Ameren Missouri
Efficient Products
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:
Sara Wist
Jane Colby
Andrew Carollo

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 Efficient Products (formally RebateSavers) 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 December 31, 2015, which is the final year of the three-year program cycle.

Program Description

In PY15, the Efficient Products program provided downstream mail-in and online rebates for:

- ENERGY STAR®-certified room air conditioners (RACs)
- ENERGY STAR-certified heat pump water heaters
- ENERGY STAR-certified air purifiers
- ENERGY STAR-certified water coolers[1]
- ENERGY STAR-certified dual-speed pool pumps
- ENERGY STAR-certified variable-speed pool pumps
- Programmable thermostats[2]
- Electric storage water heaters with an energy factor (EF) of 0.93 or higher[3]

The Efficient Products program also offered two Home Energy Kit options to customers using electric hot water heaters and who requested the kit after receiving a postcard from Ameren Missouri. Participants who wanted a free kit could order Home Energy Kit 1, which included the items shown in Table 1. Participants interested in receiving an advanced power strip could order Home Energy Kit 2 for $4.95. Other items in Kit 2 are the same as Kit 1.

The program also provided direct-install kits for multifamily properties. Eligible properties received items from Kit 1, with the expectation that property staff would install the items in each unit.

Advanced power strips were also available for purchase at a discounted price through Ameren Missouri's online store.

[1] Ameren Missouri did not market water coolers in PY15 but honored its customers' rebate requests.

[2] Ameren Missouri did not market programmable thermostats but honored its customers' rebate requests.

[3] Ameren Missouri phased out electric storage water heaters in February and March 2015.

Table 1. PY15 Home Energy Kit Contents

Measure	Kit 1 Quantity	Kit 2 Quantity*
Energy-Efficient Faucet Aerator	2	2
Energy-Efficient Showerhead	1	1
Pipe Wrap**	1	1
Advanced Power Strip	0	1
Compact Fluorescent Bulbs (CFLs)	4	4
Light Emitting Diode Bulbs (LEDs)	2	2

* Participants elected to pay $4.95 to receive this kit.

** 12-foot total

Key Impact Evaluation Findings

The Cadmus team's key findings for the PY15 evaluation period are described in the next sections.

Program Data Adjustments

The Cadmus team reviewed data for the single-family customers who received home energy kits to ensure the program was counting only one kit per customer. The PY15 program reported distributing 5,380 kits. The team found that 54 kits were sent to customers who had already received a kit earlier in PY15 so it adjusted the total to 5,326 kits, which resulted in a 99% verification rate.

Gross Impacts

As shown in Table 2, we estimated per-unit gross realization rates for all Efficient Product measures as the ratio of Ameren Missouri's *ex ante* savings from its 2012 Technical Resource Manual (TRM) and our evaluated (*ex post*) savings.[4] We found the highest realization rates were for direct-install pipe wrap (324%), dual-speed pool pumps (167%), and heat pump water heaters (159%). We attributed these higher realization rates to:

- Longer lengths of pipe wrap installed
- Differences between ENERGY STAR pool pump outputs for dual-speed pool pumps compared with 2012 TRM calculations
- Higher efficiency levels than assumed for purchased heat pump water heaters

Compared to the PY14 findings, programmable thermostats in PY15 exhibited the lowest realization rate (19%). Advanced power strips (29%-35%) and water coolers (39%) also exhibited lower realization rates in PY15 because of lower estimates of how these products would be used than assumed in the 2012 TRM.

[4] Ameren Missouri. *Technical Resource Manual.* 2012. https://www.efis.psc.mo.gov/mpsc/commoncomponents/viewdocument.asp?DocId=935658483

Because no changes were made to program delivery in PY15, the Cadmus team did not conduct participant phone surveys. Instead, the team applied installation rates from the most recent evaluation results. It used PY14 installation rates for kit measures in single-family homes and PY13 installation rates for direct-install kit measures and equipment rebate measures.

Table 2 summarizes PY15 participation, *ex post* gross per-unit savings, realization and installation rates, and *ex post* total gross savings.

Table 2. PY15 Summary: *Ex Post* Program Gross Savings Accounting for Installation Rates

Measure	PY15 Participation*	Per-Unit *Ex Post* Savings (kWh/yr)	Realization Rate	Installed and Operating	Total *Ex Post* Gross Savings (kWh/yr)
Equipment Rebates					
Electric Water Heaters	39	175	111%	100%	6,816
Heat Pump Water Heaters	371	2,865	159%	100%	1,063,044
RACs	1,171	50	43%	100%	58,085
Programmable Thermostats***	18	105	19%	99%	1,879
Dual-speed Pool Pumps	12	1,810	167%	100%	21,720
Variable-speed Pool Pumps	807	2,061	134%	100%	1,663,237
Air Purifier	1,963	515	107%	100%	1,011,268
Water Coolers	26	140	39%	100%	3,649
Kit Measures – Single-Family (5,326 total kits)					
CFLs	21,304	24	56%	75%	375,703
LEDs	10,652	26	74%	92%	249,819
Advanced Power Strips, Load Sensing	1,259	54	23%	78%	53,204
Faucet Aerators	10,652	39	35%	52%	213,678
Low-Flow Showerheads	5,326	222	29%	47%	555,878
Water Heater Pipe Wrap	5,326	312	49%	41%	673,991
Kit Measures – Multifamily (3,686 total kits)					
CFLs	14,744	24	73%	98%	341,118
LEDs	7,372	26	80%	98%	184,772
Faucet Aerators	7,372	38	102%	100%	279,938
Low-Flow Showerheads	3,686	252	106%	86%	798,135
Water Heater Pipe Wrap	3,686	91	324%	100%	334,341
Upstream Discounts – Online Store					
Advanced Power Strips, Load Sensing	275	59	32%	100%	16,269
Advanced Power Strips, Motion Sensing	21	64	35%	100%	1,354
Total	**96,082**	**N/A**	**79%**	**89%**	**7,907,987**

* Verified measures.

The program's overall gross savings realization rate increased from 57% in PY14 to 79% in PY15.

Net Savings

As shown in Table 3, the Efficient Products program has an overall savings-weighted net-to-gross (NTG) ratio of 98.1%.

Table 3. PY15 Net Impact Results Summary

Measure Group	*Ex Post* Gross Savings (kWh/yr)	Free Ridership	Participant Spillover	Non-Participant Spillover	NTG	Net Savings (kWh/yr)
Equipment Rebates	3,829,698	6.20%	3.10%	3.70%	100.6%	3,852,367
Home Energy Kits	4,060,666	10.40%	3.40%	3.70%	96.7%	3,884,225
Upstream Discount Advanced Power Strips	17,623	N/A	N/A	3.70%	103.7%	18,275
Total	7,661,134	**N/A**	**N/A**	**N/A**	98.1%	7,754,868

*Results may not match calculations in table due to rounding

As shown in Table 4, the PY15 program achieved 31% of its net energy savings target of 25,087 MWh, as specified in the Ameren Missouri's residential tariff.[5]

Table 4. PY15 Efficient Products Savings Comparisons

Metric	MPSC-Approved Target[1]	*Ex Ante* Gross Savings Utility Reported[2]	*Ex Post* Gross Savings Determined by EM&V[3]	*Ex Post* Net Savings Determined by EM&V[4]	Percent of Goal Achieved[5]
Energy (MWh)	25,087	10,049	7, 908	7,755	31%
Demand (kW)	3,838	1,586	1,162	1,152	30%

[1] Union Electric Company. Electric service applying to residential energy efficiency in Missouri service area. Effective June 30, 2013. Available at: http://www.ameren.com/-/media/missouri-site/Files/Rates/UECSheet191EEResidential.pdf

[2] Calculated by applying verified program activity to 2012 TRM savings values. Available at: https://www.efis.psc.mo.gov/mpsc/commoncomponents/viewdocument.asp?DocId=935658483

[3] MWh calculated by applying verified program activity to the Cadmus team's evaluated savings values; kW calculated by dividing Ex Post Net savings by program NTG.

[4] Calculated by multiplying the Cadmus team's evaluated gross savings and evaluated NTG ratio.

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

[5] Union Electric Company. Electric service applying to residential energy efficiency in Missouri service area. Effective June 30, 2013. Available at: http://www.ameren.com/-/media/missouri-site/Files/Rates/UECSheet191EEResidential.pdf

Key Process Evaluation Findings

Interviews with program stakeholders (program management and implementation staff) focused on changes made to PY15, including adjustments to measures offered by the program and a shifting focus to the home energy kits' direct-install component.

The program did not meet its PY15 energy savings goal of 25,087 kWh/year, as specified in the Ameren Missouri tariff. However, the program was able to achieve greater energy savings while maintaining participation levels consistent with PY14.

Marketing and Outreach

The Efficient Products program marketed each component (equipment rebates, home energy kits, direct-install kits, and discounted advanced power strips) differently:

- **Equipment Rebate Measures.** The program worked with retailers to place program materials in stores, coordinate in-store activities, and provide training on rebates and applications. Implementers also worked with retailers to conduct on-site promotions to show customers products and to discuss the rebates.
- **Home Energy Kits.** The program marketed home energy kits by sending a series of postcards targeting customers living in single-family homes and using electricity for hot water. To identify eligible multifamily properties for the direct-install kits involved cross-marketing with other programs, following up with contractors who were researching upgrades but were not qualified for other programs, and using Ameren Missouri's low-income multifamily program to identify entities that manage additional properties.
- **Advanced Power Strips.** Ameren Missouri offered discounted advanced power strips at promotional prices through its online store.

Program Data

In PY14, the program began making the transition to a new database, Vision, which was designed to make program data accessible to program administrators and evaluators in real time. The transition was completed in PY15 and the Cadmus team used these data for PY15 evaluation activities. Similar to PY14, program data did not include some relevant product information for all measures (e.g., room air conditioner data did not include Btu/hr or energy efficiency ratio (EER) values) and the Cadmus team relied on PY13 program data or TRM variables to calculate impacts.

Key Conclusions and Recommendations

The Efficient Products program achieved greater energy savings in PY15 while maintaining participation levels similar to PY14. However, the program fell short of its annual target in 2015 because of differences between the TRM-based deemed savings and evaluated savings values and phase-out of the program.

However, the dual- and multispeed pool pumps were particularly successful in PY15, and a large portion of the program's energy savings was attributed to heat pump water heaters and the installation of the kit's measures.

The Cadmus team offers these conclusions and recommendations for improving the program.

Conclusion 1. Changes made to the data tracking and reporting system are expected to improve future program reporting and evaluation activities. Although the transition to the Vision database was completed by the time of the PY15 evaluation, the measure detail available for rebated measures remained unchanged.

> **Recommendation 1. If the program continues, consider working with the evaluator and implementer to review data that is currently not recorded in Vision and identify any changes that could improve program and evaluation activities.** For example, although a field exists for EER values for RACs in the Vision database, these data were not captured. Detailed program data in Vision would improve the accuracy of evaluated savings values by allowing evaluators to base EER values on rebated RACs rather than program assumptions.

PY14 Recommendation Tracking

The Cadmus team also followed up with Ameren Missouri's response to the PY14 evaluation's recommendations to track what has and has not been implemented. These actions, as reported by Ameren Missouri, are presented in Table 5.

Table 5. PY14 Evaluation Recommendation Tracking

PY14 Recommendation	Ameren Missouri Response	Explanation
Consider tying installation of kit items to receipt of the advanced power strip through "call to action" marketing to help capture savings associated with installing Kit 4 items.	Not Implemented	Modified Home Energy Kit choices to one free Home Energy Kit and one $4.95 Home Energy Kit containing an advanced power strip.
Consider increasing the number of LEDs included in kits. In determining the optimal number of bulbs to include in the kit, consider the balance between likely installation rates and overhead cost savings achieved from providing a larger number bulbs in each kit. High LED installation rates indicate participants may be willing to replace older bulbs prior to burn out.	Partially Implemented	Modified design to decrease number of CFLs in EE Kit. CLEAResult completed customer follow-up calls to aid in increasing the installation rate of Home Energy Kit items.
Develop a protocol for property management staff to report the number and location of items installed at each property and to report these data along with current data, showing the number of kits delivered through the program. This will increase the accuracy of reported participation in this delivery channel and improve verification activities.	Partially Implemented	CLEAResult conducted installation verification in multifamily dwelling units.
Report the number of items and kits returned by property management staff. This will increase the ability to track items and kits distributed through the program.	Not Implemented	The number of multifamily dwelling units is verified before the kits mailed to property management.
Consider working with the evaluator and implementer to revisit data currently unpopulated in Vision and identify changes to would help improve program and evaluation activities. For example, while a field exists for EER values for RACs in the Vision database, these data were not captured. Detailed program data would help ensure rebated items qualify for the program and would improve verification.	Not Implemented	Rebates for RACs and other ENERGY STAR-qualified measures are verified against ENERGY STAR models in the database on Energystar.gov website.
Develop a protocol for assigning dates to participant and program activities and define the date used to establish participation year. Inconsistent dating protocols may have contributed to differences between Vision data and reported participation in PY14.	Implemented	Worked with AEG (Vision implementation) and Residential Program portfolio implementers to establish uniform protocols to aid in minimizing reporting inconsistencies.

Introduction

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

Program Description

The Efficient Products program began in Cycle 1 (2009–2012) as the energy-efficient product rebate component of the combined PY09 Lighting and Appliance program.

Ameren Missouri partnered with two third-party contractors:

- CLEAResult (formerly Applied Proactive Technologies) implemented the program and managed a network of retail partners that sell qualifying equipment.
- Energy Federation Incorporated (EFI) processed the rebates on Ameren Missouri's behalf and operated the online store for smart strips.

Beginning in PY12, Ameren Missouri discontinued the appliance portion of the combined Lighting and Appliance program so the program focused exclusively on lighting products. Ameren Missouri and CLEAResult reintroduced RebateSavers in PY13 as a new, stand-alone appliance program, designed to promote a variety of energy-efficient products in the marketplace. In PY14, Ameren Missouri changed the program name from RebateSavers to Efficient Products.

The Efficient Products program provides incentives that encourage customers to purchase technologies that can save money, improve comfort, and save energy. The program also seeks to educate customers about energy-efficient product options and energy-savings tips.

The PY15 Efficient Products program provided downstream mail-in and online rebates for the following:

- ENERGY STAR®-certified room air conditioners (RACs)
- ENERGY STAR-certified heat pump water heaters
- ENERGY STAR-certified air purifiers
- ENERGY STAR-certified water coolers[6]
- ENERGY STAR-certified dual-speed pool pumps
- ENERGY STAR-certified variable-speed pool pumps

[6] Ameren Missouri did not market water coolers but honored its customers' rebate requests.

- Programmable thermostats[7]
- Electric storage water heaters with an Energy Factor (EF) of 0.93 or higher[8]

The Efficient Products also offered a Home Energy Kit upon request to customers with electric hot water heaters. Participants who wanted a free kit could order Home Energy Kit 1, which included the items shown in Table 6. Participants interested in an advanced power strip could order Home Energy Kit 2 for $4.95. Table 6 shows items provided in each kit.

Table 6. PY15 Home Energy Kit Contents

Measure	Kit 1 Quantity	Kit 2 Quantity
Energy-Efficient Faucet Aerator	2	2
Energy-Efficient Showerhead	1	1
Pipe Wrap*	1	1
Advanced Power Strip	0	1**
Compact Fluorescent Bulbs (CFLs)	4	4
Light Emitting Diode Bulbs (LEDs)	2	2
* 12-foot total ** Participants elected to pay $4.95 to receive this measure.		

The program also provided direct-install kits for multifamily properties. Eligible properties received the items from Kit 1, with the expectation that property staff would install the items in each unit. Ameren Missouri's online store featured discounted advanced power strips.

[7] Ameren Missouri did not market programmable thermostats but honored its customers' rebate requests.

[8] Ameren Missouri phased out electric storage water heaters in February and March 2015.

Program Activity

In PY15, the Efficient Products program delivered a total of 13,715 products to Ameren Missouri participants, as shown in Table 7.

Table 7. PY15 Efficient Products Program Activity

Measure	PY15 Totals
Equipment Rebates	
Electric Water Heaters	39
Heat Pump Water Heaters	371
RACs	1,171
Programmable Thermostats	18
Dual-Speed Pool Pumps	12
VFDs on Pool Pumps	807
Air Purifiers	1,963
Water Coolers	26
Subtotal	**4,407**
Home Energy Kits	
Home Energy Kits – Single-family	5,326
Home Energy Kits – Direct Install in Multifamily	3,686
Subtotal	**9,012**
Upstream Discounts – Online Store Purchases	
Advanced Power Strips – Load Sensing	275
Advanced Power Strips – Motion Sensor	21
Subtotal	**296**
Total	**13,715**

Evaluation Methodology

In evaluating Ameren Missouri's Efficient Products program, the Cadmus team identified these objectives for PY15:

- Identify PY15 program changes
- Estimate the program's gross energy savings and demand reductions
- Calculate the program's cost-effectiveness
- Assess the program's achievements against goals

Table 8 lists evaluation activities and briefly explains the purpose of each activity. Descriptions of each activity follow the table.

Table 8. PY15 Process and Impact Evaluation Activities and Rationale

Evaluation Activity	Process	Impact	Rationale
Review the Tracking Data	✓	✓	Provide assurance that all necessary program data are tracked accurately and incorporated into savings estimates.
Interview Stakeholders	✓		Identify changes to program delivery and identify successes and challenges.
Update Engineering Analysis Variables		✓	Update gross kWh savings estimates.
Conduct a Cost-Effectiveness Analysis		✓	Measure the program's cost-effectiveness using five standard perspectives: total resource cost, utility cost, societal cost test, participant cost test, and ratepayer impact test.

Data Tracking Review

The Cadmus team reviewed the program tracking data recorded in the Vision database to determine completeness and identify variables necessary for impact calculations.

Stakeholder Interviews

In November 2015, the Cadmus team interviewed Efficient Products program stakeholders. We designed these interviews to:

- Gather information on how the program has changed since PY14;
- Identify challenges program staff or implementers have encountered; and
- Determine appropriate solutions.

The Cadmus team spoke with four program stakeholders across Ameren Missouri and CLEAResult, as shown in Table 9. Appendix B provides the stakeholder interview guide.

Table 9. PY15 Completed Stakeholder Interviews

Stakeholder Group	Interviews Conducted
Ameren Missouri Program Management	2
CLEAResult Program Management	2
Total	**4**

Throughout PY15, we regularly spoke with Ameren Missouri program staff to discuss program operations and coordinate evaluation activities.

Participant Surveys

Participant surveys were not conducted in PY15 because the Efficient Products program did not change its delivery, process, and offerings.

Engineering Analysis

To estimate per-unit gross savings for each Efficient Products measure, the Cadmus team used engineering algorithms, assumptions, and all available Ameren Missouri- and participant-specific inputs. These algorithms yielded estimates of the difference in energy use of the rebated product and usage of a similar product meeting the minimum federal standard for efficiency. The Gross Impact Evaluation Results section of this report presents each algorithm and input assumption.

Cost-Effectiveness Analysis

Using final PY15 Efficient Products participation and implementation data as well as *ex post* gross and net savings estimates presented in this report, Morgan Marketing Partners (MMP) determined the program's cost-effectiveness using DSMore (a financial analysis tool designed to evaluate the costs, benefits, and risks of demand-side management [DSM] programs and services). MMP also calculated measure-specific cost-effectiveness. As shown in the Cost-Effectiveness Results section, MMP assessed cost-effectiveness using all five of the standard perspectives produced by DSMore:

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

CSR Impact Evaluation Requirements

According to the Missouri Code of State Regulations (CSR),[9] demand-side programs that are part of a utility's preferred resource plan are subject to ongoing process and impact evaluations that meet certain

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

criteria. Specifically, the CSR requires that impact evaluations of a demand-side program satisfy the requirements listed in Table 10. The table also indicates the data our team used to satisfy these impact CSR evaluation requirements for the Efficient Products program. We provide a summary of the process CSR requirements in Table 14 at the end of the Process Evaluation section.

Table 10. 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	✓	Unchanged from the PY14 approach, the program compares the pre-adoption load based on assumed baseline technology with the post-adoption load based on program technology and estimates weather and interactive effects using TRM and industry assumptions, metering, and modeling, when necessary.
Comparisons between loads for program participants and an appropriate control group over the same period		
Data: The evaluation must use one or more of the following types of data to assess program impact:		
Monthly billing data		
Hourly load data		
Load research data		
End-use load metered data	✓	Unchanged from the PY14 approach, Cadmus used metered lighting hours of use by room in a sample of homes in the program area during 2013-2014.
Building and equipment simulation models	✓	Unchanged from the PY14 approach, Cadmus used simulation modeling to determine the waste-heat impact of efficient lighting.
Survey responses	✓	Cadmus relied on PY14 participant surveys on purchasing practices and other product participants to determine installation rates.
Audit and survey data on:		
Equipment type/size efficiency	✓	Cadmus relied on the PY14 audit of all lighting in sample of homes in program area and an audit of equipment type/efficiency for other products through review and analysis of the program database.
Household or business characteristics	✓	Cadmus relied on PY14 household characteristics from homes participating in lighting audit: home type, own/rent home, and kit participants and Low Income program participants.
Energy-related building characteristics		

Process Evaluation Findings

This section presents the Cadmus team's process evaluation findings for Ameren Missouri's Efficient Products program. The findings are organized in three sections—Program Design, Program Delivery, and Marketing and Outreach.

Program Design

The Efficient Products program design seeks to promote awareness of energy efficiency and to encourage the purchase and use of energy-efficient products. The program uses three components to achieve these objectives:

- Downstream rebates for customers purchasing high-efficiency, home energy products from participating retailers
- Free Home Energy Kits for customers with electric water heaters
- Upstream discounts for advanced power strips, sold through Ameren Missouri's online store

Downstream Rebates

The downstream rebate component primarily relies on partnerships with participating retailers to communicate available incentives and to create customer awareness about energy-efficient products. Table 11 lists the Efficient Products program's eligible products and associated rebate amounts.

Table 11. Rebated Measures*

Qualifying Products	Rebate Amount
ENERGY STAR Certified Heat Pump Water Heater	$500
ENERGY STAR Certified Dual-Speed Pool Pumps	$350
ENERGY STAR Certified Variable Speed Pool Pumps	$350
ENERGY STAR Certified Air Purifiers	$50
Electric Storage Water Heaters with an EF of 0.93 or higher**	$45
ENERGY STAR Certified Room Air Conditioner	$20
ENERGY STAR Certified Water Coolers***	$15

* Ameren Missouri did not offer programmable thermostats in PY14 or PY15 and these were not re-evaluated; however, in PY15 Ameren Missouri honored PY13 rebates for $25 per thermostat.

** Ameren Missouri phased out electric storage water heaters in February and March 2015.

*** Ameren Missouri no longer markets the water coolers but will honor its customers' rebate requests.

Similar to PY14, more than 200 retailers participated in the PY15 Efficient Products program.

Home Energy Kits

Ameren Missouri continued to distribute Home Energy Kits to its electric water heating customers in FY15. Customers could choose either Kit 1 for free or pay $4.95 for Kit 2, which included an advanced power strip. In addition to the energy-saving measures, each kit contained installation instructions. Table 12 lists the number of measures in each kit.

Table 12. Home Energy Kit Measures

Measure	Kit 1 Quantity	Kit 2 Quantity
Energy Efficient Faucet Aerator	2	2
Energy Efficient Showerhead	1	1
Pipe Wrap*	1	1
Advanced Power Strip	0	1**
Compact Fluorescent Bulbs (CFLs)	4	4
Light Emitting Diode Bulbs (LEDs)	2	2
* 12-foot total ** Participants elected to pay $4.95 to receive this kit.		

CLEAResult delivered these kits through two channels—direct mail and direct install. The majority of kits were mailed directly to single-family households requesting a kit; the remaining kits were mailed to multifamily property owners and directly installed by building maintenance staff.

Upstream Discounts

Ameren Missouri sold four types of advanced power strips at a discount through an online store managed by EFI. To qualify for the discount, customers must verify upon check-out that they live within Ameren Missouri's service territory. The price of these advanced power strips ranges from $4.95 to $32.95, as shown in Table 13.

Table 13. Available Advanced Power Strips

Manufacturer and Model	Type	Cost	Image
TrickleStar 12 Outlet Advanced Power Strip	Load-sensing	$18.95	
TrickleStar Motion Sensor Advanced Power Strip	Occupancy-sensing and Load-sensing	$15.95	
TrickleStar 7-Outlet Advanced Power Strip	Load-sensing	$4.95	
TrickleStar APS Plus +	Infra-red remote sensing and Load-sensing	$32.95	

Program Delivery

This section discusses responses from program stakeholder during the Cadmus team's interviews regarding program management and delivery topics. Interviews primarily focused on changes occurring since PY14.

PY15 Program Changes

The configuration of the Home Energy Kits remained the same as PY14. Program staff said the multifamily direct-install delivery channel received greater emphasis than the single-family direct-mail channel. Program staff reported that marketing conducted by senior field representatives to multifamily

unit owners significantly increased installations of kit products in PY15 over the same period in FY14. Stakeholders reported the program phased out water coolers and electric storage water heaters in PY15 in response to the PY14 evaluation, but had not introduced any new measures.

Delivery Successes and Program Achievements

Stakeholders reported the following about aspects of the program that worked particularly well:

- Program implementer said pool pumps and air purifiers were both "wins" in PY15, as demonstrated by pool pump participation increasing from 52 in PY14 to 819 in PY15, and air purifier participation increasing from 392 in PY14 to 1,963 in PY15. Program staff said the program received more pool pump rebates than had been "considered possible." These increases may relate to the implementer's report that retailers have changed their stocking patterns and inventory to ensure they have qualifying products and that the measures were available at the start of PY15. The increase may also be a result of the measures being available from the beginning of PY15, compared with PY14 when the measures were introduced mid-year, toward the end of the summer season.
- Staff also reported the program received more ENERGY STAR Certified Room Air Conditioner rebates, as demonstrated by air conditioner participation increasing from 372 in PY14 to 1,171 in PY15. These increases may relate to the increased incentive for these measures.

Program Implementation Challenges and Potential Changes

Program stakeholders identified few challenges and areas for future exploration:

- The program saw a decline in activity for the high-performance water heater. The implementer said in past years General Electric had discounted these products; however, it had not seen these same discounts offered in PY15.
- The implementer said smart thermostats should be considered for inclusion in the program.

Marketing and Outreach

This section provides the Cadmus team's findings on Efficient Products marketing strategies.

Primary Marketing Channels: Equipment Rebates

Efficient Products primarily conducted marketing through retailers to place program materials in stores, coordinate in-store activities, and provide training on rebates and applications. Implementers also worked with retailers to conduct on-site promotions to show products to customers and discuss rebates. The implementer reported over 200 retailers participated in the program in PY15.

Program implementers said they had increased outreach to plumbers, with the goal of increasing heat pump water heater and pool pump installations. It was unclear at the time of the evaluation if this outreach was successful, as multiple factors may have influenced the installation of these measures, including pool pumps being available to participants from the beginning of PY15 (compared to mid-way through PY14) and the phase-out of the PY15 program.

Primary Marketing Channels: Home Energy Kits and Advanced Power Strips

The program also promoted discounted advanced power strips through Ameren Missouri's online store and free Home Energy Kits. PY15 marketing for these delivery channels relied on the same strategies discussed in PY14:

- **Advanced Power Strips:** Ameren Missouri offered discounted advanced power strips at promotional prices through the online store.
- **Home Energy Kits:** The program marketed energy-saving kits through a series of postcards targeting electric hot water customers.

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 14. 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 10.

Table 14. 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?	Prior research has indicated that lack of energy-efficiency awareness and the higher upfront cost of energy-efficient products are common barriers to this market segment. The PY15 evaluation did not determine that these imperfections have been addressed and it is assumed that the primary market has remained stable across the PY13-PY15 period.
2	Is the target market segment appropriately defined, or should it be further subdivided or merged with other market segments?	PY13 findings indicated the target market of all residential customers is appropriate for the equipment rebate programs. The target market segments remain unchanged from PY13 and it was determined that a market study would not be completed in PY14 or PY15. Efficiency Kits are limited to those with electric water heating. This is appropriate for this program. Additional markets, such as schools, may be explored in future years.
3	Does the mix of end-use measures included in the program appropriately reflect the diversity of end-use energy service needs and existing end-use technologies within the target market segment?	The Efficient Products program continues to be a highly diverse program, offering 13 energy-efficient home technologies in HVAC, lighting, plug-load, pumps, and water heating end-uses. This is a dynamic, responsive program, as demonstrated by the addition of multiple measures in PY14 and the discontinuation of measures in PY14 and PY15.
4	Are the communication channels and delivery mechanisms appropriate for the target market segment?	Unchanged from PY14, the delivery channels are appropriate and reach customers through retail and direct-mail efforts, including in-store advertisements, bill inserts, contractors, postcards, and Ameren Missouri's website. In PY15, outreach to multifamily property owners resulted in increased installation of kit products.
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?	Program promotions that provide program and energy education can help to overcome market imperfections. Timing product promotions so that they coincide with seasons of high use may also help implementation, as demonstrated by the higher participation in the pool pump rebate in PY15.

Gross Impact Evaluation Results

This section details the Cadmus team's determination of each measure's installation rate and calculations of per-unit savings for Ameren Missouri's Efficient Products' program.

Measure Installation Verification

The Cadmus team used PY14 installation rates to estimate energy savings for PY15 measures.[10] As shown in Table 15, the installation rates varied by delivery channel.

Table 15. Measure Installation

Measure	Percentage Installed and Operating*
Equipment Rebates	
Electric Water Heaters	100%
Heat Pump Water Heaters	100%
RACs	100%
Programmable Thermostats	99%
Variable-speed Pool Pumps	100%
Air Purifier	100%
Water Coolers	100%
Kit Measures—Single-Family	
CFLs	75%
LEDs	92%
Advanced Power Strips	78%
Faucet Aerators	52%
Low-Flow Showerheads	47%
Water Heater Pipe Wrap	41%
Kit Measures—Multifamily	
CFLs	98%
LEDs	98%
Faucet Aerators	100%
Showerheads	86%
Water Heater Pipe Wrap	100%
Upstream Discounts – Online Store Purchases	
Advanced Power Strips, Load Sensing	100%
Advanced Power Strips, Motion Sensing	100%

*PY14 value applied in PY15.

[10] Cadmus conducted participant surveys in PY13 and PY14 to assess measure installation rates.

Measure-Specific Gross Savings

Using the engineering algorithms established in the Efficient Products evaluation plan, the Cadmus team's engineers estimated savings for each program measure. We describe the gross energy savings determined for each measure along with algorithms and inputs used.

Electric Water Heaters

We estimated per-unit electric savings for water heaters using the following algorithm:

$$\boldsymbol{Energy\ Savings\ (kWh/Year)} = \left(\frac{\mathbf{1}}{\boldsymbol{EFbase}} - \frac{\mathbf{1}}{\boldsymbol{EFeff}}\right) \times (\boldsymbol{HWT} - \boldsymbol{CWT}) \times \boldsymbol{Den} \times \boldsymbol{GPD} \times \mathbf{365} \times \boldsymbol{C_p} \times \frac{\mathbf{1}}{\mathbf{3413}}$$

Table 16. Electric Water Heaters PY15 Savings Assumptions

Term	PY15 Value	PY15 Source
EFbase	0.90	Federal minimum standard
EFeff	0.94	PY14 Efficient Products Database - Average EF
HWT	135	Ameren Missouri 2012 TRM[1]
CWT	61.3	Ameren Missouri 2012 TRM[1]
GPD	64	Secondary Source [2]
C_P	1	Specific Heat of Water (Btu/lb-oF)
Den	8.33	Density of water (lb/gallon)
Days	365	Conversion Factor (day/yr)
3413	3,413	Conversion Factor (Btu/kWh)

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

[2] U.S. Department of Energy (DOE) Federal Energy Management Program Energy Cost Calculator. Available at: http://www1.eere.energy.gov/femp/technologies/eep_waterheaters_calc.html

Using this engineering algorithm, the Cadmus team determined an *ex post* energy savings value of 175 kWh/year for each installed and retained electric water heater. This value represented approximately 111% of the program's *ex ante* value (157 kWh/year), based on Morgan Measure Library (MML) data (Table 17). The difference between *ex ante* and *ex post* savings estimates resulted from the average energy factor (EF) of the rebated measures (0.94), whereas the *ex ante* value assumed a value of 0.93.

Table 17. *Ex Ante* and *Ex Post* Comparison for Electric Water Heaters

Ex Ante Savings/Unit	*Ex Post* Savings/Unit	Realization Rate
157 kWh/yr	175 kWh/yr	111%

Heat Pump Water Heaters

The Cadmus team estimated per-unit savings for heat pump water heaters using the following algorithm:

$$\boldsymbol{Energy\ Savings\ (kWh/Year)} = \left(\frac{\mathbf{1}}{\boldsymbol{EFbase}} - \frac{\mathbf{1}}{\boldsymbol{EFeff}}\right) \times (\boldsymbol{HWT - CWT}) \times \boldsymbol{Den} \times \boldsymbol{GPD} \times \mathbf{365} \times \boldsymbol{C_p} \times \frac{\mathbf{1}}{\mathbf{3413}} - \boldsymbol{kWhheat} + \boldsymbol{kWhcool}$$

Where:

EFbase = energy factor of baseline water heater

EFeff = energy factor of program-qualified water heaters

HWT = hot water temperature (°F)

CWT = cold water temperature (°F)

GPD = gallons of hot water used per day

C_p = specific heat of water

Den = the water density (lb/gal)

kWhheat = heating interaction due to heat removed from room to heat water

kWhcool = cooling interaction due to heat removed from room to heat water

Table 18. Heat Pump Water Heaters PY15 Savings Assumptions

Term	PY15 Value	PY15 Source
EFbase	0.90	Federal minimum standard
EFeff	2.7	PY15 Efficient Products Database, Average EF[1]
HWT	135	Ameren Missouri 2012 TRM[2]
CWT	61.3	Ameren Missouri 2012 TRM[2]
GPD	64	Secondary Source [3]
kWhheat	Electric Resistance = 1,577 Heat Pump = 779	Ohio Statewide 2012 TRM [4]
kWhcool	180	Ohio Statewide 2012 TRM 4
C_P	1	Specific Heat of Water (Btu/lb-oF)
Den	8.33	Density of water (lb/gallon)
Days	365	Conversion Factor (day/yr)
3413	3,413	Conversion Factor (Btu/kWh)

[1] Value updated from PY14.

[2] Available at: https://www.efis.psc.mo.gov/mpsc/commoncomponents/viewdocument.asp?DocId=935658483

[3] DOE Federal Energy Management Program Energy Cost Calculator. Available at: http://www1.eere.energy.gov/femp/technologies/eep_waterheaters_calc.html

[4] Interactive effects were adjusted to account for the saturation of electric resistance heat, heat pumps, and central air conditioners in Ameren Missouri's territory, as found by the PY14 Efficient Products survey (11%, 29%, and 91% respectively).

Using this engineering algorithm, we determined an *ex post* energy savings value of 2,865 kWh/year for each installed and retained heat pump hot water heater. This value was approximately 159% of the program's *ex ante* value (1,802 kWh/year), based on MML data (Table 19). The difference between estimates resulted from higher-than-expected efficiency levels of actual purchases.

Table 19. *Ex Ante* and *Ex Post* Comparison for Heat Pump Water Heaters

Ex Ante Savings/Unit	*Ex Post* Savings/Unit	Realization Rate
1,802 kWh/yr	2,865 kWh/yr	159%

Room Air Conditioners

The Cadmus team estimated per-unit savings for RACs using the following algorithm:

$$\boldsymbol{Energy\ Savings\ (kWh/Year)} = \frac{\frac{\boldsymbol{BTU}}{\boldsymbol{hr}} \times \left(\frac{\mathbf{1}}{\boldsymbol{EER_{BASE}}} - \frac{\mathbf{1}}{\boldsymbol{EER_{EFF}}}\right) \times \boldsymbol{EFLH_{COOL}}}{\mathbf{1,000}}$$

Where:

Btu/hr = the RAC'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)

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

Table 20. Room Air Conditioner PY15 Savings Assumptions

Term	PY15 Value	PY15 Source
Btu/hr	9,558	PY13 Efficient Products Program Database, Average Btu/hr
EER_{BASE}	9.8	Federal minimum efficiency standard
EER_{EFF}	10.7	PY13 Efficient Products Program Database, Average EER
$EFLH_{COOL}$ – primary unit[1]	860	PY13 CoolSavers Program Data
$EFLH_{COOL}$ – secondary unit[1]	556	Secondary Source[2]
1,000	1,000	Conversion Factor (Wh/kWh)

[1] A weighted average for $EFLH_{COOL}$ for primary and secondary sources was used, based on PY14 survey responses; 84% of respondents reported using their RAC as a secondary cooling source.

[2] Based on weather-adjusted metering data from California. Report available here: Cadmus. *Residential Retrofit High Impact Measure Evaluation Report: Evaluation of PGE2000, SDGE3024, & SCE2501 Room Air Conditioners (2006-2008)*. 2010. http://www2.epa.gov/sites/production/files/documents/CA_PUC_Assessment.pdf

Using this engineering algorithm, we determined an *ex post* energy savings value of 50 kWh/year for each installed and retained RAC, which, as shown in Table 21, was approximately 43% of the program's *ex ante* value (115 kWh/year).

Table 21. *Ex Ante* and *Ex Post* Comparison for RACs

Ex Ante Savings/Unit	*Ex Post* Savings/Unit	Realization Rate
115 kWh/yr	50 kWh/yr	43%

The difference between estimates primarily resulted from the difference in effective full-load hours (EFLH)—with a higher assumed value in *ex ante* calculations, which relied on the ENERGY STAR calculator. The ENERGY STAR calculator assumes that a RAC was used as the primary cooling source in the home and that it would be used similar to a central air conditioner; however, the PY13 Efficient Products participant survey determined 84% of respondents used their RACs as secondary cooling sources. The PY13 evaluation determined a weather-adjusted EFLH for secondary units, as shown in Table 22, which lists the CPUC study EFLH, the weather adjustment factor for conversion to an Ameren Missouri-specific value, and the resulting Ameren Missouri-specific EFLH value.

Table 22. Weather-Adjusted EFLH Value for Ameren Missouri

Source Study	Metered Sites	CA Climate Zone 9 CDD	Ameren Missouri CDD	Adjustment Factor	CA Climate Zone 9 EFLH	Adjusted EFLH for Ameren Missouri
2009 CPUC	102 RACs	1,456	1,550	106%	522	556

ENERGY STAR Air Cleaner

The Cadmus team estimated per-unit ENERGY STAR air cleaner savings using the following ENERGY STAR calculator algorithm:

$$\boldsymbol{Energy\ Savings}\left(\frac{\boldsymbol{kWh}}{\boldsymbol{Year}}\right) = \left\{\boldsymbol{CADR}\left(\left(\frac{\boldsymbol{1}}{\boldsymbol{Eff_{BL}}}\right) - \left(\frac{\boldsymbol{1}}{\boldsymbol{Eff_{ES}}}\right)\right) \times \left(\boldsymbol{Hr_{oper}}\right) + \left(\boldsymbol{SB_{BL}} - \boldsymbol{SB_{ES}}\right) \times \left(\boldsymbol{24} - \boldsymbol{Hr_{oper}}\right)\right\} \times \frac{\boldsymbol{365}}{\boldsymbol{1{,}000}}$$

Where:

Eff_{ES}	=	CADR/Watt for ENERGY STAR unit
Eff_{BL}	=	CADR/Watt for baseline unit
SB_{EW}	=	Standby for ENERGY STAR unit
SB_{BL}	=	Standby for baseline unit
CADR	=	Clean air recovery rate for dust
Hr_{oper}	=	Hours per day of operation

Table 23. ENERGY STAR Air Cleaner PY15 Savings Assumptions

Term	PY15 Value	PY15 Source
Eff_{ES}	2.77	PY15 Efficient Products Database
Eff_{BL}	1.00	ENERGY STAR Appliance Calculator
SB_{EW}	0.272	ENERGY STAR Appliance Calculator
SB_{BL}	1.00	ENERGY STAR Appliance Calculator
CADR	137.59	PY15 Efficient Products Database
Hr_{oper}	16	ENERGY STAR Appliance Calculator

Using this engineering algorithm, we estimated a per-unit savings value of 515 kWh/year for each ENERGY STAR air cleaner (Table 24). This value was approximately 107% of the 2012 TRM estimate (482 kWh/year), based on an older version of the ENERGY STAR calculator algorithm (which has since been updated). The difference between 2012 TRM and estimated savings estimates primarily resulted from a higher clean-air delivery rate for dust, which was 123.5 when the 2012 TRM was developed and 137.59 in the program data.

Table 24. *Ex Ante* and *Ex Post* Comparison for ENERGY STAR Air Cleaners

Ex Ante Savings/Unit	*Ex Post* Savings/Unit	Realization Rate
482 kWh/yr	515 kWh/yr	107%

ENERGY STAR Hot and Cold Storage Tank Water Coolers

The Cadmus team estimated per-unit ENERGY STAR hot and cold storage tank water cooler savings using the following ENERGY STAR calculator algorithm:

$$\boldsymbol{Energy\ Savings}\left(\frac{\boldsymbol{kWh}}{\boldsymbol{Year}}\right) = (\boldsymbol{DEU_{BL} - DEU_{ES}}) \times \mathbf{365}$$

Where:

DEU_{BL} = Daily energy use (kWh/day) for baseline

DEU_{ES} = Daily energy use (kWh/day) for ENERGY STAR

Table 25. ENERGY STAR Hot & Cold Storage Tank Water Cooler PY15 Savings Assumptions

Term	PY15 Value	PY15 Source
DEU_{BL}	1.09	Baseline value established by ENERGY STAR Program
DEU_{ES}	0.70	PY15 Efficient Products Database

Using this engineering algorithm, we estimated a per-unit savings value of 140 kWh/year for each ENERGY STAR water cooler. This value was approximately 39% of the 2012 TRM estimate of 361 kWh/year that was based on an older version of the ENERGY STAR calculator algorithm (which has since been updated), as shown in Table 26.

The difference between 2012 TRM and estimated savings estimates primarily resulted from a lower daily energy use baseline (i.e., water coolers have become much more efficient) and the new ENERGY STAR specification level effective in February 2014. The 2012 TRM estimate was based on a much higher difference between baseline and ENERGY STAR specification daily energy use (DEU) values.

Table 26. *Ex Ante* and *Ex Post* Comparison for ENERGY STAR Water Coolers

Ex Ante Savings/Unit	*Ex Post* Savings/Unit*	Realization Rate
361 kWh/yr	140 kWh/yr	39%

* Value differs due to rounding.

ENERGY STAR Dual-Speed Pool Pumps

The Cadmus team estimated per-unit dual-speed pool pump savings using the following algorithm:

$$\boldsymbol{Energy\ Savings}\left(\frac{\boldsymbol{kWh}}{\boldsymbol{Year}}\right) = \boldsymbol{Days}_{\boldsymbol{oper}} \times \left\{\left(\frac{\boldsymbol{kWh}_{\boldsymbol{ss}}}{\boldsymbol{Day}}\right) - \left(\frac{\boldsymbol{kWh}_{\boldsymbol{ds}}}{\boldsymbol{Day}}\right)\right\}$$

Where:

$$\left(\frac{\boldsymbol{kWh}_{\boldsymbol{ds}}}{\boldsymbol{Day}}\right) = \left(\frac{\boldsymbol{kWh}_{\boldsymbol{hs}}}{\boldsymbol{Day}}\right) + \left(\frac{\boldsymbol{kWh}_{\boldsymbol{ls}}}{\boldsymbol{Day}}\right)$$

And:

$$\left(\frac{\boldsymbol{kWh}_{\boldsymbol{ss}}}{\boldsymbol{Day}}\right) = \frac{(\boldsymbol{RT}_{\boldsymbol{ss}} \times \boldsymbol{GPM}_{\boldsymbol{ss}} \times \mathbf{60})}{(\boldsymbol{EF}_{\boldsymbol{ss}} \times \mathbf{1,000})}$$

And:

$$\left(\frac{\boldsymbol{kWh}_{\boldsymbol{hs}}}{\boldsymbol{Day}}\right) = \frac{(\boldsymbol{RT}_{\boldsymbol{hs}} \times \boldsymbol{GPM}_{\boldsymbol{hs}} \times \mathbf{60})}{(\boldsymbol{EF}_{\boldsymbol{hs}} \times \mathbf{1,000})}$$

And:

$$\left(\frac{\boldsymbol{kWh}_{\boldsymbol{ls}}}{\boldsymbol{Day}}\right) = \frac{(\boldsymbol{RT}_{\boldsymbol{ls}} \times \boldsymbol{GPM}_{\boldsymbol{ls}} \times \mathbf{60})}{(\boldsymbol{EF}_{\boldsymbol{ls}} \times \mathbf{1,000})}$$

And where:

$Days_{oper}$	=	Days/year of operation
RT_{ss}	=	Runtime in hours/day using single-speed pump
RT_{ls}	=	Runtime in hours/day in low speed using dual-speed pump
RT_{hs}	=	Runtime in hours/day in high speed using dual-speed pump
GPM_{ss}	=	Gallons per minute using single-speed pump
GPM_{ls}	=	Gallons per minute in low speed using dual-speed pump
GPM_{hs}	=	Gallons per minute in high speed using dual-speed pump

EF_{ss} = Energy factor using single-speed pump

EF_{ls} = Energy factor in low speed using dual-speed pump

EF_{hs} = Energy factor in high speed using dual-speed pump

Table 27. ENERGY STAR Dual-Speed Pool Pump PY15 Savings Assumptions

Term	PY15 Value	PY15 Source
$Days_{oper}$	121.6	ENERGY STAR Pool Pump Calculator adjusted for dual speed in Missouri.
RT_{ss}	11.4	
RT_{ls}	9.8	
RT_{hs}	2.0	
GPM_{ss}	64.4	
GPM_{ls}	31.0	
GPM_{hs}	56.0	
EF_{ss}	2.1	
EF_{ls}	5.4	
EF_{hs}	2.4	

Using this engineering algorithm, we estimated a per-unit saving value of 1,810 kWh/year for dual-speed pool pumps (Table 28). This value was approximately 167% of the 2012 TRM's per unit savings (1,081 kWh/year), based on motor efficiency, load factor, and horsepower and not using the ENERGY STAR calculation methodology to estimate savings.

Table 28. *Ex Ante* and *Ex Post* Comparison for ENERGY STAR Dual-Speed Pool Pumps

Ex Ante Savings/Unit	*Ex Post* Savings/Unit	Realization Rate
1,081 kWh/yr	1,810 kWh/yr	167%

ENERGY STAR Variable Speed Pool Pumps

The Cadmus team estimated per-unit variable speed pool pump savings using the following algorithm:

$$\boldsymbol{Energy\ Savings}\left(\frac{\boldsymbol{kWh}}{\boldsymbol{Year}}\right) = \boldsymbol{Days_{oper}} \times \left\{\left(\frac{\boldsymbol{kWh_{ss}}}{\boldsymbol{Day}}\right) - \left(\frac{\boldsymbol{kWh_{vs}}}{\boldsymbol{Day}}\right)\right\}$$

Where:

$$\left(\frac{\boldsymbol{kWh_{vs}}}{\boldsymbol{Day}}\right) = \left(\frac{\boldsymbol{kWh_{hs}}}{\boldsymbol{Day}}\right) + \left(\frac{\boldsymbol{kWh_{ls}}}{\boldsymbol{Day}}\right)$$

And:

$$\left(\frac{\boldsymbol{kWh_{ss}}}{\boldsymbol{Day}}\right) = \frac{(\boldsymbol{RT_{ss}} \times \boldsymbol{GPM_{ss}} \times \mathbf{60})}{(\boldsymbol{EF_{ss}} \times \mathbf{1,000})}$$

And:

$$\left(\frac{kWh_{hs}}{Day}\right) = \frac{(RT_{hs} \times GPM_{hs} \times 60)}{(EF_{hs} \times 1,000)}$$

And:

$$\left(\frac{kWh_{ls}}{Day}\right) = \frac{(RT_{ls} \times GPM_{ls} \times 60)}{(EF_{ls} \times 1,000)}$$

And where:

$Days_{oper}$	=	Days/year of operation
RT_{ss}	=	Runtime in hours/day using single-speed pump
RT_{ls}	=	Runtime in hours/day in low speed using variable-speed pump
RT_{hs}	=	Runtime in hours/day in high speed using variable-speed pump
GPM_{ss}	=	Gallons per minute using single-speed pump
GPM_{ls}	=	Gallons per minute in low speed using variable-speed pump
GPM_{hs}	=	Gallons per minute in high speed using variable-speed pump
EF_{ss}	=	Energy factor using single-speed pump
EF_{ls}	=	Energy factor in low speed using variable-speed pump
EF_{hs}	=	Energy factor in high speed using variable-speed pump

Table 29. ENERGY STAR Variable Speed Pool Pump PY15 Savings Assumptions

Term	PY15 Value	PY15 Source
$Days_{oper}$	121.6	ENERGY STAR Pool Pump Calculator adjusted for variable speed in Missouri.
RT_{ss}	11.4	
RT_{ls}	10.0	
RT_{hs}	2.0	
GPM_{ss}	64.4	
GPM_{ls}	30.6	
GPM_{hs}	50.0	
EF_{ss}	2.1	
EF_{ls}	7.3	
EF_{hs}	3.8	

Using this engineering algorithm, we estimated a per-unit saving value of 2,061 kWh/year for variable speed pool pumps (Table 30). This value was approximately 134% of the 2012 TRM's per-unit savings (1,542 kWh/year), based on motor efficiency, load factor, and horsepower and not using the ENERGY STAR calculator to estimate savings.

Table 30. *Ex Ante* and *Ex Post* Comparison for ENERGY STAR Variable Speed 1 Pumps

Ex Ante Savings/Unit	*Ex Post* Savings/Unit	Realization Rate
1,542 kWh/yr	2,061 kWh/yr	134%

Programmable Thermostats

The Cadmus team did not evaluate this measure in PY15 because the program did not offer it. Instead, we used PY13 evaluated savings, which were estimated using the PY13 Efficient Products participant survey data with the Ameren Missouri 2012 TRM savings algorithm and assumptions.

To calculate programmable thermostat savings, we weighted the savings values from the MML database to the reported program building stock then applied an adjustment factor to account for changes in participant behavior. We used the following resources and inputs:

- MML database to obtain home type, HVAC system type, home vintage, and building type.
- Participant survey data to obtain heating and cooling system saturations.
- Participant survey data to obtain behavioral data:
  - Use of previous thermostat (whether manual or programmable)
  - Use of Ameren Missouri-rebated replacement thermostat (including Nest thermostats)

Using weighted MML savings values—modified with a thermostat use factor derived from participant behavioral data—we determined the per-unit thermostat savings using the following algorithm:

We determined per-unit thermostat savings using the following algorithm:

$$\boldsymbol{Energy\ Savings}\left(\frac{\boldsymbol{kWh}}{\boldsymbol{Year}}\right) = \boldsymbol{MML\ kWh\ X\ Thermostat\ use\ factor}$$

Where:

- MML kWh = MML kWh savings weighted by program-specific housing characteristics
- Thermostat use factor = Program-specific behavioral adjustment (%)

For our PY13 calculation of the thermostat use factor, we asked survey respondents how they used their new programmable thermostat (including participants who purchased Nest thermostats). Then, to determine if their behavior changed after the new thermostat was installed, we asked how they used their previous thermostat. Our survey showed that a large percentage (72%) of PY13 respondents had been using their previous thermostat in a way that saved energy and that that 93% of PY13 respondents used their new thermostat in a manner that would save energy. The high percentage of PY13 participants who were already using a thermostat in a manner that would save energy resulted in a low net value of 21%. Table 31 presents the MML kWh, the thermostat use factor, and the *ex post* per-unit kWh for programmable thermostats.

Table 31. Programmable Thermostat Savings

Program	MML kWh	Thermostat Use Factor	*Ex Post* kWh
Efficient Products	502.0	21%	105.4

We determined an *ex post* energy savings value of 105 kWh/year for each installed and retained programmable thermostat. As shown in Table 32, this value was approximately 19% of the program's *ex ante* value (543 kWh/year). The main differences between the *ex ante* and *ex post* savings resulted from the program-specific adjustments made for heating and cooling equipment saturations and the thermostat use factor of 21%.

Table 32. *Ex Ante* and *Ex Post* Comparison for Programmable Thermostats

Ex Ante Savings/Unit	*Ex Post* Savings/Unit	Realization Rate
543 kWh/yr	105.4 kWh/yr	19%

CFLs and LEDs

The Cadmus team estimated per-unit savings for CFLs and LEDs using the following algorithm:

$$\boldsymbol{Energy\ Savings\ (kWh/Year)} = \frac{(\boldsymbol{WattBASE} - \boldsymbol{WattEE}) \times \boldsymbol{HoursRES} \times \boldsymbol{Days}}{\boldsymbol{1,000}} \times \boldsymbol{WHF}$$

Where:

WattBASE = wattage of the original incandescent bulb replaced by a Home Energy Kit CFL or LED

WattEE = wattage of new bulb installed

HoursRES = the average hours of use per day

Days = days used per year

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

WHF = Waste heat factor to account for interactive effects

Table 33. CFL and LED PY15 Savings Assumptions

Term	PY15 Value		PY15 Source
	CFL	LED	
WattBASE	43	43	PY15 Lighting Evaluation shelf-stocking study
WattEE	13	10.5	Program Data – kits contain 13 Watt CFLs and 10.5 Watt LEDs
Hours	2.2		PY14 Lighting Evaluation*
Days	365		Conversion Factor (day/yr)
1,000	1,000		Conversion Factor (Wh/kWh)
WHF	0.98		PY13 Engineering Simulation Modeling adjusted for heating and cooling saturations**

* See the PY14 Lighting evaluation for more details regarding the metering study.

** See the PY13 evaluation report for more details.

Using this engineering algorithm, we determined an *ex post* energy savings value of 24 kWh/year for each installed and retained CFL and 26 kWh/year for LEDs. These values were approximately 75% and 81%, respectively, of the program's *ex ante* value (31.5 kWh/year), based on the MML. The difference between estimates primarily resulted from lower hours of use found during the PY14 Lighting Evaluation than those assumed by MML and from differences baseline kWh/year values.

Table 34. *Ex Ante* and *Ex Post* Comparison for Kit CFLs and LEDs

Lighting Type	*Ex Ante* Savings/Unit	*Ex Post* Savings/Unit	Realization Rate
CFLs	31.5 kWh/yr	24 kWh/yr	75%
LEDs	54.5 kWh/yr	26 kWh/yr	47%

Advanced Power Strips

For advanced power strips, we used PY13 evaluated per-unit savings derived from secondary research.[11] We calculated the *ex ante* and *ex post* per-unit savings for the different types of advanced power strips sold through the program in PY15 and used in various home locations (Table 35).

Table 35. *Ex Ante* and *Ex Post* Comparison for Advanced Power Strips

APS Type	*Ex Ante* Savings/Unit	*Ex Post* Savings/Unit	Realization Rate
Home Office—Load sensing	184 kWh/yr	31 kWh/yr	17%
Home Entertainment—Load sensing		75 kWh/yr	41%
Home Office—Motion sensing		34 kWh/yr	18%
Home Entertainment—Motion sensing		82 kWh/yr	45%

To determine final per-unit savings values for load-sensing advanced power strips provided through the kit, we adjusted *ex post* savings based on the saturation levels of peripheral device use, as determined through PY14 Home Energy Kit participant surveys. Responses to our surveys revealed saturation levels differed by delivery channel (Table 36).

Table 36. Adjusted *Ex Post* Values Considering Peripheral Device Saturation

Delivery Channel and APS Type	Home Office Saturation	Entertainment Center Saturation	Adjusted *Ex Post* Savings/unit
Home Energy Kit: Load sensing[1]	48%	52%	54 kWh/yr
Online Store: Load sensing[2]	36%	64%	59 kWh/yr
Online Store: Motion sensing[2]	36%	64%	64 kWh/yr

[1] Source: PY14 Home Energy Kit participant survey.

[2] Source: PY13 PerformanceSavers participant survey.

[11] A detailed overview of NYSERDA algorithms used and differences in assumptions between the NYSERDA report and the Ameren TRM are contained in the PY13 Final RebateSavers Evaluation.

Faucet Aerators

The Cadmus team estimated per-unit savings for faucet aerators using the following algorithm:

$$\boldsymbol{Energy\ Savings\ (kWh/Year)} = \frac{\boldsymbol{People \times Faucet\ Time \times Days \times \Delta GPM \times (T_{FAUCET} - T_{IN}) \times C_P \times Den}}{\boldsymbol{3413 \times RE \times Number\ of\ Faucets}}$$

Where:

People = the number of people using faucet aerators (people/household)

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

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

ΔGPM = the difference in rated gallons per minute between the base unit and the new unit (gal/min)

T_{FAUCET} = the average water temperature out of the faucet (°F)

T_{IN} = the average inlet water temperature (°F)

C_P = the specific water heat (Btu/lb-°F)

Den = the water density (lb/gal)

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

RE = the water heater's recovery efficiency

Number of Faucets = the number of used faucets per home

Although the engineering algorithm was the same for faucet aerators delivered to single-family homes and installed in multifamily properties, several assumptions differed, as shown in Table 37.

Using this engineering algorithm, we determined the following *ex post* energy savings values:

- 39 kWh/year for each installed and retained aerator delivered to single-family homes (approximately 68% of the program's *ex ante* values).
- 38 kWh/year for multifamily homes (approximately 102% of the program's *ex ante* values).

The difference between *ex post* and *ex ante* estimates primarily resulted from two factors:

- The 2012 TRM assumed an average faucet time of five minutes per day, based on a 1997 report by American Water Works Association Research Foundation. For the evaluated savings assumption, we used metering data from the PY11 Multifamily Income Qualified (MFIQ) program, which found an average faucet use time of 3.7 minutes per day.
- The 2012 TRM assumed 1.9 faucets per home, based on the PY10 MFIQ program site visits. In contrast, the 2012 Ameren Missouri potential study found an average of 2.04 bathrooms and assumed one kitchen faucet (for a total of 3.04 faucets per home) for single-family homes; PY13 data indicated 2.4 faucets per home in multifamily homes.

Table 37. Faucet Aerator PY15 Savings Assumptions

Term	PY15 Value: Single-Family	PY15 Source: Single-Family	PY15 Value: Multifamily	PY15 Source: Multifamily
People	2.67	PY14 Energy Kit Participant Survey[1]	2.07	PY14 Community Savers Program Data[1]
Faucet Time	3.7	PY11 MFIQ Metering Study/Person	3.7	PY11 MFIQ Metering Study/Person
Days	365	Conversion Factor (day/yr)	365	Conversion Factor (day/yr)
ΔGPM	0.7	PY13 Program Data	0.7	PY13 Program Data
T_{FAUCET}	80	Ameren Missouri 2012 TRM2	80	Ameren Missouri 2012 TRM[2]
T_{IN}	61.3	Ameren Missouri 2012 TRM2	61.3	Ameren Missouri 2012 TRM[2]
RE	0.98	Secondary Source[3]	0.98	Secondary Source[3]
CP	1	Specific Heat of Water (Btu/lb-oF)	1	Specific Heat of Water (Btu/lb-oF)
Den	8.33	Density (lb/gal)	8.33	Density (lb/gal)
3413	3,413	Conversion Factor (Btu/kWh)	3,413	Conversion Factor (Btu/kWh)
Number of faucets	3.04	Secondary Source[4]	2.4	PY13 Program Data

[1] Value updated from PY13.
[2] Available at: https://www.efis.psc.mo.gov/mpsc/commoncomponents/viewdocument.asp?DocId=935658483
[3] Recovery efficiency for electric hot water heater. *2010 Ohio Technical Reference Manual.* Available at: http://amppartners.org/pdf/TRM_Appendix_E_2011.pdf
[4] Assumes one kitchen faucet per household, plus an average of 2.04 bathrooms per home, as determined by the Ameren Missouri 2012 potential study.

Table 38 shows *ex ante* and *ex post* savings.

Table 38. *Ex Ante* and *Ex Post* Comparison for Kit Low-Flow Aerators

Home Type	*Ex Ante* Savings/Unit	*Ex Post* Savings/Unit	Realization Rate
Single-Family	57 kWh/yr	39 kWh/yr	68%
Multifamily	37 kWh/yr	38 kWh/yr	102%

Showerheads

The Cadmus team estimated energy-efficient showerhead savings using the following algorithm:

$$\boldsymbol{Energy\ Savings}\ (\boldsymbol{kWh/Year}) = \frac{\boldsymbol{People} \times \boldsymbol{Shower\ Time} \times \boldsymbol{Days} \times \%\boldsymbol{Days} \times \Delta\boldsymbol{GPM} \times (\boldsymbol{T_{SHOWER}} - \boldsymbol{T_{IN}}) \times \boldsymbol{C_P} \times \boldsymbol{Den}}{\boldsymbol{3,413} \times \boldsymbol{RE} \times \boldsymbol{Showerheads}}$$

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 per day, per person (shower/day-ppl)

ΔGPM = the difference in rated gallons per minute for the base showerhead and the new showerhead (gal/min)

T_{SHOWER} = the average water temperature at the showerhead (^{o}F)

T_{IN} = the average inlet water temperature (^{o}F)

C_P = the specific heat of water (Btu/lb-^{o}F)

Den = the water density (lb/gal)

3,413 = the conversion rate between Btu and kWh (Btu/kWh)

RE = the water heater's recovery efficiency

Showerheads = the number of showerheads used per home

Although the engineering algorithm was the same for showerheads delivered to single-family homes and installed in multifamily properties, several assumptions differed. Table 39 contains the assumptions for both home types.

Table 39. Showerhead PY15 Savings Assumptions

Term	PY15 Value: Single-Family	PY15 Source: Single-Family	PY15 Value: Multifamily	PY15 Source: Multifamily
People	2.67	PY14 Energy Kit Participant Survey[1]	2.07	PY14 CommunitySavers Program Data[1]
ShowerTime	8.66	Secondary Source[2]	8.66	Secondary Source[2]
Days	365	Conversion Factor (day/yr)	365	Conversion Factor (day/yr)
%Days	0.66	Secondary Source[3]	0.66	Secondary Source[3]
ΔGPM	0.75	PY14 Program Data	0.75	PY14 Program Data
T_{SHOWER}	105	Secondary Source[4]	105	Secondary Source[4]
T_{IN}	61.3	Ameren Missouri 2012 TRM[5]	61.3	Ameren Missouri 2012 TRM[5]
RE	0.98	Secondary Source[6]	0.98	Secondary Source[6]
C_P	1	Specific Heat of Water (Btu/lb-°F)	1	Specific Heat of Water (Btu/lb-°F)
Den	8.33	Density (lb/gal)	8.33	Density (lb/gal)
3,413	3,413	Conversion Factor (Btu/kWh)	3,413	Conversion Factor (Btu/kWh)
Showerheads	2.05	PY13 Program Data	1.4	PY13 Program Data

[1] Value updated from PY13.
[2] DeOreo, William, P. Mayer, L. Martien, M. Hayden, A. Funk, M. Kramer-Duffield, and R. Davis. *California Single-Family Water Use Efficiency Study.* Sponsored by California Department of Water Resources. 2011. pp. 90-91. http://www.aquacraft.com/sites/default/files/pub/DeOreo-%282011%29-California-Single-Family-Water-Use-Efficiency-Study.pdf.
[3] DeOreo, Op cit. %Days are calculated by the number of showers per day per household (1.96, pp. 90 of the DeOreo study) divided by the average number of people per household (2.95, pp. 182 of the DeOreo study).
[4] The Bonneville Power Administration measured average shower temperatures as 104–106.
[5] Available at: https://www.efis.psc.mo.gov/mpsc/commoncomponents/viewdocument.asp?DocId=935658483
[6] RE for electric hot water heater. *2010 Ohio Technical Reference Manual.* Available at: http://amppartners.org/pdf/TRM_Appendix_E_2011.pdf

Using this engineering algorithm, we determined the following *ex post* energy savings values for each installed and retained showerhead:

- 222 kWh/year for single-family homes (approximately 61% of the program's *ex ante* values).
- 252 kWh/year for multifamily homes (approximately 124% of the program's *ex ante* values).

Table 40 shows *ex ante* and *ex post* savings. The difference between the estimates for single-family homes primarily resulted from the following two factors:

- The 2012 TRM assumed one shower per person per day (%Days in the algorithm). The study we used, however, indicated 0.66 showers per person per day.[12]

[12] DeOreo, William, P. Mayer, L. Martien, M. Hayden, A. Funk, M. Kramer-Duffield, and R. Davis. *California Single-Family Water Use Efficiency Study.* Sponsored by California Department of Water Resources. pp. 90-91. 2011. Available at: http://www.aquacraft.com/sites/default/files/pub/DeOreo-%282011%29-California-Single-Family-Water-Use-Efficiency-Study.pdf.

- The 2012 TRM assumed one showerhead per home. However, primary data collected in PY13 found single-family homes receiving the kits had an average of 2.05 showerheads per home and multifamily homes had an average of 1.4 showerheads.

Table 40. *Ex Ante* and *Ex Post* Comparison for Kit Low-Flow Showerheads

Home Type	*Ex Ante* Savings/Unit	*Ex Post* Savings/Unit	Realization Rate
Single-family	361 kWh/yr	222 kWh/yr	61%
Multifamily	204 kWh/yr	252 kWh/yr	124%

Water Heater Pipe Wrap

The Cadmus team estimated per-unit savings from pipe wrap using the following algorithm:

$$\boldsymbol{Energy\ Savings\ (kWh/Year)} = \frac{\left(\left(\frac{\mathbf{1}}{\boldsymbol{R_{EXIST}}} - \frac{\mathbf{1}}{\boldsymbol{R_{NEW}}}\right) \times \boldsymbol{L} \times \boldsymbol{C} \times \boldsymbol{\Delta T} \times \mathbf{8,760}\right)}{\boldsymbol{RE} \times \mathbf{3413}}$$

Where:

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

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

L = length of pipe from a water heating source covered by pipe wrap (ft)

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

ΔT = average temperature difference between supplied water (hot water) and ambient air temperatures (°F)

8,760 = the number of hours during which heat loss occurs throughout the year (hr/yr)

RE= recovery efficiency of the electric hot water heater

3,413 = the conversion rate between Btu and kWh (Btu/kWh)

Although the engineering algorithm was the same for pipe wrap delivered to single-family homes and pipe wrap installed in multifamily properties, the multifamily properties used a shorter length of pipe wrap (four feet) than the average for single-family homes (12 feet), which resulted in a lower *ex post* savings value.

Table 41 shows the difference in the two assumptions.

Table 41. Pipe Wrap PY15 Savings Assumptions

Term	PY15 Value	PY15 Source
R_{EXIST}	1	Secondary Source[1]
R_{NEW}	4	PY14 Program Data
L (in feet)	12 ft – single-family 4 ft - multifamily	PY13 & PY14 Program Data[2]
C	0.196	Calculated (assumed ¾" D)[3]
ΔT	67.5 – single-family 58.9 – multifamily	Secondary Source; Ameren Missouri 2012 TRM[4] Secondary Source; PY11MFIQ site-visits[5]
8,760	8,760	Constant (Hours per year)
RE	0.98	Secondary Source[6]
3,413	3,413	Conversion Factor (Btu/kWh)

[1] Navigant Consulting Inc. "Measures and Assumptions for Demand Side Management Planning; Appendix C Substantiation Sheets." April 2009. Pg. 77.
[2] Value updated from PY13.
[3] 3/4" is standard pipe diameter.
[4]Ambient air temperature is 67.5 degrees based on U.S. Department of Energy Test Procedure for Water Heaters. May 11, 1998. http://www.gpo.gov/fdsys/pkg/FR-1998-05-11/pdf/98-12296.pdf. Hot water temperature is 135 degrees according to Ameren Missouri 2012 TRM.
[5] Ambient air temperature is 67.5 degrees based on U.S. Department of Energy Test Procedure for Water Heaters. May 11, 1998. http://www.gpo.gov/fdsys/pkg/FR-1998-05-11/pdf/98-12296.pdf. Hot water temperature of 126.4 based on site visits.
[6] RE for electric hot water heater. *2010 Ohio Technical Reference Manual.* Available at: http://amppartners.org/pdf/TRM_Appendix_E_2011.pdf

Using this engineering algorithm, we determined the following *ex post* energy savings values for installed pipe wrap:

- 312 kWh/year in single-family homes (approximately 121% of the program's *ex ante* value)
- 91 kWh/year in multifamily homes (approximately 324% of the program's *ex ante* value)

Table 42 shows *ex ante* and *ex post* savings. The difference between *ex ante* and *ex post* savings estimates for multifamily homes, compared with single-family homes, primarily resulted from installing the shorter average pipe length wrap.

Table 42. *Ex Ante* and *Ex Post* Comparison for Pipe Wrap

Home Type	*Ex Ante* Savings/Unit	*Ex Post* Savings/Unit	Realization Rate
Single-family	257 kWh/yr	312 kWh/yr	121%
Multifamily	23 kWh/yr	91 kWh/yr	324%

Summary

Table 43 lists per-unit *ex ante* and *ex post* gross savings by measure.

Table 43. PY15 Summary: Comparison of *Ex Ante and Ex Post* Per-Unit Gross Savings

Measure	*Ex Ante* (kWh/yr)	*Ex Post* (kWh/yr)	Realization Rate
Equipment Rebates			
Electric Water Heaters	157	175	111%
Heat Pump Water Heaters	1,802	2,865	159%
RACs	115	50	43%
Programmable Thermostats	543	105	19%
Dual-speed Pool Pumps	1,081	1,810	167%
Variable-speed Pool Pumps	1,542	2,061	134%
Air Purifier	482	515	107%
Water Coolers	361	140	39%
Kit Measures—Single-Family			
CFLs	32	24	75%
LEDs	32	26	81%
Advanced Power Strips—Load Sensing	184	54	29%
Faucet Aerators	57	39	68%
Showerheads	361	222	61%
Water Heater Pipe Wrap	257	312	121%
Kit Measures—Multifamily			
CFLs	32	24	75%
LEDs	32	26	81%
Faucet Aerators	37	38	102%
Showerheads	204	252	124%
Water Heater Pipe Wrap	28	91	324%
Upstream Discounts—Online Store			
Advanced Power Strips—Load Sensing	184	59	32%
Advanced Power Strips—Motion Sensing	184	64	35%

To estimate the program's total gross energy savings, we applied the per-unit values shown in Table 43 to the Efficient Products' PY15 participation rates, as shown in Table 44.

Table 44. PY15 Summary: *Ex Post* Program Gross Savings Accounting for Installation Rates

Measure	PY15 Participation	Per-Unit *Ex Post* Savings (kWh/hr)	Percent Installed and Operating	Total *Ex Post* Savings (kWh/yr)
Equipment Rebates				
Electric Water Heaters	39	175	100%	6,816
Heat Pump Water Heaters	371	2,865	100%	1,063,044
RACs	1,171	50	100%	58,085
Programmable Thermostats	18	105	99%	1,879
Dual-speed Pool Pumps	12	1,810	100%	21,720
Variable-speed Pool Pumps	807	2,061	100%	1,663,237
Air Purifier	1,963	515	100%	1,011,268
Water Coolers	26	140	100%	3,649
Kit Measures—Single-Family				
CFLs	21,304	24	75%	375,703
LEDs	10,652	26	92%	249,819
Advanced Power Strips—Load Sensing	1,259	54	78%	53,204
Faucet Aerators	10,652	39	52%	213,768
Low-Flow Showerheads	5,326	222	47%	555,878
Water Heater Pipe Wrap	5,326	312	41%	673,991
Kit Measures—Multifamily				
CFLs	14,744	24	98%	341,118
LEDs	7,372	26	98%	184,772
Faucet Aerators	7,372	38	100%	279,938
Low-Flow Showerheads	3,686	252	86%	798,135
Water Heater Pipe Wrap	3,686	91	100%	334,341
Upstream Discounts—Online Store				
Advanced Power Strips—Load Sensing	275	59	100%	16,269
Advanced Power Strips—Motion Sensing	21	64	100%	1,354
Total	**96,082**	**N/A**	**89%**	**7,907,987**

*Kit measure installation rates varied, depending on where they were mailed or installed directly. Final *ex post* savings were weighted according to the proportion of kits delivered through each method.

Table 45 compares the program's *ex ante* and *ex post* gross savings. Appendix A provides *ex post* demand savings, determined through DSMore using these *ex post* energy savings.

Table 45. PY15 Summary: Comparison of *Ex Ante and Ex Post* Program Gross Savings

Measure	*Ex Ante* (kWh/yr)	*Ex Post* (kWh/yr)	Realization Rate
Equipment Rebates			
Electric Water Heaters	6,123	6,816	111%
Heat Pump Water Heaters	668,542	1,063,044	159%
RACs	134,665	58,085	43%
Programmable Thermostats	9,774	1,879	19%
Dual-speed Pool Pumps	12,972	21,720	167%
Variable-speed Pool Pumps	1,244,659	1,663,237	134%
Air Purifier	946,156	1,011,268	107%
Water Coolers	9,395	3,649	39%
Kit Measures—Single-family			
CFLs	671,076	375,703	56%
LEDs	335,538	249,819	74%
Advanced Power Strips, Load Sensing	231,656	53,204	23%
Faucet Aerators	607,164	213,768	35%
Low-Flow Showerheads	1,922,686	555,878	29%
Water Heater Pipe Wrap	1,368,782	673,991	49%
Kit Measures—Multifamily			
CFLs	464,436	341,118	73%
LEDs	232,218	184,772	80%
Faucet Aerators	274,238	279,938	102%
Low-Flow Showerheads	750,838	798,135	106%
Water Heater Pipe Wrap	103,208	334,341	324%
Upstream Discounts—Online Store			
Advanced Power Strips, Load Sensing	50,600	16,269	32%
Advanced Power Strips, Motion Sensing	3,864	1,354	35%
Total	**10,048,590**	**7,907,987**	**79%**

Net Impact Evaluation Results

Free ridership is the percentage of savings that would have occurred in the program's absence due to participants purchasing the same measures without the program's influence. Thus free riders are customers who would have purchased the measure independent of the program and, because they account for some program costs but none of its benefits, they decrease a program's net savings.

To calculate the Efficient Products Program's NTG, the Cadmus team used the following formula:

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

Spillover is the savings that occur when customers undertake installation of additional energy efficiency measures or perform energy-efficient activities without receiving financial assistance due to their experience participating in a given program. Unlike free ridership, no program costs are associated with spillover savings, but energy-saving benefits do occur, which increase net savings.

Since the program offerings have not changed significantly, the Cadmus team applied the PY14 spillover results (Table 46) to PY15 gross savings estimates. We did not estimate market effects for the Efficient Products program. The Cadmus team did calculate nonparticipant spillover in PY15, which is shown in Table 46 with the program's net impacts.

Table 46. PY15 Net Impact Results Summary

Program Measure	*Ex Post* Gross Savings (kWh/yr)	Free Ridership	Participant Spillover	Non-participant Spillover	NTG	Net Savings (kWh/yr)
Equipment Rebates						
Electric Water Heaters	6,816	60.2%	3.1%	3.7%	46.6%	3,176
Heat Pump Water Heaters	1,063,044	18.7%			88.1%	936,542
RACs	58,085	58.2%			48.6%	28,229
Programmable Thermostats	1,879	56.0%			50.8%	954
Dual-Speed Pool Pumps	21,720	0.0%			106.8%	23,197
Variable-Speed Pool Pumps	1,663,237	0.0%			106.8%	1,776,337
Air Purifier	1,011,268	0.0%			106.8%	1,080,035
Water Coolers	3,649	0.0%			106.8%	3,897
Subtotal*	**3,829,698**	**6.2%**	**3.1%**	**3.7%**	**100.6%**	**3,852,367**
Kit Measures						
CFLs	716,821	12.0%	3.4%	3.7%	95.1%	681,696
LEDs	434,591	24.1%			83.0%	360,711
Advanced Power Strips	53,204	8.1%			99.0%	52,672
Faucet Aerators	493,706	3.7%			103.4%	510,492
Low-Flow Showerheads	1,354,013	10.6%			96.5%	1,306,622
Water Heater Pipe Wrap	1,008,332	10.7%			96.4%	972,032
Subtotal*	**4,060,666**	**11.4%**	**3.4%**	**3.7%**	**96.7%**	**3,884,225**
Upstream Discounts—Online Store*						
Advanced Power Strips—Load Sensing	16,269	N/A	N/A	3.7%	103.7%	16,871
Advanced Power Strips—Motion Sensing	1,354	N/A	N/A		103.7%	1,404
Program Total**	**7,907,987**	**8.9**	**3.2%**	**3.7%**	**98.1%**	**7,754,868**

* Values weighted by total program measure-level savings.

** Free ridership and participant spillover were not assessed for these measures.

Free Ridership Results

As discussed, the Cadmus team used the PY14 free ridership values to estimate free ridership in PY15. Table 47 provides PY15 free ridership estimates by measure.

Table 47. Efficient Products Free Ridership Results

Program Measure	Total Weighted Free Ridership Estimate
Electric Water Heater	60.2%
Heat Pump Water Heater	18.7%
Room Air Conditioner	58.2%
Programmable Thermostat	56.0%
Variable-Speed Pool Pumps*	0.0%
Air Purifier	0.0%
Water Coolers	0.0%
Overall—Equipment Rebates	**6.2%****
CFLs	12.0%
LEDs	24.1%
Faucet Aerators	3.7%
Low-flow Showerheads	10.6%
Advanced Power Strip	8.1%
Pipe Wrap	10.7%
Overall—Kit Measures	**11.4%****

* Dual-speed pool pumps were not evaluated in previous years due to there being no rebates paid for this measure. The PY15 evaluation applied the variable-speed free ridership score to dual-speed pool pumps.
** Values weighted by total program measure-level savings.

Participant Spillover Results

As discussed, the Cadmus team used PY14 spillover to estimate spillover in PY15. Table 48 provides PY15 spillover estimate for equipment rebates and Home Energy Kits.

Table 48. Participant Spillover by Data Collection Method and Measure

Delivery Channel	Spillover % Estimate
Equipment Rebates - Overall	**3.1%**
Home Energy Kits - Overall	**3.4%**

Nonparticipant Spillover

Effective program marketing and outreach generates program participation *and* increases general energy efficiency awareness among customers. The cumulative effect of sustained utility program

marketing (which often occurs concurrently for multiple programs) can affect customers' perceptions of their energy usage and, in some cases, motivates customers to take efficiency actions outside of the utility's program. This phenomenon—called nonparticipant spillover (NPSO)—results in energy savings caused by but not rebated through a utility's demand-side management (DSM) activity.

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

To understand whether Ameren Missouri's program-specific and general Act On Energy marketing efforts generated energy efficiency improvements outside of Ameren Missouri's incentive programs, the Cadmus team implemented a general population survey of residential customers in PY15 to determine the general population's energy efficiency awareness and non-program participants energy efficiency actions. This approach is consistent with the Uniform Methods Project protocols. [13]

Methodology

In PY15, the Cadmus team selected and surveyed 200 customers, based on a randomly generated sample frame of approximately 20,000 of Ameren Missouri's residential customers. Through screening survey respondents, we determined that the sample contained a number of customers (n=23) self-reporting that they participated in an Ameren Missouri residential program during PY15. When estimating NPSO, we excluded these customers from analysis, focusing on the 177 remaining random nonparticipants; this avoided potential double-counting of program savings and/or program-specific spillover. The sample of 200 is valid at 90% confidence level and within +-6% for estimating proportions.

We also limited the NPSO analysis to the same efficiency measures rebated through Ameren Missouri programs (known as "like" spillover) because Ameren Missouri focuses its marketing primarily on promoting the program portfolio, rather than through broad energy efficiency education. Program specific marketing doesn't preclude customers from implementing other energy efficiency improvements as a result of their exposure to the programs, however since spillover estimates are somewhat uncertain, restricting spillover to "like" measures adds a degree of conservativeness.[14] Examples of "like" spillover included removing a secondary refrigerator and installing a programmable thermostat. We did, however, exclude one notable category of "like" measures: lighting products. This precluded double-counting NPSO lighting savings already captured through the upstream Lighting program market affects analysis.

To ensure the responses included in the analysis represented electric spillover savings, Cadmus asked customers questions about fuel type for water heaters, heating systems, and cooling systems. The

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

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

analysis only counted savings associated with measures where there was a corresponding electric water heater, electric heat, or central air conditioning as spillover.

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

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

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

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

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

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

Results

Of 177 nonparticipants surveyed, 12 cited Ameren Missouri's marketing as "very important" or "somewhat important" in their decisions to purchase non-rebated, high-efficiency measures during 2015:[15]

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

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

Table 49 shows measures and PY15 gross evaluated kWh savings attributed to Ameren Missouri, with average savings per spillover action of 171 kWh.

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

Table 49. NPSO Response Summary

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

†Based on savings calculated for the Efficient Products program.
ˆBased on savings calculated for the Refrigerator Recycling program.
* Based on savings calculated for the Heating and Cooling program.
** Based on deemed savings from the Ameren Missouri Technical Resource Manual (TRM)
***Based on savings calculated for the Home Energy Performance program.

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

- For ceiling insulation measure we used the ex post weighted average ceiling insulation savings per home from the Home Energy Performance program.
- For the low flow showerhead measure we used the ex post average savings per showerhead from the Efficient Products program.
- For the programmed thermostat to reduce usage measure we used the ex post weighted average per setback savings from the Heating and Cooling program.
- For the removed refrigerator or freezer measure we used the ex post population weighted average of the part-use adjusted refrigerator and freezer per-unit savings estimates.
- For tune-ups we assumed the system was a central air conditioner receiving a condenser cleaning (the most common program tune-up measure). We applied the Heating and Cooling

program ex post savings for this measure of 251.4 kWh. For purposes of NPSO, we conservatively de-rated the estimated savings by 50% to get 125.7 kWh savings considering that a non-program tune-up may not meet the program quality standards and would save less.

- For smart strip plug outlets we used the ex post average savings for smart strips from the Efficient Products program.
- For the lowered temperature on water heater measure we used the deemed savings from the Ameren Missouri Technical Resource Manual which assumes a 40 gallon residential tank and a current typical existing market baseline of electric water heater thermostat set at 135 degrees F and a minimum threshold for savings credit of a post set point at 120 degrees F.
- For the respondent who installed 9 energy efficient windows we used the ex post average window savings per home from the Home Energy Performance program of 186.9 kWh.
- For the windows respondent who installed 3 energy efficient windows we applied one-third of the ex post average window savings per home from the Home Energy Performance Program.

To arrive at a single savings estimate (Variable A in Table 49), the Cadmus team used numbers in the Total kWh Savings column to calculate an average for the 15 measures assessed for NPSO. Thus, the 171 kWh estimate represented average nonparticipant energy savings, per respondent attributing spillover to Ameren Missouri's residential programs.

To determine the total NPSO generated by Ameren Missouri marketing in 2015, we used the following variables (as shown in Table 50):

- **A** is the average kWh savings per NPSO response.
- **B** is the number of NPSO measures attributed to the program.
- **C** is the number of nonparticipants contacted by the survey implementer.
- **D** is Ameren Missouri's total residential customer population (excluding PY15 participants).
- **E** is NPSO energy savings, extrapolated to the customer population, and calculated by dividing B by C, and then multiplying the result by A and D.
- **F** is Ameren Missouri's total reported 2015 program year *ex post* gross savings for Refrigerator Recycling, Heating and Cooling, Lighting, Home Energy Performance, and Efficient Products. (Similarly to PY14, the PY15 analysis did not include the Low Income program.)[16]
- **G** (representing NPSO as a percentage of total evaluated savings) is the nonparticipant percentage used in the NTG calculations.

Using this information, the Cadmus team estimated overall, portfolio-level NPSO at 8.6% of total PY15 reported *ex post* gross savings, as shown in Table 50. Smaller NPSO savings were reported in PY14 (7,592 MWH) than in PY15 (12,247 MWH). This combined with lower total *ex post* residential portfolio savings in PY15 (142,016 MHW) than in PY14 (210,530 MH). Consequently, this resulted in a higher

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

NPSO as a percent of total *ex post* residential portfolio savings values in PY15 (8.6%) than estimated for PY14 (3.6%). Both years identified a similar list of measures installed. A growing proportion of nonparticipant spillover is consistent with what we would expect from long running marketing of a program portfolio.

Table 50. NPSO Analysis

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

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

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

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

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

The Cadmus team distributed the portfolio-level result of 12,247 MWh NPSO to Ameren Missouri's residential programs (excluding Low Income). As noted, we considered the PY15 program size (in terms of total gross *ex post* MWh savings) and each program's marketing budget (as shown in Table 51) when allocating NPSO across programs.

Table 51. Program-Specific Savings and Marketing

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

The results of this approach—shown in Table 52 and Table 53—reflect each program's impact on the nonparticipant population, based on marketing expenditures and the magnitude of the program's intervention in the regional marketplace.

Table 52. Combined Savings and Marketing Allocation Approach

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

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

(accounting for 33% of marketing dollars and 8% of total energy savings) at 1,268 MWh. As NPSO impacts program-specific NTG results,[17] all NPSO estimates have been reported as a percentage of each program's total gross energy savings.

As shown in Table 53, we allocated 310 MWh of NPSO to the Efficient Products program, representing 2.5% of the combined residential portfolio savings and marketing expenditure. This resulted in a 3.9% adjustment to the program's PY15 NTG—findings generally similar to the PY14 NPSO analysis.

Table 53. NPSO by Program

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

Net Savings Summary

To estimate the overall program and measure NTG ratios, the Cadmus team used total population *ex post* gross kWh savings to weight results for each data collection method. Table 54 shows the components of each program measure's NTG estimate (free ridership and spillover) and the percentage of total program savings related to each measure's data collection method. We used the percentage of total program savings and NTG ratios specific to each measure to arrive at a savings-weighted NTG estimate of 100.6% for the program's equipment rebate portion. The savings-weighted NTG estimate for the program's kit measures portion was 95.2%.

Table 54. NTG by Measure

Measure	Free Ridership	Participant Spillover	Non-participant Spillover	NTG
Equipment Rebates				
Electric Water Heaters	60.2%	3.1%	3.7%	46.6%
Heat Pump Water Heaters	18.7%			88.1%
Room Air Conditioners	58.2%			48.6%
Programmable Thermostats	56.0%			50.8%
Dual and Variable Speed Pool Pumps	0.0%			106.8%
Air Purifiers	0.0%			106.8%
Water Coolers	0.0%			106.8%

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

Measure	Free Ridership	Participant Spillover	Non-participant Spillover	NTG
Total	**6.2%**	**3.1%**	**3.7%**	**100.6%**
Kit Measures				
CFLs	12.0%	3.4%	3.7%	95.1%
LEDs	24.1%			83.0%
Faucet Aerators	3.7%			103.4%
Low-flow Showerheads	10.6%			96.5%
Advanced Power Strip	8.1%			99.0%
Pipe Wrap	10.7%			96.4%
Total	**8.9%**	**3.2%**	**3.7%**	**98.1%**

As shown in Table 55, an overall weighted-by-total gross program savings NTG estimate of 97.9% resulted for the program as a whole.

Table 55. Overall Program NTG

Subprogram	Total Gross Program kWh Savings	Percentage of Program Savings	NTG	Overall Program NTG
Equipment Rebate Measures	3,829,698	48.4%	100.6%	98.1%
Kit Measures	4,060,666	49.8%	96,7%	
Advanced Power Strip-Online	17,623	0.2%	103.7%	

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 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 56 summarizes cost-effectiveness findings by test. Any benefit-cost score above 1.0 passed the test as cost-effective. In addition, the table includes the net present value (in 2013 dollars) of the Annual Net Shared Benefits or (sometimes referred to as UCT net lifetime benefits).[18] As shown, the Efficient Products program passed the UCT, societal, and PART tests. The program produced Annual Net Shared Benefits of more than $1,051,330, significantly lower than PY14 results. This difference is primarily due to the updated avoided energy costs, which are significantly lower than those assumed in PY14.

Table 56. Cost-Effectiveness Results (PY15)

Program	UCT	TRC	RIM	Societal	PART	Annual Net Shared Benefits*
Efficient Products	1.58	1.05	0.39	1.25	3.36	$1,051,330

* 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).

[18] 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 57. PY15 Summary: Net *Ex Post* Per-Unit Demand Reductions

Measure	PY15 Participation	Per-Unit Net *Ex Post* Demand Reduction (kW)	Total Net *Ex Post* Savings (kW)*
Equipment Rebates			
Electric Water Heaters	39	0.0091	0.4
Heat Pump Water Heaters	371	0.2830	105.0
RACs	1,171	0.0204	23.9
Programmable Thermostat	18	0.0000	0.0
Dual and Variable-speed Pool Pumps	819	0.5892	482.5
Air Purifier	1,963	0.0873	171.3
Water Coolers	26	0.0265	0.7
Kit Measures – Single-Family (7,690 total kits)			
CFLs	21,304	0.0007	15.4
LEDs	10,652	0.0008	8.6
Advanced Power Strips, Load Sensing	1,259	0.0066	8.3
Faucet Aerators	10,652	0.0023	24.7
Low-Flow Showerheads	5,326	0.0113	59.9
Water Heater Pipe Wrap	5,326	0.0137	73.1
Kit Measures – Multifamily (2,114 total kits)			
CFLs	14,744	0.0009	13.6
LEDs	7,372	0.0009	6.5
Faucet Aerators	7,372	0.0044	32.5
Low-Flow Showerheads	3,686	0.0235	86.5
Water Heater Pipe Wrap	3,686	0.0098	36.3
Upstream Discounts – Online Store			
Advanced Power Strips, Load Sensing	275	0.0097	2.7
Advanced Power Strips, Motion Sensing	21	0.0105	0.2
Total	**96,082**	**N/A**	**1,152**
*Accounts for line losses; total may not add to sum of measure-specific kW due to rounding			

CADMUS

Appendix B. Stakeholder Interview Guide

Respondent name: _____

Respondent phone: _____

Interview date: _____ Interviewer initials: _____

For the PY15 evaluation, Cadmus will interview stakeholders annually. The interview will focus on PY15 program changes and identify recommendations for improving subsequent programs.

Introduction

1. What are your main responsibilities for Ameren Missouri's Efficient Products Program? Has this changed since PY14?
2. What percent of your time is dedicated to Efficient Products?
3. What tasks do you regularly spend the majority of your time on?

Program Design and Implementation

4. Can you provide a summary of how the program has changed since PY14?
    a. Program name? Why was this change made?
    b. New measures? How was this decision made?
    c. Any delivery changes to equipment rebates?
    d. Any delivery changes to single family kits?
    e. Any delivery changes to multifamily kits?
        i. Are these installed by contractor? Property managers?
        ii. Who is paying for the $4.95 powerstrip?
    f. Did these changes have the desired outcomes?
5. What would you say is working particularly well so far in PY15? Why is that?
6. Conversely, what is not working as well as anticipated? Why is that?

Program Goals

7. What are the program's participation and savings goals for PY15? By equipment type?
8. How were these goals determined?
9. In your opinion, how has the program performed so far in PY15 (in general, as well as savings/participation goals)?
10. Why do you think this is?
11. Are there benchmarks in place to monitor progress throughout the year?
12. Have you identified the triggers for contingency plans in case goals are not being met?

Measures

13. In your opinion, should any additional measures be considered for inclusion in future programs? If so, what measures?
14. Conversely, should any current measures be excluded?

Marketing Efforts

15. How has marketing changed since PY14?

Retailer Participation

16. How many retailers currently participate in the program?
17. Has the retailer participation process changed since PY14? (Probe: do they need to sign an agreement with APT, and what are their obligations?)

Rebate Processing and Data Management

18. Do you have a goal for rebate processing times?
19. Have there been any issues or difficulties with rebate processing so far?
20. How is the online rebate portal working? (Any issues?) (PROBE: What proportion of sales do you anticipate coming through this channel? Is there a goal?)
21. How is the Vision database working? (Any issues?)

Quality Control

22. In your own words, please explain how the program's quality control process works.
23. For the EEKits, are there systems in place to prevent participants from receiving more than one kit?
24. How does the program ensure EEKit items are installed?
25. Does Ameren Missouri perform any ride-along or independent quality control checks? Please explain.
26. Is there anything else you'd like us to know?

Appendix C. Bibliography

Ameren Missouri. *Technical Resource Manual.* 2012. Available at: https://www.efis.psc.mo.gov/mpsc/commoncomponents/viewdocument.asp?DocId=935658483

Cadmus. *Residential Retrofit High Impact Measure Evaluation Report: Evaluation of PGE2000, SDGE3024, & SCE2501 Room Air Conditioners (2006-2008)*. 2010. Available at: http://www2.epa.gov/sites/production/files/documents/CA_PUC_Assessment.pdf

DeOreo, William, P. Mayer, L. Martien, M. Hayden, A. Funk, M. Kramer-Duffield, and R. Davis. *California Single-Family Water Use Efficiency Study.* Sponsored by California Department of Water Resources. pp. 90-91. 2011. Available at: http://www.aquacraft.com/sites/default/files/pub/DeOreo-%282011%29-California-Single-Family-Water-Use-Efficiency-Study.pdf.

National Renewable Energy Laboratory. *The Uniform Methods Project.* April 2013. Available online: https://www1.eere.energy.gov/office_eere/de_ump_protocols.html.

State of California. *California Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects.* October 2001. Available at: http://www.calmac.org/events/SPM_9_20_02.pdf

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

State of Ohio. *2010 Ohio Technical Reference Manual.* Available at: http://amppartners.org/pdf/TRM_Appendix_E_2011.pdf

Union Electric Company. Electric service applying to residential energy efficiency in Missouri service area. Effective June 30, 2013. Available at: http://www.ameren.com/-/media/missouri-site/Files/Rates/UECSheet191EEResidential.pdf