customers are becoming more familiar with different technology types, such as halogens, LEDs and CFLs. However, the typical lighting customer probably still does not recognize or understand the variety of options in lighting products currently on the market. Further complicating this issue is the fact that new products, such as the non-ENERGY STAR LEDs, are emerging on shelves. As a result, customers fall back on price to determine which products they buy, and less efficient options continue to be less expensive than high efficiency bulbs.
2	Is the target market segment appropriately defined, or should it be further subdivided or merged with other market segments?	The target market for the Lighting program is determined by measure. For standard lighting measures, the program targets the subsets of the general residential lighting market that have had less exposure or access to high-efficiency lighting. For specialty lighting measure, the program targets the residential lighting market more broadly. This is appropriate as the general customer base is becoming more familiar with high-efficiency technology, though more so for general purpose bulbs than specialty bulbs.
3	Does the mix of end-use measures included in the program appropriately reflect the diversity of end-use energy service needs and existing end-use technologies within the target market segment?	For the most part, yes. The program offers a diversity of both LEDs and CFLs that represent the majority of common consumer lighting needs, including a range of wattages and specialty bulbs such as decorative shapes, three-way and four-way bulbs and reflectors. However, the emergence of non-ENERGY STAR bulbs that offer the same energy savings at a fraction of the price (as a result of limiting non-energy features) may be meeting customer demand for high efficiency at an even lower price that available from the program.

4	Are the communication channels and delivery mechanisms appropriate for the target market segment?	Retailers report Ameren Missouri signage is effective. As the big box stores that typically partnered with the program in the past are now carrying and selling more high-efficiency product on their accord, the program has shifted a greater percentage of sales to non-big-box retailers. The placement-based marketing techniques that were effective at driving very high volumes through big box stores are no longer available for lower-volume measures still sold through big box stores, or for more common measures sold through non big box outlets. The program has identified some new marketing techniques, but in general relies less on placement marketing than in the past. This is appropriate for the lower sales targets in the current year relative to PY13 and PY14.
5	What can be done to more effectively overcome the identified market imperfections and to increase the rate of customer acceptance and implementation of each end-use measure included in the program?	Ameren Missouri continues to reach out to more retailers and audiences and to expand the list of eligible measures. As the volume of the program falls, it is more difficult to find an appropriate place and time in store front locations for the educational promotion activities that help customers learn to navigate new lighting options. Ameren Missouri should shift educational focus as well as marketing focus to more online activity, as a lower cost alternative to face-to face interaction.

Gross Impact Evaluation Results

Table 25 lists *ex ante* and *ex post* gross program savings by measure for PY15 and includes a comparison to PY14 realization rates. Realization rates for nearly all measures increased PY15, largely because of changes in the in-service and leakage rates, and in spite of a drop in the baseline wattage for EISA impacted measures. The next sections present discussion and tables present of the gross savings inputs and calculations.

Table 25. PY15 Gross Impact Results Summary

Bulb Type and Wattage	*Ex Ante* Savings/Unit (kWh)	*Ex Post* Savings/Unit (kWh)	Realization Rate	
			2015	2014
Upstream and Coupon Bulbs				
CFL - 13W	31.5	28.2	90%	*120%*
CFL - 18W	37.4	33.9	91%	*96%*
CFL - 23W	51.2	52.6	103%	*93%*
CFL - High Wattage	113.0	174.5	154%	*123%*
CFL - Specialty	44.1	56.9	129%	*89%*
CFL – Reflector	44.1	49.0	111%	*103%*
LED - 10.5W Downlight E26	54.5	55.6	102%	*88%*
LED - 12W Dimmable	48.0	37.1	77%	*71%*
LED - 15W Flood Light PAR30	35.0	67.4	192%	*157%*
LED - 18W Flood Light PAR38	32.0	81.8	256%	*209%*
LED - 8W Globe Light G25	32.0	33.9	106%	*91%*
Occupancy Sensor	217.0	28.4	13%	*13%*
SMD Bulbs				
CFL - 13W	31.5	20.5	65%	*86%*
CFL - 23W	51.2	33.3	64%	*67%*

CFL and LED Gross Savings

To calculate program-level lighting savings from CFLs and LEDs, the Cadmus team summed *ex post* savings, determined from using the following two equations:

Equation 1

$$\Delta kWh_{RES} = \frac{(Watt_{Base} - Watt_{EE}) * \%RES * ISR * (1 - LKG) * (Hours_{RES} * Days * WHF_{RES})}{1{,}000}$$

Equation 2

$$\Delta kWh_{NRES} = \frac{(Watt_{Base} - Watt_{EE}) * (1 - \%RES) * ISR * (1 - LKG) * (Hours_{NRES} * Days * WHF_{NRES})}{1{,}000}$$

Where:

$Watt_{BASE}$	=	Wattage of the original incandescent bulb replaced by program bulb
$Watt_{EE}$	=	Wattage of new bulb installed
LKG	=	Leakage rate (bulbs sold to customers outside Ameren Missouri's service area)
%Res	=	Percentage of program bulbs installed in residential applications as opposed to nonresidential applications
ISR	=	Installation rate (NRES is assumed to be the same as RES)
$Hours_{RES}$	=	Average HOU per day for bulbs installed in residential applications
$Hours_{NRES}$	=	Average HOU per day for bulbs installed in residential applications
Days	=	Days used per year
WHF_{RES}	=	HVAC interaction factor (adjustments for HVAC interactive effects) for bulbs installed in residential applications
WHF_{NRES}	=	HVAC interaction factor (adjustments for HVAC interactive effects) for bulbs installed in nonresidential applications
1,000	=	Conversion factor between Wh and kWh (Wh/kWh)

Table 26, which summarizes the savings assumptions and their sources, includes notes on how we calculated each value in 2015. Shaded rows indicate values that the Cadmus team updated from the previous year. The following sections provide additional information on the assumptions used to calculate gross savings.

Table 26. CFL and LED PY15 Savings Assumptions

Data Required	Data Source	Detail on Calculation
$Watts_{EE}$	Tracking database record of actual wattage of program bulbs	Sales-weighted average of the wattages in each measure category.
$Watts_{BASE}$	Wattage of most common alternative to the program bulb	Sales-weighted average of the baseline for each wattage in each measure category. EISA-impacted bulbs further weighted between an incandescent or regulated baseline.
LKG	Store Intercept Study (2013)	Weighting updated with PY15 sales.

Data Required	Data Source	Detail on Calculation
%RES	Store Intercept Study (2013)	Weighting updated with PY15 sales.
ISR	Home Inventory Study (2015)	Inventory from sample of 100 homes that compares stored bulbs to installed bulbs.
$Hours_{RES}$	Hours of Use Study (2014)	Based on analysis of light meters installed in inventory homes.
$Hours_{NRes}$	Average value for indoor nonresidential spaces, DEER 2008	Based on secondary research.
WHF_{Res}	Engineering simulation modeling	Based on Cadmus modeling analysis in 2013.
WHF_{NRes}	Engineering simulation modeling	Based on Cadmus modeling analysis in 2013.

$Watts_{EE}$ and $Watts_{Base}$

The Cadmus team determined the efficient wattage ($Watts_{EE}$) for each measure category by averaging the wattage of that measure's program bulbs. For example, bulbs sold in the 13W CFL measure category ranged from 9W to 17W. Table 27 show the $Watts_{EE}$ for each measure category.

Table 27. PY15 Evaluated Efficient Wattages by Measure Category

Measure Category	TRM[1] Value	Evaluated Value
$Watts_{EE}$ (13W)	13.0	13.0
$Watts_{EE}$ (18W)	18.0	19.2
$Watts_{EE}$ (23W)	23.0	23.2
$Watts_{EE}$ (HighWattage)	65.0	50.6
$Watts_{EE}$ (Reflector)	20.0	16.4
$Watts_{EE}$ (Specialty)	26.5	13.5
$Watts_{EE}$ (10.5 W LED Downlight E26)	11.0	10.9
$Watts_{EE}$ (12 W LED)	12.0	10.5
$Watts_{EE}$ (15 W LED Flood PAR30)	15.0	15.2
$Watts_{EE}$ (18 W LED Flood PAR 38)	18.0	18.1
$Watts_{EE}$ (8 W LED Globe G25)	8.0	8.3

[1]Ameren Missouri 2012 TRM, available at https://www.efis.psc.mo.gov/mpsc/commoncomponents/viewdocument.asp?DocId=935658483

Cadmus determined the baseline wattage ($Watts_{BASE}$) for all reflectors and specialty bulbs by mapping the efficient wattages to lumen-equivalent incandescent wattages, then averaging all baseline wattages within the measure category. For standard bulbs (13W, 18W or 23W CFLs or 12W LEDs), we determined an appropriate baseline as described in the Evaluation Methodology section.

Table 28. PY15 Evaluated Baseline Wattages by Measure Category

Baseline Category	TRM[1] Value	Evaluated Value
$Watts_{BASE}$ (13W)	45.0	43.5
$Watts_{BASE}$ (18W)	56.0	53.3
$Watts_{BASE}$ (23W)	72.0	72.8
$Watts_{BASE}$ (HighWattage)	199.6	206.7
$Watts_{BASE}$ (Reflector)	72.5	66.9
$Watts_{BASE}$ (Specialty)	79.0	57.3
$Watts_{BASE}$ (10.5 W LED Downlight E26)	65.8	60.0
$Watts_{BASE}$ (12 W LED)	60.7	43.4
$Watts_{BASE}$ (15 W LED Flood PAR30)	50.5	75.0
$Watts_{BASE}$ (18 W LED Flood PAR 38)	50.5	90.0
$Watts_{BASE}$ (8 W LED Globe G25)	40.5	40.0

[1]Ameren Missouri 2012 TRM, available at https://www.efis.psc.mo.gov/mpsc/commoncomponents/viewdocument.asp?DocId=935658483

HOU ($Hours_{Res}$ and $Hours_{Nres}$)

The Cadmus team did not make any adjustments to the HOU estimates for PY15. In PY14, Cadmus updated the HOU estimate based on results from a metering study conducted in PY13 through PY14.[11] Table 29 presents average daily residential HOU for efficient and inefficient medium screw base (MSB) bulb and specialty bulbs. The table also contains the 90% confidence interval (CI) and the relative precision. These estimates fell within the ranges of similar HOU studies of mature upstream lighting programs.

Table 29. Residential HOU Results Overall and by Technology

Bulb Type	n	HOU	Lower 90% CI	Upper 90% CI	Relative Precision
Overall MSB	1,233	1.6	1.5	1.8	11%
Efficient MSB	517	2.2	1.8	2.6	16%
Inefficient MSB	716	1.2	1.1	1.3	11%
Specialty	393	1.7	1.4	2.0	17%

Table 30 lists efficient HOU by room type along with the number of inventoried and metered bulbs.

[11] For detailed methodology and results for the metering study see: Cadmus and Nexant. *Ameren Missouri Lighting Program Impact and Process Evaluation, Program Year 2014*. June 2015.

Table 30. Residential Efficient HOU Results by Room Type

Room Type	Inventoried	Metered	HOU	Lower 90% CI	Upper 90% CI	Precision
Basement	256	25	2.6	1.1	4.2	59%
Bathroom	319	71	1.6	1.0	2.2	36%
Bedroom	505	98	1.4	1.1	1.7	21%
Closet	110	6	0.8	0.0	1.7	117%
Dining Room	104	32	1.9	1.3	2.5	30%
Garage	87	6	1.4	0.0	3.6	155%
Hall	231	45	1.5	0.7	2.4	53%
Kitchen	228	62	3.9	2.9	4.9	25%
Living Room	228	58	2.5	1.7	3.4	34%
Mechanical	51	5	3.0	0.0	9.5	218%
Office	84	20	1.7	1.1	2.4	38%
Outside	196	33	3.6	2.0	5.2	45%

The room types with the highest hours of use are kitchens, outside, and mechanical. Because of the low sample sizes at the room level, these estimates have a larger range of precision (are less precise).

HOU values used in the PY15 savings algorithms for residential and nonresidential savings are shown in Table 31.

Table 31. HOU Values (Based on 2014 Analysis)

Variable	2015	2014	2013
HOURes	2.2	2.2	2.9
HOUNRes	8.8	8.8	8.8

In-Service Rate

To determine the in-service rate (ISR), the Cadmus team used the protocol recommended in the Residential Lighting chapter of the UMP.[12] This method calculates the overall ISR as the present value of savings from PY15 program bulbs installed over a four year period.

The team updated the first-year installed rate, one of the inputs to the calculation, using the information from the home inventory analysis. The first-year installed rate is the percentage of all high-efficiency bulbs (installed, stored, disposed, or other) counted in the inventory that were installed in a socket at the time of the visit.

[12] Apex Analytics. The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures, Chapter 21: Residential Lighting Evaluation Protocol. 2015. Available at: http://www.nrel.gov/extranet/ump/pdfs/ump-res-lighting-clean.pdf.

The UMP formula assumes that the cumulative installed rate increases gradually each year, until by Year 4 (if not sooner), 97% of all program bulbs have been installed.

In Ameren Missouri's case, as shown in Table 32, the team used the results of the home inventory study to determine a first-year ISR of 79%. Applied to the total program sales of 1,849,758 in PY15, this rate means 1,470,456bulbs were installed in this calendar year. In Year 2 (2016), the cumulative ISR increases to 87.9%, and an additional 155,514 of the bulbs purchased in PY15 are installed. In Year 3 (2017), 106,205 bulbs are installed, and finally, in Year 4, a 62,091 bulbs are installed, so that a cumulative 97% of the 2015 program bulbs will have been installed.

Table 32. Rate of Future Installation of PY15 Bulbs

Installation Rate			Total Bulbs	
Total Bulbs Sold			**1,849,758**	
PY15 Installation Rate (YR1)			**0.79**	
PY15 Installed			**1,470,456**	
Year Projected	**UMP Cumulative Installed Percentage**	**Cumulative Install Rate**	**Cumulative Bulbs Installed**	**Installed in Year**
2016 (YR2)	$(1\text{-}ISR_{YR1)}$ * (.41) +ISRYR1	87.9%	1,625,970	155,514
2017 (YR3)	$(1\text{-}ISR_{YR1)}$ * (.69) +ISRYR1	93.6%	1,732,174	106,205
2018 (YR4)		97.0%	1,794,265	62,091

To take into account the time-delay of this ISR calculation, the team determined the net present value (NPV) of the savings over 4 year installation period from the PY15 bulbs, discounted back to Year 1 at 6.95% (utility discount rate).

As shown in Table 33, although 100% of the bulbs are predicted to be installed over time, the NPV of savings from the bulbs was 98.7% of potential savings if all bulbs were installed in the first year.

Table 33. Comparison of Actual Installation Impacts to Assumed First-Year Installation

Scenario 1, Installation Over Four Years						Scenario 2, Installation Assumed in Year One	Installation Rate
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Total**		
NPV					1,645,133	1,729,554	**95.1%**
1	1,470,456				1,470,456	1,849,758	
2		155,514			155,514		
3			106,205		106,205		
4				62,091	62,091		

The evaluation team determined the ISR for SMD bulbs using a PY13 survey of SMD recipients to determine the first-year installation rate. The team did not update this value in PY15. Table 34 shows the ISRs by channel used for the program savings evaluation for PY15.

Table 34. Measure Installation

Delivery Channel	Percentage Installed and Operating
Upstream Markdown	98.7%
Coupon	98.7%
SMD	86.7%*

*The first-year installation rate was lower for SMD than for the upstream program.

WHFRES and WHFNRes

Cadmus did not update the waste heat factor (WHF) values for 2015. The team used the Lighting program data—average home information from Ameren Missouri's 2009 potential study and from an engineering simulation model—to estimate the WHF for residential customers. We also worked with Ameren Missouri's nonresidential evaluation contractor to develop the WHF for nonresidential customers. Our analysis resulted in the residential and nonresidential WHFs shown in Table 35. (See the PY13 Lighting program evaluation for more detail.)[13]

Table 35. WHF by Channel

Sector	Delivery Stream	WHF
Residential	Upstream Markdown	0.99
	Coupon	0.99
	SMD*	0.98
Nonresidential	Upstream Markdown and Coupon	1.10

*SMD varies slightly due to a different mix of heating and cooling types

Updates to Leakage and Nonresidential Percentage

In 2013, the Cadmus team conducted an in-store customer survey (known as an intercept survey) to determine the percentage of bulbs purchased through the Lighting program and installed outside of Ameren Missouri's territory (i.e., leakage) and the percentage of bulbs installed in nonresidential applications. In PY14, we adjusted the sales-weighted leakage and percent-nonresidential results of that study using PY14 sales. In PY15, we again updated the PY13 values, using PY15 sales. We applied the updated leakage values to in-store markdown sales only, and we applied our estimates of nonresidential sales shares of big box and non-big box store sales to the corresponding sales levels.

[13] Cadmus and Nexant. *Ameren Missouri LightSavers Process and Impact Evaluation: Program Year 2013*. Presented to Ameren Corporation. June 2014.

Table 36 presents the leakage and nonresidential values used in PY15 by sales channel.

Table 36. Update to 2013 Leakage and Percent Nonresidential

Channel	Leakage	Nonresidential Sales
Big Box Markdown	1.8%	15.5%
Non-Big Box Markdown	1.8%	6.6%
Coupon and Online	0%	6.6%
SMD	1.3%	0%

Table 37 presents a comparison of leakage rates for PY15 with PY14 and PY13 rates. Table 38 presents a comparison of nonresidential rates for PY15 with PY14 and PY13 rates.

Table 37. Leakage Rates for PY15 and Previous Years

Lighting Channel	PY15	PY14	PY13
Markdown	1.8%	3.9%	3.3%
Coupon /Online	0.0%	0.0%	0.0%
SMD	1.3%	1.3%	1.3%

Table 38. Nonresidential Sales Rates for PY15 and Previous Years

Lighting Channel	PY15	PY14	PY13
Big Box Markdown	15.5%	9.0%	11.0%
Non-Big Box Markdown, Coupon, and Online	6.6%	9.0%	11.0%
SMD	0.0%	0.0%	0.0%

For PY15, as in PY14 and PY13s, we applied the survey-based leakage percentage only to the markdown sales. Leakage for coupon and online sales remains at 0% because customers must provide their Ameren Missouri utility account numbers to receive those discounts. We calculated SMD leakage through a separate survey of these SMD participants in 2013. One participant (who represented 1.3% of the 75 participants surveyed) reported not being an Ameren Missouri customer. (Further details on leakage analysis are provided in the PY13 evaluation of the Lighting program.)

Unlike in previous years, we also applied the nonresidential percentage to a limited subset of sales in PY15. The PY13 intercept study sampled only shoppers in big box stores, in order to represent the greatest percentage of sales in that program year. However, the sales distribution changed in PY15 so that a significant percentage of program sales were through non-big box channels. Because we did not have primary data to determine the nonresidential percentage from these stores, we applied the

average value for nonresidential sales for similar programs across the country, according to a recent Massachusetts study.[14]

Occupancy Sensor Gross Savings

The Cadmus team used this equation to calculate *ex post* energy savings for occupancy sensors:

$$\Delta kWh = Watt_{est} * HOU * \frac{Days}{Year} * SF/1000$$

Where:

$Watt_{est}$	=	Average interior fixture wattage from the PY13 home inventory study
HOU	=	Daily HOU from PY14 metering study
Days/Year	=	Days per year
SF	=	Savings factor from Ameren Missouri 2012 TRM[15]

Using this equation, we determined an *ex post* energy savings value of 28.4 kWh/year for each installed occupancy sensor. This value is based on the Ameren Missouri 2012 TRM and represents approximately 13% of the program's *ex ante* value (217 kWh/year). Ameren Missouri's value of 28.4 kWh/year assumed an occupancy sensor would control the entire home. As we established in the PY13 Lighting program evaluation, we find it more realistic to assume a sensor controls a fixture because controlling an entire home would require additional electrical work and multiple sensors.

[14] NMR Group and Cadmus. Memorandum: Massachusetts Residential Lighting Cross-Sector Sales Research, March 24, 2015. Available online: http://ma-eeac.org/wordpress/wp-content/uploads/Residential-Lighting-Cross-Sector-Sales-Research-Memo.pdf

[15] Ameren Missouri 2012 TRM, available at https://www.efis.psc.mo.gov/mpsc/commoncomponents/viewdocument.asp?DocId=935658483

Net Impact Evaluation Results

The Cadmus team calculated the program's NTG ratio using the following formula:

$$NTG = 1 - Free\ ridership + Non\ Participant\ Spillover + Lighting\ Specific\ Spillover + Market\ Effects$$

We present details of how we arrived at the results for each input in the discussion below.

Free Ridership

In PY15, the Cadmus team modeled bulb, pricing, and promotional data using an econometric model. The study modeled these data as a panel, with a cross-section of program package quantities modeled over time as a function of prices, promotional events, and retail channels. The PY15 analysis relied on the same demand elasticity model used in PY13 and PY14. However, for the PY15 evaluation the Cadmus team used the elasticity and merchandising lift factors derived in the PY14 analysis, applied to PY15 sales data. The details are specified in the PY14 report and, since no primary analysis was repeated for PY15, the details of the model specification are not repeated here.

Price Variation and Representativeness

The PY15 tracking data provided by CLEAResult contained only a small number of products with observed price changes in 2015. This was expected as the program focused on harder to reach retailers, such thrift and discount stores, drug stores, and grocery chains that were estimated to have lower free ridership in PY14. These retailers typically have low product diversity and Cadmus rarely observes price variation within these retailers.

Overall, the PY15 data observed price variation for products representing only 11% of total sales, which is not sufficient for robust, representative estimates of primary elasticities.

However, in PY14, Cadmus used a robust dataset (models with price variability were 38% of general purpose LEDs, 98% of specialty LED bulb sales, and 62% and 68% for specialty and standard CFLs sales, respectively). The PY14 data did include some of the retailers and product types sold in PY15. Overall, there were 272 products (defined as a unique combination of store location and product model number) representing 29% of PY15 sales.

Additionally, the retailers that sold the majority of bulbs in PY15—the thrift stores, discount stores, and grocery chains—were included in the Mass Market retail channel in prior years, so there is precedent for assuming the free ridership estimates from other retailers within that channel account for more of the products that are used to estimate elasticities are representative of the thrift, discount, and grocery stores. Without sufficient primary data to estimate elasticities, this is the most representative data available.

Promotional Displays

CLEAResult provided limited records of product displays for PY15 because Cadmus was not conducting a primary analysis with PY15 data. However, nearly all retailers that were included in the PY15 data were included in the PY13 and PY14 promotional display data, including many of the hard to reach retailers that PY15 focused on. These included grocery chains, drug stores, and discount retailers.

One retailer, representing nearly half of the PY15 bulb sales, was not previously included in the prior years' promotional data. For this retailer, CLEAResult provided photo documentation to show this retailer did feature merchandising displays of Ameren Missouri program bulbs.

Therefore, Cadmus also applied the display bias correction that had been applied in PY14 to account for additional sales lift generated by product merchandising, beyond the price effects[16].

Findings

Elasticities

Price elasticity of demand measures the percentage change in the quantity demanded given a percentage change in price. Because of the PY14 model's logarithmic functional form, the price elasticity simply represented the coefficients for each price variable. In previous similar analyses, the Cadmus team has seen elasticities range from -1 to -3, meaning a 10% drop in price leads to a 10% to 30% increase in the quantity sold.

Table 39 shows the elasticity estimates from PY14 that were applied to the PY15 sales. LEDs had the highest elasticities, and standard CFLs the lowest.

Table 39. Elasticity Estimates by Retail Channel and Bulb Type

Store Type	Bulb Type	Elasticity
CLUB	LED BULB	-2.14
CLUB	SPECIALTY LED BULB	-2.30
DIY	LED BULB	-1.76
DIY	SPECIALTY LED BULB	-1.93
DIY	STANDARD CFL BULB	-0.67
DIY	SPECIALTY CFL BULB	-0.84
MASS	LED BULB	-2.30
MASS	SPECIALTY LED BULB	-2.47
MASS	STANDARD CFL BULB	-0.54
MASS	SPECIALTY CFL BULB	-0.71

[16] The bias adjustment factor is described in the PY13 report (see Appendix I: Model Adjustments Promotional Displays).

Program Price Impacts

Table 40 shows the sales-weighted, average sale price, the original price, and the markdown within the program, broken out by retail channel and bulb type. The table also shows the markdown as a share of the original price, which ranged from 43% to 83%.

Table 40. Mean Prices and Markdown by Retail Channel and Bulb Type

Store Type	Bulb Type	Mean Regular Price/Bulb	Mean Target Price/Bulb	Mean Markdown/ Bulb	% Markdown
CLUB	LED BULB	$7.00	$2.95	$4.05	58%
CLUB	SPEC LED BULB	$9.70	$5.38	$4.32	45%
DIY	LED BULB	$8.76	$4.08	$4.67	53%
DIY	SPEC LED BULB	$13.66	$7.85	$5.81	43%
DIY	STAN BULB	$1.57	$0.32	$1.25	80%
DIY	SPEC BULB	$3.00	$1.00	$2.00	67%
MASS	LED BULB	$6.91	$3.27	$3.64	53%
MASS	SPEC LED BULB	$10.76	$5.51	$5.25	49%
MASS	STAN BULB	$1.50	$0.25	$1.25	83%
MASS	SPEC BULB	$1.83	$0.33	$1.50	82%

Some notable findings from the table are:

- General purpose LED markdowns were greater than 50% within each retail channel, while standard CFLs were 80% or more in all retailer channels.
- DIY stores also had the greatest discounts on specialty LED bulbs, likely because the DIY retailers also had the highest price point for specialty LEDs, primarily outdoor flood lamps and reflectors.
- Standard CFL markdowns increased dramatically from PY14 where markdown levels were below 50%.

Overall, net-of-free ridership was higher in PY15 at 81% than in PY14 at 75%. The decrease in free ridership is due to two factors. First, the markdown level – the percentage of the retail price that is covered by the program discount - increased dramatically for standard CFLs in PY15, from less than 50% of the original price in PY14 to over 80% in PY15. The program also was redesigned to focus on retail channels and lamps that in previous program years had lower free ridership.

Table 41. PY15 Freeridership Modeling Results and Comparison with PY14 and PY13

Bulb Type	Bulb Type	Measures Included	Net of FR (PY15)	Net of FR (PY14)	Net of FR (PY13)
CFL BULB	General Purpose	CFL - 13W	**82%**	***76%***	***77%***
		CFL - 18W			
		CFL - 23W			
		CFL - High Wattage			
	Specialty	CFL – Reflector	**78%**	***58%***	***76%***
		CFL - Specialty			
LED BULB	Specialty	LED - 10.5W Downlight E26	**83%**	***70%***	***99%***
	General Purpose	LED - 12W Dimmable	**60%**		
	Specialty	LED - 15W Flood Light PAR30	**47%**		
	Specialty	LED - 18W Flood Light PAR38	**55%**		
	Specialty	LED - 8W Globe Light G25	**74%**		
Program (weighted by sales)			**78%**	***74%***	***76%***

Overall, LED freeridership estimates were comparable to most other recent evaluations. Without accounting for differences in product mix, which can change the average price elasticities, Ameren Missouri's program had markdown levels similar to other recent analyses, between 40% and 60%.

Table 42. Benchmarking LED Freeridership

Evaluation	Freeridership
Ameren Missouri (2015)	**35%**
Wisconsin (2015)	29%
Ameren Missouri (2014)	30%
Mountain West (2013-2014)	34%
South (2015)	48%
Mid-Atlantic (2014-2015)	48%

Uncertainty

Because there was no primary analysis for PY15, the elasticities are treated as fixed. Therefore, there is no precision around the estimates for PY15.

Nonparticipant Non-Lighting Spillover

Effective program marketing and outreach generates program participation *and* increases general energy efficiency awareness among customers. The cumulative effect of sustained utility program marketing (which often occurs concurrently for multiple programs) can affect customers' perceptions of their energy usage and, in some cases, motivate customers to take efficiency actions outside of the

utility's program. This phenomenon—called nonparticipant spillover (NPSO)—results in energy savings caused by but not rebated through a utility's demand-side management (DSM) activity.

During PY15, Ameren Missouri spent over $1.91 million dollars to market individual residential efficiency programs (excluding low-income) and the portfolio-wide Act on Energy campaign—an amount more than Ameren Missouri's PY14 marketing expenditure ($1.53M).

To understand whether Ameren Missouri's program-specific and general Act On Energy marketing efforts generated energy efficiency improvements outside of Ameren Missouri's incentive programs, the Cadmus team implemented a general population survey of residential customers in PY15 to determine the general population's energy efficiency awareness and energy efficiency actions. This approach is consistent with the Uniform Methods Project protocols. [17]

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To understand whether Ameren Missouri's program-specific and general Act On Energy marketing efforts generated energy efficiency improvements outside of Ameren Missouri's incentive programs, the Cadmus team implemented a general population survey of residential customers in PY15 to determine the general population's energy efficiency awareness and non-program participant's energy efficiency actions. This approach is consistent with the Uniform Methods Project protocols. [18]

Methodology

In PY15, the Cadmus team selected and surveyed 200 customers, based on a randomly generated sample frame of approximately 20,000 of Ameren Missouri's residential customers. Through screening survey respondents, we determined that the sample contained a number of customers (n=23) self-reporting that they participated in an Ameren Missouri residential program during PY15. When estimating NPSO, we excluded these customers from analysis, focusing on the 177 remaining random

[17] http://energy.gov/sites/prod/files/2015/02/f19/UMPChapter23-estimating-net-savings_0.pdf

[18] http://energy.gov/sites/prod/files/2015/02/f19/UMPChapter23-estimating-net-savings_0.pdf

nonparticipants; this avoided potential double-counting of program savings and/or program-specific spillover. The sample of 200 is valid at 90% confidence level and within +-6% for estimating proportions.

We also limited the NPSO analysis to the same efficiency measures rebated through Ameren Missouri programs (known as "like" spillover) because Ameren Missouri focuses its marketing primarily on promoting the program portfolio, rather than through broad energy efficiency education. Program specific marketing doesn't preclude customers from implementing other energy efficiency improvements as a result of their exposure to the programs, however since spillover estimates are somewhat uncertain, restricting spillover to "like" measures adds a degree of conservativeness.[19] Examples of "like" spillover included removing a secondary refrigerator and installing a programmable thermostat. We did, however, exclude one notable category of "like" measures: lighting products. This precluded double-counting NPSO lighting savings already captured through the upstream Lighting program market affects analysis.

To ensure the responses included in the analysis represented electric spillover savings, Cadmus asked customers questions about fuel type for water heaters, heating systems, and cooling systems. The analysis only counted savings associated with measures where there was a corresponding electric water heater, electric heat, or central air conditioning as spillover.

To confirm a relationship between Ameren Missouri's energy efficiency programs, Ameren Missouri's awareness campaign, and actions taken by nonparticipants, our survey asked about nonparticipants' familiarity with Ameren Missouri's energy-efficiency programs and associated campaign. To be included in the NPSO analysis, nonparticipating respondents had to indicate the following:

- They were familiar with Ameren Missouri's campaign; and
- Ameren Missouri's efficiency messaging motivated their purchasing decisions.

If a reported spillover measure type was offered under an Ameren Missouri rebate program, respondents were asked why they or their contractor did not apply for a rebate through Ameren Missouri. We did not count measures towards spillover if respondents reported applying for an Ameren Missouri rebate but did not receive one because their product did not qualify. We compared the names, addresses, and phone numbers of respondents to tracking databases to ensure that the respondents were not confused by the questions and had, in fact, participated in the program. We did not find any, which would have eliminate the measure as nonparticipant spillover. Since it was the largest savings measure, we further investigated the logic of refrigerator recycling as a spillover measure—i.e. why would someone find out about the program, then recycle the refrigerator own their own? Although motivations aren't known, Ameren Missouri staff indicate that in PY15, and similar to other years, 18.2% of customers who originally sign up for recycling, cancel the pickup. Possible reasons might be inability

[19] Ameren Missouri promoted the portfolio of programs in a number of channels including pre-game shows at St. Louis Cardinals games, an outfield sign at Busch Stadium, digital banners, key word searches, metro link signs, social media, and Cardinals sweepstakes.

to agree upon a schedule or a perceived opportunity to earn more money for parts. Thus it is logical that due to Ameren Missouri's marketing efforts, customers may recycle on their own.

For measure types where it applied, we also asked respondents how they know their product is energy efficient. Examples of answers that would keep reported measures in consideration for spillover are:

- It's ENERGY STAR rated
- The retailer/dealer/contractor told me it was

We eliminated two measures from spillover consideration because the respondents 'did not know' how to justify their product was energy efficient.

Results

Of 177 nonparticipants surveyed, 12 cited Ameren Missouri's marketing as "very important" or "somewhat important" in their decisions to purchase non-rebated, high-efficiency measures during 2015:[20]

- Among nonparticipants citing their knowledge of Ameren Missouri's energy efficiency programs or the Ameren Missouri's campaign as "very important," we counted *ex post,* gross, per-unit savings, determined through the PY15 evaluation towards the NPSO analysis.
- If nonparticipants found Ameren Missouri "somewhat important" in their decisions, we applied a 50% decrement and applied one-half of *ex post* energy savings for the specified measure.

The analysis excluded nonparticipant responses indicating Ameren Missouri's programs or campaign were "not very important" or "not at all important" to their efficiency actions.

Table 43 shows measures and PY15 gross evaluated kWh savings attributed to Ameren Missouri, with average savings per spillover action of 171 kWh.

[20] This translates to approximately 7% of the general population, with a range of 90% confidence of 4% to 10%. Despite the range, the 7% middle point remains the most likely value. With 7% of the population undertaking actions on their own, a sample size of nearly 5,000 surveys would be needed to detect such a level with ±10% (6.3% to 7.7%) —clearly a prohibitive undertaking.

Table 43. NPSO Response Summary

Individual Reported Spillover Measures	Influence of Ameren Missouri Information on Purchase	Quantity	PY15 Measure Savings Per Unit (kWh)	Allocated Savings	Total kWh Savings	Avg kWh Per Spillover Measure
Ceiling Insulation	Somewhat	1 project	192***	50%	96	A
Low Flow Showerhead	Very	1	222†	100%	222	
Programmed thermostat to reduce usage	Very	1	83*	100%	83	
Programmed thermostat to reduce usage	Somewhat	1	83*	50%	41	
Programmed thermostat to reduce usage	Very	1	83*	100%	83	
Programmed thermostat to reduce usage	Very	1	83*	100%	83	
Programmed thermostat to reduce usage	Somewhat	1	83*	50%	41	
Removed Refrigerator/Freezer	Very	1	1,000ˆ	100%	1,000	
Scheduled central air conditioner tune-up	Somewhat	1	126*	50%	63	
Smart strip plug outlets	Very	3	64†	100%	193	
Lowered temperature on water heater	Very	1	163**	100%	163	
Windows	Somewhat	9 windows	187***	50%	93	
Windows	Very	3 windows	62***	100%	62	
Total (n=13 spillover actions)					**2,224**	**171**

†Based on savings calculated for the Efficient Products program.

ˆBased on savings calculated for the Refrigerator Recycling program.

* Based on savings calculated for the Heating and Cooling program.

** Based on deemed savings from the Ameren Missouri Technical Resource Manual (TRM)

***Based on savings calculated for the Home Energy Performance program.

We estimated measure savings based upon PY15 ex post evaluation results using the following assumptions:

- For ceiling insulation measure we used the ex post weighted average ceiling insulation savings per home from the Home Energy Performance program.
- For the low flow showerhead measure we used the ex post average savings per showerhead from the Efficient Products program.
- For the programmed thermostat to reduce usage measure we used the ex post weighted average per setback savings from the Heating and Cooling program.

- For the removed refrigerator or freezer measure we used the ex post population weighted average of the part-use adjusted refrigerator and freezer per-unit savings estimates.
- For tune-ups we assumed the system was a central air conditioner receiving a condenser cleaning (the most common program tune-up measure). We applied the Heating and Cooling program ex post savings for this measure of 251.4 kWh. For purposes of NPSO, we conservatively de-rated the estimated savings by 50% to get 125.7 kWh savings considering that a non-program tune-up may not meet the program quality standards and would save less.
- For smart strip plug outlets we used the ex post average savings for smart strips from the Efficient Products program.
- For the lowered temperature on water heater measure we used the deemed savings from the Ameren Missouri Technical Resource Manual which assumes a 40 gallon residential tank and a current typical existing market baseline of electric water heater thermostat set at 135 degrees F and a minimum threshold for savings credit of a post set point at 120 degrees F.
- For the respondent who installed 9 energy efficient windows we used the ex post average window savings per home from the Home Energy Performance program of 186.9 kWh.
- For the windows respondent who installed 3 energy efficient windows we applied one-third of the ex post average window savings per home from the Home Energy Performance Program.

To arrive at a single savings estimate (Variable A in Table 44), the Cadmus team used numbers in the Total kWh Savings column to calculate an average for the 15 measures assessed for NPSO. Thus, the 171 kWh estimate represented average nonparticipant energy savings, per respondent attributing spillover to Ameren Missouri's residential programs.

To determine the total NPSO generated by Ameren Missouri marketing in 2015, we used the following variables (as shown in Table 44):

- **A** is the average kWh savings per NPSO response.
- **B** is the number of NPSO measures attributed to the program.
- **C** is the number of nonparticipants contacted by the survey implementer.
- **D** is Ameren Missouri's total residential customer population (excluding PY15 participants).
- **E** is NPSO energy savings, extrapolated to the customer population, and calculated by dividing B by C, and then multiplying the result by A and D.
- **F** is Ameren Missouri's total reported 2015 program year *ex post* gross savings for Refrigerator Recycling, Heating and Cooling, Lighting, Home Energy Performance, and Efficient Products. (Similarly to PY14, the PY15 analysis did not include the Low Income program.)[21]

[21] We excluded the Low Income program as it exclusively worked directly with property managers of low-income buildings; so marketing for this program would likely generate little NPSO.

- **G** (representing NPSO as a percentage of total evaluated savings) is the nonparticipant percentage used in the NTG calculations.

Using this information, the Cadmus team estimated overall, portfolio-level NPSO at 8.6% of total PY15 reported *ex post* gross savings, as shown in Table 44. Smaller NPSO savings were reported in PY14 (7,592 MWH) than in PY15 (12,247 MWH). This combined with lower total *ex post* residential portfolio savings in PY15 (142,016 MHW) than in PY14 (210,530 MH). Consequently, this resulted in a higher NPSO as a percent of total *ex post* residential portfolio savings values in PY15 (8.6%) than estimated for PY14 (3.6%). Both years identified a similar list of measures installed. A growing proportion of nonparticipant spillover is consistent with what we would expect from long running marketing of a program portfolio.

Table 44. NPSO Analysis

Variable	Metric	Value	Source
A	Average kWh Savings per Spillover Measure	171	Survey Data/Impact Evaluation
B	Number of Like Spillover Nonparticipant Actions	13	Survey data
C	Number Contacted	177	Survey disposition
D	Total Residential Population minus PY15 participants	974,784	Customer database minus PY15 participants
E	Non-Part SO MWh Savings Applied to Population	12,247	(((B÷C)×A) × D)/1000
F	Total Reported Gross *Ex Post* Savings (MWh)	142,016	2015 Program Evaluations
G	NPSO as Percent of Total Evaluated Savings	8.6%	E ÷ F

In some jurisdictions, evaluators apply NPSO as an adjustment at the portfolio-level. Though a reasonable approach, it inherently assumes all programs contribute equally to generating observed NPSO. However, given the significant differences between the programs' marketing tactics and budgets as well as programs' designs and scales, an alternate approach likely produces a better attribution estimate.

The Cadmus team considered the following three approaches for allocating total observed NPSO to individual programs:

1. **Even Allocation**: The most straightforward approach, this allocates NPSO evenly across residential programs (i.e., makes an 8.6% adjustment to each program's NTG). Doing so, however, is equivalent to applying NPSO at the portfolio-level, which, as noted, assumes all programs contribute equally to generating NPSO. This approach may be most appropriate when NPSO derives from a broad energy efficiency education campaign, rather than the program specific marketing Ameren Missouri used.
2. **"Like" Programs:** This approach allocates NPSO savings to specific programs, based on the measure installed by the nonparticipant or by the action they took. For example, one nonparticipant reported tuning up their central air conditioner, based on energy efficiency messaging from Ameren Missouri. Using this approach, we would assign NPSO savings associated with a central air conditioner tune-up. While this approach establishes a clear connection between a reported NPSO measure and Ameren Missouri's program promoting that measure, our research has found this direct measure-program relationship does not prove as straightforward as it appears. There are indications Ameren Missouri generated NPSO through the cumulative effects of various program-specific and portfolio-level marketing efforts. Mapping NPSO measures solely to the program offering that measure could undervalue overall impacts of cumulative and sustained energy efficiency messaging.
3. **Marketing Budget and Program Size.** The final allocation approach the Cadmus team considered—and eventually chose to use—assigns overall NPSO as a function of each program's marketing and program budget. This approach remains consistent with the theory that NPSO results from the cumulative effect of program-specific and Ameren Missouri marketing and

program activity over a period of time, not necessarily by a single, program-specific marketing effort and not by a broad education campaign. In addition, while NPSO most commonly is associated with mass media marketing campaigns, the scale of program activity proves to be a factor. For example, even without a significant marketing campaign, a program's size can drive NPSO through word-of-mouth and in-store program messaging. We find this approach accurately reflects and attributes NPSO to programs, ensuring proper accounting for total costs (including marketing) and total benefits (net savings, including NPSO) when assessing overall program cost-effectiveness.

The Cadmus team distributed the portfolio-level result of 12,247 MWh NPSO to Ameren Missouri's residential programs (excluding Low Income). As noted, we considered the PY15 program size (in terms of total gross *ex post* MWh savings) and each program's marketing budget (as shown in Table 45) when allocating NPSO across programs.

Table 45. Program-Specific Savings and Marketing

Program	Program *Ex Post* Gross Savings (MWh)	Percentage of Portfolio Savings	Total Marketing	Percentage of Total Marketing
Refrigerator Recycling	10,774	7.6%	$630,194	32.9%
Heating and Cooling	54,622	38.5%	$955,454	49.9%
Lighting	68,326	48.1%	$71,804	3.8%
Home Energy Performance	385	0.3%	$46,670	2.4%
Efficient Products	7,908	5.6%	$209,907	11.0%
Total	**142,016**	**100%**	**$1,914,029**	**100%**

The results of this approach—shown in Table 46 and Table 47—reflect each program's impact on the nonparticipant population, based on marketing expenditures and the magnitude of the program's intervention in the regional marketplace.

Table 46. Combined Savings and Marketing Allocation Approach

Program	*Ex Post* Gross Energy Savings (A)	Marketing Spending (B)	Combined Savings/ Marketing (AxB)	Percentage of Combined Savings/ Marketing
Refrigerator Recycling	7.6%	32.9%	2.5%	10.4%
Heating and Cooling	38.5%	49.9%	19.2%	79.6%
Lighting	48.1%	3.8%	1.8%	7.5%
Home Energy Performance	0.3%	2.4%	0.01%	0.03%
Efficient Products	5.6%	11.0%	0.6%	2.5%
Total	**100%**	**100%**	**24.1%**	**100%**

Analysis credited two programs with the greatest NPSO: Heating and Cooling (accounting for one-half of all marketing dollars and 38% of total energy savings) at 9,749 MWh; and Refrigerator Recycling

(accounting for 33% of marketing dollars and 8% of total energy savings) at 1,268 MWh. As NPSO impacts program-specific NTG results,[22] all NPSO estimates have been reported as a percentage of each program's total gross energy savings.

As shown in Table 47, we allocated 916 MWh of NPSO to the Lighting program, representing 7.5% of the combined residential portfolio savings and marketing expenditure. This resulted in a 1.3% adjustment to the program's PY15 NTG—findings generally similar to the PY14 NPSO analysis.

Table 47. NPSO by Program

Program	Program Gross Savings (MWh)	Total NPSO (MWh)	Percentage of Combined Savings/ Marketing	Program-Specific NPSO (MWh)	NPSO as a Percentage of Gross Savings
Refrigerator Recycling	10,774	12,247	10.4%	1,268	11.8%
Heating and Cooling	54,622		79.6%	9,749	17.8%
Lighting	68,326		7.5%	916	1.3%
Home Energy Performance	385		0.03%	3	0.9%
Efficient Products	7,908		2.5%	310	3.9%
Total	**142,016**		**100%**	**12,247**	**8.6%**

Lighting Specific Spillover and Market Effects

In addition to the nonparticipant spillover generated through marketing and program outreach on energy efficiency, the Ameren Missouri Lighting program has the potential to create energy savings through non-program purchases of efficient lightbulbs (i.e., lighting specific spillover), and broader changes to the market for lighting products (i.e., market effects) resulting in increased sales of efficient lighting.

The Cadmus team used the same model in PY15 that the team used in PY13 and PY14 to estimate non-program sales of efficient lighting products, and the proportions of the non-program sales attributable to naturally occurring sales, spillover, and market effects. For PY15, the team used the results of the home lighting inventory to update several inputs to the model, in particular the saturation of high-efficiency bulbs in medium-screw base sockets, and the storage rate. Table 48 shows the components of the model and the PY15 inputs.

[22] NTG = 1 – Free Ridership + Participant Spillover + NPSO + Market Effects

Table 48. Allocation of Nonprogram Bulbs

Inputs	2015 Value	Data Source
No. Sockets Per Household	54.3	Value from 2013
Baseline Saturation		
No. of Households	1,040,928	Value from 2013
Baseline Saturation CFLs and LEDs	31%	Value from 2013
Storage CFLs &LEDs	3.7	Value from 2013
No. of CFLs & LEDs (Baseline)	21,260,330	Calculated
Current Saturation		
No. of Households	1,043,603	Average 2015 meters billed
Post Saturation CFLs & LEDS	31%	PY15 HIS (MSB Only saturation)
Storage CFLs & LEDs	5.36	PY15 HIS
Other CFLs and LEDs purchased plus disposed	2.69	Actual Value 5.37 from 2015 HIS - cut by 1/2 to be conservative
SMD bulbs	148,596	SMD July 2013 thru July 2015
CFL/LED Turnover	4.43%	Assumes 1/7 of EE bulbs replaced each year
Post CFL and LEDs without SMD	28,319,479	Calculated
Increase in CFLs & LEDs	7,059,149	Calculated
Total Program CFLs & LEDs (excluding SMD)	7,270,989	June 2013 - July 2015
Leakage and nonresidential bulbs Adjustment	946,380	Leakage and Non-residential analysis, by year
Ameren Missouri residential Program CFLs & LEDs	6,324,609	Calculated
Non Program CFLs & LEDs	**734,540**	**Calculated**
Freeridership		
Free ridership Rate	22%	PY15 analysis
Free rider CFLs & LEDs	1,572,545	Calculated
Non Free rider CFLs & LEDs	5,698,444	Calculated
Naturally Occurring Rate	27.6%	Assumed
Naturally Occurring Bulbs	202,936	Calculated
Market Inventory Proportion		
Energy Efficient Proportion of Retail Stock	44.0%	2015 Online Shelf Survey
Lighting Spillover Bulb Sales	297,698	Calculated
Market Effects Bulb Sales	233,906	Calculated
Total Program Induced (w Participant Spillover)	5,996,142	Calculated
Total Program Induced (w Participant Spillover and Market Eff)	6,230,048	Calculated

The saturation of high-efficiency lighting is one of the most important inputs to the model. The PY15 home lighting inventory found that saturation of efficient lighting overall had remained virtually unchanged since the PY13 inventory. The PY15 estimate based on the sample of 100 PY15 inventoried homes had confidence and precision of 90% +- 7.6%. In other words, we are 90% confidence that actual saturation is between 23.4% and 38.6%. Since the model results are sensitive to saturation, sample error could explain the counterintuitive result. Even though saturation appeared to be unchanged, the inventories found increased storage rates for high efficiency bulbs since PY13. The inventory also found that the concentration of LEDs in the installed high-efficiency bulbs had increased from 4% to 7% of installed high-efficiency bulbs. Table 49 and Table 50 show key inventory results for PY15, and a comparison with PY13 results.

Table 49. Saturation Rates by bulb Type, PY15, PY13 and PY10

Percentage of Sockets			
Bulb Type	**PY15**	**PY13**	**PY10**
Incandescent	64%	60%	
Halogen	5%	8%	
Other	0%	1%	
Compact Fluorescent	29%	30%	21%
LED	2%	1%	
Total	100%	100%	n/a*

*No other data is available for the PY10 study

Table 50. Storage Rates by Bulb Type, PY15, PY13, and PY10

Average Number of Storage Bulbs per Home				
Bulb Type	**Number of Bulbs**	**Avg. Bulbs / Home in PY15**	**Avg. Bulbs / Home in PY13**	**Avg. Bulbs / Home in PY10**
Incandescent	797	8.0	10.4	
Halogen	55	0.6	0.8	
Linear Fluorescent	5	0.1	0.5	
Compact Fluorescent	442	4.4	3.5	2.5
LED	26	0.3	0.1	
Total	**1,325**	**13.3**	**15.3**	

To account for the installation of high-efficiency bulbs that may be replacing other high-efficiency bulbs that had burned out, the team updated the model to include CFLs and LEDs that have burned out and been replaced by new CFLs and LEDs (CFL/LED turnover). We assumed 1/7 of CFLs and LEDs are replaced each year. The model found spillover equal to 4% of program sales, and market effects equal to 5% of program sales. Table 51 presents the components of the NTG ratio for PY15, with comparison to PY14

and PY13 values. The PY13 and PY14 values are based on the same model used in PY15. Differences between the PY15 model and PY13 include accounting for bulb turnover, leakage and cross-jurisdictional sales, which were not considered in either PY13 or PY14. The PY13 model used 2013 lighting inventory data to determine saturation and the quantity of non-program bulbs. The team did not conduct an inventory in PY14, and so the PY14 model was updated based on assumptions about saturation change and other factors. This PY15 evaluation reports an adjustment to the PY14 values, based on updated saturation data, described in the following section.

Table 51. NTG and NTG Components*

Program Year	Free Ridership	Nonparticipant Spillover (NPSO)	Lighting-Specific Spillover	Market Effects	NTG
PY15	22%	1.3%	4%	5%	88%
PY14	25%	1.2%	14%**	10%**	100%
PY13	24%	0.8%	28%	20%	125%

*Applied only to bulb sales, not SMD bulbs

** PY14 net savings were subsequently adjusted using PY15 values as described in a later section

PY15 Net Savings Summary

Table 52 presents the program's net energy savings impacts for PY15.

Table 52. PY15 Net Impacts Results Summary

Measure	*Ex post* Gross Savings (MWh/year)	Free ridership	NPSO	Lighting Spillover	Market Effects	NTG	Net Savings* (MWh/year)
Markdown							
CFL - 13W	34,039	18%	1%	4%	5%	93%	31,495
CFL - 18W	567	18%	1%	4%	5%	93%	525
CFL - 23W	1,844	18%	1%	4%	5%	93%	1,706
CFL - High Wattage	47	18%	1%	4%	5%	93%	44
CFL - Reflector	474	22%	1%	4%	5%	88%	417
CFL - Specialty	182	22%	1%	4%	5%	88%	160
LED - 10.5W Downlight	13,326	17%	1%	4%	5%	93%	12,445
LED - 12W Dimmable	11,021	40%	1%	4%	5%	70%	7,729
LED - 15W Flood PAR30	279	53%	1%	4%	5%	57%	159
LED - 18W Flood PAR38	688	45%	1%	4%	5%	66%	453
LED - 8W Globe	1,038	26%	1%	4%	5%	85%	877
Occupancy Sensor	0	N/A	N/A	N/A	N/A	100%	0
SMD							
CFL - 13W	2,064	N/A	N/A	N/A	N/A	100%	2,064
CFL - 23W	2,757	N/A	N/A	N/A	N/A	100%	2,757
Lighting Program	**68,326**						**60,830**

* May not sum to totals due to rounding

The program exceeded its energy and demand targets for the 2015 program year, as shown in Table 53.

Table 53. Lighting Net Savings Impacts

Metric	MPSC-Approved Target[1]	Ex Ante Gross Savings Utility Reported[2]	Ex Post Gross Savings Determined by EM&V[3]	Ex Post Net Savings Determined by EM&V[4]	Percent of Goal Achieved[5]
Energy (MWh)	62,371	77,093	68,326	60,830	98%
Demand (kW)	1,875	5,494	5,618	4,944	264%

[1] http://www.ameren.com/-/media/missouri-site/Files/Rates/UECSheet191EEResidential.pdf

[2] Calculated by applying tracked program activity to Ameren Missouri's 2012 Technical Resource Manual (TRM) savings values. (https://www.efis.psc.mo.gov/mpsc/commoncomponents/viewdocument.asp?DocId=935658483).

[3] Calculated by applying tracked program activity to Cadmus' evaluated savings values.

[4] Calculated by multiplying Cadmus' evaluated gross savings and NTG ratio, which accounts for free ridership, participant spillover, nonparticipant spillover, and market effects.

[5] Compares MPSC Approved Target and Ex Post Net Savings Determined by EM&V.

Net Savings Adjustment for PY14 Overage

In PY14, the team did not conduct a lighting inventory in order to update saturation results. Therefore, the team assumed spillover and market effects equal to half of the PY13 values, or 14% lighting spillover and 10% market effects. The Cadmus team estimated spillover and market effects for the two years between PY13 and PY15 to be equal to 4% and 5%, respectively. Table 54 calculates a net savings adjustment for PY14, based upon the updated estimates.

Table 54. Adjustment for PY14 Overage Applied to PY15 Results

Delivery Channel	*Ex Post* Gross Savings (MWh/yr)	Free Ridership	Participant Spillover	NPSO	Market Effects	NTG Ratio	Net Savings (MWh/yr)
PY14 Original Values							
PY14 Markdown	153,642	25.9%	14.0%	1.2%	10.0%	99.3%	152,581
PY14 SMD + Occ Sens	3,199	0.0%	0.0%	0.0%	0.0%	100%	3,199
Total	**156,841**						**155,780**
PY14 Adjusted Values							
PY14 Markdown	153,642	25.9%	4.0%	1.2%	5.0%	84.3%	**129,535**
PY14 SMD + Occ Sens	3,199	0.0%	0.0%	0.0%	0.0%	100%	3,199
Total	**156,841**						**132,734**
Net Savings Adjustment							***-23,046***
PY15 Values							
PY15 Markdown	63,506	22.1%	4.0%	1.3%	5.0%	88.2%	56,010
PY15 SMD	4,820	0.0%	0.0%	0.0%	0.0%	100%	4,820
Total	**68,326**						**60,830**
PY15 Savings After PY14 Adjustment							**37,783**

Cost-Effectiveness Results

To analyze PY15 program cost-effectiveness, MMP used DSMore and assessed cost-effectiveness using the following five tests, defined by the California Standard Practice Manual:[23]

- Total Resource Cost (TRC) test
- Utility Cost Test (UCT)
- Ratepayer Impact Measure (RIM)
- Participant Cost Test (PCT)
- Societal Cost Test (SCT)

DSMore took hourly energy prices and hourly energy savings from specific measures installed through the Lighting Program and correlated prices and savings to 30 years of historic weather data. Using long-term weather ensured the model captured and appropriately valued low probability but high consequence weather events. Consequently, the model's produced an accurate evaluation of the demand-side efficiency measures relative to alternative supply options. In PY15, Ameren Missouri updated its avoided energy, capacity, and transmission and distribution (T&D) costs to be consistent with its 2014 Integrated Resource Plan (IRP).

Table 55 presents the key cost-effectiveness analysis assumptions and corresponding source.

Table 55. Assumptions and Source for Cost-Effectiveness Analysis

Assumption	Source
Discount Rate = 6.95%	Ameren Missouri 2012 MEEIA Filing
Line Losses = 5.72%	
Summer Peak occurred during the 16th hour of a July day, on average	
Escalation rates for different costs occurred at the component level, with separate escalation rates for fuel, capacity, generation, transmission and distribution, and customer rates carried out over 25 years.	
Avoided Energy and Capacity Costs	Ameren Missouri 2014 IRP
Avoided Electric T&D = $23.60/kW	

In addition, MMP used the Batch Tools (model inputs) that Ameren Missouri used in its original analysis as input into the *ex post* DSMore analysis, then modified these solely with new data from the evaluation (e.g., PY15-specific Lighting participation counts, per-unit gross savings, and NTG), which ensured consistency.

Particularly, model assumptions were driven by measure load shapes, which indicated when the model should apply savings during the day. This ensured that the load shape for an end-use matched the system peak impacts of that end use and provided the correct summer coincident savings. MMP used

[23] *California Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects.* October 2001.

measure lifetime assumptions and incremental costs based on the program database, the Ameren Missouri TRM, or the original Batch Tool.

A key step in the analysis process required acquiring PY15 Ameren Missouri program spending data: actual spending, broken down into implementation, incentives, and administration costs. MMP applied these numbers at the program level, not the measure level. While applying incentives at the measure level can be useful for planning purposes, it proves unnecessary for cost-effectiveness modeling since results are based on a program overall.

In addition, all the program-specific cost-effectiveness results include the program's share of portfolio-level or indirect costs ($1,429,220). The Cadmus team determined each program's share of these costs using the present value of each program's UCT lifetime benefits (i.e., the present value in 2013 dollars of avoided generation costs, as well as deferral of capacity capital and transmission and distribution capital costs). The residential portfolio summary report discusses this in greater detail.

Table 56 summarizes the cost-effectiveness findings by test. Any benefit/cost score above 1.0 indicates the present value of the program's benefits is greater than the present value of its costs. In addition, the table includes the net present value (in 2013 dollars) of the Annual Net Shared Benefits or (sometimes referred to as UCT net lifetime benefits).[24] As shown, the Lighting program passed the UCT, TRC, PART, and Societal TRC tests and generated $14.6 million in annual net shared benefits, significantly less than PY14 benefits. This difference is primarily due to the updated avoided energy costs, which are significantly lower than those assumed in PY14.

Table 56. Cost-Effectiveness Results (PY15)

UCT	TRC	RIM	Societal	PART	Annual Net Shared Benefits*
3.49	1.27	0.42	1.66	3.02	$14,594,132

*Annual Net Shared Benefits shown meet the definition in 4 CSR 240-20.094(1)(C) and use avoided costs or avoided utility costs as defined in 4 CSR 240-20.094(1)(D).

[24] Net avoided costs minus program costs.

Appendix A. *Ex Post* Demand Reductions

MMP determined *ex post* demand reductions using the *ex post* energy savings estimated through this PY15 report and through DSMore (using load shapes provided by Ameren Missouri).

Table 57. PY15 Summary: *Ex Post* Net Per-Unit Demand Reductions

Measure	PY15 Participation	Per-Unit Net *Ex Post* Demand Reduction (kW)	Total Net *Ex Post* Savings (kW)*
CFL - 13W (60W incand equiv)	1,205,401	0.0020	2,352
CFL - 18W (75W incand equiv)	16,724	0.0026	44
CFL - 23W (100W incand equiv)	35,031	0.0045	156
CFL - High Wattage Bulbs	270	0.0158	4
CFL – Reflector	3,703	0.0111	41
CFL - Specialty Bulbs	8,333	0.0019	16
LED - 10.5W Downlight E26	239,733	0.0051	1,228
LED - 12W Dimmable	297,399	0.0025	757
LED - 15W Flood Light PAR30 Bulb	4,144	0.0038	16
LED - 18W Flood Light PAR38 Bulb	8,419	0.0053	45
LED - 8W Globe Light G25	30,589	0.0027	81
Occupancy Sensor	12	0.0015	0
SMD -13W (60W incand equiv)	100,470	0.0009	87
SMD - 23W (100W incand equiv)	82,708	0.0014	116
Total	**2,032,936**		**4,944**

*Accounts for line losses

Appendix B. Lumen-Equivalent Wattage

Cadmus mapped the wattage of each markdown bulb sold to the lumen-equivalent incandescent wattage in order to determine the wattage baseline under the incandescent scenario. Lumen-equivalent wattages are shown in Table 58 and Table 59.

Table 58. CFL Wattage Mapping

CFL Wattage	Lumen-Equivalent Incandescent Wattage	CFL Wattage	Lumen-Equivalent Incandescent Wattage
3	15	20	53
5	20	22	53
7	25	23	72
9	40	24	72
10	40	24	72
11	40	25	72
12	40	26	72
12	40	27	72
13	60	28	150
14	60	29	150
15	60	32	150
16	60	33	150
17	60	40	150
18	53	42	150
19	53	55	250

Table 59. LED Wattage Mapping

LED Wattage	Lumen-Equivalent Incandescent Wattage
8	40
10	40
11	60
12	60
13	60
14	75
15	75
16	75
17	75
18	75
19	100

Appendix C. Ameren Missouri Lighting Program Stakeholder Interview Guide (PY15)

Ameren Missouri - PY15 Lighting Stakeho

Appendix D. Demand Elasticity Model Outputs

The Cadmus team ran numerous model scenarios to identify the model with the best parsimony and explanatory power using the following criteria:

- Model coefficient p-values (keeping values less than <0.1, see Table 62);[25]
- Explanatory variable cross-correlation (minimizing where possible);
- Model QIC (minimizing between models, see Table 63);[26]
- Minimizing multicollinearity; and
- Optimizing model fit.

The following tables are the output statistics and information generated by the final model.

Table 60. GEE Model Information

Model Information	
Data Set	WORK.FINALMODELDATA
Distribution	Negative Binomial
Link Function	Log
Dependent Variable	MonthlyPackSales
Number of Observations Read	17249
Number of Observations Used	15991
Number of Invalid Responses	99
Missing Values	1159

[25] Where a qualitative variable had many states (such as bulb type), the Cadmus team did not omit variables if one of the states was not significant, but rather considered the joint significance of all states. The team used robust estimation of model standard errors to properly represent model accuracy and to guide the specification process.

[26] Quasi Information Criteria (QIC) was used to assess model fit, as the R-square statistic is undefined for nonlinear models. QIC also has the desirable property that it penalizes overly complex models, similar to the adjusted R-square.

Table 61. Model Classification Variable Levels

Class Level Information		
Class	Levels	Values
id	2,006	BP4BATTERIES PLUS #268CFL10115A BP4BATTERIES PLUS #268CFL10466A BP4BATTERIES PLUS #268CFL10469A BP4BATTERIES PLUS #268CFL10470A BP4BATTERIES PLUS #268CFL10471A BP4BATTERIES PLUS #268CFL10472A BP4BATTERIES PLUS #268CFL10490A ...
Channel	3	CLUB DIY MASS
style	3	LED BULB SPEC BULB STAN BULB
CFL	2	0 1

Table 62. GEE Parameter Estimates with Empirical Standard Errors

Parm	Retail Channel	CFL Dummy	Estimate	Stderr	LowerCL	UpperCL	Z	ProbZ
Intercept		-	0.00	0.00	0.00	0.00	0.00	0.00
LogPromo*Channel*CFL	CLUB	0	-2.14	0.31	-2.75	-1.53	-6.87	0.00
LogPromo*Channel*CFL	CLUB	1	-1.47	0.09	-1.65	-1.29	-15.81	0.00
LogPromo*Channel*CFL	DIY	0	-1.76	0.20	-2.16	-1.36	-8.60	0.00
LogPromo*Channel*CFL	DIY	1	-0.67	0.06	-0.78	-0.55	-11.08	0.00
LogPromo*Channel*CFL	MASS	0	-2.30	0.22	-2.73	-1.86	-10.41	0.00
LogPromo*Channel*CFL	MASS	1	-0.54	0.05	-0.64	-0.45	-11.03	0.00
LogPromoPr*Specialty		-	-0.17	0.08	-0.32	-0.01	-2.06	0.04
Trend		-	0.16	0.02	0.12	0.20	8.03	0.00

Table 63. GEE QIC Fit Criteria

Criterion	Value
QIC	-4326371.74
QICu	-4322372.64

Appendix E. Results of Homeowner Inventory Study and Homeowner Survey

The home inventory study collected information about how lighting is used in the average home in Ameren Missouri territory. In addition, as part of this study, the Cadmus team surveyed homeowners on their awareness of high-efficiency lighting and the Lighting program, their satisfaction with high-efficiency lighting, and certain demographic characteristics.

Detailed results from the survey and the inventory study are presented below. The methodology for the study is presented in the Home Inventory Study section.

Homeowner Survey Instrument

The document embedded below is the survey instrument that homeowners participating in the home inventory study completed during the site visit. The technician conducting the site visit assisted homeowners as needed, and recorded homeowner responses in some cases.

Ameren MO HIS Resident Survey_7-7-1

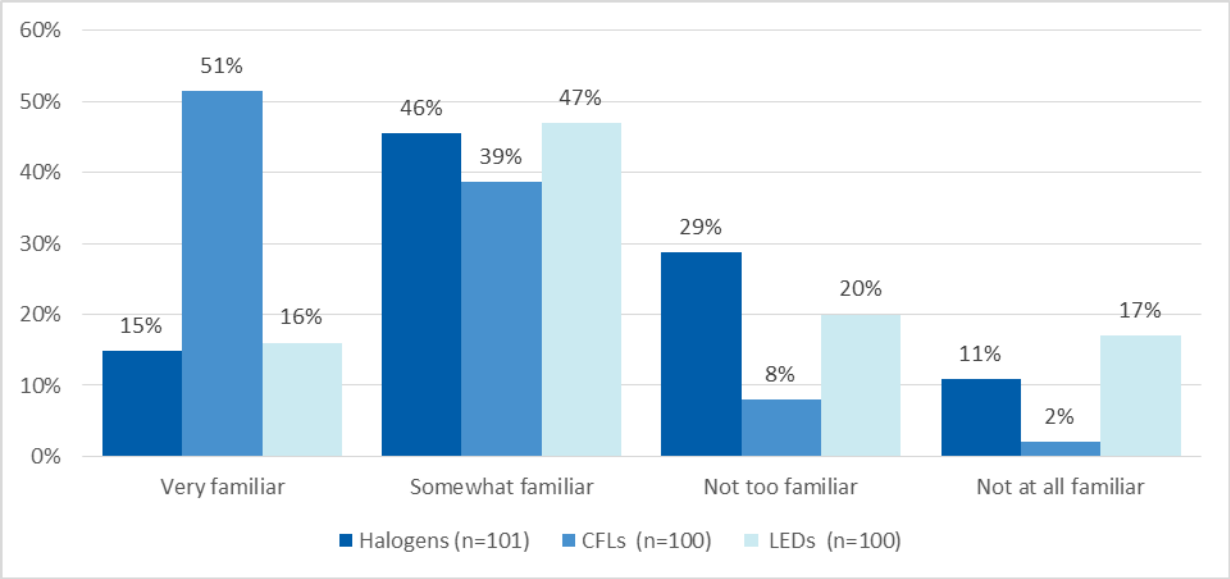
Home Inventory Study Homeowner Survey

The following results from the survey completed by the homeowner during the home inventory study are unweighted.

Awareness and Attitudes

Respondents indicated they were more familiar with CFLs than either halogens or LEDs. (Figure 3)

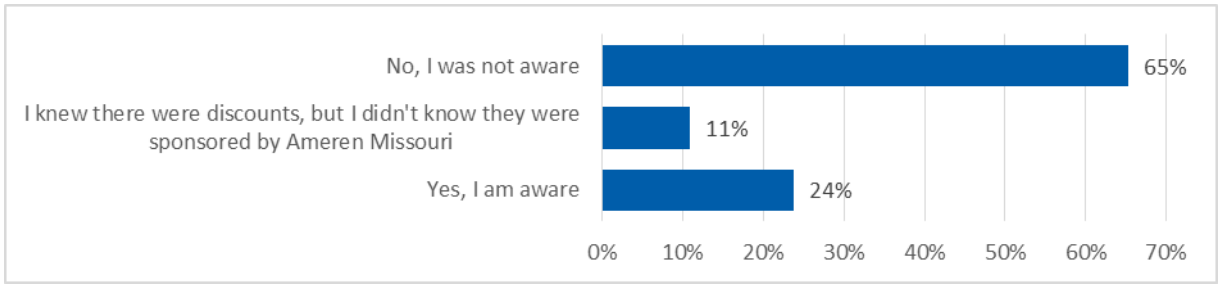
Figure 3. Familiarity with Efficient Bulb Technology



Source: PY15 Home Inventory Homeowner Survey, questions 1, 2, and 6

The majority of homeowners were not aware that Ameren Missouri offers discounts (Figure 4).

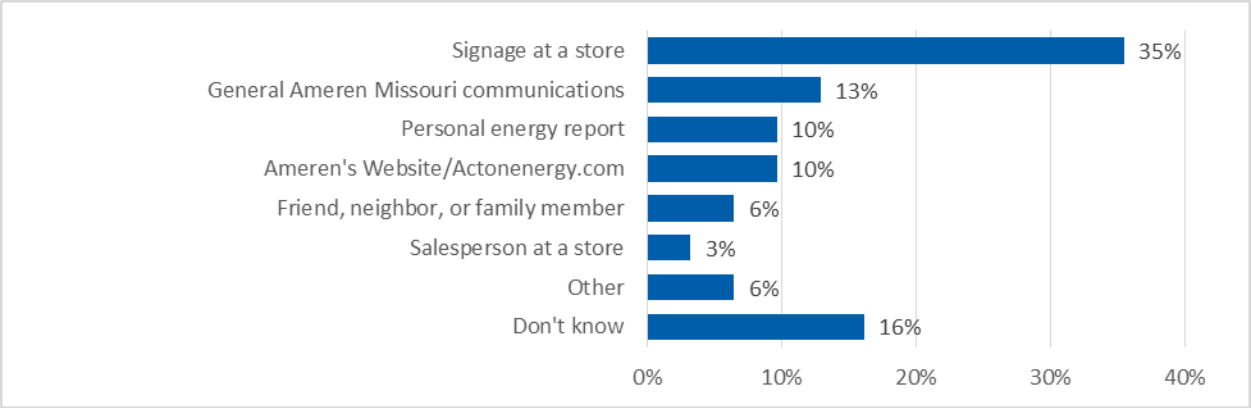
Figure 4. Awareness of Ameren Missouri Discounts (n=101)



Source: PY15 Home Inventory Homeowner Survey, question 9

Among those respondents aware of discounts, the majority learned about them through in-store signage. However, as shown in Figure 5, respondents mentioned several other sources, including the types of Ameren Missouri communication. As reported by Ameren Missouri staff, the personal energy report did raise awareness of the Lighting program.

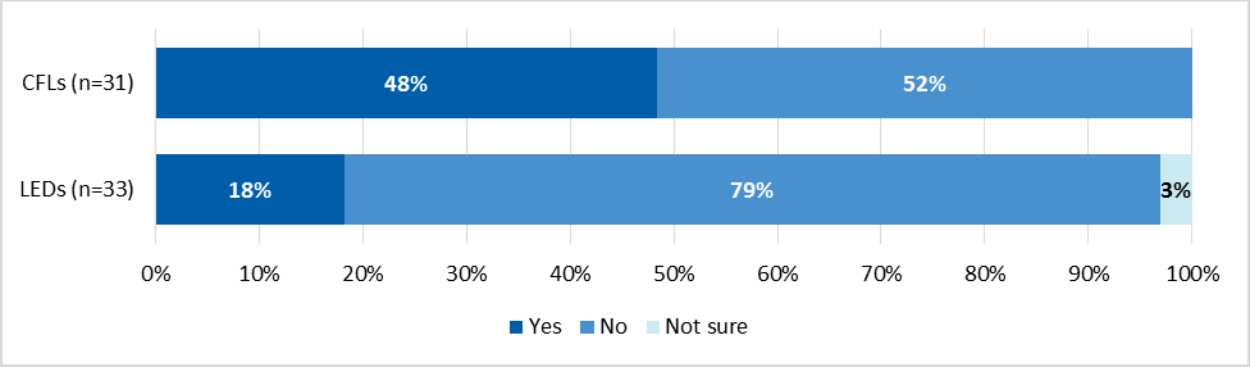
Figure 5. Source of Awareness of Discounts (n=31)



Source: PY15 Home Inventory Homeowner Survey, question 10

Respondents were almost three times more likely to report having purchased a program-discounted CFL than a program-discounted LED. This result is consistent with the volume of CFLs sold through the program relative to LEDs.

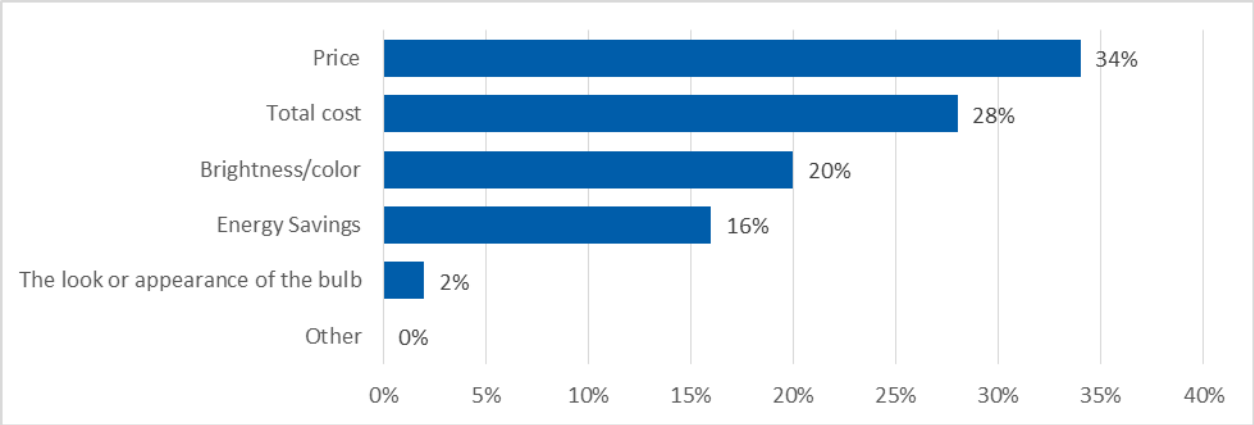
Figure 6. Customers that have Purchased a Discounted Bulb



Source: PY15 Home Inventory Homeowner Survey, questions 11 and 13

When asked what the most important factor was when choosing what light bulb to buy, price was more often selected than any other individual option. However, as shown in Figure 7, only 28% said total cost was the most important factor (price to purchase plus cost to operate), while others indicated they look for brightness or color, or energy savings. Only 2% said the bulb's appearance was the most important factor.

Figure 7. Most Important Features for Lighting (n=100)

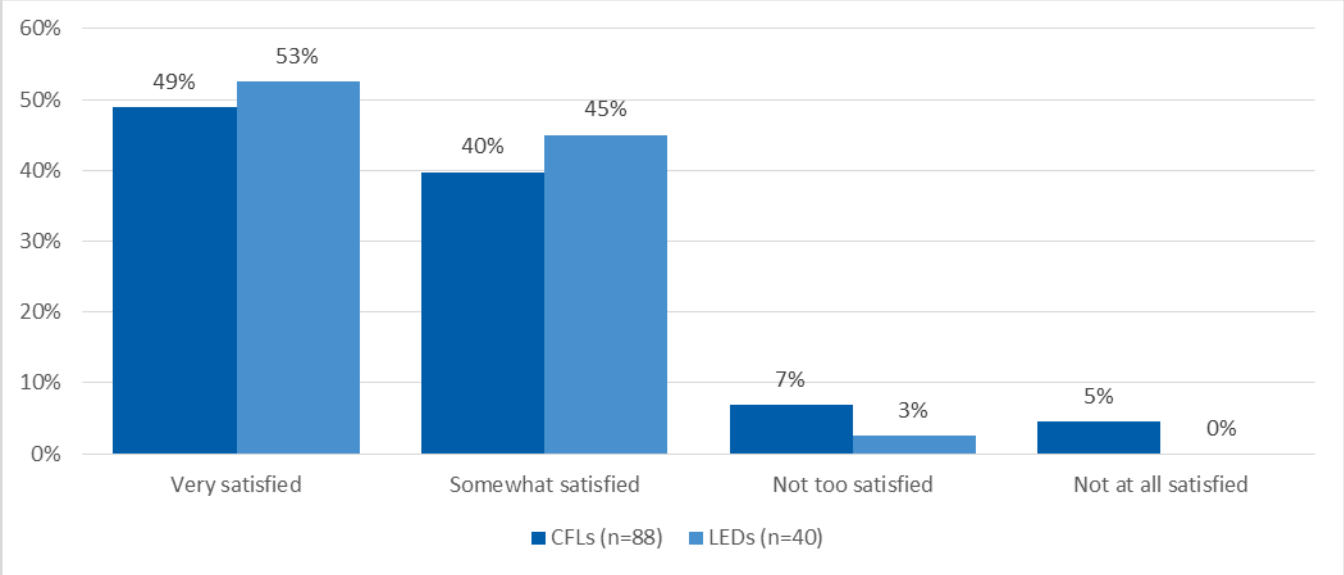


Source: PY15 Home Inventory Homeowner Survey, question 15

Satisfaction

As shown in Figure 8, customers who had experience with LEDS were more satisfied with them than customers who only had experience with CFLs. Ten percent of respondents indicated they had never had a CFL in their house (n=98), and 13% of respondents had never had an LED in their house (n=46).

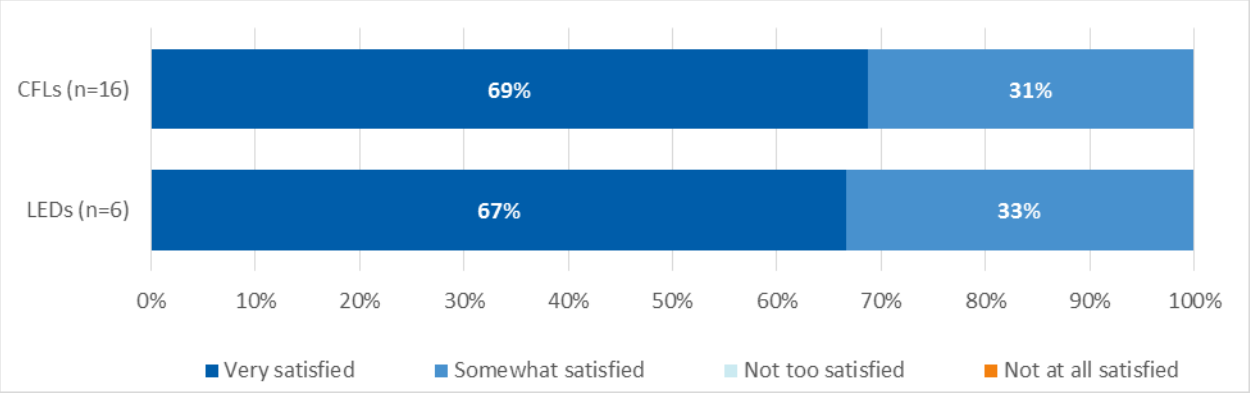
Figure 8. Satisfaction by Technology



Source: PY15 Home Inventory Homeowner Survey, questions 4 and 8

Overall respondents were satisfied with discounted bulb prices, as shown in Figure 9

Figure 9. Satisfaction with Discounted Bulb Prices

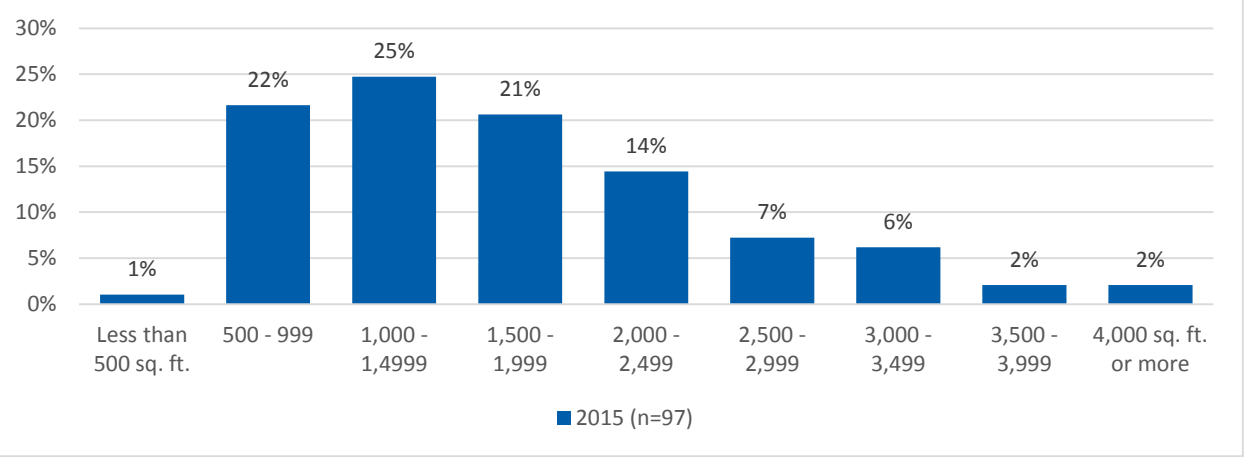


Source: PY15 Home Inventory Homeowner Survey, questions 12 and 14

Demographics

Figure 10 shows the difference in distribution between the two years. PY15 included multifamily housing and therefore has a higher proportion of homes with lower square footage.

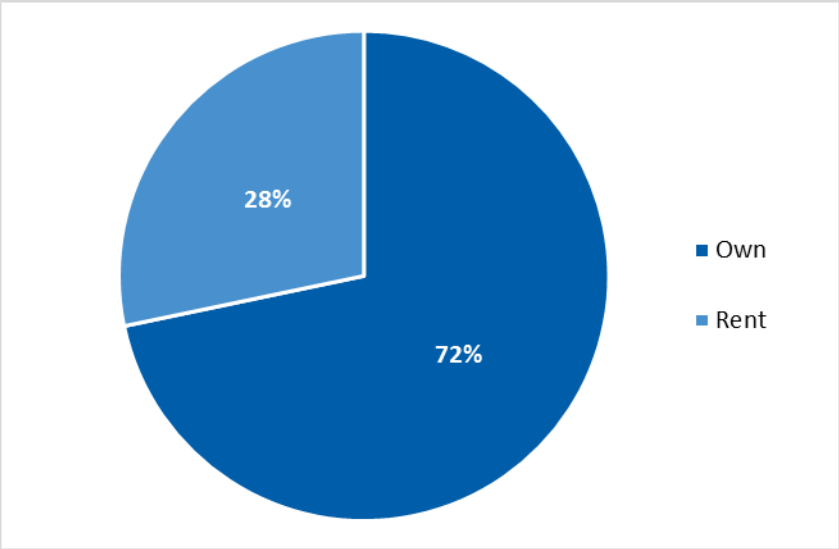
Figure 10. Respondent's Square Footage



Source: PY15 Home Inventory Homeowner Survey, questions 20

Figure 11 shows the percentage of the PY15 respondents that own, rather than rent, their homes. For those respondents who indicated they rented their home, the survey also asked whether the tenant or the landlord pays the electric bill. Every renter indicated they pay their own utility bill (100%, n=33).

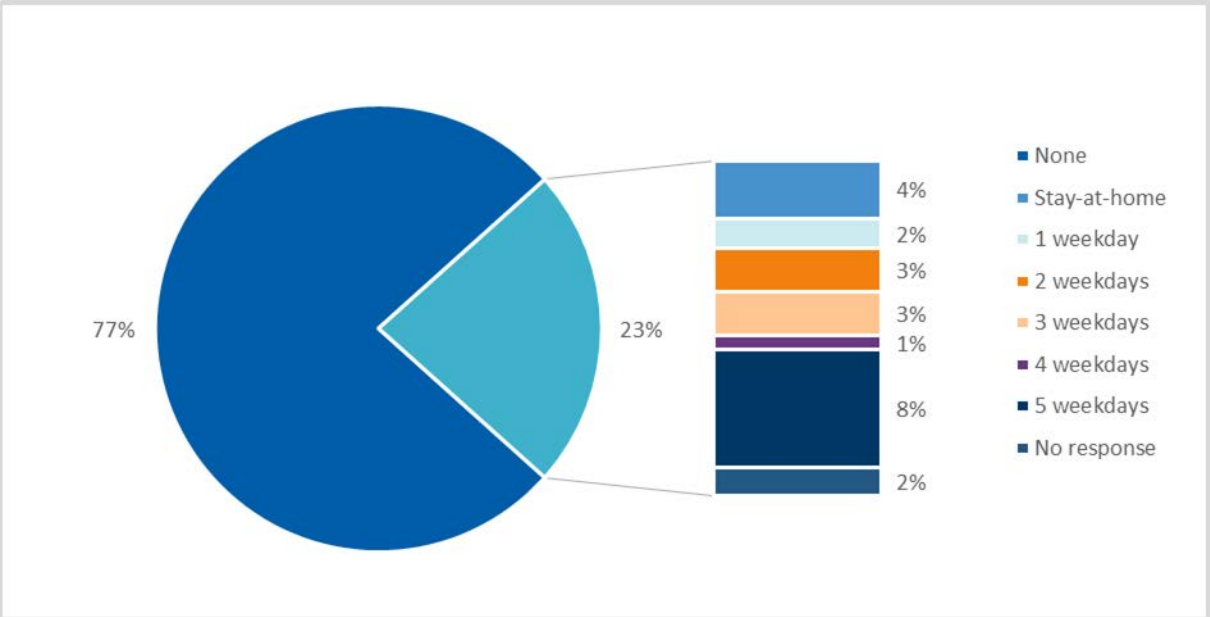
Figure 11. Ownership Status (n=99)



Source: PY15 Home Inventory Homeowner Survey, questions 25

Of 99 respondents who answered, 77% indicated no one in their home telecommuted or stayed home all day. Of the remaining 23%, the majority (13% of 99 respondents) had someone home all day most of the week, either telecommuting four or five days a week or home all the time. The final 8% of the total had someone home one to three days a week, and 2% did not respond. These results are shown in Figure 12.

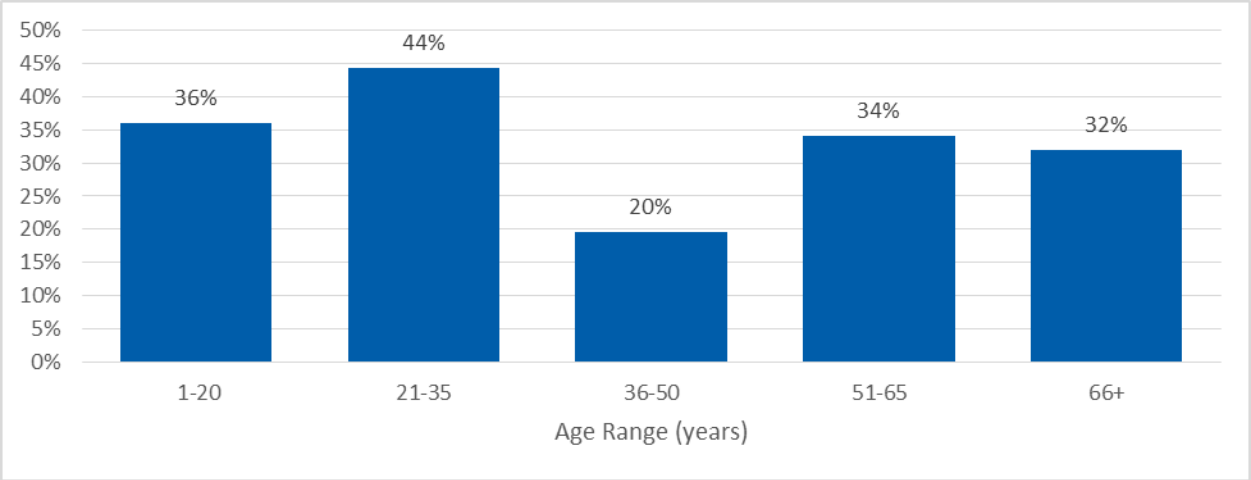
Figure 12. Percentage of Households with Someone at Home



Source: PY15 Home Inventory Homeowner Survey, questions 22 - 24

The survey asked respondents to select all age ranges that described a member of their household (i.e., a respondent in a household with two parents and two kids in school might select the 1 to 20 range and the 36 to 50 range). Figure 13 shows the percentage of respondents selecting each age range. Householders were most likely to have members in the 21 to 35 year old range, followed by the 1 to 20 range and the 51 to 65 range.

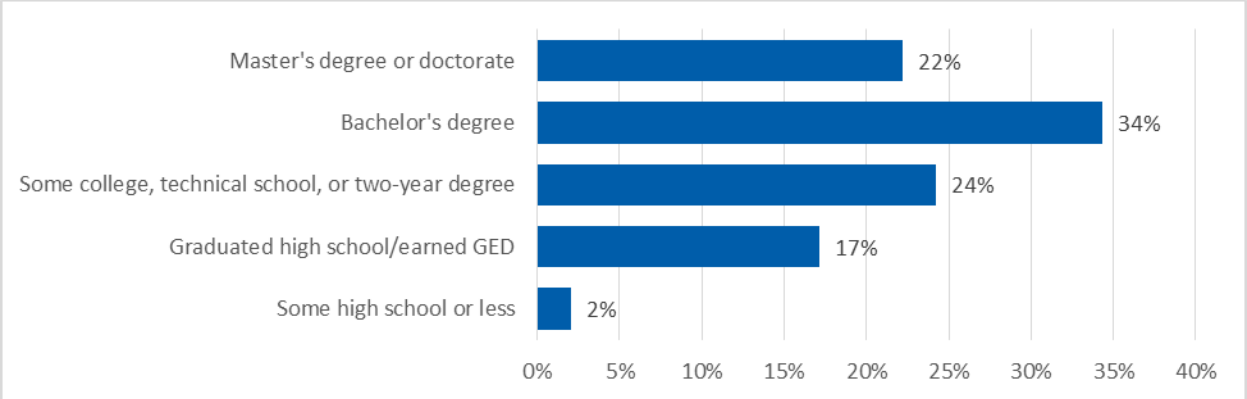
Figure 13. Ages of Home Occupants, by Age Range (n=97)



Source: PY15 Home Inventory Homeowner Survey, question 21

The majority of the home inventory study participants had a bachelor's degree or more education (56%) as shown in Figure 14.

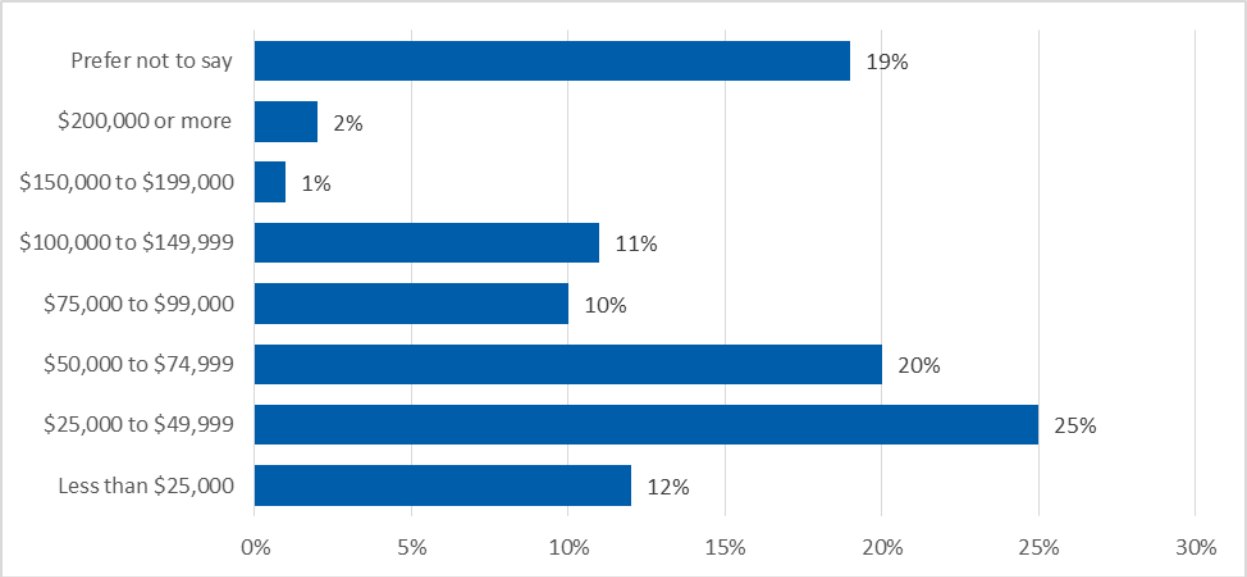
Figure 14. Education Level of Respondents (n=99)



Source: PY15 Home Inventory Homeowner Survey, question 27

Although 20% of respondents chose not to state their income, 57% indicated an annual income of less than $75,000. Of those, 37% indicated their income was less than $50,000.

Figure 15. Respondent Income



Source: PY15 Home Inventory Homeowner Survey, question 28

Appendix F. *Bibliography*

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