Ameren Missouri Refrigerator Recycling Impact and Process Evaluation: Program Year 2015

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Nexant

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Executive Summary

Ameren Missouri engaged Cadmus and Nexant (the Cadmus team) to perform annual process and impact evaluations of the Refrigerator Recycling 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, the final year in the three year program cycle.

Program Description

The Refrigerator Recycling program offers Ameren's residential customers a $50 incentive and free pick-up service for recycling any operable refrigerator and stand-alone freezer manufactured before 2002 (up to a total of three units per customer per year). With a qualifying refrigerator or freezer, customers may also recycle a working room air conditioner or dehumidifier; however, no incentives are provided for these units. The program is implemented by the Appliance Recycling Centers of America, Inc. (ARCA).

During PY15, the Refrigerator Recycling program recycled 10,619 appliances (8,381 refrigerators and 2,238 freezers). ARCA also collected 55 room air conditioners and 114 dehumidifiers. In PY15, the scale of the program was considerably larger than in PY14 (8,988 appliances) and greater than the program's previous highest collection efforts in PY11 (9,084 appliances).

Key Impact Evaluation Findings

As in the previous evaluations, the Cadmus team estimated gross energy savings by combining appliance characteristics established for PY15 with the results of a multivariate regression model that used *in situ* data from several metering studies for other recycling programs. This approach resulted in an accurate and cost-effective value specific to Ameren Missouri's program. We also applied the prospective part-use rates, which we determined through a survey of PY14 participants, to estimate the average per-unit gross energy savings for refrigerators and freezers.

As shown in Table 1, the *ex post* energy savings are significantly less than *ex ante* estimates which are based on Ameren Missouri's 2012 Technical Resource Manual (TRM).[1]

Table 1. Per-Unit Gross Energy Savings (kWh/Year)

Appliance	*Ex Ante*	*Ex Post*	Realization Rate
Refrigerators	1,440	1,028	71%
Freezers	1,429	895	63%
Room Air Conditioners	N/A	830	N/A
Dehumidifiers	N/A	964	N/A

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

Similar to PY14, the two main reasons for the differences between the PY15 *ex ante (*which Ameren Missouri based on the PY10 evaluation) and *ex post* savings was the availability of additional metering data to support our analysis and the adoption of the Uniform Methods Project (UMP) protocol.[2] (The PY13 evaluation included significant details about the disparity.)

Although the *ex ante* and *ex post* savings differ greatly, the PY15 *ex post* gross savings are nearly identical to Cadmus' estimates as part of the previous three recycling evaluations (PY11 to PY14). As evident in Table 2, the per-unit *ex post* gross energy savings for refrigerators—the program's primary measure—has consistently been between 997 kWh/year and 1,028 kWh/year since PY11.

Table 2. Comparison of Per-Unit *Ex Post* Gross Energy Savings (kWh/Year)

Appliance	PY10	PY11	PY12	PY13	PY14	PY15
Refrigerators	1,440	997	1,011	1,013	1,007	1,028
Freezers	1,429	789	922	969	867	895

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

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

However, market effects, the fourth NTG input, are not appropriate for appliance recycling programs because we already accounted for the program's impact on the regional used-appliance market by estimating induced replacement and secondary market impacts. Therefore, we did not adjust evaluated NTG for market effects.

Participant surveys were not conducted in PY15. To determine NTG, we used the findings from our PY14 surveys in which we asked participants about their likely actions independent of the program and asked nonparticipants how they *actually* discarded of operable units. This approach, recommended by the UMP, improves the reliability of the participants' self-reported actions—which are commonly subject to socially desirable response bias—by combining participant responses about likely actions with the actual actions reported by nonparticipants.

Given the consistency of NTG values derived from surveys conducted during PY11 through PY14, we believe the PY14 results are a valid and reliable source for estimating participant free ridership. Table 3 compares these *ex post* and *ex ante* values for the program's most common measures.

[2] U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy. *Uniform Methods Project: Determining Energy Efficiency Program Savings.* Available at: http://energy.gov/eere/about-us/ump-protocols

Table 3. *Ex Ante* and *Ex Post* Net-to-Gross Ratios

Appliance	*Ex Ante* NTG	*Ex Post*			
		Free Ridership (PY14)[3]	Participant Spillover	Nonparticipant Spillover (PY15)	NTG
Refrigerators	64%	35.7%	0%	11.8%	76.1%
Freezers		33.9%	0%		77.9%
Total	**64%**	**35.3%**	**0%**	**11.8%**	**76.9%**

We applied PY14 free-ridership values, combined with PY15 nonparticipant spillover (NPSO) values, to PY15 participation and *ex post* per-unit gross savings to calculate the program's net energy savings (Table 4).

Table 4. *Ex Post* Net Energy Savings

Appliance	PY15 Participants	Gross Per-Unit Energy Savings (kWh/Year)	NTG	Total Energy Savings (MWh/Year)
Refrigerators	8,381	1,028	76.1%	6,557
Freezers	2,238	895	77.9%	1,560
Room Air Conditioners*	55	830	76.9%	35
Dehumidifiers*	114	964	76.9%	85
Total	**10,788**	**N/A**	**76.9%**	**8,237**

*Because of very limited participation, we did not assess NTG for these four appliances separately. The 76.9% represents the weighted average of the refrigerator and freezer NTGs.

As shown in Table 5, the program achieved 59% of its proposed net energy savings target of 13,888 MWh for PY15. The program achieved a greater percentage (82%) of its demand reduction target. Ameren Missouri's targets were codified in its residential tariff and approved by the Missouri Public Service Commission (MPSC).

[3] Survey results from PY14 are used to inform free ridership in PY15. However, free ridership values are marginally different due to changes in the relative proportion of each type of measure in PY15 tracking data compared to PY 14 tracking data. This is largely driven by the proportion of units where replacement was induced by the program according to PY14 survey respondents.

Table 5. Refrigerator Recycling Net Savings Comparisons (PY15)

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)	13,888	9,982	10,774	8,237	59%
Demand (kW)	1,934	1,298	2,068	1,583	82%

[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 tracked program activity to Ameren Missouri's 2012 TRM, available here: https://www.efis.psc.mo.gov/mpsc/commoncomponents/viewdocument.asp?DocId=935658483

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

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

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

Key Process Evaluation Findings

Due to the long term program stability and limited evaluation resources, the Cadmus team did not conduct an extensive process evaluation in PY15. As reported in stakeholder interviews, the program appears to remain popular with participants. Some minor process-related issues concerning participant reimbursement have largely been resolved by moving toward a check-based, rather than a prepaid card, approach. No major changes to program design were implemented in PY15.

Key Conclusions and Recommendations

Based on the impact and process evaluation findings reported above, the Cadmus team offers one conclusion and recommendation.

Conclusion 1. The program has had difficulty reaching its participation and savings goals despite rebranding and making more effective marketing expenditures, but had its best participation year in PY15. It is notable that the program continues to increase participation annually, given its maturity and the continued decline in potential recyclable units in Ameren Missouri territory, largely driven by program success in previous years (PY12-PY14). The program also had difficulty meeting savings goals due to overly generous per-unit savings assumptions incorporated into goal-setting.

Recommendation. Continue the targeted marketing efforts initiated in PY14, as well as the research into how to encourage Refrigerator Recycling participants to enroll in other Ameren Missouri programs. As in PY14, we recommend that Ameren Missouri continue promoting additional incentives refrigerator recycling participants can earn through other programs (such as Home Energy Analysis, which offers a range of energy-saving measures) through participants' recent and positive experience with Refrigerator Recycling, making it more likely that they will take additional energy efficiency actions. Ameren Missouri started including marketing materials for other programs as part of the Refrigerator Recycling program process in PY15. We recommend continuing that practice.

PY14 Recommendations Tracking

Cadmus also examined the actions Ameren Missouri has taken on the same recommendation made in the PY14 evaluation. The implementation status is presented in Table 6.

Table 6. PY14 Evaluation Recommendation Tracking

PY14 Recommendation	Cadmus Findings	Explanation
Continue the targeted marketing efforts initiated in PY14, as well as research into how to get Refrigerator Recycling participant to enroll in other programs. Similar to PY13, we recommend considering additional incentives for participating in other programs (such as Home Energy Analysis, which offers a range of energy-saving measures) that will leverage the participants' recent and positive experience with Refrigerator Recycling and make them more likely to take additional energy-efficiency actions.	This item was implemented in PY15.	We continued targeted marketing and we also handed out Residential Energy Efficiency Program Flyers to all Refrigerator Recycling participants to inform customers of other energy savings opportunities.

Introduction

Ameren Missouri engaged Cadmus and Nexant (the Cadmus team) to perform annual process and impact evaluations of the Refrigerator Recycling 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, the final year in the three year program cycle.

Program Description

Through its Refrigerator Recycling program, Ameren Missouri offers residential customers a $50 incentive and free pick-up service for recycling operable refrigerators and stand-alone freezers. Customers may also recycle a working room air conditioner or dehumidifier, along with a qualifying refrigerator or freezer, with a limit of three per customer per year. The incentive is not provided for air conditioners or dehumidifiers. The program implementer, Appliance Recycling Centers of America, Inc. (ARCA), decommissions the appliances in an environmentally responsible manner,[4] thereby ensuring that the appliance is permanently removed from the grid.

All Ameren Missouri residential electric customers qualify for the Refrigerator Recycling program if the appliance meets these four criteria:

- Must be at the electric customer's account location
- Must be operational at the time of pick-up
- Must be between 10 and 27 cubic feet
- Must be manufactured before 2002

Program Activity

During PY15, the Refrigerator Recycling program recycled 10,619 appliances (8,381 refrigerators and 2,238 freezers). As in all previous years, the majority of the units recycled (79%) were refrigerators. Through the program, 55 room air conditioners and 114 dehumidifiers were also collected by ARCA. This was the third year those measures were eligible.

[4] ARCA properly disposes of oils, polychlorinated biphenyls, mercury, and trichlorofluoromethane foam; recycles or destroys dichlorodifluoromethane; and recycles hydrofluorocarbon refrigerants (specifically HFC-134a), plastic, glass, steel, and aluminum.

Table 7. Program Participation (PY15)

Appliance	Units	Percentage of Participation
Refrigerators	8,381	79%
Freezers	2,238	21%
Total	10,619	100%

The scale of the program in PY15 was considerably larger than in PY14 and also larger than PY11, the program's most successful year with 9,084 appliances recycled. Table 8 and Figure 1 present Ameren Missouri's appliance recycling activity. Ameren Missouri has recycled more than 39,000 appliances since the program launched in late 2010.

Table 8. Historical Program Participation (PY10–PY15)

Appliance	PY10*	PY11	PY12	PY13	PY14	PY15	Total
Refrigerators	518	6,978	2,186	5,237	6,978	8,381	30,278
Freezers	186	2,106	784	1,644	2,010	2,238	8,968
Total	**704**	**9,084**	**2,970**	**6,881**	**8,988**	**10,619**	**39,246**

*Only two months long.

Figure 1. Historical Program Participation (PY10-PY15)

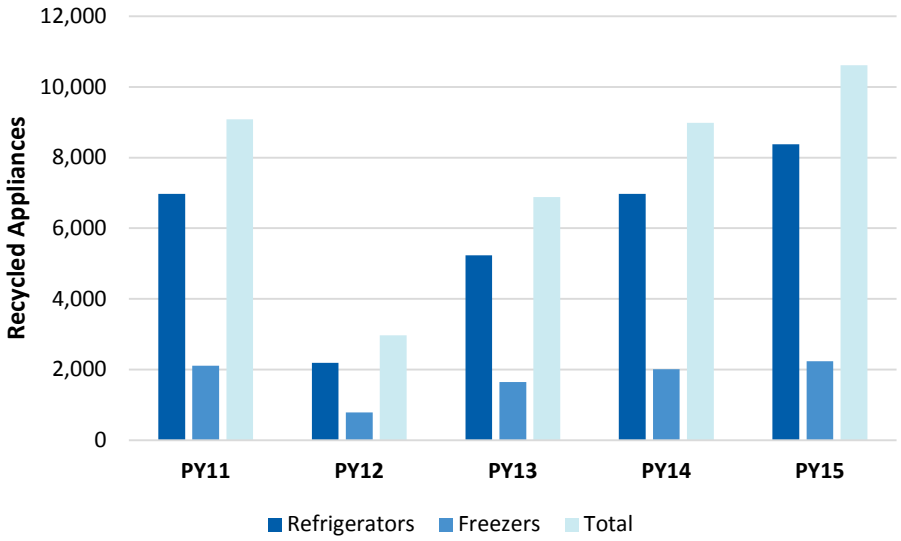


Figure 2 shows PY15 program participation by month. Participation for both refrigerators and freezers was highest in June and July, with another peak in November.

Figure 2. PY15 Program Participation by Month

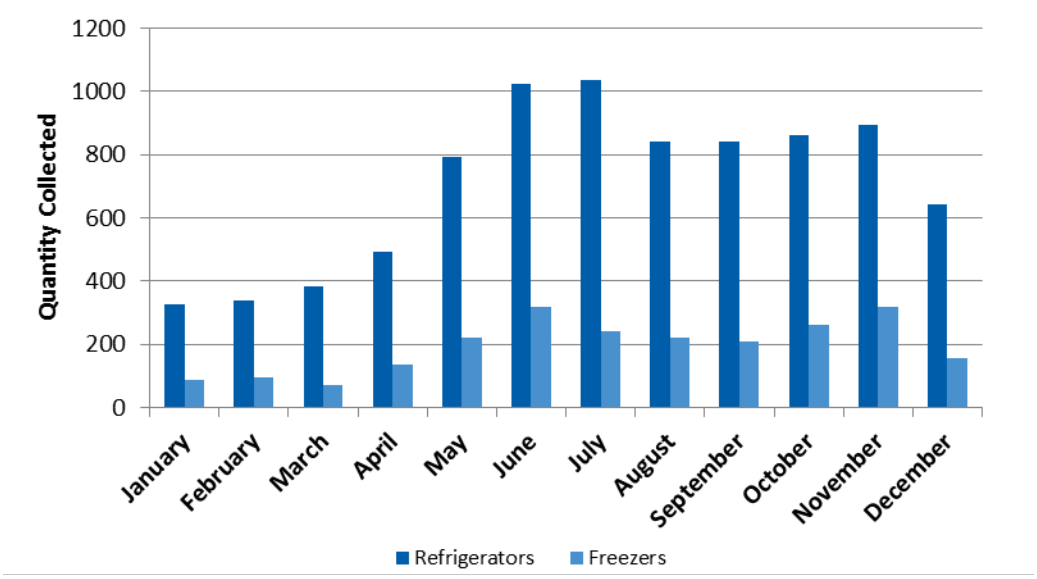
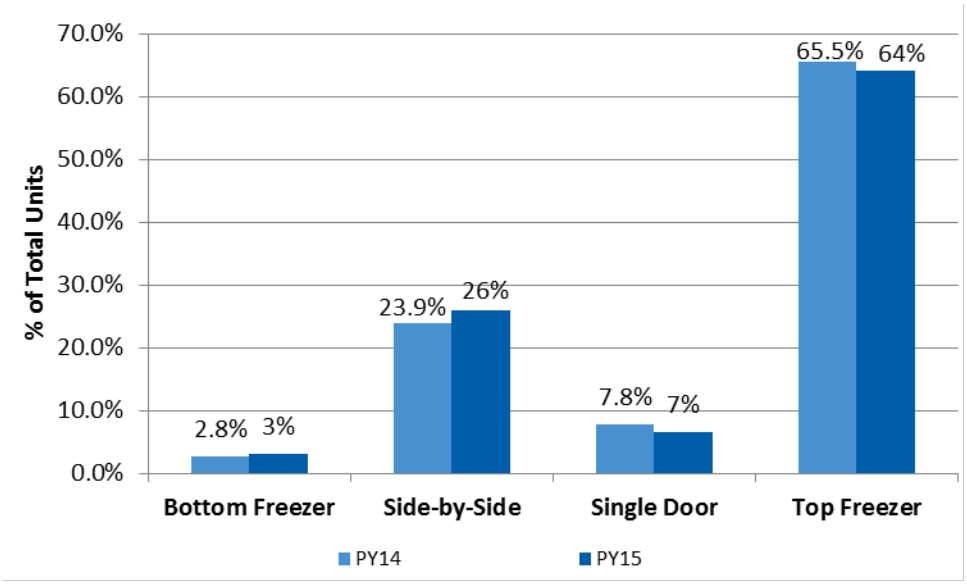


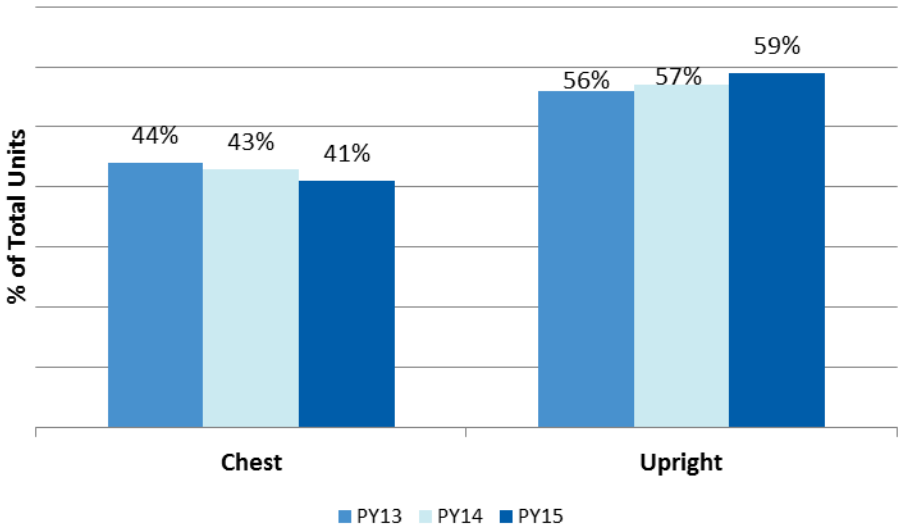
Figure 3 shows that the distribution of refrigerator configurations recycled in PY15 and PY14 is nearly identical. The majority of recycled refrigerators were top-freezer models. This distribution is typical for mature recycling programs.

Figure 3. PY14 vs. PY15 Refrigerator Configurations



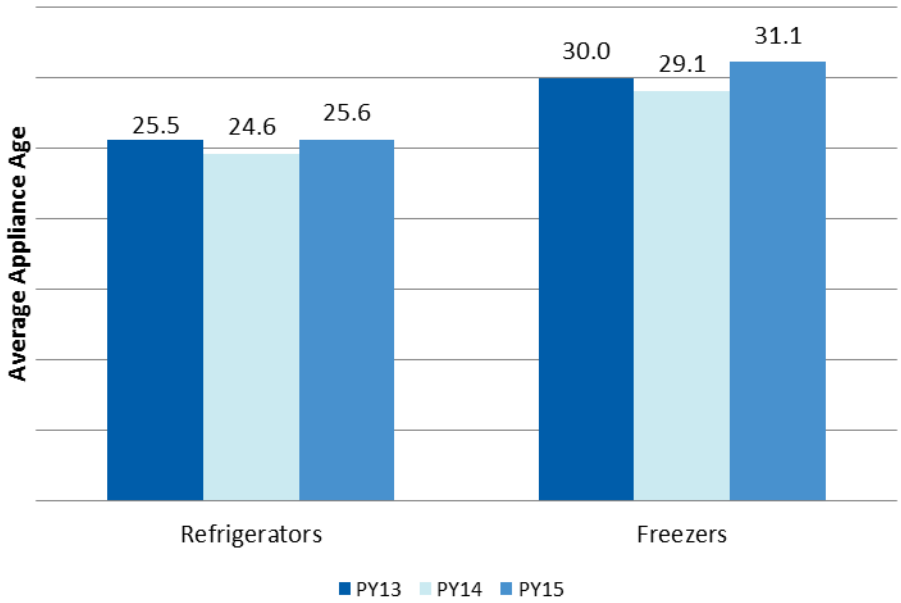
The distribution of freezer configurations did not change significantly in PY15. Figure 4 shows chest and upright freezers recycled in PY13, PY14, and PY15.

Figure 4. PY13, PY14, and PY15 Freezer Configurations



The average ages of appliance types have remained fairly stable over the three-year program cycle.

Figure 5. Comparison of Average Ages (Years Old) for PY13, PY14, and PY15



Evaluation Methodology

The Cadmus team used the Uniform Methods Project (UMP) evaluation protocol from the U.S. Department of Energy (DOE) to evaluate the Refrigerator Recycling program in PY15.[5] This is the same approach we used to evaluate the program in PY13 and PY14.

Uniform Methods Project

In 2011, the DOE launched the UMP with the goal of "strengthen[ing] the credibility of energy savings determinations by improving EM&V, increasing the consistency and transparency of how energy savings are determined."[6] The UMP identified seven common residential and commercial demand-side management (DSM) measures—including refrigerator recycling—and enlisted subject matter experts to draft evaluation protocols for each measure. The DOE engaged Cadmus to manage the UMP process for refrigerator recycling and to be the lead author for the recycling protocol.

Through a collaborative process that entailed reviews by a technical advisory group and a steering committee and a public review and response period, the resulting UMP protocols capture the consensus of the evaluation community. In addition to establishing broadly accepted best practices for the evaluation of these key measures, each protocol identifies and explains the key parameters, data sources, gross algorithms, and net-related algorithms.

More information about UMP is available on the DOE's website.[7]

Evaluation Activities

The Cadmus team identified these impact and process evaluation priorities for PY15.

Impact Evaluation Priorities

- Determine the gross and net energy savings generated from participating appliances
- Track trends by comparing the PY15 average gross energy savings and other key program and evaluation metrics from previous evaluations
- Calculate the total net energy savings and demand savings from the program

Process Evaluation Priorities

- Assess the impacts of program design changes, marketing activities, and program processes
- Assess the program's achievements against its goals

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5 U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy. *Uniform Methods Project: Determining Energy Efficiency Program Savings.* Available at: http://energy.gov/eere/about-us/ump-protocols

6 U.S. Department of Energy. *Uniform Methods Project: Protocols Development.* 2014. Available online: http://www.nrel.gov/docs/fy13osti/54945.pdf

7 U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy. "About Us." Accessed January 2016: http://www1.eere.energy.gov/office_eere/de_ump.html

Table 9 lists our evaluation activities and a brief explanation of the purpose of each activity. Following the table are explanations of each activity.

Table 9. PY15 Process and Impact Evaluation Activities and Rationale

Evaluation Activity	Process	Impact	Rationale
Interview Stakeholders	✓		Obtain information and insights into program design and delivery.
Analyze Gross and Apply Net Impacts		✓	Develop per-unit gross savings from the impact analysis using appliance characteristics data from the program database and *in situ* metering data from existing industry/evaluation databases. Apply NTG to estimate net savings.
Analyze Cost-Effectiveness		✓	Measure the cost-effectiveness of the program through five standard perspectives: total resource cost, utility cost, societal cost test, participant cost test, and ratepayer impact test.

Stakeholder Interviews

In August 2015, the Cadmus team interviewed two groups of program stakeholders: Ameren Missouri's internal implementation program manager and several members of ARCA's team, including the day-to-day account manager, project contract manager, and program marketing lead.

Prior to conducting the interviews, we prepared a guide consisting of questions designed to elicit comprehensive information about the program's design and current performance. We also asked for suggestions from the stakeholders regarding mid-stream course corrections that would improve the program. Our questions addressed the following topics:

- Design and implementation, particularly regarding changes since PY14
- Offering pick-up services through retailers
- Participation goals
- Marketing

A copy of the stakeholder interview guide is provided in Appendix B.

Impact Analysis (Gross and Net)

Our impact analysis for PY15 mirrored our analysis from the PY14 evaluation. To estimate gross unit energy consumption (UEC) for each participating refrigerator, we used the multivariate regression model specification detailed in the UMP refrigerator recycling protocol. Because this protocol does not address freezers, we used the analogous freezer model originally created for Ameren Missouri's PY12 evaluation to estimate freezer UECs.

Similar to our previous evaluations, the UMP model we used in PY15 relied on an aggregated *in situ* metering dataset,[8] which consisted of approximately 564 appliances metered during five recent California and Michigan evaluations.[9]

Cost-Effectiveness Analysis

Using the final PY15 Refrigerator Recycling participation data, implementation data, the *ex post* gross savings estimates, and the *ex post* net savings estimates (presented in this report) with the DSMore tool,[10] Morgan Marketing Partners (MMP) determined the program's cost-effectiveness. MMP also calculated measure-specific cost-effectiveness (as shown in the Cost-Effectiveness chapter) using the five standard perspectives produced by DSMore:

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

Impact CSR

According to the Missouri Code of State Regulations (CSR), demand-side programs that are part of a utility's preferred resource plan are subject to ongoing process and impact evaluations that meet certain criteria. Specifically, the CSR requires that impact evaluations of demand-side programs satisfy the requirements noted in Table 10. The table indicates the data our team used to satisfy these impact CSR evaluation requirements for the Refrigerator Recycling program. We provide a summary of the process CSR requirements in Table 11 at the end of the Process Evaluation section.

8 *In situ* metering involves metering units in the environment in which they are typically used. This approach contrasts with lab testing, where units are metered under controlled conditions.

9 The California utilities were Southern California Edison, Pacific Gas & Electric, and San Diego Gas & Electric. The Michigan utilities were DTE Energy and Consumers Energy.

10 DSMore is a powerful financial analysis tool designed to evaluate the costs, benefits, and risks of DSM programs and services.

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	✓	The program compares the estimated pre-participation load based on the characteristics of recycled appliances, usage data from surveys, weather, and participants' self-reported alternative disposal methods, with the estimated post-participation load based upon these same data given that the appliance was taken off the grid by the program.
Comparisons between program participants' loads and those of an appropriate control group over the same time period		
Data: The evaluation must use one or more of the following types of data to assess program impact:		
Monthly billing data		
Hourly load data		
Load research data		
End-use load metered data	✓	Cadmus used yearly energy consumption data from 563 appliances metered in DTE, Consumer's Energy, PGE, SCE, and SDGE service territories to model annual unit energy consumption as a function of each unit's age and configuration and Ameren Missouri PY14 average part-use and appliance location (conditioned or unconditioned space).
Building and equipment simulation models		
Survey responses	x	Cadmus surveyed PY14 RRP program participants to determine average part-use, freeridership, and secondary market impacts.
Audit and survey data on:		
Equipment type/size efficiency	✓	Evaluation team received the age and configuration of all appliances recycled through the program from ARCA and used this, in combination with PY14 survey results, to determine unit energy consumption and gross and net savings.
Household or business characteristics		
Energy-related building characteristics		

Process Evaluation

This section details the findings from the Cadmus team's stakeholder interviews.

Stakeholder Interview Findings

Our interviews with the Refrigerator Recycling stakeholders (one from Ameren Missouri and three from ARCA) provided information about implementing the PY15 program and about the program's future.

Program Design

Neither Ameren Missouri nor ARCA reported any major changes in how the program operated in PY14 and PY15 in terms of goals, program management and responsibilities, incentive size, or project flow. One change was to shift incentives from a pre-paid card to a check, which has reduced problems arising from the card-issuer (such as cards with misspelled names on them) and helped streamline processes and resolve customer issues more quickly.

Offering Pick-Up Services Through Retailers

Similar to PY14, a very small percentage of the program's total participation came through three Sears locations in Ameren Missouri territory. Although program activity is relatively small, this retail channel provides some benefits by allowing participants to enroll in the program when purchasing a new appliance at select participating retailers and to schedule a single appointment to have their new unit dropped off and their existing unit picked up for recycling. Ameren Missouri is tentatively exploring adding a few more locations and retailers in coming program years.

Program Goal Targeting

Stakeholders anticipated meeting the annual program goals but said they altered the monthly goals to more closely to align with the natural flow of appliance recycling, which tends to be heavier in the spring and summer and lighter in the winter. For example, the program reset goals to zero recycled units for November and December, even though it anticipated recycling at least a few units in those months.

Marketing

In PY15, Ameren Missouri and ARCA continued to employ many of the same marketing strategies as in PY14.

The Shelton Group continues to lead the program's marketing efforts. Shelton implemented online advertising, Internet radio ads, traditional radio ads, television ads, and direct mailers to Ameren Missouri customers.

ARCA did additional advertising in fitness centers, print advertising, and door hangers. ARCA has also focused the marketing on clear themes, with less text than in previous years (PY10-PY14) and more emphasis on the rebate and potential energy cost savings. ARCA said the targeted direct mail campaign has been the most successful in generating increased participation in the program.

Ameren Missouri, ARCA, and Shelton held monthly meetings regarding marketing and targeting, which ARCA attributed to greater program success.

Communication

As in previous evaluations, all stakeholders said communications between Ameren Missouri and ARCA were conducted weekly and were effective. Stakeholders also noted that a new e-mail system, informing customers about their incentive's expected arrival date, had reduced questions regarding customer incentives at the call center.

Customer Feedback

Program stakeholders said customer feedback was largely positive, with customers reporting high levels of satisfaction with program drivers and staff, often naming the contractors who picked up their equipment and complimenting them on their courteousness, professionalism, and friendliness. The only area of negative feedback centered on issues with the prepaid cards used as incentives. In some cases, these cards could not be used as intended, and customers complained. Program stakeholders expressed hope the switch from cards to checks would eliminate this area of customer concern.

CSR Summary

As previously stated, the Missouri CSR requires that demand-side programs that are part of a utility's preferred resource plan be subject to ongoing process and impact evaluations that meet certain criteria.[11] Process evaluations must address, at a minimum, the five questions listed in Table 11. The table summarizes the response for each specified CSR process requirement, taken from this year and the prior year's evaluations. We previously summarized the data used to meet with impact CSR requirements in Table 10.

[11] http://s1.sos.mo.gov/cmsimages/adrules/csr/current/4csr/4c240-22.pdf

Table 11. Summary Responses to CSR Process Evaluation Requirements

CSR Number	CSR Requirement Description	Summary Response
1	What are the primary market imperfections common to the target market segment?	There were no changes to the primary market for refrigerator recycling in Ameren Missouri territory in PY15. The primary market imperfections common to the target market are an inadequate understanding of the operating costs of old or secondary refrigerators, misconceptions regarding the market for used appliances or costs associated with appliance disposal, and, in many cases, the inability to physically discard the appliance without assistance.
2	Is the target market segment appropriately defined, or should it be further subdivided or merged with other market segments?	Without conflicting evidence, based on PY15 research, we continue to feel that the target market segment is appropriately defined as it serves all single-family residential customers regardless of the appliance's usage type (primary or secondary), age, part-use, or aesthetic condition.
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?	Yes, the current mix of end-use measures included in the program is appropriate. In PY13, the program began collecting room air conditioners and dehumidifiers with eligible refrigerators and freezers, which provided additional benefits for customers and savings for Ameren Missouri. The program continued this practice in PY14 and PY15. As recommended in PY13, the program could also provide energy efficiency kits (including LEDs and other easy-to-install measures) to achieve deeper savings and encourage participation in other programs.
4	Are the communication channels and delivery mechanisms appropriate for the target market segment?	Yes, delivery channels are appropriate. The implementer ARCA handles scheduling and pick-up for appliances recycled through the program, which makes the program convenient for participants.
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?	Cadmus recommends that the program continue to explore new communication channels through which customers can learn about the program. Possible channels could include advertising through social media, YouTube, and other popular social network sites.

Gross Impact Evaluation Results

This section of the gross impact evaluation report organizes the program results under two subsections: Annual Gross Unit Consumption and Gross Savings. In this section, the Cadmus team focuses exclusively on refrigerators and freezers, the program's primary measures. Information about the gross savings of room air conditioners and dehumidifiers is provided in Appendix C.

Gross Annual Unit Energy Consumption

The Cadmus team used the UMP-specified regression model to estimate consumption for refrigerators and a similar model developed outside of the UMP for freezers. The coefficient of each independent variable indicates the influence of that variable on daily consumption, holding all other variables constant:

- A positive coefficient indicates an upward influence on consumption
- A negative coefficient indicates a downward effect.

The value of the coefficient indicates the marginal impact on the UEC of a one-point increase in the independent variable. For instance, a one-cubic-foot increase in refrigerator size results in a 0.067 kWh increase in daily consumption.

In the case of dummy variables, the value of the coefficient represents the difference in consumption if the given condition is true. For example, in the refrigerator model, the coefficient for the variable indicating a refrigerator was a primary unit is 0.60; this means that, all else being equal, a primary refrigerator consumes 0.60 kWh per day (or 219 kWh per year) more than a secondary unit.

Refrigerator Model

Table 12 shows the UMP model specifications used to estimate a PY15 refrigerator's annual energy consumption and its estimated parameters.

Table 12. Refrigerator UEC Regression Model Estimates
(Dependent Variable = Average Daily kWh, R^2 = 0.31*)

Independent Variables	Coefficient	p-Value	Standard Error
Intercept	0.5822	0.33	0.60
Age (years)	0.0269	0.08	0.02
Dummy: Unit manufactured pre-1990s	1.0548	<.0001	0.21
Size (sq. ft.)	0.0673	0.02	0.03
Dummy: Single Door	-1.9767	<.0001	0.42
Dummy: Side-by-Side	1.0706	<.0001	0.26
Dummy: Primary	0.6046	0.01	0.22
Interaction: Unconditioned Space x HDDs	-0.0447	0.03	0.02
Interaction: Unconditioned Space x CDDs	0.0200	0.33	0.02

*It is important to note that cross-sectional models, such as the refrigerator UEC regression model, typically yield lower R^2 values. The R^2 determined is within the range of acceptable explanatory power for these types of models.

Freezer Model

Table 13 lists the Cadmus team's final model specifications for estimating the energy consumption of participating freezers and the results of those calculations. Again, because UMP only specifies a refrigerator model, we created an analogous freezer model.

Table 13. Freezer UEC Regression Model Estimates
(Dependent Variable = Average Daily kWh, R^2 = 0.48*)

Independent Variables	Coefficient	p-Value	Standard Error
Intercept	-0.8918	0.30	0.85
Age (years)	0.0384	0.01	0.01
Dummy: Unit Manufactured Pre-1990	0.6952	0.03	0.31
Size (sq. ft.)	0.1287	<.0001	0.04
Dummy: Chest Freezer	0.3503	0.20	0.27
Interaction: Unconditioned Space x HDDs	-0.0313	0.05	0.02
Interaction: Unconditioned Space x CDDs	0.0695	0.06	0.04

*It is important to note that cross-sectional models, such as the freezer UEC regression model, typically yield lower R2 values. The R2 determined is within the range of acceptable explanatory power for these types of models.

Extrapolation

The Cadmus team analyzed the corresponding characteristics (the independent variables) for the participating appliances, as captured by ARCA in the PY15 program database. Table 14 lists the program averages or proportions for each independent variable. CDDs and HDDs are based on typical meteorological year 3 (TMY3) data from the Lambert-St. Louis International Airport weather station.

Table 14. PY15 Participant Mean Explanatory Variables

Appliance	Independent Variables	PY15 Mean Value or Proportion
Refrigerator	Age (years)	25.59
	Dummy: Manufactured pre 1990s	0.41
	Size (cubic feet)	19.37
	Dummy: Single Door	0.07
	Dummy: Side-by-Side	0.26
	Dummy: Primary	0.37
	Interaction: Unconditioned Space x HDDs	3.57
	Interaction: Unconditioned Space x CDDs	1.18
Freezer	Age (years)	31.14
	Dummy: Unit Manufactured Pre-1990	0.66
	Size (cubic feet)	15.71
	Dummy: Chest Freezer	0.41
	Interaction: Unconditioned Space x HDDs	3.02
	Interaction: Unconditioned Space x CDDs	1.00

Using values from Table 12, Table 13, and Table 14, we estimated the UEC of the average refrigerator and freezer recycled by participants in Refrigerator Recycling in PY15. An example of the calculation (for freezers) is:

$$\begin{aligned} Freezer\ UEC = {} & 365.25\ days \\ & * (-0.8918 + 0.0384 * [31.14\ years\ old] + 0.6952 \\ & * [66\%\ units\ manufactured\ pre-1990] + 0.1287 * [15.71\ ft.^3] + 0.3503 \\ & * [41\%\ units\ that\ are\ chest\ freezers] - 0.0313 * [3.02\ Unconditioned\ HDDs] \\ & + .0695(1.00\ Unconditioned\ CDDs) = 1{,}061\ kWh \end{aligned}$$

Unit Energy Consumption

Table 15 shows the average per-unit UEC that the Cadmus team calculated for refrigerators and freezers, both of which are slightly larger than PY14. This increase in UEC is the result of subtle changes in the PY15 participant profile compared to last year.

Table 15. Average UEC by Appliance Type (PY15)

Appliance	Average Unit Energy Consumption (kWh/Year)	Standard Error	Relative Precision (90% Confidence)
Refrigerator	1,181	6%	9.4%
Freezer	1,061	5%	16.5%

When we benchmarked the estimated PY15 Refrigerator Recycling program's UEC with the evaluated UECs for similar programs offered through other utilities (Table 16), we determined that Ameren Missouri's savings were within the expected range.

Table 16. Benchmarking: Average Program UECs

Utility (Year)	Years Implemented	Average UEC (kWh/Year)	
		Refrigerators	Freezers
Ameren Missouri (PY15)	5.5	1,181	1,061
Ameren Missouri (PY14)	4.5	1,157	1,028
Ameren Missouri (PY13)	3.5	1,178	1,078
Ameren Missouri (PY12)	2.5	1,175	1,072
Ameren Missouri (PY11)	1.5	1,092	940
Focus On Energy (2012)	1	1,045	940
Progress Energy Carolinas (2011)	2	1,032	805
Ameren Illinois (2011)	3	1,239	1,172
Ontario Power Authority (2010)	4	1,126	1,045
Ontario Power Authority (2011)	5	1,240	1,172
PacifiCorp - Washington	5	1,153	935
Avista	6	1,147	1,074

Gross Savings

To convert the UEC estimates above into per-unit gross savings, the Cadmus team used responses from the PY14 participant survey to determine the part-use factor for PY15.

Part-Use

Part-use—an adjustment factor specific to appliance recycling—is used to convert the UEC into an average per-unit gross savings value. The UEC itself is not equal to the gross savings value because:

- The UEC model yields an estimate of annual consumption.
- Not all recycled refrigerators would have operated year-round had they not been decommissioned through the program.

Although the UMP part-use methodology uses information from surveyed customers regarding pre-program use patterns, the final estimate of part-use reflects how appliances would probably have been operated had they not been recycled (rather than how the appliances were previously operated). For example, it is possible that a primary refrigerator operated year-round would have become a secondary appliance and been operated part-time.

The UMP methodology accounts for these possible shifts in usage types. Specifically, part-use is calculated using a weighted average of the following prospective part-use categories and factors:

- Appliances that would have run full-time (part-use = 1.0)
- Appliances that would not have run at all (part-use = 0.0)
- Appliances that would have operated a portion of the year (part-use is between 0.0 and 1.0)

Using part-use values determined in PY14, we adjusted gross savings for PY15 units.

Table 17. Part-Use Factors: PY13– PY14

Appliance	PY13	PY14
Refrigerators	0.86	0.87
Freezers	0.90	0.84

The PY14 part-use estimate for refrigerators is similar to the part-use factors determined for other evaluated programs.

Table 18. Benchmarking: Part-Use

State or Utility	Number of Years Implemented	Part-Use	
		Refrigerators	Freezers
Ameren Missouri (PY14)	4.5	0.87	0.84
Ameren Missouri (PY13)	3.5	0.86	0.90
Ameren Missouri (PY12)	2.5	0.86	0.86
Ameren Missouri (PY11)	1.5	0.91	0.84
Focus On Energy (2012)	1	0.67	0.81
Progress Energy Carolinas (2011)	2	0.90	0.93
Ameren Illinois (2011)	3	0.88	0.93
Commonwealth Edison (2010)	3	0.90	0.75

In Table 19, the Cadmus team provides estimates of average PY15 per-unit evaluated (or *ex post*) gross energy savings after adjusting the determined UECs to account for part-use.

Table 19. Per-Unit PY15 Gross Energy Savings for Refrigerators and Freezers

Appliance	UEC (kWh/Year)	Part-Use Factors	Gross Energy Savings (kWh/Year)	Relative Precision (90% confidence)*
Refrigerators	1,181	0.87	1,028	11.0%
Freezers	1,061	0.84	895	19.6%

* Reflects the combined effect of error generated by the regression model used to determine the UEC and the survey-based part-use estimate.

Table 20 lists the program's total *ex post* gross energy savings, calculated using the per-unit gross savings shown in the previous table and PY15 participation.

Table 20. Total PY15 Gross Energy Savings for Refrigerators and Freezers

Appliance	Per Unit Gross Energy Savings (MWh/Year)	PY15 Participation	Total Program Gross Savings (MWh/Year)
Refrigerator	1.028	8,381	8,616
Freezer	0.895	2,238	2,003
Total		**10,619**	**10,619**

Replacement

In most cases, the per-unit gross energy savings attributable to the Refrigerator Recycling program are equal to the energy consumption of the recycled appliance (rather than being equal to the difference between the consumption of the recycled appliance and its replacement, when applicable). This is because the energy savings generated by the program are not limited to the change within the participant's home, but rather to the total change in energy consumption at the grid level.

This concept is best explained with an example. Suppose an Ameren Missouri customer decides to purchase a new refrigerator to replace an existing one. When the customer mentions this to a neighbor, the neighbor asks to use that existing refrigerator as a secondary unit. The customer agrees to give the old appliance to the neighbor. However, before this transfer is made the customer learns about the program and decides to participate (since the incentive offsets a small portion of the cost of the new refrigerator). The existing refrigerator is hauled away and decommissioned and, as a result of the program's intervention, the customer's appliance is permanently removed from operation in the utility's service territory.

From Ameren Missouri's perspective, the difference in grid-level energy consumption—and the corresponding increase in program savings—is equal to the consumption of the recycled appliance *and not* to the difference between the energy consumption of the participating appliance and its replacement. In this example, it is important to note that the participant planned to replace the appliance and had considered disposing the appliance prior to learning about the program.

In general, the purchase of a new refrigerator is part of the naturally occurring appliance lifecycle, typically independent of the program and tantamount to refrigerator load growth. It is not the purpose of the program to prevent these inevitable purchases, but rather to minimize the grid-level refrigerator load growth by limiting the number of existing appliances that continue to operate after they are replaced. This is the replacement philosophy described in UMP, and that Cadmus has applied it in previous Ameren Missouri evaluations.

However, UMP does note that when a recycling program ***induces*** replacement (i.e., the participant would ***not*** have purchased the new refrigerator in the absence of the recycling program), that savings must account for replacement. UMP considers this induced replacement to be a net impact, since the additional energy consumption induced by the program is akin to negative spillover. More information about induced replacement in provided in the Net Savings section.

Net Impact Evaluation Results

This section details the Cadmus team's approach to determining net savings. In the case of appliance recycling, programs only generate net savings when the recycled appliance would have continued to operate absent program intervention (either within the participating customer's home or at the home of another utility customer). The UMP protocol contains two parameters related to net savings—secondary market impacts and induced replacement. In addition, UMP employs a decision-tree approach to calculate and present net program savings.

The decision tree—populated by the responses of surveyed PY14 participants and information gathered from interviewed market actors as part of previous Ameren Missouri evaluations—presents all of the program's possible savings scenarios. We used a weighted average of these scenarios to calculate the net savings attributable to the Refrigerator Recycling program. The decision tree accounts not only for what the participating household would have done independent of the program but also accounts for the possibility that the unit was transferred to another household, whether or not the would-be acquirer of that refrigerator finds an alternate unit instead. We used the findings from our PY14 analysis in our PY15 report, noting the strong consistency of free ridership values observed between PY11 and PY14, we believe the PY14 values are an accurate reflection of participant free ridership. As in PY14, we will not be applying participant spillover.

To estimate PY15 NTG ratios for refrigerators and freezers, we used the following formula:

NTG = 1.0 – PY14 Free Ridership + Nonparticipant Spillover + Market Effects

However, market effects, the fourth NTG input, are not appropriate for appliance recycling programs, as we have already accounted for the program's impact on the regional used-appliance market by estimating induced replacement and secondary market impacts. As a result, we did not adjust evaluated NTG for market effects.

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. [12]

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.[13] Examples of "like" spillover included removing a secondary refrigerator and installing a programmable thermostat. We did, however, exclude one notable category of "like" measures: lighting products. This precluded double-counting NPSO lighting savings already captured through the upstream Lighting program market affects analysis.

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

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

- They were familiar with Ameren Missouri's campaign; and

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

[13] 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.

- 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:[14]

- 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.

[14] 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 21 shows measures and PY15 gross evaluated kWh savings attributed to Ameren Missouri, with average savings per spillover action of 171 kWh.

Table 21: 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 22), 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 22):

- **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.)[15]

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

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

Using this information, the Cadmus team estimated overall, portfolio-level NPSO at 8.6% of total PY15 reported *ex post* gross savings, as shown in Table 22. Smaller NPSO savings were reported in PY14 (7,592 MWH) than in PY15 (12,247 MWH). This combined with lower total *ex post* residential portfolio savings in PY15 (142,016 MHW) than in PY14 (210,530 MH). Consequently, this resulted in a higher NPSO as a percent of total *ex post* residential portfolio savings values in PY15 (8.6%) than estimated for PY14 (3.6%). Both years identified a similar list of measures installed. A growing proportion of nonparticipant spillover is consistent with what we would expect from long running marketing of a program portfolio.

Table 22: 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 23) when allocating NPSO across programs.

Table 23: 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 24 and Table 25—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 24: 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,[16] all NPSO estimates have been reported as a percentage of each program's total gross energy savings.

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 25) when allocating NPSO across programs.

Table 25: 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

Table 26 compares these *ex post* and *ex ante* values. We have also provided a detailed diagram illustrating the UMP approach for estimating net savings in the appendices (Appendix C and D).

Table 26. *Ex Ante* and *Ex Post* Net-to-Gross Ratios

Appliance	*Ex Ante*	*Ex Post*
Refrigerators	64%	76.1%
Freezers		77.9%
Overall*	**64%**	**76.9%**

*Reflects PY15 appliance participation mix and includes free ridership (35.0%), participant spillover (0%), and nonparticipant spillover (11.8%).

Table 27 shows the NTG ratio's components—free ridership and secondary market impacts (including induced replacement), participant spillover, and nonparticipant spillover. Cadmus calculated the percentage for each component as the per-unit kWh associated with each component, divided by the per-unit gross savings.

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

Table 27. NTG Ratio Components

Appliance	Free Ridership	Participant Spillover	Nonparticipant Spillover	NTG Ratio
Refrigerators	35.7%	0%	11.8%	76.1%
Freezers	33.9%	0%		77.9%
Total	**35.3%**	**0%**	**11.8%**	**76.9%**

Applying these NTG values to PY15 participation and *ex post* per-unit gross savings yields the program's net energy savings (Table 28). The total MWh/year savings and NTG ratio include nonparticipant spillover savings attributed to the program as a whole.

Table 28. *Ex Ante* and *Ex Post* Net Energy Savings

Appliance	PY15 Participants	Gross Per-Unit Energy Savings (kWh/Year)	NTG	Total Energy Savings (MWh/Year)
Refrigerators	8,381	1,028	76.1%	6,557
Freezers	2,238	895	77.9%	1,560
Room Air Conditioners	55	830	76.9%	35
Dehumidifiers	114	964	76.9%	85
Total	**10,788**	**N/A**	**76.9%**	**8,237**

*Due to very limited participation, we did not assess NTG for these measures separately. 76.9% represents the weighted average of the refrigerator and freezer NTGs.

As shown in Table 29, the program achieved 59% of its proposed net energy savings target for PY15 (13,888 MWh). The program achieved a greater percentage (82%) of the demand reduction target. Ameren Missouri's targets were codified in their residential tariff and approved by the MPSC.

Table 29. Refrigerator Recycling Net Savings Comparisons

Metric	MPSC-Approved Target[1]	*Ex Ante* Gross Savings Utility Reported[2]	*Ex Post* Gross Savings Determined by EM&V[3]	*Ex Post* Net Savings Determined by EM&V[4]	Percentage of Goal Achieved[5]
Energy (MWh)	13,888	9,982	10,774	8,237	59%
Demand (kW)	1,934	1,298	2,068	1,583	82%

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

[2] Calculated by applying tracked program activity to Ameren Missouri's 2012 TRM, available here: https://www.efis.psc.mo.gov/mpsc/commoncomponents/viewdocument.asp?DocId=935658483.

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

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

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

Cost-Effectiveness Results

To analyze PY15 program cost-effectiveness, MMP used DSMore and assessed cost-effectiveness using the following five tests, defined by the California Standard Practice Manual:[17]

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

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

Table 30 presents the key cost-effectiveness analysis assumptions and corresponding source.

Table 30. Assumptions and Source for Cost-Effectiveness Analysis

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

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

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

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

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

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

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

Table 31 summarizes the 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 (sometimes referred to as UCT net lifetime benefits). As seen in the table, the Refrigerator Recycling program passes the UCT, TRC, and Societal tests and produced Annual Net Shared Benefits of $1,098,929, which is significantly lower than PY14. This difference is primarily due to the updated lower avoided energy costs.

Table 31. Refrigerator Recycling Cost-Effectiveness Results (PY15)

Program	UCT	TRC	RIM	Societal	PART	Annual Net Shared Benefits*
Refrigerator Recycling	1.60	1.60	0.40	1.80	n/a	$1,098,929

* 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).

Appendix A. *Ex Post* Demand Reductions

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

Table 32. PY15 Summary: Net *Ex Post* Per-Unit Demand Reductions

Measure	PY15 Participation	Net Per-Unit *Ex Post* Demand Reduction (kW)	Total Net *Ex Post* Savings (kW)*
Refrigerators	114	0.12	13
Freezers	2,238	0.17	379
Room Air Conditioners	8,381	0.14	1,161
Dehumidifiers	55	0.53	29
Total	**10,788**		**1,583**

*Accounts for line losses

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Appendix B. Stakeholder Interview Guide

Ameren Missouri Fridge/Freezer Recycling Program
Stakeholder Interview Guide (PY15)

Respondent name: _____

Respondent phone: _____

Interview date: _____ Interviewer initials: _____

A. Introduction

1) What are your main responsibilities for Ameren Missouri's Fridge/Freezer Recycling Program?

2) What percent of your time is dedicated to the program?

3) What tasks do you regularly spend the majority of your time on?

B. Program Implementation

4) Have there been program design changes between PY14 and PY15? If yes, what were they and what was the impetus for the change?

5) Can you please tell me about the program's marketing efforts this year? How, if at all, have these efforts differed from PY14?

6) Have you done any cross-marketing of any other Ameren Missouri program to ApplianceSavers participants?

7) What do you think have been the most marketing strategy this year?

8) In general, what would you say is working particularly well so far in PY15? Why is that?

9) Conversely, what is not working as well as anticipated? Why is that?

C. Program Goals

10) How has the program performed in PY15 relative to its filing goals?

11) Why do you think this is?

D. Measures

12) In your opinion, should any additional measures be considered for inclusion in future programs? If so, what measures?

E. Retail Channel

13) What is the status of the program's retailer channel?

14) What do you think is the future retailer channel in future program years?

F. Customer Feedback

We know from past evaluations that ARCA surveys participants and provides Ameren Missouri with a sample of recorded communications with participants. Based on the results of these surveys, and based on your own knowledge:

15) Do you think your customers understand the energy-related benefits of the program?

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

17) Have customer drop-out or cancellation rates changed at all this year?

G. Summary

18) Is there anything else you'd like us to know about your experience administrating/ implementing the program so far this year?

Appendix C. Gross Savings Detail: Room Air Conditioners and Dehumidifiers

Room Air Conditioners

The Cadmus team estimated per-unit RAC savings using the following algorithm and inputs (Table 33):

$$EnergySavings\ (kWh/Year) = \frac{\frac{BTU}{hour} * \frac{1}{EER_{BASE}} * EFLH_{COOL}}{1000}$$

Table 33. PY13 RAC Savings Assumptions

Term	PY13 Value	PY13 Source
BTU/Hour	10,000	Assumption (2013 Pennsylvania TRM)
$\mathrm{EER_{BASE}}$	6.7	OPA laboratory testing of used RACs
$\mathrm{EFLH_{COOL}}$	556	Weather-adjusted 2009 CPUC RAC Metering Study

The average size of room air conditioner (RAC) units reported by ARCA in PY14 was 8,388 BTU/hour. However, the Cadmus team believed the average value was unreliable (similar to PY13) because of the small sample size (only 38 units) and the fact that the Low Income program unit size for RAC was over 12,000 BTU/hour. We instead assumed a BTU/hour of 10,000 as cited by the 2013 Pennsylvania TRM. For the baseline EER (EER_{BASE}) value, we relied upon OPA's laboratory testing of used 30 RACs collected in a 2008 OPA appliance bounty program (this characteristic was not collected by Ameren Missouri's Refrigerator Recycling program). Other benchmarked TRMs (Northeast Energy Efficiency Partnerships [NEEP] and Pennsylvania) assume larger baseline EER values (7.7 and 9.07, respectively), but they are based upon engineering estimates and assumptions rather than the actual lab testing of existing, older RACs (as in the OPA study). Finally, for the equivalent full load hours ($EFLH_{COOL}$) we rely upon a weather-adjusted value from CPUC's 2009 RAC metering study similar to RebateSavers.

The resulting *ex post* savings value and the *ex ante* savings value are shown in Table 34. The *ex post* savings value (830 kWh/year) is approximately 735% of the program's *ex ante* value (113 kWh/year), which was based on Morgan Measure Libraries (MML) data. The large difference between *ex ante* and *ex post* savings estimates occurs because of our evaluation cites the savings as the full energy consumption of the unit (not the difference between the recycled unit and a replacement). Finally, the MML's assumptions for the key terms in the RAC savings calculation (Table 33) are not available.

Table 34. *Ex Ante* and *Ex Post* Comparison for Room Air Conditioners

Ex Ante Savings/Unit	*Ex Post* Savings/Unit	Realization Rate
113 kWh/year	830 kWh/year	735%

Dehumidifiers

The evaluated dehumidifier savings of 964 kWh/year come from OPA's 2008 metering of recycled dehumidifiers. Our evaluated savings for this measure are much larger than the Ameren Missouri TRM (139 kWh/year), which sites the MML data. It is difficult to pinpoint the reason for the difference between the *ex ante* and *ex* post savings values without greater insight into the MML assumptions of unit size, efficiency, and annual usage. However, our larger savings value is much closer to those of other programs (Table 35).

Table 35. Dehumidifier Savings Benchmarking

Source	Savings/Unit (kWh/year)	Assumptions
Appliance Savers PY13 (OPA 2008)*	964	-
Ameren Missouri TRM**	139	-
NEEP TRM (2013) ***	983	46 pints/day capacity, 1632 annual hours of use
PA TRM (2013) ****	988	45-54 pints/day capacity, 1620 annual hours of use
ENERGY STAR calculator*****	857	35 – 45 pints/day capacity, 1632 annual hours of use

*http://www.powerauthority.on.ca/sites/default/files/new_files/2008/2008%20OPA%20Residential%20Every%20Kilowatt%20Counts%20Power%20Savings%20Event%2C%20Keep%20Cool%2C%20and%20Rewards%20for%20Recycling%20Evaluation.pdf

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**** http://www.puc.pa.gov/electric/pdf/Act129/Act129_TRM-2013_Redlined.pdf

***** http://www.energystar.gov/buildings/sites/default/uploads/files/appliance_calculator.xlsx

The large difference between the *ex ante* and *ex post* savings results in a realization rate of 694% (Table 36).

Table 36. *Ex Ante* and *Ex Post* Comparison for Dehumidifiers

Ex Ante Savings/Unit	*Ex Post* Savings/Unit	Realization Rate
139 kWh/year	964 kWh/year	694%

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