Ameren Missouri
Low Income Impact and Process Evaluation: Program Year 2015

Final May 13, 2016

Ameren Missouri
1901 Chouteau Avenue
St. Louis, MO 63103

Nexant

The Cadmus Group, Inc.

An Employee-Owned Company • www.cadmusgroup.com

This page left blank.

CADMUS

Prepared by:
Wyley Hodgson
Andrew Dionne
Nexant

Andrew Carollo
Jane Colby
Cadmus

This page left blank.

CADMUS

Table of Contents

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 2015 (PY15), the period from January 1, 2015, through November 30, 2015, the final year of the three-year program cycle.

Program Description

Through the Low Income Program, Ameren Missouri delivered cost-effective, energy-efficiency services to low-income multifamily properties with three or more dwelling units.

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

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

Additionally, Ameren Missouri offered replacement of older appliances—such as refrigerators and air conditioners (both room and through-the-wall units)—with ENERGY STAR® models. Ameren Missouri also offered tune-ups for central air conditioning (CAC) systems through the program.

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 PY15 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 PY15. The *ex post* savings values for CFLs, refrigerators, and programmable thermostats were significantly lower than those estimated in the Ameren Missouri Technical Resource Manual (TRM).[1] However, a few measures, especially cooling

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

measures, showed much higher savings than the TRM estimates (as they did in PY13 and PY14), and these contributed to a realization rate of 98% (inclusive of measure persistence) for PY15.

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. PY15 Participation, Per-Unit *Ex Post* Gross Savings, Realization Rates, and Total Savings

Measure	PY15 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	19,786	31.5	20.6	65%	96%	390.1
CFL - 18W	4,411	37.5	26.4	70%		111.4
CFL - 23W	1,306	51.3	35.4	69%		44.2
Refrigerator	1,140	1,126.0	888.2	79%	100%	1,012.5
Showerhead	3,017	203.7	213.0	105%	95%	607.2
Programmable Thermostat	4,336	234.0	39.8	17%	100%	172.7
Faucet Aerator	6,765	37.2	43.7	117%	96%	284.1
Pipe Wrap	7,195	23.0	21.8	95%	100%	157.1
Room Air Conditioner	109	273.5	498.8	182%	100%	54.4
HVAC Tune-up**	7,572	74.9	142.6	190%	100%	1,079.6
HVAC Charging**	2,218	87.1	512.4	588%	100%	1,136.6
Total	**57,855**					**5,049.8**

*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 (9,790 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 PY15 net-to-gross (NTG) ratios, the Cadmus team used the following formula:

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

Unlike the other Ameren Missouri programs, the Low Income Program was not available to the general public, but rather served an income-qualified population; therefore, nonparticipant spillover was not applicable. Similarly, we did not assess market effects, as marketing for Low Income targeted 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 PY15. As shown in Table 2, applying an overall NTG of 95.8% resulted in total net savings of 4,837.6 MWh for PY15.

Table 2. PY15 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	5,049.8	4.2%	0%	0%	0%	95.8%	4,837.6

As shown in Table 3, the PY15 Low Income Program realized 145% of its net energy savings target, approved by Missouri Public Service Commission (MPSC), and 184% 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)	3,338	4,976	5,050	4,838	145%
Demand (kW)	744	724	1,428	1,368	184%

[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.

Payment Analysis

As part of the PY15 evaluation, the Cadmus team assessed how changes to utility bill payment behavior was impacted by Low Income Program participation. Specifically, the team quantified the effects of the program on the customers' average monthly bill totals and examined the impacts on the account balances or arrearages that trigger disconnection notices.

The analysis showed a net decrease in program participants' received bill amount and a decrease in their outstanding balance. Specifically:

- The net average bill amount for program participants decreased by $3.16, or 3.6% relative to the comparison group of nonparticipants.
- The net outstanding average balance for program participants dropped by 13.8% relative to the comparison group of nonparticipants.

Key Process Evaluation Findings

At the outset of PY15, Honeywell reassigned prior program staff (who had managed the program since its inception) and in their place Honeywell appointed a non-local program manager to oversee the program remotely, while operations were transferred to the outreach manager and reporting transferred to a program coordinator. Local Honeywell staff noted that this change in personnel was problematic, as the local staff found it challenging to maintain day-to-day operations while managing contractor performance, work schedule, and field safety.

In PY14, Ameren Missouri intended to expand the Low Income Program to single-family, low income neighborhoods. However, the inclusion of the single-family segment was ultimately not approved by statewide stakeholders. Therefore, Ameren Missouri cancelled that portion of the program and the anticipated work. As a result, Honeywell was forced to remove one of its direct-install subcontractors from the program during the first quarter of 2015. The remaining three contractors continued to stay active for the remainder of the program year.

The program continued its successful relationship with Laclede Gas, which joined as a program sponsor in PY14. Laclede Gas committed to co-sponsoring natural gas-saving measures, such as showerheads, faucet aerators, and programmable thermostats. The addition of Laclede Gas funding helped customers by providing for measures that could not have been funded by Ameren Missouri (such as faucet aerators or showerheads for apartments with natural gas water heat). In addition, it provided the program implementer and installers with an additional source of revenue to fill the production and funding gaps that occurred as a result of the cancellation of the single-family component of the program.

According to Ameren Missouri and Honeywell program managers, field data collection was significantly improved by the transition from Nextel phones to tablet software. In the prior program years, Honeywell contractors relied on Nextel phone systems to input field data and upload to Honeywell's tracking database. Honeywell reported that the deployment of tablets resulted in increased reliability and speed of data entry and saved significant time for the subcontractors overall. Reporting, however, was noted by Honeywell to be onerous. In particular, Honeywell noted the difficulty in aligning three separate tracking systems (Ameren Missouri's Vision program database, Applied Energy Group's planning database, and Honeywell's own program database). Additionally, Honeywell indicated that the frequency in which Ameren Missouri required reports to be submitted seemed greater than is typical of other utility programs Honeywell implements.

Key Conclusions and Recommendations

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

Conclusion 1. The program was cost-effective during PY13 and PY14. It was not cost-effective in its final year; however, this is due to Ameren Missouri's lower avoided production costs relative to PY13 and PY14.

> **Recommendation 1. Focus future program design on measure offerings and program administration costs to ensure cost-effectiveness.** The Low Income Program's PY15 measure mix and delivery mechanisms can serve as a template for future program design. Ameren Missouri should explore the potential for adding more higher impact measures to the program (e.g., ceiling insulation, air sealing, CAC repair), but only through careful program planning and measure-level cost-effectiveness analysis.

Conclusion 2. Ameren Missouri developed strong relationships with its program subcontractors, who in turn have a strong understanding of the program operations and processes.

> **Recommendation 2. Maintain relationships with the program subcontractors in the event that the program is relaunched in the future.** Maintaining these relationships will facilitate a streamlined ramp up of this program and/or possibly other programs implemented by Ameren Missouri.

Conclusion 3. The Low Income Program successfully maintained high levels of participation through the program cycle. However, the same market opportunities, such as Low-Income Housing Tax Credit (LIHTC) or Housing and Urban Development (HUD) buildings, may be limited or not available in the future. Ameren Missouri may need to expand into different regions and/or customer types in future program cycles.

> **Recommendation 3. Carefully consider program eligibility requirements in future design to ensure the program maximizes its reach to the low-income population.** For example, Ameren Missouri should consider including single-family low-income customers. Doing so would drastically increase the opportunity for program penetration in the low-income market. Additionally, Ameren Missouri could consider extending program eligibility to the individual customers living in multifamily complexes, rather than requiring the entire building to participate. Doing so would help remove barriers posed by split incentive concerns, and could provide program implementers with an alternative entry point other than the building property management group.

PY14 Recommendations Tracking

Cadmus also examined the actions taken on our PY14 evaluation recommendations, as shown in Table 4.

Table 4. PY14 Evaluation Recommendation Tracking

PY14 Recommendation	Ameren Missouri Action
Ameren Missouri could provide more targeted tenant education. Most tenants with programmable thermostats maintained a temperature around 70°F 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 to set energy-efficient temperatures.	Ameren Missouri has always offered separate one-on-one training for customers that receive thermostats. The installer recommended thermostat settings to customers, but did not record the actual programmed temperature settings.
Ameren Missouri could consider discontinuing the programmable thermostat measure or offering it to targeted households. Ameren Missouri has determined it will discontinue offering programmable thermostats for the 2016–2018 program filing; given the very low savings, the company should consider whether it may be best to discontinue the measure for the 2016 program year. Alternatively, Ameren Missouri and Honeywell could target households for programmable thermostats that are most engaged in energy efficiency and have a consistent schedule.	Ameren Missouri will continue to offer programmable thermostats in 2016-2018 if approved as a joint measure with Laclede Gas, with a focus on enhanced educational detail.
Ameren Missouri could consider only installing CFLs in requested areas of senior apartments or in sockets that seniors indicate are highest use fixtures. 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.	Ameren Missouri focused on installing CFLs in highest hour-of-use (HOU) areas first, then consults with the customer on light wattage to install to help increase customer satisfaction and bulb retention.
Ameren Missouri could 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.	Ameren Missouri continued to promote common area energy efficiency measure incentives offered through its business programs. The 2016-2018 program cycle, if approved, will include direct install of some common area measures.

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 2015 (PY15), the period from January 1, 2015, through November 30, 2015, the final year of the three-year program cycle.

Program Description

Through the Low Income Program, Ameren Missouri delivered cost-effective, energy-efficiency services to low-income residents in multifamily properties having three or more dwelling units.

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

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

Additionally, Ameren Missouri offered replacements of older appliances through the program—such as refrigerators and air conditioners (both room and through-the-wall units)—with ENERGY STAR® models. Ameren Missouri also offered tune-ups for central air conditioning (CAC) systems.

Program participants for multifamily buildings were defined as program-enrolled owners, operators, and managers of income-eligible, multifamily residential properties; these individuals determined whether or not a property participates. Program participants for multifamily buildings had to 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 conducted outreach to identified multifamily buildings that house low-income families. These residences included 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 Low Income Housing Tax Credit (LIHTC) properties. Ameren Missouri continued its LIHTC recruitment in PY15; however, the rate of recruitment decreased slightly relative to PY14.

Honeywell subcontracted energy efficiency measures (EEM) installation and appliance recycling to several program partners, which also provided in-home education to tenants. Table 5 lists the PY15 program partners.

Table 5. Low Income Program Installer Partners

Installer	Program Role
7 Oaks Home Inspection, LLC	Installed measures on site and delivers energy education to tenants in homes. This company delivered the program to residents since the program began in 2010.
Urban League of Metropolitan St. Louis, Inc.	Installed measures on site and delivered energy education to tenants in homes. This entity began delivering the program to residents in PY13 and completed the majority of projects inside the city of St. Louis; however, it left the program in the first quarter of 2015 due to the program exclusion of single family homes.
Advantage Air, LLC	Provided CAC tune-ups and charging. In PY13 and PY14, this company served as an installer, but in PY15 it provided only CAC and heat pump charging and tune-ups.
ARCA	Delivered 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 conducted educational meetings with tenants and residents to encourage project acceptance and to provide energy-efficiency education. In large building complexes with common area meeting spaces, Honeywell staff hosted these meetings.

Program Activity

During PY15, the Low Income Program served 269 properties, resulting in 9,475 tenant units receiving measures and services (such as CAC tune-ups) and installations of 57,855 measures, as detailed by measure in Table 6.

Table 6. PY15 Program Participation

Measure	PY15
EEMs	
13W CFL Post-EISA*	19,786
19W CFL Post-EISA	4,411
23W CFL Post-EISA	1,306
Refrigerator	1,140
Showerhead	3,017
Programmable Thermostat	4,336
Faucet Aerator	6,765
Pipe Insulation	7,195
Room Air Conditioner	63
Through-the-Wall Air Conditioner	46
CAC Tune-up	7,572
CAC Charging	2,218
Education	
Group Energy Education	515
In-home Energy Education	3,356

*Energy Independence and Security Act of 2007.

Honeywell reported the total number of tune-ups completed on CACs and heat pumps to be 7,572 (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 PY15.

Impact Evaluation Priorities

- Determining gross and net energy savings and demand reductions generated by the program.

Process Evaluation Priorities

- 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. PY15 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 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

In October and November of 2015, the Cadmus team interviewed the three program stakeholders shown in Table 8. We designed the interviews to accomplish the following: (1) gather information on how the program operated; (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 C provides a copy of this guide).

Table 8. Completed Interviews

Stakeholder Group	Interviews Conducted
Ameren Missouri Program Staff	1
Honeywell Program Management	2
Total	**3**

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).

Payment Analysis

For the PY15 evaluation, the Cadmus team analyzed program participant utility bill payment behavior. Specifically, we investigated any potential impacts on customers' bills and payments as a direct result of program participation, using customer billing and invoice data. The Payment Analysis and Results section outlines our analysis approach and findings.

Cost-Effectiveness Analysis

Using the final PY15 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 compared 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	X	The Cadmus team conducted a regression analysis using customer payment data to analyze the impacts of installed high-efficiency measures on customer bill payment behavior. The analysis included a comparison group to enable us to assess the presence and magnitude of this effect.
Data: The evaluation must use one or more of the following types of data to assess program impact:		
Monthly billing data	X	The Cadmus team conducted an analysis of monthly bill payment data for participants, spanning from 2012 through 2015.
Hourly load data		
Load research data		
End-use load metered data	X	The Cadmus team 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	The Cadmus team gathered equipment information from homes participating in metering, and from program data in PY14.
Household or business characteristics	X	The Cadmus team collected household characteristics from homes participating in metering, and from program data in PY14.
Energy-related building characteristics		

Process Evaluation Findings

The Cadmus team limited process evaluation data collection activities in PY15 to stakeholder interviews with three staff: Ameren Missouri's program implementation manager and Honeywell's program managers.

We did not complete property manager or tenant surveys in PY15 as our previous four evaluation cycles produced very similar conclusions every year: property managers and tenants highly rated the program and the measures and free ridership remained low.

Program Design and Implementation

The Low Income Program achieved 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 subsidized all measures installed through the program by providing them at no cost to tenants and property managers.

In PY14, Ameren Missouri intended to expand the Low Income Program to single-family, low income neighborhoods. However, the inclusion of the single-family segment was ultimately not approved by statewide stakeholders. Therefore, Ameren Missouri cancelled that portion of the program and the anticipated work. As a result, Honeywell removed one of its contractors from the program during the first quarter of 2015. The remaining three contractors continued to stay active for the remainder of the program year.

Ameren Missouri continued its successful program relationship with Laclede Gas, which joined as a program sponsor in PY14. Laclede Gas committed to co-sponsoring natural gas-saving measures, such as showerheads, faucet aerators, and programmable thermostats. 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.

Both Ameren Missouri and Honeywell reported that the addition of Laclede Gas was very positive for the program by increasing eligibility to customers with natural gas service, thus increasing the program exposure, offsetting costs associated with specific program measures, and ultimately helping customers realize greater energy savings.

Marketing and Outreach

The Low Income Program differed from other the Ameren Missouri residential programs, as it targeted eligible property managers rather than Ameren Missouri's residential customers. Therefore, it did 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, gained ground in the low-income housing community. Honeywell reported word-of-mouth program promotion between different housing complexes and housing associations was the primary driver to bring new properties into the program.

While the program required participating properties to commit to participate in Ameren Missouri's Business or Residential Rebate program for common area lighting, many properties served did not have the means or desire to participate in this portion of Ameren Missouri 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. This trend continued into PY15, although the overall number of participating LIHTC properties slightly decreased relative to PY14.

Application Forms

Once Honeywell identified eligible properties and their managers/owners agree to participate, these property managers/owners completed enrollment paperwork, which included providing existing refrigerator specifications for all units. Honeywell staff reported that procuring this information from some property managers was a challenge, as the application was not always completed by the most appropriate personnel. Honeywell estimated that they returned approximately 70% of applications due to pertinent data missing.

Tenant Notification, Signage, and Education

Property management staff notified tenants—the ultimate recipient of Low Income Program services—of program delivery in their buildings. Tenants received information about the program through door hangers, window clings, and signage.[2] Honeywell also sent a letter to all tenants in advance of installation work, informing them of work to be completed. This letter included a refrigerator magnet with tips on behavioral changes that can help the tenant save additional energy.

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

Installation contractors provided individual education in tenant units during installation. At least 85% of tenants receive energy education through the program, with installers sometimes returning several

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

times to a property to provide education to tenants who were not at home during the installation process.

The education materials (attached as Appendix D) were mostly focused on measure acceptance and proper measure usage. The installers indicated that some tenants engaged in the education and became interested in learning about new measures in their homes, while others expressed 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 Participation

In PY15, the program used the same direct-install subcontractors as in PY13 and PY14. 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 installed small measures and programmable thermostats and replaced room or through-the-wall air conditioners. However, due to the exclusion of the single family segment, Honeywell did not have sufficient work for both subcontractors. Consequently, Urban League of Metropolitan St. Louis left the program during the first quarter of 2015.

Two other subcontractors support program implementation. In PY15, ARCA, Inc., continued its role as the refrigerator replacement and decommissioning subcontractor and Advantage Air continued to conduct air conditioner tune-ups and charging.

Measures and Installation

Ameren Missouri did not introduce any new program measure offerings in PY15; however, the Ameren Missouri program manager indicated that in the future they will consider adding ceiling insulation, air sealing, CAC repair, and LEDs to the measure mix. Honeywell suggested the program also consider windows as an additional measure offering for future program cycles.

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.

In PY14, 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. These concerns, however, were much reduced in PY15 due to educational outreach, including one-on-one training for programmable thermostats and informative materials on CFLs. Despite this improvement, programmable thermostats remained an optional measure for property managers who wanted to avoid tenant concern or confusion over the measure.

Similar to prior years, the program managers reported that property managers and tenants continued to express interest in or appreciation of certain measures, especially for the 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.

Quality Assurance

The quality assurance process conducted by Honeywell primarily sought to verify measure installations, ensure that proper protocols are followed, and confirm quality work performance in customer units. Ameren Missouri required 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. 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 Ameren Missouri, reporting data continued to be challenging in PY15. Particularly, Honeywell noted the difficulty in aligning three separate tracking systems (Ameren Missouri's Vision program database, Applied Energy Group's planning database, and Honeywell's own program database). Additionally, Honeywell indicated that the frequency in which Ameren Missouri required reports to be submitted seemed greater than is typical of the programs Honeywell implements for other utility clients.

Data collection, however, improved significantly as the program successfully transitioned from field collection using Nextel phones to tablet software. 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 re-enter data manually back in the office. Honeywell reported that deployment of the tablets increased the reliability and speed of data entry and saved significant time for the subcontractors overall.

Program Administration and Communications

At the outset of PY15, Honeywell's local program managers left the program and in their place Honeywell appointed a non-local program manager to oversee the program remotely, while operations were transferred to the outreach manager and reporting transferred to a program coordinator. Local Honeywell staff noted that this change in personnel was problematic, as the local staff found it challenging to maintain day-to-day operations while managing contractor performance, work schedule, and field safety. Honeywell and Ameren Missouri did maintain weekly communications with Honeywell's remote program manager and had more frequent check-in's with the local program staff. The Ameren Missouri program manager did note that his responsibilities and time commitment to the program

increased during PY15 due to the change in Honeywell staffing, but overall said the program performed well in PY15.

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 remains largely unchanged from PY13 and PY14 and 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 have been merged with a low-income, single-family market; however, this concept was suspended due to stakeholder concerns. Additionally, the current target market could be revised to include low-income tenants.
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?	As in PY13 and PY14, the mix of measures were appropriate for multifamily buildings for low-income residents. The program measures addressed lighting, water heating, appliances, and heating, and cooling. In PY14, advanced power strips were discontinued because of low evaluated savings. Additional measures were supplied in PY14 for households with natural gas heating or water heating. Program stakeholders have also suggested including ceiling insulation, air sealing, windows, CAC repair, and LEDs in future program cycles.
4	Are the communication channels and delivery mechanisms appropriate for the target market segment?	As in PY13 and PY14, the communication channels for the target market included direct contact with property managers by Honeywell staff as well as word-of-mouth. Communication with tenants was handled by property managers through workshops with Honeywell staff and directly with installation contractors in apartments. The delivery mechanism was direct installation, performed by program subcontractors. The communication and delivery mechanism were necessarily direct and hands-on as both the tenant and property managers were 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 had great success for several years, with high levels of participation and tenant acceptance of new measures. Many federally-subsidized properties were treated, and LIHTC properties generated 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 in future program cycles. Alternatively, the program can assess the feasibility of treating individual units as opposed to the requiring treatment of the entire complex.

Gross Impact Evaluation Results

The Cadmus team estimated PY15 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 HVAC, Lighting, and Refrigerator Recycling programs. This section of the report details each measure's per-unit savings calculations and installation rates.

Measure Installation Verification

Measure retention rates for PY15 relied on PY13 tenant surveys. As shown in Table 11, the Cadmus team verified that the majority of program measures remained installed and continued to operate.

Table 11. Measure Verification and Retention

Measure	PY15 Installations	Percentage Verified and Operable
CFL - 13W	19,786	95.7%
CFL - 19W	4,411	
CFL - 23W	1,306	
Refrigerator	1,140	100%
Showerhead	3,017	94.5%
Programmable Thermostat	4,336	100%
Faucet Aerator	6,765	96.2%
Pipe Wrap	7,195	100%
Room Air Conditioner	109	100%
CAC Tune-up	7,572	100%
CAC Charging	2,218	100%

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:

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

[3] Replacements did not include specialty bulbs.

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.

The Cadmus team applied an incandescent baseline wattage value to calculate CFL savings. The application of the incandescent baseline reflects an "early replacement" assumption, in which we assume the program sub-contractors replaced existing incandescents while customers would purchase halogens (the cheapest available alternative) once when existing bulbs burnout[4].

HOU Results

In PY14, Cadmus analyzed the CFL HOU metering results by room type and 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 for PY15, we weighted the participant type-specific results shown in Table 12 to reflect the mix of CFLs installed in homes of seniors and families. However, the majority of the program data did not indicate which type of tenant facility was treated, therefore the Cadmus team used the average of the senior and families HOU values for these undocumented facilities. We weighted each HOU value by the count of participation for which seniors comprised 12%, families 21%, and undocumented 69%. This process resulted in a program average of 1.5 hours per day as presented in Table 13.

[4] The Cadmus team only applied the incandescent baseline for the first-year savings. For cost effectiveness calculations, the baseline was adjusted to a halogen EISA baseline after the first year based on the assumption that customers would replace burned out bulbs with halogen bulbs. This adjustment in the baseline is reflected in the net benefits over the useful life of the lighting measure.

Table 13. HOU Results Overall and by Demographics

	% of PY15 CFL Installations	HOU
Seniors	12%	1
Families	21%	1.9
Undocumented	69%	1.45
Overall	**100%**	**1.5**

Table 14 shows the updated PY15 inputs for the CFL algorithm.

Table 14. CFL Engineering Algorithm Inputs

Term	Value	Source
WattsINC (60W)	60	Incandescent Wattage
WattsINC (75W)	75	Incandescent Wattage
WattsINC (100W)	100	Incandescent Wattage
WattsCFL (13 W)	14	PY15 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. As mentioned above, the Cadmus team applied an incandescent baseline for the first year energy savings of each lighting measure. We adjusted the HOU downward (as discussed above) relative to the TRM assumptions based upon results of the metering study which drove the variation in *ex ante* and *ex post* estimates, which ultimately resulted in the PY15 *ex post* savings equaling roughly two-thirds of the TRM ex-ante value.

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

Measure	*Ex Ante*	*Ex Post*	Realization Rate
CFL - 13W	31.5 kWh/year	20.6 kWh/year	65%
CFL - 19W	37.4 kWh/year	26.4 kWh/year	70%
CFL - 23W	51.2 kWh/year	35.4 kWh/year	69%

Refrigerators

Under the program, ARCA 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 Refrigerator Recycling evaluation information to estimate the energy use of existing refrigerators. This methodology, which the Refrigerator 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 Refrigerator 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. We used this assumption throughout the measure life for cost effectiveness purposes because it is likely that should a refrigerator fail, this population would replace the unit with a used refrigerator rather than a new standard efficiency unit. 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	PY14 Program Data
$EnergyUse_{New}$	368	PY15 Program Data and ENERGY STAR

Using these engineering algorithms and inputs, we estimated *ex post* energy savings of 888 kWh/year for each refrigerator, which is very similar to 890 kWh/year from PY14. This rate fell below the program's *ex ante* value (1,126 kWh), which was based on the PY10 Multifamily Income Qualified evaluation that included a different mix of existing refrigerators.

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

Ex Ante	*Ex Post*	Realization Rate
1,126 kWh/year	888 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 213 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	2.07	PY15 Low Income Program Data
Shower Time	8.66	Secondary Source*
Days	365	Conversion Factor (day/yr)
%Days	0.66	Secondary Source*
ΔGPM	0.499	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	3,413	Conversion Factor (BTU/kWh)
Number of Showerheads	1.1	PY15 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 1.1 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 remained constant at 2.1 in PY15 and PY14 (and increased from 1.9 in PY13). The 213 kWh/year for PY15 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	213 kWh/year	105%

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%	82%	84%	31.1
	New	88	42%	16%	84%	4.8
	Old	115	42%	2%	84%	0.8
CAC with Electric Furnace	Average	632	11%	82%	84%	48.1
	New	483	11%	16%	84%	6.9
	Old	671	11%	2%	84%	1.3
PTAC	Average	523	44%	82%	84%	159.4
	New	269	44%	16%	84%	15.4
	Old	719	44%	2%	84%	5.4
Central Air Source Heat Pump	Average	345	4%	82%	84%	9.6
	New	269	4%	16%	84%	1.4
	Old	368	4%	2%	84%	0.2
Total (PY15)						**284.5**

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. For the metering study, the Cadmus team calculated the percentage of Low Income Program participants who used their programmable thermostats in an energy-saving manner. The results of the metering study revealed a 14% overall yearly efficient use factor (see the PY14 evaluation report for additional details on the programmable thermostat metering study).

We used these analysis results to make behavioral adjustments to savings values in the MML database, (i.e., 284.5 x 0.14 = 40 kWh/year), as shown in Table 21.

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

Table 21. 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 PY15. 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%).

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:

$$Savings = \frac{People \times FaucetTime \times Days \times \Delta GPM \times (T_{FAUCET} - T_{IN}) \times C_P \times Den}{3{,}413 \times RE \times NumberofFaucets}$$

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.

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

RE = Recovery efficiency of the electric hot water heater.

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

Table 22 lists the values and sources used for each faucet aerator algorithm input.

Table 22. Faucet Aerator Savings Assumptions

Term	Value	Source
People	2.07	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	2.03	PY15 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).

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 PY15 was higher than assumed in the TRM, which partially offset the GPM disparity. The PY15 *ex post* savings (44 kWh) were slightly less than *ex post* savings in PY14 (50 kWh) due to a higher number of faucets per home. Yet, the PY15 *ex post* savings were still much higher than the TRM-based *ex ante* savings (37 kWh).

Table 23. Faucet Aerators: *Ex Ante* and *Ex Post* Comparison

Ex Ante	*Ex Post*	Realization Rate
37 kWh/year	44 kWh/year	117%

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:

$$Savings = \frac{\left(\left(\frac{1}{R_{EXIST}} - \frac{1}{R_{NEW}}\right) \times L \times C \times \Delta T \times 8{,}760\right)}{\text{RE} \times 3{,}413}$$

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

Table 24. 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	8760	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. *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 25. 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 26 lists the values and sources used for the room air conditioner algorithm inputs.

Table 26. Room Air Conditioners: Engineering Algorithm Inputs*

Input	Value	Source
BTU/hr	12,022	PY15 Program Data (weighted average of installed units)
EER_{BASE}	6.7	Secondary Source**
EER_{EFF}	9.9	PY15 Program Data (weighted average of installed units)
EFLHCOOL	860	PY13 CoolSavers Metering Study
AF	1,000	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 26, we estimated *ex post* energy savings of 499 kWh/year for each room air conditioner, which was much higher than the program *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).

Table 27. Window Air Conditioners: *Ex Ante* and *Ex Post* Comparison

Ex Ante	*Ex Post*	Realization Rate
273 kWh/year	499 kWh/year	182%

CAC Tune-ups and Refrigerant Charge

The program first offered CAC tune-ups and refrigerant charge in PY13. The offering proved popular, with 7,572 tune-ups and/or refrigerant charges conducted in PY15. 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 measure 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). The PY15 *ex post* savings (143 kWh/year for CAC tune-ups and 512 kWh/year for CAC refrigerant charge) are listed below in Table 28 and Table 29.

Table 28. CAC Tune-Ups: *Ex Ante* and *Ex Post* Comparison

Ex Ante	*Ex Post*	Realization Rate
75 kWh/year	143 kWh/year	190%

Table 29. CAC Refrigerant Charge: *Ex Ante* and *Ex Post* Comparison

Ex Ante	*Ex Post*	Realization Rate
87 kWh/year	512 kWh/year	588%

Summary of Measure-Level Gross Savings

In this section, several tables provide summaries of measure-level gross savings. Table 30 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 30. PY15 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	20.6	65%
CFL - 19W	37.5	26.4	70%
CFL - 23W	51.3	35.4	69%
Refrigerator	1,126.0	888.2	79%
Showerhead	203.7	213.0	105%
Programmable Thermostat	234.0	39.8	17%
Faucet Aerator	37.2	43.7	117%
Pipe Wrap	23.0	21.8	95%
Room Air Conditioner	273.5	498.8	182%
CAC Tune-up	74.9	142.6	190%
CAC Charging	87.1	512.4	588%

Table 31 applies these per-unit values to the Low Income Program' PY15 participation rates to estimate the program's total gross energy savings.

Table 31. PY15 Summary: *Ex Post* Program Gross Savings Accounting for Retention Rates

Measure	PY15 Installations	Per-Unit *Ex Post* Savings (kWh/Year)	Verified & Operable	Total *Ex Post* Savings (MWh/Year)
CFL - 13W	19,786	20.6	96%	390.1
CFL - 19W	4,411	26.4		111.4
CFL - 23W	1,306	35.4		44.2
Refrigerator	1,140	888.2	100%	1,012.5
Showerhead	3,017	213.0	95%	607.2
Programmable Thermostat	4,336	39.8	100%	172.7
Faucet Aerator	6,765	43.7	96%	284.1
Pipe Wrap	7,195	21.8	100%	157.1
Room Air Conditioner	109	498.8	100%	54.4
CAC Tune-up	7,572	142.6	100%	1,079.6
CAC Charging	2,218	512.4	100%	1,136.6
Total	**57,855**			**5,049.8**

Net Impact Evaluation Results

For PY15, the Cadmus team used the NTG ratio found in the PY13 evaluation: 95.8%. A brief description of free ridership 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 (Renamed Low Income Program in PY14) 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. We did not find measurable spillover.

Summary

Table 32 lists the program's net impacts.

Table 32. 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	5,049.8	4.2%	0%	0%	0%	95.8%	4,837.6

Payment Analysis and Results

As part of the PY15 evaluation, the Cadmus team assessed how changes to utility bill payment behavior was impacted by Low Income Program participation. Specifically, the team quantified the effects of the program on the customers' average monthly bill totals and examined the impacts on the account balances or arrearages that trigger disconnection notices.

To conduct this analysis, the Cadmus team developed a sample of program participants (treatment group) and designed a comparison group that matched the profile of program participants but whose payment behavior was not affected by program participation. Our analysis revealed that the Low Income Program improved participants' payment behavior. The installations and education delivered through the program are correlated to participants' ability to realize lower monthly energy costs and to reduce outstanding balances. Table 33 summarizes the impacts to customer bill amounts and outstanding balance payments between the comparison and treatment groups, as calculated by a difference-in-differences (DID) analysis.

Table 33. Difference in Difference Analysis Results

	Group	Pre-Program Participation	Post-Program Participation	Difference	Percentage Change
Bill Amount	Comparison	$80.37	$85.90	$5.53	6.9%
	Treatment	$73.23	$75.60	$2.37	3.2%
	Difference	**-$7.14**	**-$10.30**	**-$3.16**	**-3.6%**
Outstanding Balance at Cut Notice	Comparison	$228.04	$275.68	$47.64	20.9%
	Treatment	$236.3	$253.12	$16.82	7.1%
	Difference	**$8.26**	**-$22.56**	**-$30.82**	**-13.8%**

The analysis showed a net decrease in program participants' received bill amount and a decrease in their outstanding balance. Specifically:

- The net average bill amount for program participants decreased by $3.16, or 3.6% relative to the comparison group of nonparticipants.
- The net outstanding average balance for program participants dropped by 13.8% relative to the comparison group of nonparticipants.

Data Sources

The Cadmus team requested data for a random sample of 2,500 units that participated in the Low Income Program between PY13 and PY15. PY13 and PY14 participants comprised the treatment group. We developed the comparison group using data from PY15 participants, but using data from PY13 and PY14 (i.e., the time period prior to program participation). This comparison group accounts for naturally occurring changes in kWh consumption and payment behavior among low-income customers, which are largely due to changes in broader economic conditions.

The Cadmus team used four key sources of data to conduct the analysis:

1. **Low Income Program database.** Ameren Missouri provided complete records for all low-income customers who participated in the Low Income Program. Data included customer identification information, measures installed, measure quantities, installation dates, and deemed savings.
2. **Utility billing records.** Ameren Missouri supplied historic utility billing records for the 2,500 sampled customers. Data included billing period start/end dates, as well as reported kWh usage and billed amount ($) for each billing period.
3. **Customer payment records.** Ameren Missouri supplied bill payment information for the sampled participants. These data included the payment amount, the method of the payment, and the date the payment was processed.
4. **Cut notice records.** Ameren Missouri supplied records of service disconnection notices issued to customers. Data included the date each notice was processed, the reason for the notice (e.g., lack of bill payment) and the account balance ($) at the time of the notice.

The Cadmus team used the program database to draw a sample of 2,500 households, half of which received improvements prior to January 1, 2015 and half of which received improvements beginning on January 1, 2015. The team required all treatment group households to have 12 months or more of pre- and post-weatherization billing data, and all comparison group households to have 24 months or more of pre-weatherization billing data in order to be included in the sample.

The Cadmus team merged all four data sources listed above into a single dataset, which we screened for unrealistic data points. We designated a post-indicator variable to all account billing periods, where post equaled 0 if the billing period occurred prior to weatherization installs and post equaled 1 if the billing period occurred after weatherization. We excluded data for the billing period in which the improvements were installed from each account.

Method

The Cadmus team used a DID approach to net out any underlying differences between the treatment and comparison groups, then applied a linear fixed-effects regression model to account for these disparities. The DID method allowed us to calculate the effect of a treatment on one or more outcomes by comparing the average change for the treatment group relative to the comparison group between the pre- and post-treatment periods. Using this methodology and the fixed-effects model, we estimated program impacts between treatment and comparison groups for two primary outcomes:

1. Monthly bill amount
2. Outstanding balance amount

Results

Table 34 provides an example of how the Cadmus team conducted the DID calculation. In this example, we used observed increases in customers' monthly bills to estimate the impact of program participation on monthly bill amounts for treatment group participants.

Table 34. Bill Amount Difference-in-Differences Findings

Group	Pre-Program Participation	Pre-Program Participation	Difference	Percentage Change
Comparison	$80.37	$85.90	$5.53	6.9%
Treatment	$73.23	$75.60	$2.37	3.2%
Difference	**-$7.14**	**-$10.30**	**-$3.16**	**-3.6%**

The average monthly bill amounts for both the comparison group and treatment group increased in the post-program participation period compared to the pre-program participation period.[6] The treatment group's average bill amount increased by $2.37, or 3.2%, while the comparison group's average bill increased by $5.53, or 6.9%. To estimate the impact attributable to program participation, the team calculated the difference between the treatment group's pre- and post- bill amounts, then subtracted the difference between the comparison group's pre- and post- amounts. As shown in Table 34, this yielded an average net difference of $3.16, or 3.6%, in participants' monthly bills as a result of the program.

Following the same DID method, Table 35 shows the net change in the average outstanding balance amount for the treatment and comparison groups.

Table 35. Outstanding Balance Difference-in-Differences Findings

Group	Pre-Program Participation	Pre-Program Participation	Difference	Percentage Change
Comparison	$228.04	$275.68	$47.64	20.9%
Treatment	$236.3	$253.12	$16.82	7.1%
Difference	**$8.26**	**-$22.56**	**-$30.82**	**-13.8%**

In the post period, the total outstanding balance increased for both the treatment and comparison groups. However, relative to the comparison group, program participants realized a lower increase in their outstanding balance during the post period. Program participants saw, on average, an outstanding balance that was approximately 14% less than the balance realized by nonparticipants.

Fixed-Effects Regression Analysis

The Cadmus team used a fixed-effects billing regression analysis to complete the analysis. We compared the two key metrics monthly bill amount and outstanding balance amount) during months prior to and after program participation.

We analyzed the data as a panel, and selected the fixed-effects specification in order to properly account for the time-invariant characteristics of the household/customer. As an example, Table 36

[6] These increases in utility bill amounts, despite unit efficiency gains, are likely due in part to the rise in residential retail electricity rates during the observed period.

presents the regression coefficients for the impacts on customers' bill amount and outstanding balance amount in both absolute and percentage terms. The key terms in Table 36 are the coefficients on the Comparison Post and Treatment Post terms.

The model estimated that the comparison group's average bill amount increased by $5.14 in the post-treatment period, while the treatment group's average bill increased by $4.26 in the same time period, or $0.88 less than the comparison group.[7] When comparing the outstanding balance amount, the model predicted that during the pre- to post-treatment period, the comparison group's outstanding balance increased by $49.12 while the treatment group's outstanding balance increased by $17.85, or $31.27 less the comparison group. Regression coefficients and goodness of fit statistics are in Appendix B. Payment Analysis Fixed Effects Regression Outputs.

Table 36. Fixed-Effects Regression Results

	Group	Coefficient	p-value
Bill Amount	Comparison	5.138	0.000
	Treatment	-0.880	0.102
	Intercept	76.010	0.000
Percentage of Bill Amount	Comparison	0.069	0.000
	Treatment	-0.014	0.000
	Intercept	4.162	0.042
Outstanding Balance at Cut Notice	Comparison	49.120	0.000
	Treatment	-31.270	0.109
	Intercept	234.503	0.000
Percentage of Balance at Cut Notice	Comparison	0.253	0.000
	Treatment	-0.048	0.244
	Intercept	5.275	0.000

Ultimately, our findings suggest that participation in the program caused a decrease in customers' average bill amount and their outstanding bill balance relative to a nonparticipants.

[7] These increases in utility bill amounts, despite unit efficiency gains, are likely due in part to the rise in residential retail electricity rates during the observed period.

Cost-Effectiveness Results

To analyze PY15 program cost-effectiveness, MMP used DSMore and assessed cost-effectiveness using the following five tests, defined by the California Standard Practice Manual:[8]

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

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

Table 37 presents the key cost-effectiveness analysis assumptions and corresponding source.

Table 37. Assumptions and Source for Cost-Effectiveness Analysis

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

In addition, MMP used the Batch Tools (model inputs) that Ameren Missouri used in its original analysis as input into the *ex post* DSMore analysis, then modified these solely with new data from the evaluation (e.g., PY15-specific Lighting participation counts, per-unit gross savings, and NTG), which ensured consistency. For HVAC, we also updated the per-unit demand reduction based on our analysis of primary sub-meter data.

Particularly, model assumptions were driven by measure load shapes, which indicated when the model should apply savings during the day. This ensured that the load shape for an end-use matched the

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

system peak impacts of that end use and provided the correct summer coincident savings. MMP used measure lifetime assumptions and incremental costs based on the program database, the Ameren Missouri TRM, or the original Batch Tool.

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

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

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 Annual Net Shared Benefits or (sometimes referred to as UCT net lifetime benefits). [9] As shown in Table 38, the Low Income Program did not pass any of the tests, and the Annual Net Shared Benefits were negative. In PY14, the program was cost effective; the difference is primarily a result of the new avoided energy costs.

Table 38. Cost-Effectiveness Results (PY15)

	UCT	TRC	RIM	Societal	PART	Annual Net Shared Benefits*
Low Income	0.88	0.88	0.37	1.03	n/a	($337,746)

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

[9] Net avoided costs minus program costs.

Appendix A. *Ex Post* Demand Reductions

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

Table A-1. PY15 Summary: *Ex Post* Per-Unit Demand Reductions

Measure	PY15 Installations	Net Per-Unit *Ex Post* Demand Reduction (kW)	Total *Ex Post* Savings (kW)*
Room Air Conditioner	63	0.3993	25.15
Through-the-Wall Air Conditioner	46	0.3993	18.37
CFL - 13W	19,786	0.0008	15.76
CFL - 19W	4,411	0.0010	4.50
CFL - 23W	1,306	0.0014	1.79
Refrigerator	1,140	0.1507	171.82
CAC Tune-up	7,572	0.0607	459.96
Faucet Aerator	6,765	0.0045	30.52
Showerhead	3,017	0.0216	65.20
Pipe Wrap	7,195	0.0023	16.85
CAC Tune-up	2,218	0.2183	484.13
Programmable Thermostat	4,336	0.0170	73.51
Total	**57,855**		**1,368**

Appendix B. Payment Analysis Fixed Effects Regression Outputs

Figure B-1. Regression Output for Impact on Bill Amount

```
Fixed-effects (within) regression               Number of obs      =    114564
Group variable: cust_id                         Number of groups   =      2500

R-sq:  within  = 0.0041                         Obs per group: min =        17
       between = 0.0002                                        avg =      45.8
       overall = 0.0014                                        max =        58

                                                F(2,2499)          =    153.18
corr(u_i, Xb)  = -0.0153                        Prob > F           =    0.0000

                                (Std. Err. adjusted for 2500 clusters in cust_id)
------------------------------------------------------------------------------
             |               Robust
    bill_amt |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        post |    5.137596   .4017649    12.79   0.000     4.349769    5.925422
   treatpost |   -.8796148   .5369798    -1.64   0.102    -1.932586    .1733563
       _cons |    76.00993   .1052732   722.03   0.000     75.80349    76.21636
-------------+----------------------------------------------------------------
     sigma_u |   33.256116
     sigma_e |   34.925098
         rho |   .47553604   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Figure B-2. Regression Output for Percent Impact on Bill Amount

```
Fixed-effects (within) regression               Number of obs      =    114541
Group variable: cust_id                         Number of groups   =      2500

R-sq:  within  = 0.0053                         Obs per group: min =        17
       between = 0.0000                                        avg =      45.8
       overall = 0.0019                                        max =        58

                                                F(2,2499)          =    169.63
corr(u_i, Xb)  = -0.0105                        Prob > F           =    0.0000

                                (Std. Err. adjusted for 2500 clusters in cust_id)
------------------------------------------------------------------------------
             |               Robust
  ln_billamt |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        post |   .0688843   .0047417    14.53   0.000     .0595862    .0781824
   treatpost |  -.0138259   .0067917    -2.04   0.042    -.0271438    -.000508
       _cons |   4.162545   .0013551  3071.85   0.000     4.159888    4.165202
-------------+----------------------------------------------------------------
     sigma_u |   .42507263
     sigma_e |   .40421313
         rho |   .52513766   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Figure B-3. Regression Output for Impact on Balance at Time of Cut Notice

```
Fixed-effects (within) regression               Number of obs      =      4091
Group variable: cust_id                         Number of groups   =       841

R-sq:  within  = 0.0121                         Obs per group: min =         1
       between = 0.0449                                        avg =       4.9
       overall = 0.0244                                        max =        29

                                                F(2,840)           =     16.35
corr(u_i, Xb)  = 0.0767                         Prob > F           =    0.0000

                                (Std. Err. adjusted for 841 clusters in cust_id)
------------------------------------------------------------------------------
             |               Robust
     balance |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        post |     49.1196   8.729577     5.63   0.000     31.98526    66.25395
   treatpost |    -31.2696   19.50944    -1.60   0.109    -69.56257    7.023372
       _cons |     234.5027   3.752919    62.49   0.000     227.1365    241.8689
-------------+----------------------------------------------------------------
     sigma_u |     117.1861
     sigma_e |    149.18824
         rho |    .38156966   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Figure B-4. Regression Output for Percent Impact on Balance at Time of Cut Notice

```
Fixed-effects (within) regression               Number of obs      =      4091
Group variable: cust_id                         Number of groups   =       841

R-sq:  within  = 0.0530                         Obs per group: min =         1
       between = 0.0940                                        avg =       4.9
       overall = 0.0745                                        max =        29

                                                F(2,840)           =     68.80
corr(u_i, Xb)  = 0.0921                         Prob > F           =    0.0000

                                (Std. Err. adjusted for 841 clusters in cust_id)
------------------------------------------------------------------------------
             |               Robust
  ln_balance |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        post |    .2526088   .0254225     9.94   0.000     .2027098    .3025079
   treatpost |    -.048342   .0414675    -1.17   0.244    -.1297342    .0330501
       _cons |    5.274644   .0079047   667.28   0.000     5.259129    5.290159
-------------+----------------------------------------------------------------
     sigma_u |    .3790149
     sigma_e |   .43205587
         rho |   .43488225   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

CADMUS

Appendix C. Stakeholder Interview Guide

Ameren Missouri Low Income Program
Stakeholder Interview Guide (PY15 – third program year)

Respondent name:_____

Respondent phone: _____

Interview date:_____ Interviewer initials:_____

Introduction

1. Please describe any significant changes to your primary responsibilities, regular tasks, and time commitments for Ameren Missouri's Low Income Program.
   a. If so, is your schedule more or less focused on this program? What percentage of your time is dedicated to the program?

Program Design and Implementation

2. Have any significant changes occurred in communication, both formal and informal, between Honeywell and Ameren?
3. How is the integration process with Ameren's Vision database progressing? What issues did the integration face in 2015?
4. How has the transition been from the Nextel phones to tablets?
5. Is the activity of the LIHTC still the same as PY14, decreased, increased?
   a. Has activity increased around the business participation for common area lighting?
   b. Has there been a concerted push to get business customers for common area lighting?
6. How was the program's success in penetrating the non-governmental multifamily housing market?
7. Were any updates made to the application form?
8. Have there been any changes to the program design in PY15?
   a. Are there any program design changes made to date that have either caused challenges or increased facilitation of the program's implementation?
9. What would you say worked particularly well in PY15? Why is that?
10. Conversely, what did not work as well as anticipated? Why is that?

Program Goals

11. Were there changes in program performance expectations for PY15?
12. What were the program's participation and savings goals for PY15?
13. Did the program achieve its education goal in PY15?
    a. Did installation contractors continue to do education efforts including the return to sites to educate customers who were not available during installation?
    b. Was any extra effort made toward behavioral education in PY15?

Measures

14. Additional measures recommended by staff in PY14 included insulation, air sealing, CAC repair and LED lighting. Any others recommendations?
15. To confirm, are programmable thermostats still being offered through the program?
    a. If so, has there been increased educational effort to help customers understand the benefits of programming the programmable thermostats?
    b. And, are the programmable thermostats being targeted to any particular customer profile?
16. Have there been any challenges encountered with measure installations?
17. Has there been any specific customer feedback with any measures?
18. Has the program amended how it installs CFLs at seniors' homes?

Marketing Efforts

19. Please describe the marketing approach used in PY15.
20. Were you satisfied with the response to the program outreach in PY15?

Program Partners

21. Has there been any change to the partnership or role of Laclede Gas in PY15?
22. Are the contractors still: ARCA, 7 Oaks, Urban League, and Advantage Air?
23. Have the program contractors remained busy, or has the program needed to drop any contractors?
24. Are communications to get Advantage Air into the buildings still seeing the same improved success as seen in PY14?
25. Did quarterly contractor trainings continue in PY15?

Quality Control

26. For QC efforts, what percentage does HW inspect in 2015?

Customer Feedback

27. Are there any recurring or common customer praises or complaints? If so, what are they?

Summary

28. From your perspective, what are the biggest challenges facing the program moving forward?
29. What do you consider as the main lessons learned since the program cycle kicked off in 2015?
30. Is there anything else you'd like us to know?

Appendix D. Tenant Energy Education Materials

A PowerPoint presentation is provided on the following pages.

Appendix E. Bibliography

Ameren Missouri TRM.
https://www.efis.psc.mo.gov/mpsc/commoncomponents/viewdocument.asp?DocId=935658483

National Renewable Energy Laboratory. *Chapter 6: Residential Lighting Evaluation Protocol*. Available online: http://www1.eere.energy.gov/wip/pdfs/53827-6.pdf

Rules of Department of Economic Development. Available online: http://sos.mo.gov/adrules/csr/current/4csr/4c240-22.pdf

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