
# Ameren Missouri
# Low Income Impact and Process Evaluation: Program Year 2014

**June 17, 2015**

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Nexant

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# Executive Summary

Ameren Missouri engaged Cadmus and Nexant (the Cadmus team) to perform annual process and impact evaluations of the Low Income Program for a three-year period, from 2013 through 2015. This annual report covers the impact and process evaluation findings for Program Year 2014 (PY14), the period from January 1, 2014, through December 31, 2014.

## *Program Description*

In PY14, Ameren changed the name of the program from CommunitySavers (used in PY13) to the Low Income Program. Through the Low Income Program, Ameren Missouri delivers cost-effective, energy-efficiency services to low-income multifamily properties with three or more dwelling units.

Honeywell Smart Grid Solutions (Honeywell), the program implementer, contracts the direct installation of all energy-efficiency measures (EEMs) to multiple contractors. The EEMs consist of low-cost measures such as the following:

- Lighting (CFLs)
- Insulation of hot water heaters and pipes
- Showerheads and faucet aerators
- Programmable thermostats

Additionally, the program offers replacement of older appliances—such as refrigerators and air conditioners (both room and through-the-wall units)—with ENERGY STAR® models. In Program Year 2013 (PY13), the program also began offering tune-ups for central air conditioning (CAC) systems, which continued during PY14.

To be eligible for the Low Income Program, the participating property owners and/or managers committed to implementing standard lighting installations in common areas, as applicable, through Ameren Missouri's Business Energy Efficiency Program. This commitment, although nonbinding, bridged Ameren Missouri's residential and commercial program offerings to provide comprehensive, whole-building energy savings in the low-income multifamily sector.

## *Key Impact Evaluation Findings*

The Cadmus team's key impact findings for PY14 follow.

### Gross Impacts

Table 1 shows measure installations, the Cadmus team's per-unit *ex post* annual energy savings, retention rates, and total *ex post* energy savings by measure for PY14. The *ex post* savings values for 13W CFLs, refrigerators, and programmable thermostats were lower than those estimated in the Ameren Missouri Technical Resource Manual (TRM). However, a few measures, especially cooling measures, showed much higher savings than the TRM estimates (as they did in PY13), and these contributed to the high realization rate for PY14.

The Cadmus team's measure-specific realization rates equal the ratio of Ameren Missouri's planning (*ex ante*) savings from its TRM and our evaluated (*ex post*) savings.

**Table 1. PY14 Participation, Per-Unit *Ex Post* Gross Savings, Realization Rates, and Total Savings**

| Measure | PY14 Installations | *Ex Ante* Per-Unit Gross Savings (kWh/Year) | Per-Unit *Ex Post** Savings (kWh/Year) | Realization Rate (*Ex Post**/ *Ex Ante*) | Verified and Operable | Total *Ex Post* Savings (MWh/Year) |
|---|---|---|---|---|---|---|
| CFL - 13W | 51,430 | 31.5 | 19.3 | 61% | 95.7% | 949.9 |
| CFL - 18W | 5,634 | 37.4 | 18.0 | 48% | | 97.1 |
| CFL - 23W | 3,924 | 51.2 | 24.8 | 48% | | 93.1 |
| Refrigerator | 1,625 | 1,126 | 890 | 79% | 100% | 1,446.3 |
| Showerhead | 2,801 | 204 | 211 | 104% | 95% | 561.5 |
| Programmable Thermostat | 5,475 | 234 | 40 | 17% | 100% | 219.0 |
| Faucet Aerator | 5,028 | 37 | 50 | 133% | 96% | 241.3 |
| Pipe Wrap | 5,068 | 23 | 22 | 95% | 100% | 111.5 |
| Room Air Conditioner | 545 | 273 | 499 | 183% | 100% | 272.0 |
| HVAC Tune-up** | 3,682 | 75 | 154 | 205% | 100% | 567.0 |
| HVAC Charging** | 1,347 | 87 | 382 | 439% | 100% | 514.6 |
| Advanced Power Strip | 108 | 184 | 70 | 38% | 95% | 7.2 |
| **Total** | **86,667** | | | | | **5,080.5** |

***Excluding measure retention (verified and operable).

****Honeywell reported the total number of tune-ups completed on CACs and heat pumps under the CAC Tune-up measure (5,029 reported in the program database). These included units both tuned and charged through the program. The Cadmus team's approach did not break these into two separate measures when completed on the same unit.

## Net Savings

To estimate PY14 net-to-gross (NTG) ratios, the Cadmus team used the following formula:

*NTG = 1 - Freeridership + Participant Spillover + Nonparticipant Spillover + Market Effects*

Unlike other program evaluations, the Low Income Program is not available to the general public, but rather serves an income-qualified population; therefore, nonparticipant spillover is not applicable. Similarly, we did not assess market effects, as marketing for Low Income targets property managers or owners of the units, not income-eligible recipients.

As part of the PY13 evaluation, we completed interviews with a representative sample of participating property managers and determined the program's NTG as 95.8%. This result was consistent with the high NTG levels we determined through the previous two evaluations (PY11 and PY12). Due to the program's consistent NTG findings, we allocated evaluation resources to other elements of our research and used the PY13 NTG value for PY14. As shown in Table 2, applying an overall NTG of 95.8% resulted in total net savings of 4,867.2 MWh for PY14.

**Table 2. PY14 Net Impact Results Summary**

| Program | *Ex Post* Gross Savings (MWh/yr) | Free Ridership | Participant Spillover | Nonparticipant Spillover | Market Effects | NTG Ratio | Net Savings (MWh/yr) |
|---|---|---|---|---|---|---|---|
| Low Income | 5,080.3 | 4.2% | 0% | 0% | 0% | 95.8% | 4,867.2 |

As shown in Table 3, the PY14 Low Income Program realized 107% of its net energy savings target, approved by Missouri Public Service Commission (MPSC), and 139% of its demand reduction goal.

**Table 3. Low Income Program Savings Comparisons**

| Metric | MPSC-Approved Target[1] | *Ex Ante* Gross Savings Utility Reported (Prior to Evaluation)[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) | 4,530 | 6,561 | 5,081 | 4,867 | 107% |
| Demand (kW) | 841 | 650 | 1,216 | 1,167 | 139% |

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

[2] Calculated by applying tracked program activity to TRM savings values.

[3] Calculated by applying tracked program activity and retention rates from tenant surveys 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 the MPSC-approved target and *ex post* net savings determined by EM&V.

## *Key Process Evaluation Findings*

The PY14 program saw the following two major program changes:

- The program's neighborhood sweep portion, targeting single-family properties, was officially cancelled.
- Laclede Gas began funding natural gas-saving measures for units with gas heating or water heating.

The planned "neighborhood sweep" portion of the Low Income Program would have provided single-family residences in neighborhoods defined as low-income with many of the same measures included in

the program's multifamily portion. The single-family component, however, ultimately was canceled due to stakeholder concerns. Cancellation of this component meant that the program had to reduce overall production goals from original expectations. Implementer goals also were reduced, and contractors implementing the measures were put on notice that production would be vastly reduced in PY15. Honeywell worked hard, however, to maintain a full production schedule in PY14, ensuring the installers did not lose their expected revenue in PY14.

Laclede Gas, which serves much of the same territory as Ameren Missouri, began sponsorship of gas-saving measures at the beginning of PY14 and has committed to continue funding through the end of PY15. The addition of Laclede Gas funding helped customers by providing measures that could not have been funded by Ameren Missouri (such as faucet aerators or showerheads for apartments with gas water heat). In addition, it provided the program implementer and installers with an additional source of revenue and helped fill the production and funding gaps left by cancellation of the program's neighborhood sweeps portion.

According to Ameren Missouri and Honeywell program managers, data collection and reporting improved in PY14. While the number of reports required for the program did not decline, the Ameren Missouri data tracking system came online towards the end of PY14 and has helped ease the work necessary to produce reports. Currently, all parties work on defining reporting protocols; so Ameren Missouri and Honeywell have the same program information. In addition, in Fall 2014, Honeywell moved its internal data-tracking system away from the Nextel phone data entry, and all data entry now can be accomplished using computers and tablets.

PY14 saw a significant increase in the number of Low Income Housing Tax Credit (LIHTC) properties participating in the program. This marks a change from PY13, when many representatives of LIHTC properties expressed concerns about being excluded from program participation. In addition, for the first time, several properties participated in the business portion of Ameren Missouri's programs and installed common area lighting they committed to at the beginning of the application process.

## *Key Conclusions and Recommendations*

Based on the impact and process evaluation findings, the Cadmus team presents the following conclusions and recommendations.

**Conclusion 1. Very few tenants use their programmable thermostats in a manner that saves energy.** Installation crews work with families to set programmable thermostats in a manner comfortable for them while saving energy. However, our metering study showed only a few of the households (14%) maintained a thermostat schedule that saved energy. Most tenants set their thermostats on hold, while others sporadically set highly variable temperatures.

> **Recommendation 1. Ameren Missouri could provide more targeted tenant education.** Most tenants with programmable thermostats maintained a temperature around 70 degrees year-round. Tenants who are not elderly could save energy and money by adjusting their thermostat

more regularly and at more efficient temperatures. Tenant education could provide more information, dollar savings expectations, and recommended settings to help encourage tenants set energy-efficient temperatures.

**Recommendation 2. Ameren Missouri could also consider discontinuing the programmable thermostat measure or offering it to targeted households.** Ameren Missouri has determined they will discontinue offering programmable thermostats for the 2016–2018 program filing; given the very low savings, it should consider whether it may be best to discontinue the measure for the 2016 program year. Alternatively, Ameren Missouri and Honeywell could target households that are most engaged in energy-efficiency and have a consistent schedule to provide programmable thermostats.

**Conclusion 2. On average, Low Income households have lower lighting hours of use (HOU) per installed CFL (1.6) than other Ameren Missouri lighting customers. However, CFLs installed in apartments with families had higher HOU at 1.9 hours, while those installed in homes with seniors had much lower HOU at 1 hour.**

**Recommendation 3. Consider only installing CFLs in areas where requested in senior apartments.** The program served a larger number of senior housing complexes earlier in its history. A larger percentage of the housing being served now is for families, and stakeholders expect this trend to continue. When the program serves seniors, it may consider only installing CFLs where residents request them or that seniors indicate are highest use fixtures.

**Conclusion 3. LITHC properties have engaged in the common area lighting measure more than many prior Low Income participating properties.**

**Recommendation 4. Continue to promote the common area lighting measure to property managers.** Since the Low Income Program transitioned to including for-profit management firms in PY14, the program should continue to promote the business rebates. These firms will more likely have access to the resources necessary to undertake common area improvements.

Cadmus also examined the actions taken on the PY13 evaluation's recommendations to track what has and has not been implemented from them. These findings are in Table 4.

**Table 4. PY13 Evaluation Recommendation Tracking**

| PY13 Recommendation | Cadmus Findings | Explanation |
|---|---|---|
| Continue the program's focus on providing high levels of customer service, both to property managers and tenants. | Implemented | Per Ameren, this recommendation will continue to be a focus along with program education in 2015. |

| PY13 Recommendation | Cadmus Findings | Explanation |
|---|---|---|
| Continue offering air conditioner and heat pump tune-ups to all eligible properties. | Implemented | AC and heat pump tune-ups are still offered to eligible properties. The Low Income Program will contact property management participants from pre-PY13 and offer tune-ups and refrigerant charges in 2015. |
| Continue offering the diversity of CFL wattages. | Implemented | Three different wattages (13W, 18W, and 23W) were installed in customer properties during PY14. This recommendation will continue to be a part of program design in 2015. |
| Honeywell and Ameren need to consider methods to increase future program participation. | Implemented | Neighborhood Sweeps was rejected by Stakeholders, but Ameren Missouri was able to increase participation by successfully gaining MoPSC approval to incorporate properties that have >50% of its units federally subsidized. |
| Reduce the reporting requirements for the program overall or prioritize the most important reporting and allow less formal reports on other items. | Not Implemented | The Reporting requirements for MEEIA 1 are quite onerous compared to past requirements but are a result of the current regulatory structure. Honeywell uses an older legacy system that can cause this level of reporting to be tedious for their employees. |
| Honeywell should implement Cadmus' PY12 recommendation to upgrade its data entry systems from the Nextel phone application to a more universal and manageable technology. | Implemented | The Nextel application was phased out and Honeywell updated its data entry system in 2014 with the use of iPad tablets for both direct installation and HVAC tune-up contractors. |
| Ameren should enable greater collaboration between the Low Income Program and the Business Energy Efficiency Program. | Implemented | The Low Income Program informs the property management company of the opportunities to receive incentives for common area upgrades and leaves behind Business Energy Efficiency program brochure. Community Savers forwards to the Business Energy Efficiency program manager contact info for properties completed to aid in marketing Business Energy Efficiency program. The Business Energy Efficiency program sent marketing information to past participants of low income properties to promote participation in the program. |

# Introduction

Ameren Missouri engaged Cadmus and Nexant (the Cadmus team) to perform a process and impact evaluation of the Low Income Program for a three-year period. This annual report covers the impact and process evaluation findings for Program Year 2014 (PY14), the period from January 1, 2014, through December 31, 2014.

## *Program Description*

In PY14, Ameren changed the name of the program from CommunitySavers (used in PY13) to the Low Income Program. Through the Low Income Program, Ameren Missouri delivers cost-effective, energy-efficiency services to low-income residents in single-family homes and multifamily properties having three or more dwelling units.

Honeywell Smart Grid Solutions (Honeywell), the program implementer, contracts the direct installation of all energy-efficiency measures (EEMs) to multiple contractors. The EEMs consist of the following low-cost technologies:

- Lighting (CFLs);
- Insulation of hot water heaters and pipes;
- Showerheads and faucet aerators; and
- Programmable thermostats.

Additionally, the program offers replacements of older appliances—such as refrigerators and air conditioners (both room and through-the-wall units)—with ENERGY STAR® models. In Program Year 2013 (PY13), the program also began offering tune-ups for central air conditioning (CAC) systems, which continued during PY14.

Program participants for multifamily buildings are defined as program-enrolled owners, operators, and managers of income-eligible, multifamily residential properties; these individuals determine whether or not a property participates. Program participants for multifamily buildings must commit to implementing standard lighting installations in property common areas, as applicable through Ameren Missouri's Business or Residential Energy Efficiency Program.

## *Program Implementer and Installers*

Honeywell conducts outreach to identified multifamily buildings that house low-income families. These residences include federally subsidized buildings overseen by agencies such as the U.S. Department of Agriculture (USDA), the U.S. Department of Housing and Urban Development, and local housing authorities. In PY13, Honeywell performed outreach to and secured the participation of some Low Income Housing Tax Credit (LIHTC) properties. In PY14, they continued to secure greater participation of these buildings.

Honeywell subcontracts EEM installation old appliance recycling to several program partners, which also provide in-home education to tenants. Table 5 lists the PY14 program partners.

**Table 5. Low Income Program Installer Partners**

| Installer | Program Role |
|---|---|
| 7 Oaks Home Inspection, LLC | Installs measures on site and delivers energy education to tenants in homes. This company has delivered the program to residents since the program began in 2010. |
| Urban League of Metropolitan St. Louis, Inc. | Installs measures on site and delivers energy education to tenants in homes. This entity began delivering the program to residents in PY13 and completes the majority of projects inside the city of St. Louis. |
| Advantage Air, LLC | Provides CAC tune-ups and charging. In previous years, this company served as an installer, but in PY13 it provided only CAC and heat pump charging and tune-ups. |
| ARCA | Delivers new refrigerators to residents and recycles removed refrigerators. ARCA joined the program in PY14, but has experience running many similar programs around the country. |

Before or during installation, program staff conduct educational meetings with tenants and residents to encourage project acceptance and to provide energy-efficiency education. In large building complexes, Honeywell staff host these meetings.

## *Program Activity*

During PY14, the Low Income Program served 147 properties, resulting in 7,537 tenant units receiving measures and services (such as CAC tune-ups) and installations of 86,667 measures, as shown in Table 6.

**Table 6. PY14 Program Participation**

| Measure | PY14 |
|---|---|
| **EEMs** | |
| 13W CFL Post-EISA* | 51,430 |
| 19W CFL Post-EISA | 5,634 |
| 23W CFL Post-EISA | 3,924 |
| Refrigerator | 1,625 |
| Showerhead | 2,801 |
| Programmable Thermostat | 5,475 |
| Faucet Aerator | 5,028 |
| Pipe Insulation | 5,068 |
| Room Air Conditioner | 30 |
| Through-the-Wall Air Conditioner | 515 |
| CAC Tune-up | 3,682 |
| CAC Charging | 1,347 |
| Advanced Power Strip | 108 |

| Measure | PY14 |
|---|---|
| **Education** | |
| Group Energy Education | 773 |
| In-home Energy Education | 4,322 |

*Energy Independence and Security Act of 2007.

Honeywell reported the total number of tune-ups completed on CACs and heat pumps to be 5,029 (listed as *CAC Tune-up* in the program database). This count included units that the program only tuned, only charged, and both tuned and charged. For the purpose of this evaluation, the Cadmus team separated these into two separate measures (tune-up and charge). When a unit was both tuned and charged, we categorized the unit as a tune-up (as this service is more comprehensive).

# Evaluation Methodology

The Cadmus team identified the following impact and process evaluation priorities in PY14.

## *Impact Evaluation Priorities*

- Determining gross and net energy savings and demand reductions generated by the program;
- Calculating the number of tenants properly using their programmable thermostats through metering data; and
- Determining the hours of use (HOU) for installed CFLs in tenant units via metering data.

## *Process Evaluation Priorities*

- Assessing the success in penetrating the non-governmental multifamily housing market;
- Assessing programmatic changes and the impacts of those changes;
- Assessing achievements against goals;
- Determining the ease of program operations for Ameren Missouri, the implementer, and all subcontractors; and
- Determining the program's ability to generate participation in the commercial program (i.e., common-area improvements), where applicable.

Table 7 lists the evaluation activities and provides a brief explanation of each activity's purpose.

**Table 7.PY14 Process and Impact Evaluation Activities and Rationale**

| Evaluation Activity | Process | Impact | Rationale |
|---|---|---|---|
| Interview Program Managers and Implementers | • | | Obtain an in-depth understanding of the program and identify its successes and challenges. |
| Conduct a Metering Study | | • | Determine daily hours of operation for program CFLs, both for the program overall by room and tenant type (seniors/ families). Monitor programmable thermostat usage. |
| Conduct an Engineering Analysis | | • | Determine gross kWh savings for each measure. |
| Conduct a Cost-Effectiveness Analysis | | • | Measure the program's cost-effectiveness through five standard perspectives. |

## *Program Manager and Implementer Interviews*

Beginning in July 2014, the Cadmus team interviewed the four program stakeholders shown in Table 8. We designed the interviews to accomplish the following: (1) gather information on how the program operates; (2) identify changes or challenges encountered by program staff or implementers; and (3) determine appropriate solutions, as needed. Before conducting the interviews, we prepared an

interview guide, consisting of questions designed to elicit comprehensive information about the program (Appendix B provides a copy of this guide).

**Table 8.Completed Interviews**

| Stakeholder Group | Interviews Conducted |
|---|---|
| Ameren Missouri Program Staff | 1 |
| Honeywell Program Management | 1 |
| Third-Party Installation Subcontractors | 2 |
| **Total** | **4** |

## *Metering Study*

The Cadmus team conducted a metering study to measure lighting HOU temperature settings in units with programmable thermostats, contracting with 7 Oaks to install meters in the summer and fall of 2013 and remove meters in July 2014. We developed a written metering protocol, and Cadmus staff traveled to St. Louis to train 7 Oaks staff and conduct a series of installations. 7 Oaks staff completed an in-unit data collection form for all units where meters were installed, noting the following: the number of residents in a unit; the type of heating and cooling equipment; and the number and position of meters installed. 7 Oaks staff installed metering equipment in 73 participating tenant units, across eight different properties.

The Cadmus team randomly selected units for meter placement during the measure-installation process, and asked 7 Oaks staff to install meters in every fifth, sixth, or seventh unit (depending on the property's size). If a tenant in one unit refused meter installation, the team installed meters in the next available unit. Tenants agreeing to the meter installation received a $50 gift card following the meter installation, and they received $50 gift card via mail two to three weeks after successful meter retrieval.

7 Oaks placed 321 light loggers (up to seven loggers per unit) on program-installed CFLs to measure their hours of operation over the metering period. Loggers tracked the number of hours each day that lights remained turned on. They also simultaneously installed 67 temperature loggers on programmable thermostats to track home temperatures and to determine thermostat-setting behaviors for programmable thermostat users. Placed next to the thermostat, the loggers recorded the home's temperature every hour.

The Cadmus team retrieved logger data after the return of loggers, and uploaded the data into a spreadsheet. Analysis followed data cleaning. The following discussion addresses our methodologies for analyzing the captured data.

### CFL HOU Estimation Methodology

The Cadmus team estimated average daily HOU from meter data collected at participating households.

### *Weighting*

The Cadmus team calculated and applied lamp room weights to the lighting analysis. This important weighting scheme ensured the HOU findings from sampled lamps metered were weighted to represent the population of installed lamps in participating units. The team used the following equation to calculate individual room lamp weights:

$$Lamp\ room\ weight = \frac{\left(\frac{total\ inventoried\ lamps\ by\ room\ type}{total\ inventoried\ lamps\ in\ all\ room\ types}\right)}{\left(\frac{total\ metered\ lamps\ by\ room\ type}{total\ metered\ lamps\ in\ all\ room\ types}\right)}$$

### *Annualization*

Once the Cadmus team verified the raw metering files' quality, we calculated the total time (in seconds) that each logger indicated the lamp was on for each hour and for each day of the metering period. The team then calculated total daily HOU for each logger by summing the time the lamp remained on across each hour of each day. The team merged this dataset with records containing information collected by field technicians regarding household demographics and room types.

As the metering period did not span the entire year for some loggers, the team estimated an annual average HOU for all lamps, fitting the data to a fixed-effects (for each logger) sinusoidal curve that represented changes in hours of available daylight per day.[1] Using the following equation, the team calculated separate intercepts and amplitudes for each room type and robust clustered standard errors:

$$Hours\ of\ Use_{it} = \alpha_1 \ldots \alpha_i + \beta_j * Room\ type * Sin\left(-2\pi\left(\frac{284 + Day_t}{365}\right)\right) + \varepsilon_{it}$$

Where:

Hours of $Use_{it}$ = HOU for each day of the year ($t$) for each logger ($i$)

$\alpha$ = Average daily HOU for each logger

$\beta_j$ = Amplitude of sinusoid function for each room type (slope coefficient of the regression)

Room type = Room type of each logger, as recorded by field technicians

Day = Day of the year, where January 1 has a value of 1 and December 31 has a value of 365

$\varepsilon_{it}$ = Error term of the regression

The team calculated the overall HOU by taking the weighted mean of predicted HOU. We present these results in the Section: Gross Impact Evaluation Results, beginning on page 24.

[1] Page 15 of the Uniform Methods Protocol for lighting impact evaluations recommends using the sinusoidal annualization approach due to the strong relationship between daylight hours and lighting usage observed in a large number of studies. Available online at: http://www1.eere.energy.gov/wip/pdfs/53827-6.pdf

### Programmed Temperature Estimation Methodology

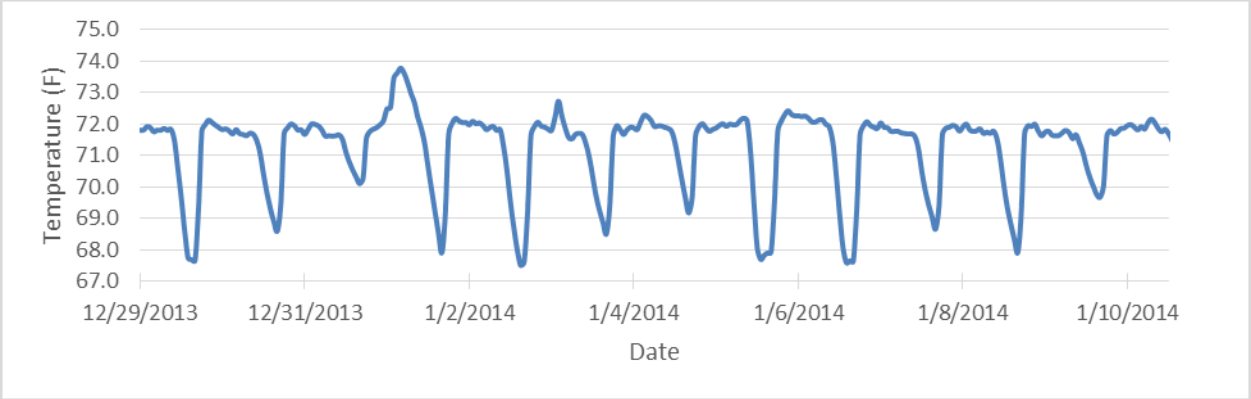
The Cadmus team assessed programmable thermostat usage for the 67 participants using temperature loggers. We assessed thermostat operations during the cooling season separately from operations during the heating season, as in case some households operate thermostats differently in summer than in winter. Further, we defined the heating season as November through March and the cooling season as June through September.

After compiling and cleaning all data retrieved from installed meters, our final data sample included 38 thermostats operating during the cooling season and 61 operating during the heating season.

We evaluated each meter individually, using two different techniques to identify whether the thermostat operated in a programmatic and energy efficient manner.

- **Visual Inspection.** First, using an Excel function, we plotted the hourly indoor air temperature for each meter across the course of the metering period, as shown in Figure 1.

**Figure 1. Example Thermostat: Programmed**




Using the temperature graph for each individual unit, we visually assessed whether the metering data indicated that residents used the thermostat's programmatic features to set temperatures in the home in a manner that saved energy. We considered energy-saving settings as those showing some regular increase (in summer) or decrease (in winter) in temperatures of at least two degrees at some point during most days. Based on this visual assessment, we categorized each thermostat as programmed or not programmed for the heating season and (separately) for the cooling season.

- **Formulaic Evaluation.** Second, Cadmus used the formulaic approach described below to characterize each thermostat as programmed or not programmed for both the heating season and the cooling season.
  1. We calculated an "average day" for each meter and each season, where each hour represented the average indoor air temperature during that hour throughout the season. If less than a two-degree difference occurred between the maximum and minimum temperature in the average day, we classified the thermostat as "Not Programmed."

2. We computed the minimum (in the cooling season) or maximum (in the heating season) temperature for the average day for each meter and compared this to the daytime hours of the "average day." The team defined the daytime hours as 10:00 a.m. through 4:00 p.m. If the minimum (in the cooling season) or the maximum (in the heating season) temperature fell within these daytime hours, we deemed the thermostat operated inefficiently, and designated it "Not Programmed." If the minimum or maximum temperature fell outside of the daytime hours, we designated the thermostat as "Programmed."

Through our formulaic evaluation and visual inspection, we produced similar results for each apartment. For thermostats where the two methods produced conflicting results (e.g., visual inspection indicated not programmed while formulaic evaluation indicated programmed), we performed a secondary review of the thermostat settings, examining, in detail hourly temperatures collected through the meter over the course of the metering period. The secondary review overturned the formulaic evaluation results only on one occasion.

Figure 1 (above) and Figure 2 show two different types of meter operations. Figure 1 shows a meter operated programmatically. It indicates steady and regular patterns of high and low temperatures, with temperatures varying on most days by 4 degrees (data shown are for the heating season).

Figure 2 shows temperature set points for a programmable thermostat that a Low Income participant did not operate in an energy-saving manner (Not Programmed). This programmable thermostat operated largely at a single set point, with intermittent periods showing sporadic temperature swings.

**Figure 2. Example Thermostat: Not Programmed**


## *Engineering Analysis*

To estimate per-unit, *ex post,* gross savings for each Low Income measure, the Cadmus team utilized engineering algorithms and assumptions along with all Ameren Missouri- and program-specific inputs available. These algorithms yielded estimates of the difference between energy usage of the installed product and energy usage of the replaced measure.

The Gross Impact Evaluation Section provides every algorithm and input assumption used (as originally provided in the Low Income Program evaluation plan).

## Cost-Effectiveness Analysis

Using the final PY14 Low Income Program participation data, implementation data, the *ex post* gross savings estimates, and the *ex post* net savings estimates (presented in this report) with the DSMore tool, Morgan Marketing Partners (MMP) determined the program's cost-effectiveness. MMP also calculated measure-specific cost-effectiveness (shown in the Cost-Effectiveness chapter) using the five standard perspectives produced by DSMore:

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

## Impact CSR

According to the Missouri Code of State Regulations (CSR), 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 demand-side program satisfy the requirements noted in Table 9. The table indicates the data our team used to satisfy these impact CSR evaluation requirements for the Low Income Program. We provide a summary of the process CSR requirements in Table 10 at the end of the Process Evaluation section

**Table 9. 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) 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 and hourly thermostat usage in a sample of program properties during 2013-2014. |
| Building and equipment simulation models | | |
| Survey responses | | |
| **Audit and survey data on:** | | |
| Equipment type/size efficiency | x | Evaluation team gathered equipment information from homes participating in metering, and from program data. |
| Household or business characteristics | x | Evaluation team collected household characteristics from homes participating in metering, and from program data. |
| Energy-related building characteristics | | |

## Process Evaluation Findings

The Cadmus team limited process evaluation data collection activities in PY14 to stakeholder interviews with four staff: Ameren Missouri's program implementation manager, Honeywell's program manager, and two program subcontractors.

We did not complete property manager or tenant surveys in PY14 as our previous four evaluation cycles produced very similar conclusions every year: property managers and tenants highly rated the program and the measures, and freeridership remained low. This decision allowed us to focus evaluation resources on other evaluation priorities: those programs and measures with greater uncertainty associated with them.

### *Program Design and Implementation*

The Low Income Program achieves energy savings and demand reductions through the direct installation of cost-effective EEMs in the tenant units of low-income housing within Ameren Missouri's service territory. Ameren Missouri subsidizes all measures installed through the program, providing them at no cost to tenants and property managers.

In PY14, the program experienced several key design changes.

First, while the set of eligible program measures remained largely unchanged from last year, Ameren Missouri eliminated the advanced power strip measure due to low evaluated energy savings in PY13.

Second, as Ameren Missouri could not convince statewide stakeholders to support expansion of the Low Income Program to single-family, low-income neighborhoods, that portion of the program was canceled. To accommodate this, Ameren Missouri reduced the Low Income overall program goals for the remainder of the PY13–PY15 contract. Honeywell worked with its subcontractors to engage them as expected with jobs for 2014, but plans to slow production by about half in PY15 in accordance with the reduced goals. When asked about this eventuality, program subcontractors expressed concerns about maintaining the same staff levels in their organizations.

Third, the program experienced a program expansion in 2014: Laclede Gas, which shares a fair amount of customer territory with Ameren Missouri, joined as a program sponsor. Laclede Gas committed to co-sponsoring gas-saving measures, such as showerheads, faucet aerators, and programmable thermostats, through the end of 2015. This addition has succeeded by accomplishing the following:

- Providing all program implementation staff with additional work and revenue;
- Ensuring tenants received electric and natural gas savings;
- Increasing the cost-effectiveness of programmable thermostats in gas-heated units; and
- Providing seamless program outreach and services to property managers, while offering a more comprehensive set of measures.

All stakeholders reported that the addition of Laclede Gas to the program has been an easy transition, only requiring some revision of program materials to incorporate the Laclede Gas logo and updating the program databases to include gas savings. Laclede Gas also uses more minimal reporting requirements, which makes it easy for Honeywell and the subcontractors to meet its needs with reporting tools they currently use.

## *Marketing and Outreach*

The Low Income Program differs from other Ameren Missouri Act On Energy programs as it targets eligible property managers rather than Ameren Missouri's residential customers. Therefore, it does not use typical marketing tools, such as direct mail, bill inserts, radio or television advertising, billboards, or point-of-purchase signage. Honeywell, after managing this program for a number of years, has gained ground in the low-income housing community. Honeywell reports word-of-mouth program promotion between different housing complexes and housing associations has helped bring in new properties.

In past years, Ameren Missouri and Honeywell solicited program participation from avenues such as USDA low-income properties and local housing authorities, where all residents are low-income. In PY13, the companies began outreach to property management companies with Low-Income Housing Tax Credit (LIHTC) properties in their portfolios. For these properties to qualify for program participation, at least 50% of resident households had to be considered low-income. Although some LIHTC properties proved reluctant to participate in PY13 due to a Missouri state law forbidding the properties from accepting public funds, this issue resolved in PY14, and a number of these properties participated.

While the program requires participating properties to commit to participate in Ameren Missouri's Business or Residential Rebate program for common area lighting, many properties served have not had the means or desire to participate in this portion of Ameren Missouri's offerings. In PY13, stakeholders expected the for-profit property management firms in the program (LIHTC properties) would be more able and likely to participate in the common-area lighting program. During PY14, this proved true, with several properties engaging in Ameren Missouri's Business program offerings and installing common area lighting.

### Application Forms

Once Honeywell identifies eligible properties and their managers/owners agree to participate, these property managers/owners must complete enrollment paperwork, which includes providing existing refrigerator specifications for all units. Honeywell staff reported that procuring this information from some property managers continued to be a challenge. At times, Honeywell returned to properties after initial visits to gather the information themselves, avoiding delays in the application process.

### Tenant Notification, Signage, and Education

Property management staff notify tenants—the ultimate recipient of Low Income Program services—of program delivery in their buildings. Tenants receive information about the program through door

hangers, window clings, and signage.[2] Honeywell also sends a letter to all tenants in advance of installation work, informing them of work to be completed. This letter includes a refrigerator magnet with tips on behavioral changes that can help the tenant save additional energy.

At large properties, Honeywell or subcontractor staff sometimes conduct information sessions to provide tenants with an overview of work occurring in their units. However, these sessions have been so sparsely attended in the past that the program relies more on tenant letters sent by Honeywell and on property managers advising tenants of the program and its work.

Installation contractors provide individual education in tenant units during installation. At least 85% of tenants receive energy education through the program, with installers sometimes returning several times to a property to provide education to tenants who were not at home during the installation process.

The education materials (attached as Appendix C) mostly focus on measure acceptance and proper measure usage. The installers indicate some tenants engage in the education and become interested in learning about new measures in their homes, while others express disinterest. The Cadmus team examined program materials and determined these covered measure specifics and usage well, but less-effectively address opportunities for households to achieve additional savings through behavioral changes.

## *Contractor Training and Participation*

In PY14, the program used the same direct-install subcontractors as in previous years. 7 Oaks Home Inspection has participated in the program since PY10 and the Urban League of Metropolitan St. Louis has participated since PY13. These two organizations directly install small measures and programmable thermostats and replace room or through-the-wall air conditioners.

Two other subcontractors support program implementation. In PY14, the refrigerator replacement and decommissioning subcontractor changed from Whirlpool/JB Hunt to ARCA, Inc., after an open bid process. Advantage Air continues to conduct air conditioner tune-ups and charging for a second year.

Honeywell conducts quarterly meetings with all program subcontractors and offers program assistance and *ad hoc* training on a regular basis through calls, e-mails, or on-site work. Subcontractors interviewed indicated very minimal need for training, as most already were familiar with their roles and responsibilities. All interviewed subcontractors indicated that Honeywell staff remained available as needed for questions, assistance, or additional training.

[2] The program's PY13 Report: *Ameren Missouri CommunitySavers Impact and Process Evaluation: Program Year 2013* provides examples of the signage.

## Measures and Installation

For future years, interviewed program staff suggested adding the following to the program:

- Insulation measures, especially attic insulation in multifamily buildings with electric heating and cooling;
- Some small air-sealing measures, such as caulking or window repairs;
- CAC repairs identified during cleaning and tuning; and
- LED lighting, especially in outdoor fixtures known to remain on continuously.

We asked program staff to share any particular challenges they encountered with measure installations. As in PY13, Advantage Air staff indicated that some CACs were often poorly maintained and required extensive tune-up work. Other program staff indicated that aerators could be impossible to safely install due to rusted or corroded pipes.

Interviewed stakeholders also noted tenants or property managers sometimes expressed concerns about particular measures or refused to install them. Program staff indicated that at almost every property, someone became very concerned about CFL mercury content. In addition, many people reportedly refused to allow CFL installations in their reading lamps due to concerns about poor lighting. Senior citizens and property managers of complexes housing seniors also expressed concerns about programmable thermostats and the ability of tenants to properly use them.

Property managers and tenants also expressed interest in or appreciation of certain measures. According to program staff, many property managers and property maintenance staff greatly appreciated CAC cleaning and tune-ups. Advantage Air staff notified property managers of any repair or maintenance issues to be addressed for each unit, which helped maintenance staff address issues before outages during extreme weather. In addition, tenants reportedly expressed a great deal of excitement about new refrigerators and the room air conditioners.

In a noted improvement since PY13, property managers and maintenance personnel became more readily available when Advantage Air staff arrived to conduct CAC cleaning and tune-ups. As this activity generally must be conducted between five to seven days after the direct-install measures, it has been somewhat overlooked by property manager and maintenance staff. Advantage Air staff indicated communications between the property managers and the program seemed to have improved over the last year, and Advantage staff rarely were left waiting before beginning services.

## Quality Assurance

The quality assurance process primarily seeks to verify measure installations, ensure proper protocols are followed, and conform quality work performance in customer units. Ameren Missouri requires Honeywell to conduct a follow-up inspection at 5% of units.

Honeywell reported exceeding that goal and said it generally checked some installations at almost all participating properties. (Some subcontractors also sent a project manager back to check after

installations at a property.) In addition, the Ameren Missouri project manager occasionally accompanied Honeywell on some quality assurance inspections. The installers and Honeywell remained available for callbacks if measure installations did not pass inspection or if property managers called with problems.

## Data Collection and Reporting

According to Honeywell and subcontractor staff, collecting and reporting data continued to be challenging in PY14. Early in the year, as Ameren Missouri rolled out a new database to track its energy-efficiency programs, Honeywell staff had to track data in both the Honeywell system and the new Ameren Missouri system. In another change, the Laclede Gas addition to the program required updating measure costs and savings. Staff reported it took a long time to get the new Ameren Missouri database up and running and to generate accurate reports. During the first part of the year, Honeywell updated and corrected reports outside of the system to account for small changes or anomalies. By the end of the year, the new database system worked better for both parties, but Honeywell and Ameren Missouri currently are reviewing the reporting logic to make sure they work from the same program information.

The installation subcontractors said reporting continued to be a challenge in PY14, although some improvements occurred. They all stated that the program required a great deal of data collection, which could be challenging to complete and sometimes required additional staff solely dedicated to data entry.

However, there were some positive developments in PY14. Advantage Air was pleased to report a steep reduction in the amount of data it had to report for each CAC cleaning and tune-up. In addition, Honeywell no longer required the Urban League and 7 Oaks to use Nextel phones as a primary database input. Subcontractors used the phones through the first half of PY14 and reported repeated failures from phones dropping connections, difficulties in entering data correctly, and having to double-check or reenter data manually back in the office. All subcontractors also said reporting required for the program's Laclede Gas portion proved very easy and did not introduce an additional burden on program staff.

## Communications

Communication among program staff again succeeded for the Low Income Program in PY14. Stakeholders reported easy, consistent communications regarding all program delivery aspects. Ameren Missouri and Honeywell spoke at least weekly and conducted regularly scheduled meetings to ensure the program remained on track to meet its goals and to discuss any issues that emerged. Honeywell and the subcontractors also communicated regularly, and all subcontractors found Honeywell easy to contact and responsive to concerns or issues they raised. As in past years, all subcontractors praised Honeywell staff in PY14 and said they enjoyed the opportunity to work with them.

## CSR Summary

As previously mentioned, the Missouri CSR requires that 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. Process evaluations must address, at a minimum, the five questions listed in Table 10. The table provides a summary response for each specified CSR process requirement, taken from both this year's evaluation and the prior year. We previously offered a summary of the data used to meet with impact CSR requirements in Table 9.

Table 10. 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 primary market imperfections include: split incentives between property managers and tenants; and the work required by the property manager/maintenance staff to facilitate installations. |
| 2 | Is the target market segment appropriately defined, or should it be further subdivided or merged with other market segments? | The low-income, multifamily market could be merged with a low-income, single-family market; however, this concept has been suspended because of stakeholder concerns. |
| 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? | The mix of measures provides cost-effective electric savings in multifamily buildings housing low-income residents. Current measures address lighting, water heating, appliances, and heating, and cooling. In PY13 and early PY14, Advanced Power Strips were distributed through the program to address electronics usage. However, this measure was discontinued because of low evaluated savings. Additional measures are supplied beginning this program year for households with natural gas heating or water heating. Program stakeholders have also suggested including air-sealing measures and LEDs. |
| 4 | Are the communication channels and delivery mechanisms appropriate for the target market segment? | The communication channels for the target market include direct contact with property managers by Honeywell staff. Communication with tenants is handled by property managers, through workshops with Honeywell staff, and directly with installation contractors in apartments. The delivery mechanism is direct installation, performed by program subcontractors. The communication and delivery mechanism are necessarily direct and hands-on as both the tenant and property managers are considered a hard-to-reach population and have split incentives. |
| 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? | The Low Income Program design and implementation has had great success for several years, with high levels of participation and tenant acceptance of new measures. Many federally-subsidized properties have been treated, and LIHTC properties are generating additional participation. It is likely that most multifamily properties with at least 50% low-income residents will be treated in the next few years. It may behoove the program to consider drawing in some market rate properties under different cost-effectiveness criteria. |

# Gross Impact Evaluation Results

The Cadmus team estimated PY14 per-unit *ex post* gross energy savings for the Low Income Program using program data, secondary sources, and data and analysis leveraged from concurrent Cadmus evaluation activities for the Lighting, Appliance Recycling, and Home Energy Analysis programs. This section of the report details each measure's per-unit savings calculations and installation rates.

## Measure Installation Verification

Measure retention rates for PY14 relied on PY13 tenant surveys. As shown in Table 11, last year the Cadmus team verified that the majority of program measures remained installed and continued to operate.

**Table 11. Measure Verification and Retention**

| Measure | PY14 Installations | Percentage Verified and Operable |
|---|---|---|
| CFL - 13W | 51,430 | 95.7% |
| CFL - 19W | 5,634 | |
| CFL - 23W | 3,924 | |
| Refrigerator | 1,625 | 100% |
| Showerhead | 2,801 | 94.5% |
| Programmable Thermostat | 5,475 | 100% |
| Faucet Aerator | 5,028 | 96.2% |
| Pipe Wrap | 5,068 | 100% |
| Room Air Conditioner | 545 | 100% |
| CAC Tune-up | 3,682 | 100% |
| CAC Charging | 1,347 | 100% |
| Advanced Power Strip | 108 | 94.7% |

## Measure-Specific Gross Savings

Engineers on the Cadmus team developed measure-specific savings algorithms for all program measures in the Low Income Program PY13-PY15 evaluation plan. This section discusses these algorithms and specifies energy savings determined for each measure.

### CFLs

The program installed CFLs in lamps and light fixtures of participating residences.[3] Program-installed CFL bulbs included: 13W, 19W, and 23W. The Cadmus team estimated CFL savings using the following algorithm:

[3] Replacements did not include specialty bulbs.

$$Savings = \frac{(WattINC - WattCFL) \times Hours \times Days}{1{,}000} \times WHF$$

Where:

WattINC = The wattage of the original incandescent bulb replaced by a Low Income Program CFL.

WattCFL = The wattage of the CFL installed by the Low Income Program.

Hours = The average HOU per day.

Days = The days used per year.

1,000 = The conversion factor between Wh and kWh (Wh/kWh).

WHF = The waste heat factor to account for interactive effects.

Two inputs used to calculate CFL savings changed in PY14—lighting HOU (updated based on the metering study) and the baseline wattage for 13 and 14W CFLs (updated based on the 2014 Baseline Wattage Shelf Survey conducted as part of the Lighting evaluation).

### HOU Results

Cadmus analyzed the CFL HOU metering results by room type (as detailed in the methodology section) and by type of residents. As shown in Table 12, the Cadmus team determined separate HOU averages for those Low Income units occupied by seniors and those occupied by families. Specifically, we determined program CFLs installed in seniors' homes operated an average of 1.0 hour per day. Unsurprisingly, we found CFLs installed in homes occupied by families operated, on average, longer: 1.9 hours per day. The table also contains 90% confidence intervals and the precision associated with our metering sample.

**Table 12. Participant-Specific Metering Study Results**

| Participant Type | Meters | HOU | Lower 90% CI | Upper 90%CI | Precision |
|---|---|---|---|---|---|
| Seniors | 135 | 1.0 | 0.8 | 1.3 | 25% |
| Families | 146 | 1.9 | 1.5 | 2.3 | 21% |

To calculate the average program HOU, we weighted the participant type-specific results shown in Table 13 to reflect the mix of CFLs installed in homes of seniors (29%) and families (71%) participating in the PY14 program. This process resulted in a program average of 1.6 hours per day. Similarly to the preceding table, we provide confidence intervals and precision estimates for the overall HOU (calculated through a bootstrapping process).

Table 13. HOU Results Overall and by Demographics

| | % of PY14 CFL Installations | HOU | Lower 90% CI | Upper 90%CI | Precision |
|---|---|---|---|---|---|
| Seniors | 29% | 1 | 0.8 | 1.3 | 25% |
| Families | 71% | 1.9 | 1.5 | 2.3 | 21% |
| Overall | 100% | 1.6 | 1.3 | 2.0 | 21% |

## 2014 Baseline Wattage Shelf Survey Results

For the Lighting Program evaluation, the Cadmus team calculated a wattage baseline for program bulb types based on the prevalence of incandescent bulbs in stores where programs bulbs were sold. The baseline is a weighted average of sales of program bulbs in stores that did stock lumen-equivalent incandescents, versus sales in stores that did not, assessed quarterly over PY14 (see the PY14 Lighting evaluation for more detail). The Cadmus team used this data to establish a baseline for the bulbs used in non-lighting programs as well.[4] Although Low Income bulbs were not distributed through the upstream channels as Lighting Program bulbs were, we adopted the Lighting Program baseline as the best representation of the likely substitute had the Low Income bulbs not been available.

Table 14 shows the updated PY14 inputs for the CFL algorithm.

Table 14. CFL Engineering Algorithm Inputs

| Term | Value | Source |
|---|---|---|
| WattsINC (60W) | 53.8 | 2014 Baseline Wattage Shelf Survey |
| WattsINC (75W) | 56.1 | 2014 Baseline Wattage Shelf Survey |
| WattsINC (100W) | 74.2 | Post-EISA baseline wattage |
| WattsCFL (13 W) | 13.9 | PY14 Low Income Program Data |
| WattsCFL(19 W) | 19 | Program Wattage |
| WattsCFL (23 W) | 23 | Program Wattage |
| Hours | 1.6 | PY14 Low Income Program Metering Study |
| Days | 365 | Conversion Factor (day/yr) |
| WHF | 0.83 | PY13 Low Income Program Data |

Using the engineering algorithms, calculations, and inputs, we estimated *ex post* energy savings for each wattage of CFL listed in Table 15. Two important downward adjustments drove the variation in *ex ante*

[4] The baselines values used for the Lighting Program differ slightly from those used for the other programs. Lighting Program bulb types are actually categories that include several bulb models of similar lumens but different wattages. For example, the "13W CFL bulb" in the Lighting Program includes bulbs with wattages ranging from 9 to 17, and baselines based on lumen-equivalencies ranging from 40W to 60W incandescents (or 29to 45 W halogens). The Lighting Program baseline values are therefore a weighted average of individual bulb baselines as well as a sales weighted average of incandescent versus halogen alternatives.

and *ex post* estimates: adjusting the baseline due to post-EISA wattages determined by the shelf survey; and lowering the HOU compared to the TRM assumptions. Due to these factors, these PY14 *ex post* savings were roughly one-half of those from PY13.

**Table 15. CFLs: *Ex Ante* and *Ex Post* Comparison**

| Measure | *Ex Ante* | *Ex Post* | Realization Rate |
|---|---|---|---|
| CFL - 13W | 31.5 | 19.3 | 61% |
| CFL - 19W | 37.4 | 18.0 | 48% |
| CFL - 23W | 51.2 | 24.8 | 48% |

## Refrigerators

Under the program, Whirlpool replaced all refrigerators manufactured before 2000. These new, ENERGY STAR-qualified, replacement refrigerators varied in capacity (e.g., 12, 15, 18, and 21 cubic feet), and the capacity of the existing unit determined the size of the replacement.

Similarly to past years, we leveraged the concurrent Appliance Recycling evaluation information to estimate the energy use of existing refrigerators. This methodology, which the Appliance Recycling report describes in detail, drew upon multiple metering studies and on a replaced refrigerator's age, size, configuration, and location within the home.

For the Low Income Program, we determined the energy use of the new unit using a weighted average of ENERGY STAR-based energy consumption by refrigerator size and configuration. We estimated refrigerator savings using the following algorithm:

$$Savings = EnergyUse_{EXISTING} - EnergyUse_{NEW}$$

Where:

$EnergyUse_{Existing}$ = The use of the replaced refrigerator.

$EnergyUse_{New}$ = The use of the new ENERGY STAR refrigerator.

Unlike Appliance Recycling—where gross savings equaled consumption of the replaced appliances, the Low Income refrigerator savings equaled the difference in consumption between existing units and new units. This resulted from the Low Income Program' direct-install program design prohibiting refrigerators recycled through the Low Income Program from being relocated for continued use. Table 16 lists the value and source used for each refrigerator algorithm input.

**Table 16. Refrigerator Savings Assumptions**

| Input | Value | Source |
|---|---|---|
| $EnergyUse_{Existing}$ | 1,256 | Calculated |
| $EnergyUse_{New}$ | 366 | PY14 Program Data and ENERGY STAR |

Using these engineering algorithms and inputs, we estimated *ex post* energy savings of 890 kWh/year for each refrigerator, which is very similar to 906 kWh/year from PY13. This rate fell below the program's *ex ante* value (1,126 kWh), which was based on the PY10 Multifamily Income Qualified evaluation.

**Table 17. Refrigerators: *Ex Ante* and *Ex Post* Comparison**

| *Ex Ante* | *Ex Post* | Realization Rate |
|---|---|---|
| 1,126 kWh/year | 890 kWh/year | 79% |

### Showerheads

The program installed two types of showerheads (handheld and fixed units), replacing equivalent units. Both showerheads produced a rated flow of 2.0 gallons per minute (GPM). The Cadmus team estimated showerhead savings using the following algorithm:

$$Savings = \frac{People \times ShowerTime \times Days \times \%Days \times GPM \times (T_{SHOWER} - T_{IN}) \times C_P \times Den}{3{,}413 \times RE \times Number of Showerheads}$$

Where:

People = The number of people taking showers (ppl/household).

Shower Time = The average shower length (min/shower).

Days = The number of days per year (day/yr).

%Days = The number of showers taken per person, per day.

ΔGPM = The difference in GPM for the base showerhead and the new showerhead (gal/min).

$T_{SHOWER}$ = The average water temperature at the showerhead (°F).

$T_{IN}$ = The average inlet water temperature (°F).

CP = The specific water heat (BTU/lb-°F).

Den = The water density (lb/gal).

3,413 = The conversion rate between BTU and kWh (BTU/kWh).

RE = Recovery efficiency of the electric hot water heater.

Number of Showerheads = The number of showerheads installed per home.

Table 18 lists the values and sources used for each showerhead algorithm input. Using these engineering algorithm and inputs, we estimated *ex post* energy savings of 211 kWh/year for each showerhead installed by the Low Income Program and retained by a participating resident—a rate slightly higher than the program's *ex ante* value (204 kWh).

Table 18. Showerheads: Engineering Algorithm Inputs

| Term | Value | Source |
|---|---|---|
| People | 2.1 | PY14 Low Income Program Data |
| Shower Time | 8.66 | Secondary Source* |
| Days | 365 | Conversion Factor (day/yr) |
| %Days | 0.66 | Secondary Source* |
| ΔGPM | 0.49 | PY14 Low Income Program Data |
| $T_{SHOWER}$ | 105 | Secondary Source** |
| $T_{IN}$ | 61.3 | Ameren Missouri TRM |
| RE | 0.98 | PY11 Low Income Site Visits |
| CP | 1 | Constant (BTU/lb-oF) |
| Den | 8.33 | Constant (lb/gal) |
| 3,413 | 3413 | Conversion Factor (BTU/kWh) |
| Number of Showerheads | 1.09 | PY14 Low Income Program Data |

*DeOreo, William, P. Mayer, L. Martien, M. Hayden, A. Funk, M. Kramer-Duffield, and R. Davis (2011). "California Single-Family Water Use Efficiency Study."

**The Bonneville Power Administration measured average shower temperatures as 104–106°F.

The disparity in *ex ante* and *ex post* estimates resulted from program and secondary data. Provided program data indicated an actual change in GPM of 0.5, not 0.75. Also an average of 1.09 showerheads were installed in each home (rather than 1.0) as some units had multiple bathrooms with showers. In addition, our research indicated most residents did not shower in the home every day. Therefore, the percentage of shower days dropped from 100% to 66%. Counteracting those factors (which decreased program savings) was the increase in the number of occupants per apartment, which rose to 2.1 in PY14 from 1.9 in PY13. The 211 kWh/year for PY14 is slightly higher than the 184 kWh/year *ex post* savings from PY13.

Table 19. Showerheads: *Ex Ante* and *Ex Post* Comparison

| *Ex Ante* | *Ex Post* | Realization Rate |
|---|---|---|
| 204 kWh/year | 211 kWh/year | 104% |

## Programmable Thermostats

Programmable thermostats can generate savings when programmed to reduce heating temperatures and increase cooling temperatures at certain times of day, generally when the apartment remains unoccupied. Low Income Program installation staff installed and programmed thermostats in tenant homes.

Thermostat savings depended on several variables: (1) the type of heating and cooling equipment in the unit; (2) the square footage of space heated and cooled; and (3) the rate at which tenants used their

thermostat correctly. (That is, the rate at which tenants allowed the programmed thermostat to control the temperature of the unit, without frequent manual adjustments.)[5]

We used the MML database savings estimates—specific for heating equipment types and home vintages—to calculate savings for the programmable thermostats. Table 20 lists data used in our analysis.

**Table 20. Low Income Program MML kWh Value**

| System Type | Vintage | MML Database kWh (per 1,000 sq ft) | PY14 HVAC System Weighting | Vintage Weighting | Square Footage Conversion | kWh |
|---|---|---|---|---|---|---|
| CAC with Gas Furnace | Average | 107 | 42% | 33% | 84% | 12.5 |
| | New | 88 | 42% | 33% | 84% | 10.2 |
| | Old | 115 | 42% | 33% | 84% | 13.4 |
| CAC with Electric Furnace | Average | 632 | 44% | 33% | 84% | 19.3 |
| | New | 483 | 44% | 33% | 84% | 14.7 |
| | Old | 671 | 44% | 33% | 84% | 20.5 |
| PTAC | Average | 523 | 4% | 33% | 84% | 63.8 |
| | New | 269 | 4% | 33% | 84% | 32.8 |
| | Old | 719 | 4% | 33% | 84% | 87.7 |
| Central Air Source Heat Pump | Average | 345 | 11% | 33% | 84% | 3.8 |
| | New | 269 | 11% | 33% | 84% | 3.0 |
| | Old | 368 | 11% | 33% | 84% | 4.1 |
| **Total (PY14)** | | | | | | **285.7** |

To determine how participants used their thermostats, the Cadmus team leveraged temperature meter data collected through the PY13/PY14 metering effort. At hourly intervals, these meters logged temperatures of participating apartments.

### *Metering Results*

The Cadmus team used metering data to calculate the percentage of Low Income Program participants who used their programmable thermostats in an energy-saving manner. Due to the variance in installation and removal dates, we evaluated each meter individually (see Methodology Section for additional detail).

We found only nine thermostats of 67 metered thermostats programmed in the heating season, in the cooling season, or both (year-round). As the sample size varied from season to season, we evaluated the

[5] Detailed information on these topics is provided in the memo to Ameren: *Programmable Thermostats Methodology and PY13 Savings Estimates*. January 16, 2014.

efficient use percentage for each season. Table 21 shows the heating season results, and Table 22 shows the cooling season results.

**Table 21. Heating Season Programming Assignments**

| Heating Season Programming Assignments | Number of Participants | Percent of Active Loggers |
|---|---|---|
| Programmed | 8 | 13% |
| Not Programmed | 53 | 87% |
| Not Enough Data | 4 | |

**Table 22. Cooling Season Programming Assignments**

| Cooling Season Programming Assignments | Number of Participants | Percent of Active Loggers |
|---|---|---|
| Programmed | 7 | 18% |
| Not Programmed | 31 | 82% |
| Not Enough Data | 27 | |

During the cooling season, 18% of eligible meters exhibited energy-efficient programmatic behaviors. During the heating season, 13% of the eligible meters exhibited energy-efficient programmatic behaviors. The Cadmus team estimated a yearly efficient-use factor by weighting the heating season and cooling season efficient-use percentages by the ratio of heating degree days (HDD) to cooling degree days (CDD) in Missouri. A heating-dominant state, Missouri has roughly four times as many HDD as CDD. Table 23 shows the degree day breakdown.

**Table 23. Breakdown of Degree Days in Missouri**

| Type of Degree Day | Number of Degree Days | Percent of Degree Days | Efficient Use Percentage |
|---|---|---|---|
| HDD | 5,329 | 80% | 13% |
| CDD | 1,295 | 20% | 18% |
| **Overall** | **6,624** | **100%** | **14%** |

The 14% overall yearly efficient-use factor is the weighted product of the number of loggers active in a given season and the percent of degree days in that season. Given Missouri's status as a heating-dominant state, the overall efficient-use factor was much closer to the efficient-use factor in the heating season.

Program participants fall into two main household types, seniors and families. The Cadmus team investigated if there were any differences between the household types in terms of efficient use of programmed thermostats. There was not a strong difference found, and the difference in effective use of thermostats by senior and family household types is shown in Table 24.

**Table 24. Efficient Use by Demographics**

| Demographic Type | Efficient Use Percentage |
|---|---|

| | |
|---|---|
| Seniors | 15.8% |
| Families | 13.0% |
| **Overall** | **14.2%** |

We used analysis results to make behavioral adjustments to savings values in the MML database, (i.e., 285.7 x 0.14 = 40 kWh/year), as shown in Table 25.

**Table 25. Programmable Thermostat: *Ex Ante* and *Ex Post* Comparison**

| *Ex Ante* | *Ex Post* | Realization Rate |
|---|---|---|
| 234 kWh/year | 40 kWh/year | 17% |

These *ex ante* savings drew upon original implementer estimates (assumed in PY10). Ex-post savings were lower due to the average square footage of apartments below 1,000 square feet, as originally assumed by the MML. In addition, the assumed proportions of heating and cooling system combinations in the TRM differed from the program in PY14 (and in PY13). Most critically, the MML assumed all participants with programmable thermostats (i.e., programmed by installer staff) would use the programming, but our metering-based evaluation results produced a much lower number (only 14%). This was also the most significant factor in the variance between PY14 and PY13 *ex post* savings (166 kWh).

### Faucet Aerators

The program installed two types of faucet aerators (fixed and swivel). These high-efficiency aerators (with a flow rate of 1.5 GPM) replaced older units of equivalent types. Most apartments received two faucet aerators: one for the kitchen and one for the bathroom. We used the following algorithm to estimate faucet aerator savings:

$$Savings = \frac{People \times FaucetTime \times Days \times \Delta GPM \times (T_{FAUCET} - T_{IN}) \times C_P \times Den}{3413 \times RE \times NumberofFaucets}$$

Where:

People = The number of people in the home (ppl/household).

Faucet Time = The average length of faucet use per day (min/day).

Days = The number of days per year (day/yr).

ΔGPM = The GPM difference between the base unit and the new unit (gal/min).

TFAUCET = The average water temperature out of the faucet (°F).

TIN = The average inlet water temperature (°F).

ΔTemp = The temperature at the tap minus the temperature at the water main.

RE = Recovery efficiency of the electric hot water heater.

Number of Faucets = The number of faucets installed per home.

Table 26 lists the values and sources used for each faucet aerator algorithm input.

**Table 26. Faucet Aerator Savings Assumptions**

| Term | Value | Source |
|---|---|---|
| People | 2.1 | PY14 Low Income Program Data |
| Faucet Time | 3.7 | PY11 CommunitySavers Metering Study |
| Days | 365 | Conversion Factor (day/yr) |
| ΔGPM | 0.68 | PY14 Low Income Program Data |
| $T_{FAUCET}$ | 80 | Secondary Source* |
| $T_{IN}$ | 61.3 | Ameren Missouri TRM |
| RE | 0.98 | PY11 CommunitySavers Site Visits |
| CP | 1 | Constant (BTU/lb-oF) |
| Den | 8.33 | Constant (lb/gal) |
| 3413 | 3,413 | Conversion Factor (BTU/kWh) |
| Number of faucets | 1.79 | PY14 Low Income Program Data |

*Vermont Technical Reference Manual, 2009.

The results from the water metering study we conducted for PY11 provided one of the most critical inputs—daily minutes of use—as these were Low Income Program-specific primary data (as opposed to those from secondary sources). The PY11 study (consisting of 13 kitchen faucets and 15 bathroom faucets) determined that Low Income Program participants used their kitchen faucets 4.7 minutes per person per day, and they used their bathroom faucets 2.6 minutes per person per day. As program records did not differentiate between kitchen and bathroom aerators, the algorithm above relied on a simple average of the two values (3.7 minutes/ day/person/faucet).

Using our engineering algorithm and these inputs, we estimated *ex post* energy savings of 50 kWh/year for each faucet aerator—a level slightly higher than the program's *ex ante* value (37 kWh).

Similarly to last year, the primary difference between *ex ante* and *ex post* savings arose in the difference in the delta GPM value between the TRM and primary data collected by Honeywell. While this difference reduced savings, the actual number of people per household in PY14 was higher than assumed in the TRM, which partially offset the GPM disparity. The PY14 *ex post* savings (50 kWh) were very similar to the PY13 *ex post* savings (49.5 kWh) and still much higher than the TRM-based *ex ante* savings (37 kWh).

**Table 27. Faucet Aerators: *Ex Ante* and *Ex Post* Comparison**

| *Ex Ante* | *Ex Post* | Realization Rate |
|---|---|---|
| 37 kWh/year | 50 kWh/year | 133% |

### Water Heater Pipe Wrap

Under the Low Income Program, installation contractors applied pipe wrap in three-foot increments to reduce heat loss from pipes attached to the water heater.

The Cadmus team used the following algorithm to estimate savings resulting from water heater pipe wrap:

$$Savings = \frac{\left(\left(\frac{1}{R_{EXIST}} - \frac{1}{R_{NEW}}\right) \times L \times C \times \Delta T \times 8{,}760\right)}{\text{RE} \times 3413}$$

Where:

$R_{EXIST}$ = The pipe heat loss coefficient of uninsulated pipe (existing) (Btu/hr-°F-ft) = 1.0.

$R_{NEW}$ = The pipe heat loss coefficient of insulated pipe (new) (Btu/hr-°F-ft).

L = The length of pipe from the water heating source covered by pipe wrap (ft).

C = The circumference of pipe (ft); (Diameter (in) * π * 0.083).

ΔT = The average temperature difference between supplied hot water (at the faucet) and the outside water main temperature (°F).

8,760 = The number of hours in which heat loss occurred throughout the year (hr/yr).

RE = The recovery efficiency of the electric hot water heater.

3,413 = The conversion rate between BTUs and kWhs (BTU/kWh).

Table 28 lists the values and sources used for the water heater pipe wrap algorithm inputs.

**Table 28. Water Heater Pipe Wrap: Engineering Algorithm Inputs**

| Input | Value | Source |
|---|---|---|
| $R_{EXIST}$ | 1 | Secondary Source* |
| $R_{NEW}$ | 3.6 | PY13 CommunitySavers Program Data |
| L | 1 | PY13 CommunitySavers Program Data |
| C | 0.196 | PY11 CommunitySavers Site Visits |
| Δ T | 58.9 | PY11 CommunitySavers Site Visits and Secondary Source** |
| 8760 | 8,760 | Hours per year |
| RE | 0.98 | PY11 CommunitySavers Site Visits |
| 3413 | 3,413 | Conversion Factor (BTU/kWh) |

*Navigant. *Measures and Assumptions for DSM Planning; Appendix C Substantiation Sheets*. April 2009. p 77.

**126.4 – 67.5 = 58.9; 126.4 is based on hot water temperatures collected during PY11 CommunitySavers site visits; 67.5 degrees is the average ambient air temperature.

Using these engineering algorithm and inputs, we estimated *ex post* energy savings of 22 kWh/year for every foot of pipe wrap—a rate slightly lower than the program's *ex ante* value (23 kWh), as determined

through the PY11 evaluation, but exactly the same as PY13. *Ex ante* and *ex post* savings primarily differed in the temperature change assumed between the hot water in the pipe and in the ambient air.

**Table 29. Water Heater Pipe Wrap: *Ex Ante* and *Ex Post* Comparison**

| *Ex Ante* | *Ex Post* | Realization Rate |
|---|---|---|
| 23 kWh/year | 22 kWh/year | 95% |

### Room Air Conditioners

For participating residences, the Low Income Program replaced older, inefficient room air conditioners (both window units and through-the-wall units) with new, ENERGY STAR units that offered comparable cooling capacities. To estimate savings for this measure, the Cadmus team used the following algorithm:

$$Savings = \frac{\frac{BTU}{hr} \times \left(\frac{1}{EER_{BASE}} - \frac{1}{EER_{EFF}}\right) \times EFLH_{COOL} \times AF}{1,000}$$

Where:

BTU/hr = The room air conditioner's cooling capacity (BTU/hour).

$EER_{BASE}$ = The baseline energy-efficiency ratio (BTU/W-hour).

$EER_{EFF}$ = The energy-efficiency ratio (BTU/W-hour).

$EFLH_{COOL}$ = The cooling equivalent full-load hours (hour).

AF = The adjustment factor converting central air conditioner HOU to room air conditioner HOU.

1,000 = The conversion factor between Wh and kWh (Wh/kWh).

Table 30 lists the values and sources used for the room air conditioner algorithm inputs.

**Table 30. Room Air Conditioners: Engineering Algorithm Inputs***

| Input | Value | Source |
|---|---|---|
| BTU/hr | 12,022 | PY14 Program Data (weighted average of installed units) |
| $EER_{BASE}$ | 6.7 | Secondary Source** |
| $EER_{EFF}$ | 9.9 | PY14 Program Data (weighted average of installed units) |
| EFLHCOOL | 860 | PY13 CoolSavers Metering Study |
| AF | 1.0 | Secondary Source*** |

*The PY13 CoolSavers Report describes the algorithm inputs, such as the EERBASEM, EFLH, and AF, in detail.

**The Cadmus Group. *OPA Keep Cool Metering Study*. 2008: (http://www.powerauthority.on.ca/sites/default/files/2008%20OPA%20Every%20Kilowatt%20Counts%20PowerSavings%20Event%2C%20Keep%20Cool%2C%20and%20Rewards%20for%20Recycling%20Evaluation%20Retailer%20Names%20redacted.pdf)

***The Cadmus team's findings from a low-income HVAC metering study at a Midwest utility. In addition, Low Income Program participants use their room air conditioners as their primary (and usually only) cooling source.

Using the engineering algorithm and inputs listed in Table 30, we estimated *ex post* energy savings of 499 kWh/year for each room air conditioner, a rate much higher than the program's *ex ante* value (274 kWh). *Ex ante* savings were based on assuming the program replaced a current, standard-efficiency room air conditioner. As the program replaced much older room air conditioners, its base efficiency was lower and *ex post* savings were higher. In addition, the room air conditioners operated as the primary cooling source in apartments rather than as a secondary or supplemental unit (as occurs in other programs). While quite a bit higher than the TRM-based *ex ante* savings, our PY14 *ex post* savings (499 kWh) were similar to our PY13 findings (539 kWh).

**Table 31. Window Air Conditioners: *Ex Ante* and *Ex Post* Comparison**

| *Ex Ante* | *Ex Post* | Realization Rate |
|---|---|---|
| 273 kWh/year | 499 kWh/year | 183% |

### CAC Tune-ups and Refrigerant Charge

The program first offered CAC tune-ups and refrigerant charge in PY13. The offering proved popular, with 5,029 tune-ups and/or refrigerant charges conducted in PY14. Data provided on individual jobs indicated many CAC units were in poor repair; thus, the program's tune-ups and charging provided a significant boost to the units' efficiency.

The Cadmus team calculated savings for these measures based on evaluation activities completed through the CoolSavers evaluation. We adjusted program savings to reflect the number of CACs and heat pumps tuned and charged through the program. We also made adjustments to reflect the smaller size and smaller cooling load of units used in apartment buildings (versus single-family homes). *Ex post* savings (shown in Table 32 and Table 33) were higher in PY14 (154 kWh/year and 382 kWh/year) than in PY13 (131 kWh/year and 365 kWh/year).

**Table 32. CAC Tune-ups: *Ex Ante* and *Ex Post* Comparison**

| *Ex Ante* | *Ex Post* | Realization Rate |
|---|---|---|
| 75kWh/year | 154 kWh/year | 205% |

**Table 33. CAC Refrigerant Charge : *Ex Ante* and *Ex Post* Comparison**

| *Ex Ante* | *Ex Post* | Realization Rate |
|---|---|---|
| 87 kWh/year | 382 kWh/year | 439% |

### Advanced Power Strips

The program discontinued installation of advanced power strips early in the PY14 program cycle. Therefore, the program only installed 108. The MML indicated original savings estimates as high at

185kWh per year. The PY13 evaluation found average savings of 31 kWh for those advances power strips installed in home offices and 75kWh for those installed as part of home entertainment centers.[6]

The Cadmus team estimated *ex post* energy savings of 70 kWh/year for each advanced power strip (exactly the same as last year), based on the number installed with home office systems and the number installed on entertainment systems, as found by the PY13 tenant survey.

**Table 34. Advanced Power Strips: *Ex Ante* and *Ex Post* Comparison**

| Ex Ante | *Ex Post* | Realization Rate |
|---|---|---|
| 185 kWh/year | 70 kWh/year | 38% |

## *Summary of Measure-Level Gross Savings*

In this section, several tables provide summaries of measure-level gross savings. Table 35 summarizes per-unit *ex ante* and *ex post* gross savings by measure. Appendix A provides *ex post* demand savings, determined through DSMore using the *ex post* energy savings.

**Table 35. PY13 Summary: Comparison of *Ex Ante and Ex Post* Per-Unit Gross Savings**

| Measure | *Ex Ante* (kWh/yr) | *Ex Post* (kWh/yr) | Realization Rate |
|---|---|---|---|
| CFL - 13W | 31.5 | 19.3 | 61% |
| CFL - 19W | 37.4 | 18.0 | 48% |
| CFL - 23W | 51.2 | 24.8 | 48% |
| Refrigerator | 1,126 | 890 | 79% |
| Showerhead | 204 | 211 | 104% |
| Programmable Thermostat | 234 | 40 | 17% |
| Faucet Aerator | 37 | 50 | 133% |
| Pipe Wrap | 23 | 22 | 95% |
| Room Air Conditioner | 273 | 499 | 183% |
| CAC Tune-up | 75 | 154 | 205% |
| CAC Charging | 87 | 382 | 439% |
| Advanced Power Strip | 185 | 70 | 38% |

Table 36 applies these per-unit values to the Low Income Program' PY14 participation rates to estimate the program's total gross energy savings.

[6] Additional information on this measure's savings can be found in the PY13 Report: *Ameren Missouri CommunitySavers Impact and Process Evaluation: Program Year 2013*.

Table 36. PY13 Summary: *Ex Post* Program Gross Savings Accounting for Retention Rates*

| Measure | PY14 Installations | Per-Unit *Ex Post* Savings (kWh/Year) | Verified & Operable | Total *Ex Post* Savings (MWh/Year) |
|---|---|---|---|---|
| CFL - 13W | 51,430 | 19.3 | 95.7% | 949.9 |
| CFL - 19W | 5,634 | 18.0 | | 97.1 |
| CFL - 23W | 3,924 | 23.8 | | 93.1 |
| Refrigerator | 1,625 | 890 | 100% | 1446.3 |
| Showerhead | 2,801 | 211 | 95% | 561.5 |
| Programmable Thermostat | 5,475 | 40 | 100% | 219.0 |
| Faucet Aerator | 5,028 | 50 | 96% | 241.3 |
| Pipe Wrap | 5,068 | 22 | 100% | 111.5 |
| Room Air Conditioner | 545 | 499 | 100% | 272.0 |
| CAC Tune-up | 3,682 | 154 | 100% | 567.0 |
| CAC Charging | 1,347 | 382 | 100% | 514.6 |
| Advanced Power Strip | 108 | 70 | 95% | 7.2 |
| **Total** | **86,667** | | | **5,080.5** |

*Confidence and precision rates for these estimates to be provided in the final draft.

## Net Impact Evaluation Results

For PY14, the Cadmus team used the NTG ratio found in the PY13 evaluation: 95.8%. A brief description of freeridership and spillover as they relate to the Low Income Program follows below. For additional information and calculations, please see: *Ameren Missouri Missouri CommunitySavers Impact and Process Evaluation for Program Year 2013*.

To calculate CommunitySavers PY13 NTG ratios, the Cadmus team used the following formula:

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

Unlike other program evaluations, the Low Income Program is unavailable to the general public: rather, it is an income-qualified population. The Cadmus team nonparticipant survey did not target Low Income Program nonparticipants (i.e., nonparticipating property managers overseeing low-income properties). Therefore, nonparticipant spillover did not apply. Similarly, we did not assess market effects as marketing for Low Income Program targeted property managers or unit owners, not the income-eligible recipients or the general public.

The Low Income Program defined free riders as property managers who would have purchased and installed the measures their tenants received without the program's support. These property managers accounted for some costs but none of the program's benefits, thus decreasing program net savings. We estimated free ridership by asking participating property managers a battery of questions regarding their purchasing decisions.

Spillover can be defined as additional savings that would be generated by property managers installing additional energy-efficient measures outside the program and due to their experience participating in the Low Income Program, either at the participating property, or at another property. Unlike free ridership, spillover savings do not present program costs, but energy saving benefits increase net savings.

### *Summary*

Table 37 lists the program's net impacts.

**Table 37. Low Income Program NTG and Net Savings**

| Program | *Ex Post* Gross Savings (MWh/yr) | Free Ridership | Participant Spillover | Non-participant Spillover | Market Effects | NTG Ratio | Net Savings (MWh/yr) |
|---|---|---|---|---|---|---|---|
| Low Income | 5,080.5 | 4.2% | 0% | 0% | 0% | 95.8% | 4,867.2 |

## Cost-Effectiveness Results

To analyze the cost-effectiveness of the PY14 Low Income Program, MMP used DSMore and assessed cost-effectiveness using the following five tests defined by the California Standard Practice Manual:[7]

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

DSMore took hourly prices and hourly energy savings from specific measures installed through the Low Income Program and correlated prices and savings to 30 years of historic weather data. Using long-term weather ensured the model captured low probability but high consequence weather events and appropriately valued them. As a result, the model's produced an accurate evaluation of the demand-side efficiency measure relative to other alternative supply options.

Key assumptions included the following:

- Discount Rate = 6.95%
- Line Losses = 5.72%
- Summer Peak would occur during the 16$^{th}$ hour of a July day on average
- Avoided Electric T&D = $31.01/kW
- Escalation rates for different costs occur at the component level with separate escalation rates for fuel, capacity, generation, T&D, and customer rates carried out over 25 years.

In addition, MMP leveraged the "Batch Tools" (model inputs) used by Ameren Missouri in its original analysis as input into the *ex post* DSMore analysis. Starting with the original DSMore Batch Tool used by Ameren Missouri and modifying it only with new data from the evaluation (e.g., PY14-specific Low Income participation counts, per-unit gross savings, and NTG) ensured consistency. In particular, measure load shapes drove assumptions in the model, telling the model when to apply savings during the day. This ensured load shapes for that end use matched the system peak impacts of the end use and provided the correct summer coincident savings. MMP used measure lifetime assumptions and incremental costs, based the program's database, the Ameren Missouri Missouri TRM, or the original Batch Tool.

Acquiring PY14 Ameren Missouri program spending data proved a key step in the analysis process. This broke actual spending down into implementation, incentives, and administration costs. MMP applied

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

these numbers at the program level, not the measure level. While applying incentives at the measure level proved useful for planning purposes, it was unnecessary for cost-effectiveness modeling as the results were based on the program overall.

Table 38 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 present value (in dollars) of the UCT net lifetime benefits (net avoided costs minus program costs).

As determined through a consensus-building process with stakeholders, all the cost-effectiveness results shown include the program's share of portfolio-level or indirect costs. We determined each program's share of these costs using the present value of each program's UCT lifetime benefits (i.e., the present value 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.

As shown in Table 38, the Low Income Program passed the UCT, TRC, and societal tests. UCT net lifetime benefits equaled $479,907.

**Table 38. Cost-Effectiveness Results (PY14)**

| | UCT | TRC | RIM | Societal | PART | UCT Net Lifetime Benefits |
|---|---|---|---|---|---|---|
| Low Income | 1.14 | 1.14 | 0.50 | 1.38 | N/A | $479,907 |

# Appendix A. *Ex Post* Demand Reductions

MMP determined *ex post* demand reductions using *ex post* energy savings, estimated in this PY14 report and DSMore (using load shapes provided by Ameren Missouri).

**Table 39. PY14 Summary: *Ex Post* Per-Unit Demand Reductions**

| Measure | PY14 Installations | Net Per-Unit *Ex Post* Demand Reduction (kW) | Total *Ex Post* Savings (kW)* |
|---|---|---|---|
| Room Air Conditioner | 30 | 0.393 | 11.944 |
| Through-the-Wall Air Conditioner | 515 | 0.393 | 205.036 |
| CFL - 13W | 51,430 | 0.001 | 41.761 |
| CFL - 19W | 5,634 | 0.001 | 4.087 |
| CFL - 23W | 3,924 | 0.001 | 3.764 |
| Refrigerator | 1,625 | 0.149 | 244.614 |
| CAC Tune-up | 3,682 | 0.065 | 240.752 |
| Faucet Aerator | 5,028 | 0.005 | 26.915 |
| Showerhead | 2,801 | 0.022 | 63.274 |
| Pipe Wrap | 5,068 | 0.002 | 11.937 |
| CAC Tune-up | 1,347 | 0.160 | 218.472 |
| Programmable Thermostat | 5,475 | 0.017 | 92.984 |
| Advanced Power Strip | 108 | 0.010 | 1.145 |
| **Total** | **86,667** | | **1,167** |

CADMUS

# Appendix B. Stakeholder Interview Guide

## Ameren Missouri Low Income Program
## Stakeholder Interview Guide (PY14)

Respondent name:_____

Respondent phone: _____

Interview date: _____ Interviewer initials: _____

For the PY14 and PY15 evaluations, Cadmus is interviewing the program staff and delivery organizations annually. The interviews focus on how the program is operating, any program design changes, gathering assessments of program progress, and identifying any areas for improvement.

Questions in this interview guide will be targeted to those parties with the most experience or exposure to that particular process or issue.

**Introduction**

1) What are your main responsibilities for Ameren Missouri's Low Income Program?
2) What percent of your time is dedicated to the program?

**Program Design and Implementation**

3) We are going to walk through the different steps in the program and ask you some questions about each step including: marketing and outreach, program enrollment, property audits, measure installation, energy education, and quality assurance procedures.
4) Can you list for me any changes to the program in PY14? [PROBE: LIHTC properties, Gas company participation, measure changes, name change]
5) What is the impact of not starting the Neighborhood Sweeps component planned for single family homes in PY13?
6) Are you working with or coordinating with local low-income weatherization programs?
7) If so, has that helped with providing more services to program participants? Has it helped with successful outreach to potential participants?
8) If not, why has the program decided not to coordinate services with local low-income agencies?

**Marketing, Outreach, Program Enrollment**

9) Who is the program targeting for participation this year?
10) Has that changed in the last year? If so, what opportunities or challenges has that change presented? [PROBE: HUD, USDA, Housing Authority]

11) Are there any common challenges in reaching these potential participants or securing their interest in the program? [PROBE: LIHTC properties]
12) Do you think there should be other groups included in the program? If so, who and why would they be a good addition?
13) Will the program return to any properties served in prior years to provide additional measures?
14) How do property managers find out about the program? Have you changed your outreach strategy at all since PY13 or with the addition of new property types?
15) What do you think have been the most influential program or market factors to attract program participation this year?
16) What program or market factors have you seen as a barrier to participation this year?
17) Have you made any changes to the marketing materials you have for the program?
18) How useful are those materials? Are they effective in garnering the interest of potential participants? Do they provide the information property managers need to decide whether they will participate in the program?
19) Have you made any changes to the program enrollment forms in PY14? Do property managers have any difficulty completing these forms? If so, how is that handled?

**Property Audits and Measure Installations**

20) Who generally performs the building audits? What is checked during the audit? How many units are generally audited? Does the auditor review the property common areas as well?
21) Is a formal audit result prepared and presented to the participant?
22) Who decides which measures each property will receive through the program? Is this different in PY14? If so, why?
23) Can landlords refuse measures?
24) Are there measures you think should be discontinued or are not useful? Are there measures not included that you think the program should begin installing?
25) Are there additional measures offered as a result of the gas company participation in the program?
26) Does program staff talk with participants about the business program and the opportunity to get rebates for installing common area energy-efficiency measures? If so, are these leads tracked in any way?
27) Do property managers express any interest in the business program rebates? To your knowledge, have any participated in the business program?
28) How do you schedule contractors to serve the different properties? [IF CONTRACTOR] How are you scheduled to serve different properties?
29) Does this process work well? Do contractors have the amount of work they expect (not too much, not too little)?
30) How are measures for the properties purchased, stored, and delivered to contractors?
31) Can you tell us about notification to tenants about the work to be completed in their units? How far in advance is this done? Are there ever any problems with tenant notification?

32) When installation crews get to the location, how do they get access to tenant units? Are there ever any difficulties with getting access? What happens if a crew is unable to gain access?
33) Are any measures left with tenants, property managers, or maintenance staff to be installed?
34) Are there measures tenants are most interested in or excited about? Are there measures that tenants do not like as much?
35) Can tenants refuse measures? How often do they do so and which measures?
36) What are the protocols around CFL installation? Where do you generally install the CFLs?
37) Are the faucet aerators and showerheads provided by the program high-quality? Have you personally tried them?
38) Do tenants comment on the effectiveness of the AC tune-ups?

**Energy Education**

39) What type of education is provided to tenants as part of the program? Does the education just focus on measures installed, or do you provide other tips for how the tenant can save additional energy? How many tenants go through the education? What is the goal for number of tenants educated?
40) Is there anything in particular that tenants find compelling in the information you provide? Are most tenants interested in the education or is it just something they tolerate?
41) How does the workshop curriculum differ from the in-unit curriculum shared with tenants?
42) Are there any tips or ideas for saving money that you feel should be included in the tenant education?

**Quality Assurance Procedures**

43) Is there any monitoring or quality control process to assure measures are installed appropriately?
44) Who completes the quality control? How many buildings and units are checked for quality?

**Program Goals**

45) What are the program's participation and savings goals for PY14?
46) How are these goals determined?
47) Does the program have any process or non-impact goals for PY14? (Probe: subcontractor participation, increased awareness, education of participants or subcontractors, minimization of logistical problems, cancelation rates)?
48) How are these goals determined?
49) In your opinion, how has the program performed so far in PY14 (in terms of both process and savings/participation goals)?
50) Are there benchmarks in place to monitor progress throughout the year? Have you identified any contingency plans in case goals are not being met this year?

**Subcontractors**

51) [AMEREN and HONEYWELL ONLY] Next, I'd like to discuss the other parties involved in delivering the program. Can you please tell me if you have engaged any new contractors and their roles in the program?
52) What training, if any, was provided for the contractors so far in PY14? Do you have additional training planned for PY14?

**Communication and Data Tracking**

53) [AMEREN and HONEYWELL ONLY] How is communication, both formal and informal, between Honeywell and Ameren conducted?
54) How does Honeywell communicate with building managers/owners?
55) How often do Honeywell and the contractors communicate? Is this sufficient?
56) How is the program collecting and tracking participation data? There were some concerns in PY13 about the amount of data that needed to be tracked for the program in PY13, have these concerns been addressed?
57) Has the new data tracking system at Ameren launched and if so, is it simplifying the data collection process?
58) How effective would you say the process has proved to date in PY14?
59) Is the Honeywell Nextel phone system still in place?

**Summary**

60) From your perspective, what are the biggest challenges facing the program in PY14?
61) Is there anything else you'd like us to know about your experience administrating/implementing the program so far this year?
62) Cadmus is reaching out to program stakeholders earlier in the year for PY14 to figure out how each stakeholder group can best benefit from the program evaluation process. Is there anything specific you were hoping to learn from this evaluation?
63) Is there anything else you'd like us to know?

# Appendix C. Tenant Energy Education Materials

A PowerPoint presentation is provided on the following pages.

# Appendix D. Bibliography

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