Ameren Missouri Heating and Cooling Program Impact and Process Evaluation: Program Year 2015

Final May 13, 2016

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Table of Contents

Executive Summary 1

Program Description 1

Key Impact Evaluation Findings 1

Key Process Evaluation Findings 4

Key Conclusions 4

Introduction 8

Program Description 8

Program Activity 8

Evaluation Methodology 10

Impact Evaluation Priorities 10

Process Evaluation Priorities 10

Data Tracking Review 11

Stakeholder Interviews 12

Contractor Interviews 12

Distributor Interviews 13

Participant Surveys 13

Engineering Analysis 14

Cost-Effective Analysis 16

Impact CSR 16

Process Evaluation Findings 18

Heating and Cooling Program Design and Delivery 18

CSR Summary 32

Gross Impact Evaluation Results 35

Cooling Savings Estimates 35

Heating Savings Estimates 35

Measure-Specific Gross Savings 35

Summary 45

Net Impact Evaluation Results 47

Free Ridership–Ground Source and Air Source Heat Pumps 48

Free Ridership: Tune-Ups 50

Participant Spillover 53
Nonparticipant Spillover 54
HVAC Nonparticipant Spillover Data Collection 62
Data Summary 63
HVAC Nonparticipant Spillover 65
NTG Summary 67
Cost-Effectiveness Results 68
Appendix A. Ex Post Demand Reductions 70
Appendix B. Stakeholder Interview Guide 72
Appendix C. Detailed Engineering Calculations and Explanations 74
Appendix D. Free Ridership Scoring Tables 77
Appendix E. Participant Survey Instruments 84
Appendix F. Contractor Interview Guide 85

Executive Summary

Ameren Missouri engaged Cadmus and Nexant (the Cadmus team) to perform annual process and impact evaluations of the Heating and Cooling 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 of the three-year program cycle.

Program Description

The Heating and Cooling Program offered Ameren Missouri customers living in single-family homes, condos, or townhomes incentives for installing high-efficiency central air conditioners (CAC) or heat pumps (HP) through a participating program contractor. The program also offered incentives for diagnostic testing and tuning of existing HVAC systems to manufacturer specifications and for installation of variable-speed fan motors. ICF International (ICF) implemented the Heating and Cooling Program.

Key Impact Evaluation Findings

This section presents the Cadmus team's key impact findings for PY15.

Gross Impacts

Through an engineering analysis and PY13 meter data results, we determined the PY15 program realized 93.5% of the expected (*ex ante)* gross savings assumed in Ameren Missouri's Technical Resource Manual (TRM)[1]. The evaluation determined a gross realization rate of 86.4% in PY13 and 90.5% in PY14. The realization rate increased from year-to-year primarily because ground source heat pump participation increased each year and ground source heat pump *ex post* savings were more than 160% of *ex ante* savings.

Net Savings

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

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

For the PY15 evaluation, we estimated free ridership and participant spillover through participant surveys and contractor interviews. We conducted a nonparticipant spillover (NPSO) survey to determine NPSO for all of Ameren Missouri's programs. Program staff worked closely with local contractors and distributors to improve installation and stocking practices, which could generate a change in the efficiency of HVAC systems sold in the market. Cadmus interviewed HVAC contractors and equipment

[1] "Appendix A - Ameren Missouri Technical Resource Manual" Online: https://www.efis.psc.mo.gov/mpsc/commoncomponents/viewdocument.asp?DocId=935658483

distributors to determine the impact of the program over time and to quantify HVAC nonparticipant spillover (HVAC NPSO). We did not compute market effects because we believe additional program effects were all captured in the spillover calculations as described in the Net Impact section. Table 1 shows a summary of PY15 participation, realization rate, and *ex post* evaluated savings for each measure type.

Table 1. PY15 Participation, Per-Unit *Ex Post* Gross Savings, Realization Rate

Measure	PY15 Participation	Per-Unit *Ex Post* Savings (kWh/yr)	Realization Rate	Total *Ex Post* Savings[3] (kWh/yr)
HPs				
Air Source HP (ASHP)—Early Replacement of ASHP[1]	729	5,101	109.6%	3,718,745
ASHP—Early Replacement of Electric Furnace[1]	1005	14,405	93.6%	14,476,863
ASHP—Replace at failure of ASHP[1]	406	1,595	89.9%	647,581
ASHP—Replace at failure of Electric Furnace[1]	68	12,840	92.5%	873,111
Dual Fuel HP (DFHP) [1]	102	1,184	99.3%	120,734
Ground Source HP (GSHP)	330	21,340	163.2%	7,042,243
CAC—Early Replacement[1]	9,619	1,799	87.7%	17,305,994
CAC—Replace on Burnout[1]	300	355	68.7%	106,576
HVAC Systems Receiving Condenser Cleaning[2]	9,250	258	50.0%	2,383,997
HVAC Systems Receiving Refrigerant Charge Adjustment[2]	1,028	856	448.4%	880,460
HVAC Systems Receiving Evaporator Cleaning[2]	359	117	18.3%	41,998
HVAC Systems Receiving General Maintenance	196	174	100.0%	34,084
ECM Auto Mode, Early Replacement	8,234	649	69.9%	5,346,006
ECM Auto Mode, Replace at failure	376	662	71.3%	248,898
ECM Continuous Mode	400	3,487	375.5%	1,394,769
Thermostat Installed with Setback Programmed (Discontinued in PY14)	5	83	15.2%	414
Total	**32,407**	**n/a**	**93.5%**	**54,622,474**

[1] Combined incentive tiers (SEER 14, SEER 15, SEER 16).

[2] Savings adjusted assuming 18% of tune-ups were ASHPs, which have additional savings in heating mode.

[3]Per-unit *ex post* savings rounded to the nearest integer; therefore, total *ex post* savings do not exactly equal the product of per-unit *ex post* and participation quantity.

As shown in Table 2, the Cadmus team determined an overall weighted NTG of 111.1% for the program, which can be attributed to the following main findings:

- The program exhibited 8% free ridership for new GSHP installations and 6.0% for new ASHP installations.
- Tune-up free ridership was 40.5%, slightly lower than the value in PY14 (41.7%).
- Overall, free ridership—a decrement to NTG—was 11.9% in PY15, down from PY14 (17%). This value included the free ridership rates determined in PY14 for CAC and ECM measures.
- The program realized 0.1% participant spillover (other non-HVAC actions undertaken by HVAC participants), an increase to NTG.
- Ameren Missouri and ICF's substantial investment in HVAC-specific marketing (approximately $955,000) generated 17.8% NPSO, an increase to NTG.
- The Heating and Cooling Program caused an increase in efficiency of equipment sales in the market outside the program, resulting in HVAC NPSO of 5.1%.

Table 2. PY15 Net Impact Results Summary

Measure Group	*Ex Post* Gross Savings (kWh/yr)	Free Ridership	Participant Spillover	NPSO	HVAC NPSO	NTG Ratio	Net Savings (kWh/yr)*
ASHP	19,837,034	6.0%	0.1%	17.8%	5.1%	117.0%	23,214,605
CAC/ECM/T-Stat	24,402,657	14.0%				109.0%	26,602,845
GHSP	7,042,243	8.0%				115.1%	8,102,920
Tune-Up	3,340,540	40.5%				82.5%	2,756,809
Program Total	54,622,474	11.9%	0.1%	17.8%	5.1%	111.1%	60,677,178

*Total may not add to sum of measure-specific kW due to rounding

Combining the measure-specific *ex post* results from the previous two tables revealed the PY15 Heating and Cooling Program achieved 95.7% of its proposed net energy savings target for PY15 (63,386 MWh) as shown in Table 3. In addition, the program achieved 78.8% of its proposed net demand savings target for PY15 (36,745 kW). Ameren Missouri's residential tariff approved by the Missouri Public Service Commission (MPSC) set the yearly targets for energy and demand prior to the start of the PY13 program. For detailed measure-level demand savings values, see Table 39 in Appendix A.

Table 3. PY15 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)	63,386	58,451	54,622	60,677	95.7%
Demand (kW)	36,745	19,435	26,949	28,951	78.8%

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

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

[3] Calculated by applying tracked program activity to Cadmus' evaluated savings values. Includes line loss factor of 5.72%.

[4] Calculated by multiplying Cadmus' evaluated gross savings and the NTG ratio, which accounted for free ridership, participant spillover, NPSO, and HVAC NPSO.

[5] Compares MPSC-approved target and *ex post* net savings, determined by evaluation, measurement, and verification (EM&V).

Key Process Evaluation Findings

Stakeholders (Ameren Missouri and ICF), program participants, and participating HVAC contractors were generally satisfied with the Heating and Cooling Program. Stakeholders believed the program was largely successful in PY15 in terms of savings, satisfaction, and meeting participation goals. Greater than 90% of program participants were satisfied or very satisfied with the program and with their participating HVAC contractor. HVAC contractors generally felt that since PY13, the program had become much more streamlined. Though contractors commonly express displeasure with HVAC incentive application process requirements of utility energy efficiency programs, PY15 Ameren Missouri participating contractors offered few complaints about the program requirements. In fact, many claimed that some requirements benefitted both their customers and their businesses.

Ameren Missouri aggressively marketed the Heating and Cooling Program in PY15, allocating more than 50% of its entire energy efficiency marketing budget to the Heating and Cooling Program. Participation of nearly all measures increased in PY15. ASHPs save more energy than CACs; so Ameren Missouri specifically promoted these systems in various ways. As a result, heat pump incentives increased significantly, relative to other measures.

Key Conclusions

Based on the preceding findings, the Cadmus team presents the following conclusions.

Conclusion 1. ***Free ridership of high-efficiency equipment measures decreased each year, from PY13 to PY15.*** In PY13, Cadmus found free ridership (25%) similar to or lower than other residential heating and cooling efficiency programs. Free ridership in PY14 declined to 17% overall for the Heating and Cooling Program and declined again to 11.9% in PY15. The decline from PY14 to PY15 was attributed entirely to the updated free ridership rates of HP participants.

The increase in program familiarity and high satisfaction leading to promotion by word of mouth appeared to be factors helping to promote the program to Ameren Missouri customers, who otherwise would not have chosen to participate. Ameren Missouri program staff increased incentives and encouraged HVAC contractors to promote HP measures, which also likely contributed to the decrease in free ridership rates.

Recommendation: Continue to perform targeted marketing, especially to Ameren Missouri customers with high electric energy consumption (i.e., weather-related heat load) during the heating season and who are eligible for an HP early replacement measure.

Conclusion 2. ***The program's presence affected the volume and efficiency of HVAC systems sold in Ameren Missouri service territory.*** According to the contractor and distributor sales data, the distribution of 13 SEER units decreased from 2012 to 2015. Contractors reported that 39% of 2012 installs were 13 SEER, compared to only 9% in 2015. Distributors reported a similar drop in 13 SEER units, from 76% of all sales in 2012 to only 53% in 2015. It is noteworthy that distributors estimated that their 2016 share of 13 SEER units will increase to 68% of all sales (absent the program); this reflects a decrease in energy-efficient units from current levels, but still remains higher than in 2012. The team found that HVAC NPSO is 5.1% of total Heating and Cooling Program energy savings. The distributor estimates of 13 SEER sales in absence of a heating and cooling program is anecdotal evidence that the HVAC NPSO estimate is reasonable.

Conclusion 3. ***Heating and Cooling Program implementers, managers, and participants are generally satisfied with the program.*** Through interviews and surveys of contractors, stakeholder, and program participants, Cadmus identified various complaints and issues in PY13 and PY14. These included the following:

The application process was too cumbersome and time-consuming;

- The tune-up testing requirements were cost-prohibitive
- HP eligibility criteria precluded participation of systems that could save energy.

In PY15, Cadmus interviewed HVAC contractors, participants, stakeholders, and distributors and did not identify substantial or common issues with the program process or measures offered. In PY15, the program operated smoothly and successfully.

Conclusion 4. ***HVAC contractors are the key to the program's success, but it takes time to build a successful program with them.*** ICF held contractor advisory sessions (started midway through PY14), working directly with contractors to better understand their needs and to find ways to ensure a successful program. Ameren Missouri and ICF continued to use the advisory sessions to make various types of program improvements. ICF also employed five service account managers, who were dedicated to working directly with contractors. Contractors claimed the program interaction, web application process, and marketing tools in PY15 improved substantially and helped to drive the sale of high-

efficiency equipment. Most participants claimed their contractor was very influential in their decision-making process, implicitly implying that HVAC contractors were key to program successes.

Recommendation: To the extent possible, continue positive and regular communications, even prior to launching any new energy efficiency program offerings; this keeps contractors informed and interested in future participation.

PY14 Recommendation Tracking

Cadmus also examined actions taken on the PY14 evaluation's recommendations to track which of these were or were not implemented. Ameren Missouri implemented all PY14 recommendations, as shown in Table 4.

Table 4. PY14 Evaluation Recommendation Tracking

PY14 Recommendation	Cadmus Findings	Explanation
ICF should develop a systematic methodology for screening reported data. Although ICF already works directly with contractors who report erroneous data or who fail post-measure M&V tests, they could continue to improve the effectiveness of this process. ICF should consider using engineering values and limits to instantly flag bad data, so they can efficiently report this to the contractor. Examples of automatic screening include permissible maximum and minimum values of recorded measurements, such as CFM/ton, Watts/CFM, kW/ton, and the supply and return temperature differential.	Implemented	ICF implemented a screening of several factors, in consultation with Cadmus. These were tracked in conjunction with tune-up data collection requirements for contractors.
Recommendation 2. Consider including additional multifamily-style buildings. Currently, the Heating and Cooling Program precludes multifamily style buildings larger than four units. Such buildings may offer substantial savings opportunities for both the program's tune-up and replacement elements, especially those with electric resistance heat.	Implemented	This change was made in February 2015. Program guidelines were changed to allow "rowhouses" (greater than four units) into the program.
Recommendation 3. Continue marketing efforts, especially targeted marketing of homes with high-propensity electric energy consumption data. The replacement of electric resistance heat results in the highest savings of all Heating and Cooling Program measure offerings. If customers with electric heat are targeted by the program, the free ridership rate could continue to decline in PY15.	Implemented	Marketing to all-electric customers has been underway throughout the program cycle. The fall-targeted marketing was coupled with a contractor contest to drive HP production to 250% of that attained in 2014.
Recommendation 4. Continue marketing efforts and consider offering a focus group to solicit feedback from contractors. The Evaluation Team did not perform contractor interviews in PY14. Continued participation and stakeholder feedback indicates contractors are relatively satisfied with the program. If Ameren Missouri or ICF hosts a focus group of the largest participating contractors and those who choose not to participate, they may uncover invaluable information for future	Implemented	This was implemented in 2014. A Contractor Advisory Group was initiated, including quarterly in-person meetings and ad-hoc communications. Input from this group was used when implementing design changes, marketing campaigns, and

PY14 Recommendation	Cadmus Findings	Explanation
program design changes. Contractors also offer unique perspectives that could be used to inform future program measure planning decisions. Contractors are well-positioned to discuss the current measure offerings, assess the impact of new technology entering the market (e.g., ductless mini-split HPs), or assess the impact of the changing efficiency standards.		measure mix and availability. The group included not only the largest contractors, but regional representation as well.

Introduction

Ameren Missouri engaged Cadmus and Nexant (the Cadmus team) to perform a process evaluation and an impact evaluation of the Heating and Cooling Program for a three-year period. This annual report covers impact and process evaluation findings for Program Year 2014 (PY15), the period from January 1, 2015, through December 31, 2015, the final year of the three-year program cycle.

Program Description

The Heating and Cooling Program offered Ameren Missouri customers living in single-family homes, condos, or townhomes incentives for installing high-efficiency central air conditioners (CAC) or heat pumps (HP) through a participating program contractor. The program also offered incentives for the installation of variable-speed fan motors. In addition to equipment incentives, the program offered an incentive for diagnostic testing and tuning of existing HVAC systems to manufacturer specifications through the Tune-Up Plus Ameren Missouri Efficiency Analysis (TEA).

To participate, a residential customer must have had a measure installation performed by a participating contractor. The participating contractor submitted all required paperwork for incentive processing. To become a participating contractor, an HVAC company representative needed to attend a program training session conducted by ICF International (ICF), the implementer.

Program Activity

In PY15, 20,233 participants received a total of 32,407 measures through the Heating and Cooling Program (many program participants received multiple rebates). This represented a 31% increase in rebates from PY14. Table 5 summarizes results from the four primary measure types. The process evaluation findings section explains the factors contributing to the increase in participation. Key factors include:

- Increased program marketing efforts
- Additional contractor training options
- Mid-year incentive increases
- Contractor promotional sales bonuses
- Contractor familiarity with the program
- Incentive application process improvements

Table 5. PY14 and PY15 Program Activity of the Measures with Highest Participation

Measure	Number of Systems/ Measures in PY14	Number of Systems/ Measures in PY15
ASHPs	1,362	2,310
GSHPs	138	330
CACs	7,288	9,919
Tune-Ups*	8,894	10,833

*Total number of HVAC systems receiving a tune-up. Total does not match total number of tune-up measures as some systems received multiple tune-up measures.

Evaluation Methodology

In evaluating Ameren Missouri's Heating and Cooling Program, the Cadmus team identified the following objectives for PY15.

Impact Evaluation Priorities

- Conduct a detailed engineering review of Tune-Up Plus Ameren Missouri Efficiency Analysis (TEA) measurements to determine savings from HVAC system tune-ups;
- Assess free ridership;
- Assess spillover;
- Determine effects from the Heating and Cooling program changing the efficiency of HVAC equipment sold in Ameren Missouri Service territory.

Process Evaluation Priorities

- Assess the impacts from program design changes, marketing activities, and program processes.
- Assess the program's achievements against goals.
- Examine participants' experiences, satisfaction with various program design elements, and decision-making motivations.
- Examine participating HVAC contractors' experiences with the program, satisfaction with the program, and their assessments of the Heating and Cooling Program's impact.
- Identify primary market barriers, and offer suggestions for effectively overcoming barriers through program design and delivery improvements.

Table 6 lists evaluation activities conducted in PY15 to reach the above objectives, followed by brief summaries of each activity.

Table 6.PY15 Process and Impact Evaluation Activities and Rationale

Evaluation Activity	Process	Impact	Rationale
Review the Tracking Data	•	•	Provide ongoing support to ensure tracking of all necessary program data; identify gaps for evaluation, measurement, and verification (EM&V) purposes.
Interview Stakeholders	•		Obtain an in-depth understanding of the program and identify its successes and challenges.
Survey Participants (Phone)	•	•	Verify measure installation; collect data to inform the net-to-gross (NTG) ratio; collect process-related data and resident satisfaction.
Interview Participating HVAC Contractors	•	•	Obtain an in-depth understanding of the program and identify its successes and challenges, and determine recommendations for improvement from a contractor's perspective. Collect data on recent sales and efficiency of equipment installed to determine HVAC NPSO.
Interview HVAC Distributors		•	Collect data on recent sales and efficiency of equipment installed to determine HVAC NPSO.
Conduct an Engineering Analysis		•	Determine gross kWh savings for each measure.
Conduct a Cost-Effectiveness Analysis		•	Measure the program's cost-effectiveness through five standard perspectives: total resource cost, utility cost, societal cost test, participant cost test, and ratepayer impact test.

Data Tracking Review

The Ameren Missouri Technical Resource Manual (TRM) provides deemed savings estimates, rather than savings algorithms, for each measure. In PY13, the Cadmus team performed a detailed engineering review of the TRM's *ex ante* savings estimates for each measure. The PY13 Evaluation Report describes the Cadmus team's observations and findings of the deemed savings value for each measure.[2] In conjunction with the TRM review, the Cadmus team reviewed the program's online reporting database (Vision Analytics) used by ICF. Specifically, we assessed whether ICF gathered the data necessary for an accurate evaluation; this included an assessment of data quality and completeness.

ICF provided two databases: Vision and the "OCC Savings"[3] database—an Excel file used to track diagnostic tune-up data from each tune-up performed.

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[2] "Ameren Missouri CoolSavers Impact and Process Evaluation: Program Year 2013". Online: https://www.efis.psc.mo.gov/mpsc/commoncomponents/viewdocument.asp?DocId=935842419
CAC measures: pg. 40. ASHP and GSHP measures: pg. 45. Tune-up measures: pg. 46-47. ECM measures: pg. 50-51.

[3] ICF's nomenclature for this database.

The Vision database, which was continuously updated, contained information such as the following:

- Incentive amount
- Measure type
- Customer information
- New HVAC equipment information
- Existing (replaced) equipment information

The OCC savings database (transmitted electronically) contained diagnostic information regarding program tune-ups and tracked the following information:

- Qualitative information about the work performed (e.g., refrigerant was adjusted, condenser was cleaned)
- Outdoor air temperature
- Pre and post HVAC cooling capacity
- Pre and post HVAC system power
- HVAC system type (AC or HP)
- HVAC system serial number
- HVAC system size

Stakeholder Interviews

For the Heating and Cooling Program PY15 evaluation, the Cadmus team interviewed Ameren Missouri and ICF program managers. We designed these interviews to accomplish the following:

- Gather information on how effectively the program operated;
- Identify challenges encountered by program staff and the implementer; and
- Determine appropriate solutions.

Appendix B provides a copy of the guide used.

Contractor Interviews

In December 2015, the Cadmus team completed interviews with 11 participating contractors inside Ameren Missouri's territory. From a list of 310 actively participating contractors, we generated a random sample of 30 for contacts. Our probability of selecting a contractor was weighted by the volume of participation. The random sample of 11 contractors interviewed were responsible for 70% of all tune-ups and 37% of CAC and ASHP installations. We also used interviews to capture data on recent sales and on the efficiency of equipment installed. We focused the data collection from PY15 participating contractors on the number of sales of various efficiency levels before and during the 2013–2015 Heating and Cooling Program (PY15 data), which we then compared to similar data collected from PY13 participating contractors in February and March 2014 (PY13 data). Appendix F provides a copy of the interview guide used.

Distributor Interviews

In December 2015 and January 2016, Cadmus interviewed and collected data from HVAC equipment distributors operating within Ameren Missouri's service territory to capture data on recent sales and on the efficiency of equipment installed. We focused the data collection from PY15 distributors on the number of sales of various efficiency levels before and during the 2013–2015 Heating and Cooling Program (PY15 data), which we then compared to similar data collected from PY13 distributors in February and March 2014 (PY13 data). In total, we interviewed seven distributors, and four offered sales data.

Participant Surveys

In December 2015, the Cadmus team conducted two telephone surveys of Heating and Cooling Program participants, completing 140 surveys, as shown in Table 7. A total of 70 TEA participants were surveyed. Another 70 Heat Pump participants were surveyed, with this group made up of 22 customers that installed GSHPs and 48 customers that installed ASHPs.

This process evaluation refers to the two groups of Heating and Cooling Program surveyed participants as TEA participants (n=70) and Heat Pump participants (n=70). Except where noted, answers to survey questions do not include participants that responded "don't know" or refused to respond.

The surveys covered topics for both the impact and process evaluations. These included: measure verification, free ridership, spillover, participant awareness and decision making, and satisfaction. Appendix E provides copies of the survey instruments used. The average participation month for respondents who received a tune-up rebate was July; the average participation month for respondents who received an HVAC replacement rebate was late August. This resulted in a time lapse of four to five months between participation and survey.

Table 7. Heating and Cooling Program Participant Survey Summary

Target Audience	Survey Method	Field Dates	Completed Surveys
HVAC - GSHP	Phone	12/15 – 12/17	22
HVAC - ASHP	Phone	12/15 – 12/17	48
TEA Participants	Phone	12/14 – 12/17	70
Total	**-**	**-**	**140**

Survey results may be influenced by the time elapsed between a participants' engagement with a program and a survey's administration. Logic implies that a participant's memory will be more accurate (i.e., greater recall) closer to the time of participation and less accurate (i.e., recall bias) further from the participation time. With greater recall, survey results most accurately reflect a participant's experience with a program and with installation activities.

However, allowing greater elapsed time between program participation and survey administration enhances a study's ability able to capture: installations over time, measure retention, and spillover

estimates. Inadequate evidence exists to determine whether recall bias increases or decreases free ridership estimates.

Optimally, participant surveys will be administered immediately after participation to capture greater recall and further from the participation time to capture later installations, retention, and spillover. Conducting multiple participant surveys, however, depends on program and evaluation timelines as well as budget constraints.

Engineering Analysis

To estimate per-unit gross savings for each HVAC measure, the Cadmus team used engineering algorithms and assumptions with all Ameren Missouri-specific inputs available. These algorithms yielded estimates of the difference between the energy usage of rebated products and the usage of similar products meeting the minimum federal standard for efficiency. Table 8 provides a brief overview of the engineering methodology used to estimate savings.

Table 8. Engineering Analysis Summary by Measure

Measure	Baseline (Cooling)	Baseline (Heating)	Type of Savings Calculation
ASHP—Early Replacement of ASHP	7.2 SEER from Cadmus meter data (PY10), adjusted by age of existing system	6.3 HSPF estimated from SEER and database correlating HSPF to SEER	Metered cooling from PY13 updated with PY15 tracking data; engineering estimate of heating savings for PY15
ASHP—Early Replacement of Electric Furnace	7.2 SEER from Cadmus meter data (PY10), adjusted by age of existing system	Electric furnace (HSPF =3.412)	Metered cooling from PY13 updated with PY15 tracking data; engineering estimate of heating savings for PY15
ASHP—Replace at Failure of ASHP	13 SEER—federal minimum	7.7 HSPF—federal minimum	Metered cooling from PY13 updated with PY15 tracking data; engineering estimate of heating savings for PY15
ASHP—Replace at Failure of Electric Furnace	13 SEER—federal minimum	Electric furnace (HSPF =3.412; COP = 1)	Metered cooling from PY13 updated with PY15 tracking data; engineering estimate of heating savings for PY15
GSHP – Replaces Electric Resistance Heat	7.2 SEER from Cadmus meter data (PY10), adjusted by age of existing system	Electric furnace (HSPF =3.412; COP = 1)	Metered cooling from PY13 updated with PY15 tracking data; engineering estimate of heating savings for PY15
GSHP – Replaces ASHP	7.2 SEER from Cadmus meter data (PY10), adjusted by age of existing system	6.3 HSPF estimated from SEER and database correlating HSPF to SEER	Metered cooling from PY13 updated with PY15 tracking data; engineering estimate of heating savings for PY15
CAC—Early Replacement	7.2 SEER from Cadmus meter data (PY10), adjusted by age of existing system	N/A	Metered cooling from PY13 updated with PY15 tracking data
CAC—Replace on Burnout	13 SEER –federal minimum	N/A	Metered cooling from PY13 updated with PY15 tracking data
HVAC Systems Receiving Condenser Cleaning	Pre tune-up EER from contractor reported measurements	Apply % EER improvement to HSPF for HPs	Apply ΔEER to metered cooling consumption
HVAC Systems Receiving Refrigerant Charge Adjustment	Pre tune-up EER from contractor reported measurements	Apply % EER improvement to HSPF for HPs	Apply ΔEER to metered cooling consumption from PY13 metering
HVAC Systems Receiving Evaporator Cleaning	Pre tune-up EER from contractor reported measurements	Pre tune-up EER from contractor reported measurements	Apply ΔEER to metered cooling consumption

Measure	Baseline (Cooling)	Baseline (Heating)	Type of Savings Calculation
HVAC Systems Receiving General Maintenance	TRM deemed savings	N/A	Deemed
ECM Installed with AHRI*-Rated HVAC System	Already included in SEER rating	Already included in HSPF rating	Savings weighted using % of metered sites with continuous usage
ECM Installed (not in Conjunction with HVAC System)	Engineering estimate	Engineering estimate	Engineering estimate

*Air-Conditioning, Heating, and Refrigeration Institute

In general, we used metered data results and program tracking data to estimate cooling savings and engineering calculations to estimate heating savings. This report's Gross Impact Evaluation Results section presents each algorithm and input assumption.

Cost-Effective Analysis

Using final PY15 HVAC participation data, implementation data, and the *ex post* gross and net energy savings estimates presented in this report, Morgan Marketing Partners (MMP) determined the program's cost-effectiveness using DSMore.[4] MMP also calculated measure-specific cost-effectiveness. As shown in the Cost-Effectiveness Results section, we assessed cost-effectiveness using the five standard perspectives produced by DSMore:

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

Impact CSR

According to the Missouri Code of State Regulations (CSR), demand-side programs that are part of a utility's preferred resource plan are subject to ongoing process and impact evaluations that meet certain criteria. Specifically, the CSR requires that impact evaluations of demand-side programs satisfy the requirements noted in Table 9. The table indicates the data our team used to satisfy these impact CSR evaluation requirements for the Heating and Cooling Program. We provide a summary of the process CSR requirements in Table 12, at the end of the Process Evaluation Findings section.

[4] A financial analysis tool designed to evaluate the costs, benefits, and risks of demand-side management programs and services.

Table 9. Summary Responses to CSR Impact Evaluation Requirements

CSR Requirement	Method Used	Description of Program Method
Approach: The evaluation must use one or both of the following comparisons to determine the program impact:		
Comparisons of pre-adoption and post-adoption loads of program participants, corrected for the effects of weather and other intertemporal differences	X	The program compares the pre-adoption load based on assumed baseline technology, with the post-adoption load based on program technology, and savings based on submetered data from sample of participants
Comparisons between program participants' loads and those of an appropriate control group over the same time period		
Data: The evaluation must use one or more of the following types of data to assess program impact:		
Monthly billing data		
Hourly load data		
Load research data		
End-use load metered data	x	Metered HVAC power, indoor temperature, and outdoor conditions at 2-minute intervals during 2013
Building and equipment simulation models		
Survey responses	x	Verified measure installation through participant surveys in 2013, 2014, and 2015
Audit and survey data on:		
Equipment type/size efficiency	x	Evaluation team gathered equipment information from homes participating in metering and from program data
Household or business characteristics	x	Evaluation team collected household characteristics from homes participating in metering and from program data.
Energy-related building characteristics		

Process Evaluation Findings

This section presents the Cadmus team's process evaluation findings for Ameren Missouri's Heating and Cooling Program.

Heating and Cooling Program Design and Delivery

According to stakeholders, Ameren Missouri and ICF collaborated to design the Heating and Cooling Program to achieve three main objectives:

- Broaden the market supply for high-efficiency HVAC equipment and diagnostic tune-up services;
- Educate customers about Ameren Missouri's full suite of residential energy-efficiency offerings; and
- Minimize NTG impacts.

Ameren Missouri and ICF implemented several changes in PY15, including the following:

- Adding an incentive for a geothermal HP that replaces an ASHP;
- Increasing various incentives for most types of CAC, ASHP, and GSHP installations;
- Requiring contractors to provide tune-up participants with an Ameren Missouri Efficiency Analysis form that provides the results of the diagnostic test of their HVAC system (this included options for replacement incentives);
- Including a $100 additional incentive for early replacement CAC and ASHP equipment in August and September 2015; and
- Offering a tiered financial incentive to HVAC contractors installing ASHP in the fall (October 15–December 15).

Program Marketing

According to the Cadmus team's assessment of PY15 marketing expenditures, Ameren Missouri marketed the Heating and Cooling Program more aggressively than all of its residential energy-efficiency programs combined (58% of total PY15 marketing). Ameren Missouri increased marketing spending from $882,000 in PY14 to $955,000 in PY15. The following list represents some of the primary methods Ameren Missouri and ICF used to market the Heating and Cooling Program to Ameren Missouri customers in PY15:

- Targeted direct-mail postcards to customers with low-efficiency systems (determined through performance testing from tune-up measure)
- Targeted direct-mail postcards to customers in areas of the highest participation propensity
- Target direct-mail postcards to customers identified as all electric
- Fall Heat Pump Promotion marketing

- Increased rebates marketing
- E-mails to customers
- Website banners and Ameren Missouri's website
- Gas pump toppers
- Newspaper advertisements
- Utility bill inserts, including personal energy reports
- Newspaper advertisements
- Radio advertisements
- Radio live reads
- Internet radio ads (e.g., Pandora)
- Television commercials
- Television "taggables" (e.g., Weather Channel)

Stakeholders believed ongoing outreach to and positive relationships with participating contractors proved invaluable and necessary to ensure the program met its savings goals. ICF hosted various luncheons for contractors as well as an appreciation dinner in February, which recognized contractors with the highest participation rates. ICF employed five dedicated account managers to work closely with contractors throughout the year.

To better understand the needs of contractors, stakeholders held quarterly contractor advisory meetings. The advisory group included contractors of varying participation rates and sizes. The stakeholders used the feedback from the contractor advisory group to inform marketing to customers and to develop marketing materials for all contractors. More than one-half of the contractors Cadmus interviewed said the program itself served as a good marketing tool: simply being a qualified contractor proved beneficial to their business. In addition to the Ameren Missouri name, ICF created a contractor marketing toolkit, which included templates that provided guidance on co-branding, co-op marketing, radio, TV, and social media.

Additionally, ICF continued to work with distributors, encouraging them to sell high-efficiency equipment. In doing so, ICF hired a dedicated account manager to work directly with distributors. The account manager provided promotional flyers, program information, and a marketing toolkit to distributors serving Ameren Missouri's market area. Distributors provided access to their facilities, and, with help from their territory managers, trained local contractors. Distributors also provided AHRI certificate information, making the rebate application process easier for contractors. The impact that an account manager dedicated to working with distributors may have is difficult to quantify. However, using data provided by distributors, the Cadmus team found that HVAC NPSO resulted in energy savings equivalent to 5.1% of the total Heating and Cooling Program savings in 2015 (See Section "HVAC Nonparticipant Spillover" and Table 35). The Cadmus team has attempted to collect sales data from distributors for numerous evaluations of other utility HVAC programs and has had limited or no success

in obtaining useful sales data. With relatively minimal effort, in PY15 Cadmus was able to successfully interview seven distributors and collect sales data from four (See PY15 Distributor and Contractor Data section). This success indicates that distributors are willing to support the Heating and Cooling Program. In addition, the relationship that the ICF dedicated account manager developed, undoubtedly helped to produce sales data which improved accuracy of the net energy savings estimates attributable to HVAC NPSO.

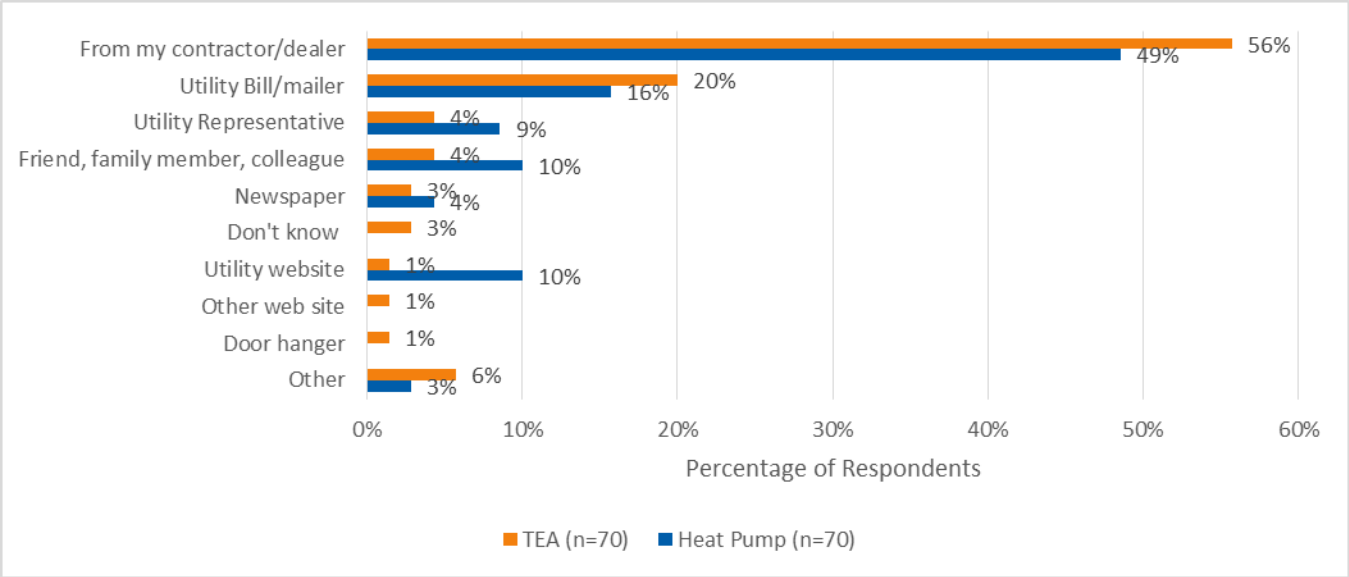
Participant Program Awareness

The Cadmus team surveyed program participants receiving a tune-up (i.e., TEA participants) or installing a new GSHP or ASHP (i.e. Heat Pump participants). As shown in Figure 1, both customer types included the following first points of entry:

- Learning of the program from a contractor: 56% (n=70) of TEA customers and 49% (n=70) of Heat Pump customers; or
- Learning of the program a utility bill or mailer: 20% of TEA customers and 16% of Heat Pump customers.

Differences emerged, however, between the two groups' first points of entry. Heat pump customers—rather than TEA customers—more likely learned of the program through a utility representative, the utility website, or an acquaintance.

Figure 1. Awareness of Program, Heat Pump, and TEA Customers



Ameren Missouri HVAC PY7 Participant Survey: Heat Pump, QB2 (n=70); TEA, QB2 (n=70); "How did you first hear about the [program]?" Single response, includes don't know.

Surveys then asked customers to name other sources from which they heard of the program. TEA customers' most common secondary point of entry was a utility bill (23%, n=13), followed by a contractor (15%), a utility website (15%), or a friend, family member, or colleague (15%). Heat Pump

participants' three most common additional sources of program information included a contractor (29%, n=28), a television ad (29%), or a friend, family member, or colleague (18%).

HVAC Equipment Installation Measures

Table 10 summarizes incentives offered by the Heating and Cooling Program for installations of AHRI-rated air conditioner and heat pump systems. To further promote participation, the implementers increased many incentives midway through the year. The table shows incentive amounts for all measures and for changes made after June 2015. For CAC and ASHP systems installed in the months of August and September, the program offered an additional $100 incentive if replacing an existing, operating system before its end of life (early replacement).

Table 10 also shows the majority of installations in PY15 were early replacements. A low proportion of new CAC installations (3%) and new ASHP installations (21%) received an incentive after failure of a previous HVAC system.

Table 10. Rebated HVAC System Measure Summary

Measure Type	Qualifying Products	Jan - June	July - Dec	Total # Measures
ASHP	SEER 14 – Replace Operating Air-Source Heat Pump* (Early Replacement)	$400		284
	SEER 14 – Replace Failed Air-Source Heat Pump	$400		102
	SEER 14 – Replace Operating Central Air Conditioner and Electric Resistance Furnace* (Early Replacement)	$600		360
	SEER 14 – Replace Failed Central Air Conditioner and Electric Resistance Furnace (Early Replacement)	$600		26
	SEER 15 – Replace Operating Air-Source Heat Pump* (Early Replacement)	$450	$500	185
	SEER 15 – Replace Failed Air-Source Heat Pump	$450	$500	69
	SEER 15 – Replace Operating Central Air Conditioner and Electric Resistance Furnace* (Early Replacement)	$700	$800	271
	SEER 15 – Replace Failed Central Air Conditioner and Electric Resistance Furnace	$700	$800	18
	SEER 16+ – Replace Operating Air-Source Heat Pump* (Early Replacement)	$550	$650	260
	SEER 16+ – Replace Failed Air-Source Heat Pump	$550	$650	235
	SEER 16+ – Replace Operating Central Air Conditioner and Electric Resistance Furnace* (Early Replacement)	$800	$900	374
	SEER 16+ – Replace Failed Central Air Conditioner and Electric Resistance Furnace	$800	$900	24
Dual Fuel Heat Pump	SEER 14 – Replace Operating or Failed Central Air Conditioner and Non-Electric Heat Source	$150		25
	SEER 15 – Replace Operating or Failed Central Air Conditioner and Non-Electric Heat Source	$175		28
	SEER 16+ – Replace Operating or Failed Central Air Conditioner and Non-Electric Heat Source	$200		49
GSHP	EER 14+ – Replace Operating Air-Source Heat Pump (Early Replacement)	N/A	$2,000	56
	EER 14+ – Replace Operating Electric Resistance Furnace (Early Replacement)	$1,200	$2,000**	65
	EER 14+ – Replace Failed Electric Resistance Furnace	$1,200	$2,000**	209
CAC	SEER 14 – Replace Operating Central Air Conditioner* (Early Replacement)	$300		3,899
	SEER 14 – Replace Failed Central Air Conditioner	$150	$250	150
	SEER 15 – Replace Operating Central Air Conditioner* (Early Replacement)	$400		1,772
	SEER 15 – Replace Failed Central Air Conditioner	$175	$275	88

Measure Type	Qualifying Products	Jan - June	July - Dec	Total # Measures
	SEER 16+ – Replace Operating Central Air Conditioner* (Early Replacement)	$475	$500	3,941
	SEER 16+ – Replace Failed Central Air Conditioner	$200	$300	61

*$100 bonus for installations occurring in August and September.
**Incentive increase in September.

Five of 11 contractors said the program training improved their ability to convince customers of the benefits of high-efficiency equipment, particularly in explaining the concept of their home as a whole-house system in which all components need to be in place and functioning. All contractors said the early replacement incentives proved influential in encouraging their customers to make decisions to install new units in 2015. Eight of the eleven contractors said the incentive had been very influential. Based on their recollection of historical sales data, contractors estimated the rebates also drove customers to install higher-efficiency systems than they would have otherwise, with responses averaging about 50% of the time and ranging from 20% to 80%.

In PY14, ASHPs and GSHPs represented 17% of HVAC equipment incentives. In PY15, the proportion of HPs increased to 21%. To increase participation, stakeholders reported implementing the following changes:

- Midyear increase in incentives for all 15 SEER and 16+ SEER ASHPs;
- Additional August and September $100 bonus incentive; and
- Fall heat pump promotion that paid incentives to contractors coupled with a customer-facing marketing campaign.

While heat pump sales remained unchanged or were not a significant component for six contractors, the other five contractors said they saw an increase in these sales. The incentive moved customers "on-the-fence" to purchase the higher-efficiency heat pump. One contractor said they sold 15 times the number of HPs sold before the program.

All contractors said the program was accomplishing its purpose of increasing demand for energy-efficient equipment. Nine contractors said customers were more interested in purchasing energy-efficient options than before the program began; they did not, however, attribute this change exclusively to the program, explaining most customers wanted energy-efficient equipment. Though the contractors credited the program rebates, which made the decision for higher-efficiency equipment a "no-brainer," they also credited: the population with educating itself through the Internet; people becoming more aware in general of the importance and benefits of higher-efficiency equipment; and Ameren Missouri's "great job" in marketing the program and raising customer awareness.

Contractors offered some additional opinions and insights about the impact of the presence of the Heating and Cooling Program and the forthcoming absence of the incentive offerings. Nine of 11 contractors said they would sell fewer high-efficiency systems as a result of the program ending,

anticipating customers will drop back to SEER 13 equipment. Contractors expected early replacement sales of existing, functional equipment to diminish or take longer to close. Several contractors said the program ending was a significant or huge disappointment, and the impacts would not be fully known until summer 2016. One dreaded what could happen to the business. Only one contractor did not anticipate negative impacts, saying their equipment manufacturer did a good job of training them to sell high-efficiency equipment, and they did not expect that to change.

Heating and Cooling Program Tune-Ups and Furnace Fan (ECM) Measures

Table 11 shows tune-up and ECM measures offered through the Heating and Cooling Program. The vast majority (93%) of ECM installations occurred in conjunction with a new HVAC system installation (i.e., an incentive was also provided for installation of the AC or HP).

Table 11. HVAC Tune-up

Measure	Rebate	Participation
TEA	$75	10,778*
ECM included in AHRI Efficiency Rating of Incented CAC, ASHP, or GSHP	$50	8,344
ECM Retrofit or not included in AHRI	$100	666

*Number of incentives paid does not match total number of tune-up measures for two reasons. 1) Some HVAC systems receive multiple measures. 2) Some HVAC systems receive only a diagnostic test only and no tune-up work is required; system efficiency will not benefit from tune-up service work.

Both stakeholders and participating contractors characterized current measure offerings in the Heating and Cooling Program as appropriate, based on recent evaluation results and program participation.

In PY15, Ameren Missouri changed the tune-up measure slightly, requiring a form that contractors showed to their customers; this displayed the results of the diagnostic test of their HVAC systems and, when deemed necessary, provided recommendations for improvements (as shown in Figure 2). To assist contractors in messaging the TEA measure, Ameren Missouri also created a video explaining the TEA process of diagnosing an HVAC system.

Figure 2. Customer-Facing TEA Form

Ameren Missouri
Efficiency Analysis

Congratulations! You've taken an important first step in improving your home's cooling comfort and energy efficiency. This Efficiency Analysis, performed through the Ameren Missouri Heating and Cooling program, is a great way to diagnose and recommend solutions to common air conditioner problems that may help increase your cooling system's performance.

Your Test Results

Your contractor performed a series of airflow, temperature, refrigerant charge and electrical readings that were taken as part of the Efficiency Analysis testing process. When these readings are evaluated together, they indicate your system's actual operating capacity. Every cooling system has a manufacturer's rated capacity at installation. Due to many factors – such as age, system deterioration and/or inadequate ductwork – your system may be operating below the manufacturer's rated capacity. To determine the efficiency of your system, the Efficiency Analysis compares the operating capacity to the manufacturer's rated capacity. For example, if your cooling system is designed to deliver 48,000 BTUs but is operating at 36,000 BTUs, then your efficiency is 75% (36,000/48,000 = 75%). The Ameren Missouri Efficiency Analysis provides you with the efficiency of your system, allowing you to make decisions about repairs or upgrades that could save you money for years to come.

Your Path to Maximum Performance

In some cases, the Efficiency Analysis results may indicate a need to go beyond the basic tune-up to achieve maximum performance. Your contractor may recommend additional service or repairs to increase comfort and energy savings, such as adjusting the refrigerant charge, making specific improvements to your home's duct system or adding attic ventilation or insulation. In some cases, such as if your system is more than 10 years old, 10 SEER or less, or inefficient, your contractor may recommend replacing your existing equipment. Additional service and repairs may incur added cost.

Location in Home: _____ System _____ of _____ Systems
Age of System(s): _____ SEER: _____

System Efficiency	Recommendations
Good Operating Condition ☐	❑ Add supply runs/ductwork to improve airflow ❑ Install a more efficient blower motor
Preventive Maintenance or Upgrades Recommended ☐	❑ Add returns/ductwork to improve airflow ❑ Install a less restrictive, more efficient filter(s)
Maintenance, Upgrades or Replacement Recommended ☐	❑ Make airflow improvements ❑ Replace system
Current Percentage _____	Other: _____

Contractor Name:	Technician Name:
Phone Number:	Date:

Take advantage of available rebates until December 15, 2015. Get more details at AmerenMissouri.com/hvac.

Up To $500 cash back*
Replace your central air conditioner.
Installing a new air conditioner with a SEER (energy efficiency) rating of 14 or higher will help you conserve energy.

Up To $900 cash back*
Install an air-source heat pump.
An air-source heat pump is an incredibly efficient way to heat your home and cool it in the summer.

Up To $2,000 cash back*
Install a geothermal heat pump.
A geothermal heat pump is an energy efficient, long-lasting alternative to conventional HVAC systems.

Thank You!

Ameren MISSOURI

*Some restrictions may apply. Valid through December 15, 2015. Visit AmerenMissouri.com/hvac for full program details.

Ten of the 11 contractors interviewed provided tune-up services through the Ameren Missouri program; one contractor, who did not provide tune-ups through the program, said that tune-ups were simply not cost-effective, given the additional time required, and, at that time, they had more work than they could respond to.

Among the contractors who provide program tune-ups, an average of more than half of the tune-ups were performed on equipment with existing service contracts as part of an annual maintenance plan. A majority of the contractors (n=7) said the TEA testing requirements and report were useful. This process helped identify underperforming systems (particularly those with poor ductwork), and it helped contractors talk with customers about the benefits of maintenance and the efficiency of older systems vs. new high-efficiency systems.

Six of the seven contractors also agreed the TEA requirements helped them upsell or diagnose and correct system issues they might not have found prior to using the program protocol. When asked how often the form helped them convince customers to purchase a new system, four contractors said this occurred from 5% to 50% of the time. The higher percentages (30% and 50%) were given by two contractors who, combined, performed more than 3,000 program tune-ups in 2015. The two contractors citing the lower range (5% to 10%), combined, performed 179 program tune-ups in 2015. One contractor who did not find the form useful cited the subjectivity of the system efficiency rating and requested Ameren Missouri provide efficiency ranges for each green, yellow, or red rating.

All of the contractors (n=11) said the program tune-up required more time to perform and gave ranges of 15 minutes to 1 hour longer, with the largest group (n=5) saying 30 to 45 minutes longer. They reported the time spent on pre- and post-inspection testing, taking static pressure readings, running the necessary calculations, and completing the paperwork. All said it took longer when they began the program, but, over time, they became more efficient.

Three contractors provided the Ameren Missouri program tune-up and a less-rigorous tune-up option; one contractor eliminated the static pressure measurements, one did not include tests to calculate the efficiency of the unit; and one was not exactly sure how the tune-ups varied. Two charged more for the program tune-up (20% and 50%) than for a non-program tune-up.

Seven of the 10 contractors providing tune-up services said they would continue to use a tune-up process similar to Ameren Missouri's Efficiency Analysis protocol after the program ended. Six of these would use it without making changes; one would provide a similar but less extensive tune-up.

Only one contractor was familiar with the TEA video, a short video that explained the TEA process and benefits of diagnosing an HVAC system. The TEA video, which was a relatively new additional marketing piece, was produced and distributed to contractors about two months prior to Cadmus conducting the interviews.

Motivation of TEA Participants

As shown in Figure 3, the majority of TEA participants (52% [n=85]) participated in the program for reasons related to equipment maintenance. These reasons included the following:

- Time for a check-up (16%);
- Scheduled check-up as part of maintenance contract (14%);

- Equipment experiencing problems (9%);
- Equipment stopped working (2%);
- Keep equipment running (6%);
- Ensuring equipment lasts longer (2%);
- As part of other home maintenance projects (2%); and/or
- To find out if equipment needs repair (1%).

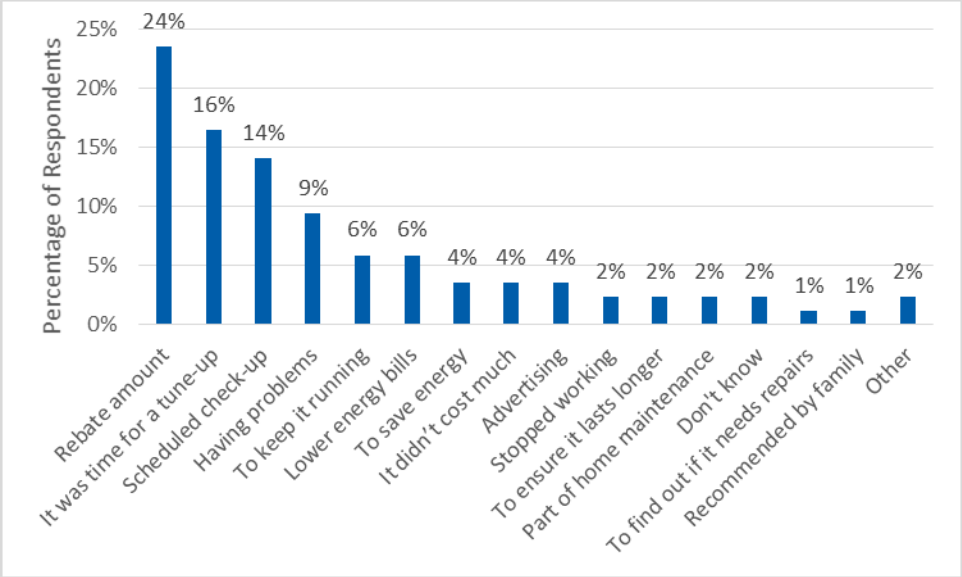
Financial reasons served as the second-most prevalent motivating factor, accounting for 38% (n=85) of the responses, including the following:

- Motivated by the rebate amount (24%);
- Lower energy bills (6%);
- Saving energy (4%); and/or
- As a tune-up was relatively inexpensive (4%).

The least common reasons cited for participation included the following:

- Advertising (5%);
- Being reminded by a friend or family member (1%);
- Unknown (2%); or
- Other (2%).

Figure 3. Motivation to Participate in Program, TEA Customers



Ameren Missouri HVAC PY7 Participant Survey: TEA, QB4 (n=85); "What motivated you to purchase the tune-up service? Multiple responses, includes don't know.

Communication and Program Processes

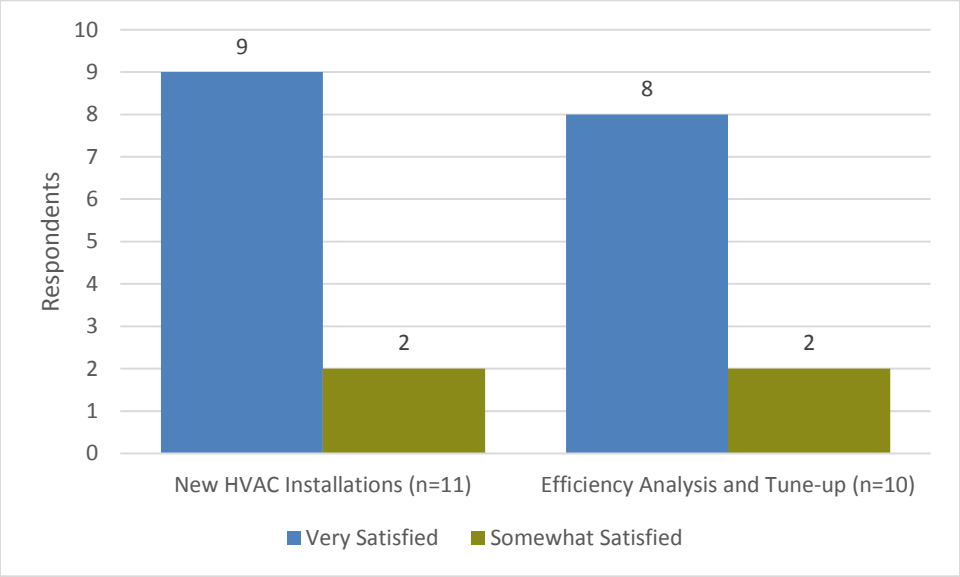
The Cadmus team found stakeholders generally agreed on most issues and found the program ran effectively during PY15.

ICF sent bimonthly newsletters to contractors; these included program updates and reminders. For communication of crucial information, ICF sent e-mails as necessary and would resend and even follow up with phone calls if an e-mail was unopened by a contractor.

ICF used a website called the "Online Intake Tool" to relay information to and to collect information from participating HVAC contractors. This tool hosted recent updates, archived all communications, and provided live chat help. Contractors could access co-branding resources and obtain advertising schedules to coordinate their own advertising with the program's advertising. Stakeholders believed the tool worked very well in PY15.

Throughout the interviews, contractors said, at the launch of the program, verification and paperwork were particularly cumbersome, but the Online Intake Tool significantly improved the process of submitting applications and relaying information. Overall, contractors were satisfied with the application processes for new HVAC installations and the application process for Efficiency Analysis and tune-up service work, as shown in Figure 4.

Figure 4. Contractor Satisfaction with Program Application Processes and Online Intake Tool



Participant Program Satisfaction

Surveys asked program participants receiving a tune-up or installing a new HVAC system to rate satisfaction with the following four elements:

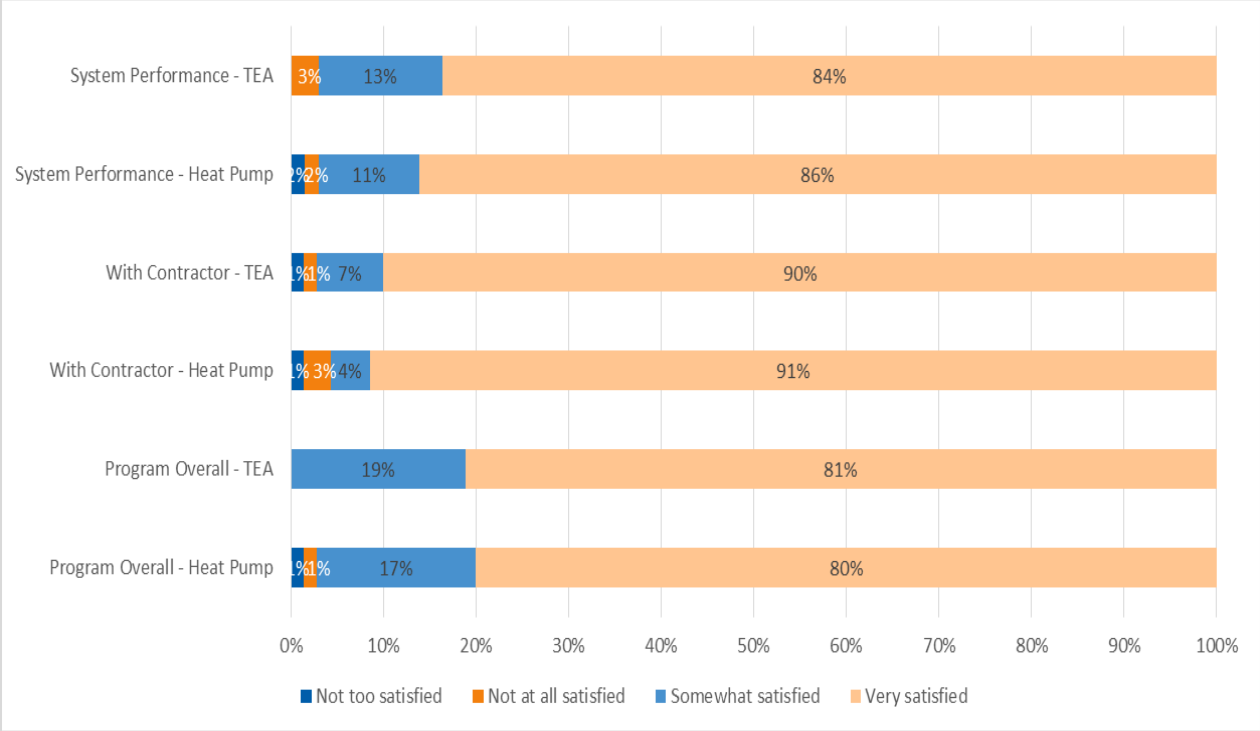
- Overall experience with the program;

- The service and quality of work provided by the program contractor;
- The performance of the new or tuned-up HVAC system; and
- Overall satisfaction with Ameren Missouri.

Figure 5 shows that customers of both programs expressed high satisfaction levels with each program overall and with the components of each program. Responses of both programs' customers followed a similar pattern, where the percentage of customers very satisfied with the program overall—81% (n=69) of TEA customers and 80% (n=70) of Heat Pump customers—was smaller than the percentage of those:

- Very satisfied with their contractors—90% (n=70) of TEA customers and 91% (n=70) of Heat Pump customers; and
- Very satisfied with their systems' performance—84% (n=67) of TEA customers and 86% (n=65) of Heat Pump customers.

Figure 5. TEA and Heat Pump Customers Satisfaction with Program Overall, with Contractor, and with System Performance



Ameren Missouri HVAC PY7 Participant Survey: Heat Pump, QD5 (n=70), TEA, QD5 (n=69); "Thinking back over the scheduling, servicing, available rebates, and rebate processes, how satisfied are you with the overall [program]? Heat Pump, QD1 (n=70); TEA, QD1 (n=70); "How satisfied are you with the contractor you worked with?" Heat Pump QD3 (n=65); TEA, QD2 (n=67); "How satisfied are you with the performance of your [new heat pump/system since the tune-up]?"

Overall Program Satisfaction and Suggested Program Improvements

TEA participants described themselves as very satisfied with the program overall (81%, n=69), while the remaining participants (19%) were somewhat satisfied; no customers described themselves as unhappy with the program. Most Heat Pump participants described themselves as very satisfied with the program overall (80%, n=70), while 17% were somewhat satisfied, and 2% described themselves as not too satisfied or not at all satisfied.

Most survey participants—70% (n=69) of TEA participants and 51% (n=70) of Heat Pump participants—did not think the program could be improved. Some participants, however, had suggestions for program improvements. Figure 6 shows suggestions for each type of customer. Prevalent suggestions from TEA customers included the following:

- Better advertising of the program (17%);
- Larger rebates (3%); and
- Faster rebate processing times (3%).

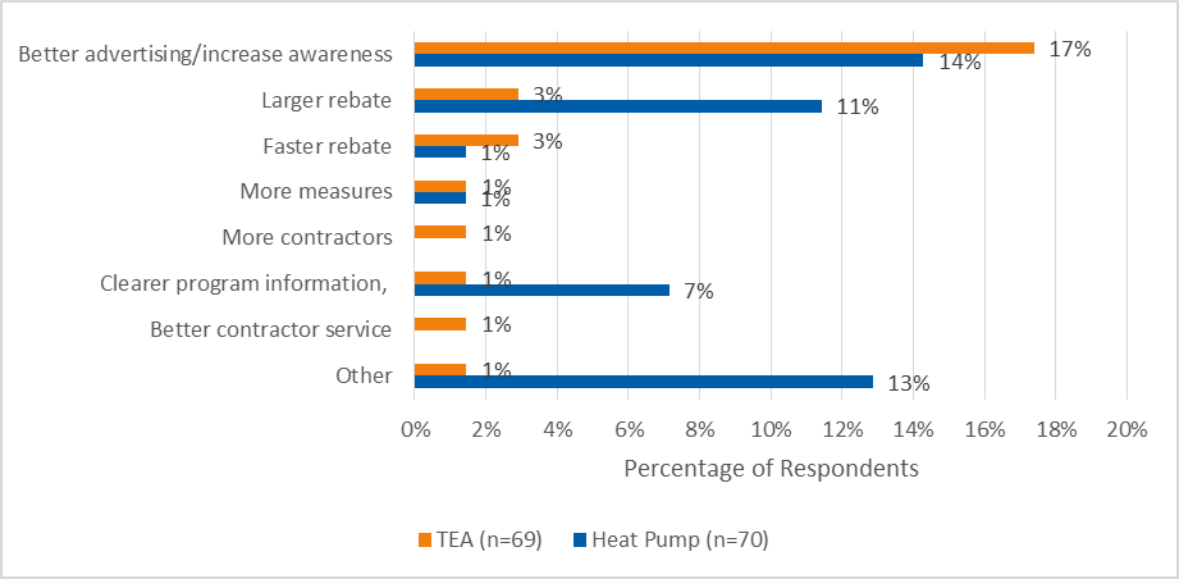
Heat Pump customers suggested the following:

- Better advertising (14%);
- Larger rebates (11%); and
- Clearer program information (7%).

A notable number of Heat Pump participants (13%) offered the following suggestions that fell into the "other" category:

- Four suggested energy rates be lowered (n=4);
- Two suggested extending the program (n=2);
- One didn't know if the program was cancelled or not (n=1);
- One cited rebates in Illinois and suggested that Ameren Missouri offer the same rebates (n=1); and
- One suggested that customers be allowed to fill in their rebate themselves (n=1).

Figure 6. Suggestions for How to Improve the Programs, TEA and Heat Pump Participants



Ameren Missouri HVAC PY7 Heat Pump Participant Survey: Heat Pump, QD8 (n=70); TEA, QD7 (n=69) "What suggestions, if any, do you have for improving the program?" (n=70)

Satisfaction with the Participating Contractor

A great majority of participants for both programs described themselves as very satisfied with their contractors. Of participants having their HVAC systems tuned-up, 90% (n=70) described themselves as very satisfied with their contractor; 91% (n=70) of Heat Pump customers were very satisfied with the contractor performing the installation.

The majority of TEA customers worked with contractors with whom they had previously worked (66% of customers, n=70). Heat Pump customers proved less reliant on contractors with whom they had previously worked (36%, n=76), also commonly finding contractors through referrals from family, friends, or neighbors (28%).

Satisfaction with the System/Measure Performance

Most TEA participants described themselves as very satisfied with the performance of their HVAC systems following a tune-up (84%, n=67), while 13% of remaining participants described themselves as somewhat satisfied, and 3% described themselves as not at all satisfied. Despite the majority's satisfaction with post tune-up system performance, when asked if they experienced benefits, many surveyed customers said they had not experienced benefits (56%, n=64). Of those perceiving benefits, over one-fifth noticed increased energy savings and lower monthly utility bills (23%); smaller numbers of customers experienced increased comfort in their home (6%), increased convenience or productivity (3%), lowered maintenance costs (3%), and improved air quality in the home (6%). One respondent said they had experienced "peace of mind" (2%).

Most customers installing a new heat pump (86%, n=65) were very satisfied with the new equipment; 11% of remaining participants were somewhat satisfied; and 4% of participants were not too satisfied or not at all satisfied. Participants cited three top reasons for satisfaction with their new HPs: a decrease in their monthly utility bills (36%, n=76); improved comfort in the home due to the system heating or cooling more effectively than the previous system (20%); and a quieter system (16%).

Satisfaction with Ameren Missouri

The majority of surveyed Ameren Missouri customers for both programs expressed satisfaction with Ameren Missouri as their utility. Of TEA customers surveyed, 70% (n=66) were very satisfied with Ameren Missouri; 29% were somewhat satisfied; and 2% were not at all satisfied. Of customers installing HP systems, 60% (n=70) said they were very satisfied with Ameren Missouri; 36% were somewhat satisfied; 1% were not too satisfied; and 3% were not at all satisfied.

A higher percentage of customers installing new HPs increased their opinion of Ameren Missouri through program participation than customers receiving a tune-up: 56% (n=68) of Heat Pump customers in comparison to 48% (n=65) of TEA customers.

Program Implementation Challenges

Contractors reported they were very satisfied with the program and found it easy to participate; they explained that stakeholders were responsive to issues identified by contractors in the program's early days, and that they streamlined the program forms and processes. No significant barriers were identified by HVAC contractors in the 2015 program delivery. Only one contractor cited any barriers with the program as it functioned today, saying the 30-day limit on the rebate request was somewhat tight and 45 days would be better.

According to stakeholders, the two most common complaints from Ameren Missouri residential customers addressed timeliness of the incentive payment ("where's my rebate check") and a compliant about program eligibility ("why can't I get a rebate—my contractor told me I could"). Combined, these complaints represented less than 1% of the total number of rebates and generally were due to HVAC contractor errors.

Cadmus' review of participant survey responses, contractor interviews, and stakeholder interviews indicates only a small number of insignificant implementation barriers and no major implementation barriers that inhibit participation.

CSR Summary

According to the Missouri CSR,[5] demand-side programs that are part of a utility's preferred resource plan are subject to ongoing process evaluations that address, at a minimum, the five questions listed in Table 12 (which offers a summary response for each specified CSR requirement).

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

Table 12. Summary Responses to CSR Process Evaluation Requirements

CSR Requirement Number	CSR Requirement Description	Summary Response
1	What are the primary market imperfections common to the target market segment?	The primary market imperfection common to the target market was inadequate information and/or knowledge regarding the energy-saving benefits of proper HVAC maintenance, high-efficiency HVAC systems for cooling and electric heating, and the use of electric resistance heating. Additionally, the investment/cost of installing a new HVAC unit deterred customers from ultimately making the decision to purchase until absolutely necessary. Further, when customers replaced a system, the greater upfront cost of high-efficiency systems could cause them to purchase a lower-efficiency unit, even if the lifetime operating costs of the system were greater.
2	Is the target market segment appropriately defined, or should it be further subdivided or merged with other market segments?	The target market segment was appropriately defined and comprehensively served for the single-family residential market. The program expanded in 2015 to include "rowhouses" (townhouse-style buildings with more than four units). Specifically, the Heating and Cooling Program was designed to help customers maintain the efficiency of operable systems (through tune-ups) and offered tiered incentives for customers replacing a failed and functional system (early retirement).
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 program targeted the primary end-use technologies within the targeted market segment. When given the opportunity to offer suggestions for program changes or improvements, participating contractors and participants did not suggest that the program precluded any type of end-use measure. Thermostat with internet connectivity and adaptive temperature control strategies are relatively new to the market. The program could include incentives for this type of measure.
4	Are the communication channels and delivery mechanisms appropriate for the target market segment?	Yes, current communication channels were appropriate. The program expanded marketing efforts in PY15 and communicated information through high-propensity direct marketing, television advertisements and banners, website and internet radio advertisements and also increased its outreach to equipment distributors. Participating contractors contributed to marketing strategies during contractor advisory group sessions.

CSR Requirement Number	CSR Requirement Description	Summary Response
5	What can be done to more effectively overcome the identified market imperfections and to increase the rate of customer acceptance and implementation of each end-use measure included in the program?	The marketing materials allocated a significant proportion of resources specific to the targeted market. In the first program year, the most common suggestion for improvement from program participants surveyed was the need to increase program awareness and benefits, an indication that marketing efforts should continue or increase. The program could continue to perform billing data analysis to market to customers with relatively high apparent heating and cooling energy consumption.

Gross Impact Evaluation Results

This section details how the Cadmus team calculated gross savings and determined realization rates for each measure's per-unit energy savings.

Cooling Savings Estimates

In PY13, the Cadmus team metered 83 HVAC systems that received tune-ups and 78 new, high-efficiency HVAC systems installed through the program. We used detailed submeter data, collected in conjunction with PY13 program tracking data, to estimate per-unit savings for all program measures. This year, we used the PY13 metering data and the program's detailed tracking data for PY15 to estimate evaluated (*ex post*) per-unit savings. Table 13 summarizes the PY13 meter data results.

Table 13. Summary of Metering Results

Measure Type	PY13 Population	Metered Sample Size	Seasonal Metered Weather Normalized kWh	Coefficient of Variation (cv)	Relative Precision at 90% Confidence Interval
New HVAC System Installations	6,738	73	1,892	0.56	10.9%
Tune-Up HVAC Systems	2,800	81	2,836	0.57	10.6%

*The ratio of Base 65° CDD Metered/CDD 2013.

Heating Savings Estimates

Some measures offered in the Heating and Cooling Program required cooling and heating savings estimates. The Cadmus team assumed the U.S. Department of Energy's[6] equivalent full load hour (EFLH) value for St. Louis (2,009 hours) provided a reasonable estimate of heating savings. Where necessary (e.g., dual fuel HPs [DFHPs]), we performed engineering analysis to adjust the EFLH heating value.

Measure-Specific Gross Savings

Using the engineering algorithms, data from the program tracking database, and results from the PY13 metering study, the Cadmus team estimated measure-specific gross savings for all program measures.

SEER 14, 15, and 16+ CAC Installations

We calculated early-replacement savings for each metered interval (*i*) (either two or four minutes) using the following algorithm:

$$kWh_i saved \ = metered\ kWh_i \times \frac{EER_{efficient}(T)}{EER_{base}(T)} - metered\ kWh_i$$

[6] Environmental Protection Agency's ENERGY STAR Calculator.

Using detailed manufacturer data (shown in Figure 7), we developed an energy efficiency ratio (EER) versus an outdoor temperature correlation for each new high-efficiency HVAC system metered. We used a synthetic baseline curve (described in Appendix C), representing a 7.2 seasonal energy efficiency ratio (SEER) HVAC unit. If the measure was replace on burnout, we used the federal minimum efficiency rating of 13 SEER.[7]

Figure 7. Example Manufacturer Cut Sheet

DETAILED COOLING CAPACITIES# (CONTINUED) [redacted]

EVAPORATOR AIR		CONDENSER ENTERING AIR TEMPERATURES °F (°C)														
		75 (23.9)			85 (29.4)			95 (35)			105 (40.6)			115 (46.1)		
CFM	EWB °F (°C)	Capacity MBtuh		Total Sys. KW**	Capacity MBtuh		Total Sys. KW**	Capacity MBtuh		Total Sys. KW**	Capacity MBtuh		Total Sys. KW**	Capacity MBtuh		Total Sys. KW**
		Total	Sens‡		Total	Sens‡		Total	Sens‡		Total	Sens‡		Total	Sens‡	
24ACB430A30 Outdoor Section With CAP**3014A* Indoor Section																
875	72 (22.2)	34.32	17.27	1.96	32.83	16.71	2.19	31.24	16.13	2.44	29.59	15.54	2.71	27.80	14.90	3.01
	67 (19.4)	31.45	21.21	1.96	30.06	20.64	2.18	28.59	20.05	2.43	27.04	19.44	2.71	25.38	18.78	3.01
	62 (16.7)	28.82	25.13	1.95	27.56	24.55	2.18	26.24	23.94	2.43	24.86	23.29	2.70	23.47	23.47	3.00
	57 (13.9)	28.00	28.00	1.95	26.98	26.98	2.18	25.89	25.89	2.43	24.74	24.74	2.70	23.48	23.48	3.00
1000	72 (22.2)	34.88	18.05	2.01	33.32	17.49	2.23	31.66	16.90	2.48	29.96	16.30	2.76	28.11	15.65	3.06
	67 (19.4)	31.98	22.49	2.01	30.53	21.91	2.23	29.00	21.31	2.48	27.40	20.68	2.75	25.69	20.03	3.05
	62 (16.7)	29.44	26.90	2.00	28.16	26.29	2.23	26.81	26.81	2.48	25.62	25.62	2.75	24.28	24.28	3.05
	57 (13.9)	29.10	29.10	2.00	28.01	28.01	2.23	26.85	26.85	2.48	25.62	25.62	2.75	24.28	24.28	3.05
1125	72 (22.2)	35.27	18.78	2.06	33.67	18.21	2.28	31.96	17.61	2.53	30.22	17.01	2.81	28.32	16.36	3.11
	67 (19.4)	32.36	23.68	2.05	30.87	23.10	2.28	29.29	22.50	2.53	27.66	21.88	2.80	25.91	21.21	3.10
	62 (16.7)	30.02	28.49	2.05	28.84	28.84	2.28	27.62	27.62	2.52	26.32	26.32	2.80	24.92	24.92	3.10
	57 (13.9)	29.99	29.99	2.05	28.84	28.84	2.28	27.62	27.62	2.52	26.32	26.32	2.80	24.92	24.92	3.10

Using the engineering algorithm, the Cadmus team determined the *ex post* savings values shown in Table 15. Savings calculated were based on reported, nameplate-rated efficiency (SEER) and unit capacity information (tons). Metered new HVAC units averaged 3.1 tons and 15.1 SEER, similar to the HVAC units reported in PY15 (shown in Table 14).

Table 14. PY15 SEER and Tons Averages

Measure	*SEER*	*Tons*	PY13 Metered SEER	PY13 Metered Tons
CAC—SEER 14	14.2	3.01		
CAC—SEER 15	15.2	3.28		
CAC—SEER 16+	16.3	3.06		
ASHP—SEER 14	14.2	2.88		
ASHP—SEER 15	15.1	3.02		
ASHP—SEER 16+	17.9	2.80		
Average (All Systems)	**15.4**	**3.04**	**15.1**	**3.1**

We adjusted the weather-normalized cooling savings for these systems, determined through PY13 metering and analysis (1,805 kWh average cooling energy saved for early replacement ASHPs and CACs), by a ratio of reported SEER and tons for each of the measure levels (SEER 14, SEER 15, and SEER 16+). The resulting *ex post* savings estimates in PY15 were within 2-3% of the PY13 and PY14 estimates because the average efficiency and system sizes were very similar.

[7] Federal Standards Document: CFR-2012-title10-vol3-sec430-32. Online: https://www.gpo.gov/fdsys/pkg/CFR-2012-title10-vol3/pdf/CFR-2012-title10-vol3-sec430-32.pdf

Table 15. *Ex Ante* and *Ex Post* Comparison for CACs

Measure	*Ex Ante* Savings/Unit	*Ex Post* Savings/Unit	Realization Rate	PY14 Participants
CAC—SEER 14 ER	1,900	1,631	85.9%	3,901
CAC—SEER 14 Replace at Fail	409	329	80.6%	150
CAC—SEER 15 ER	2,057	1,907	92.7%	1,773
CAC—SEER 15 Replace at Fail	566	380	67.2%	88
CAC—SEER 16+ ER	2,202	1,917	87.1%	3,945
CAC—SEER 16+ Replace at Fail	710	382	53.8%	62

Central HP Installations

The Cadmus team used a similar methodology to estimate CAC cooling savings from the installation of high-efficiency HPs.

All ASHP and GSHP savings used the same general algorithm to estimate heating savings:

$$\Delta kWh = ratingofunit(tons) \times 12\frac{kBTU}{ton}\left[EFLH_{heating} \times \left(\frac{1}{HSPF_{base}} - \frac{1}{HSPF_{efficient}}\right)\right]$$

Table 16 shows HP measures, baseline assumptions for HPs installed through the Heating and Cooling Program, and participation totals for each measure.

Table 16. *Ex Ante* and *Ex Post* Comparison for ASHPs

Measure	Measure Baseline Description: Cooling	Measure Baseline Description: Heating	Notes	PY15 Participants (Quantity)
ASHP—SEER 14 ER with ASHP Early Replacement	7.2 SEER	6.3 HSPF	HSPF estimated from SEER	284
ASHP—SEER 14 Replace at Fail with ASHP	13 SEER	7.7 HSPF		102
ASHP—SEER 14 ER Elec Resist Furnace Early Replacement*	7.2 SEER	3.4 HSPF (COP=1)		360
ASHP—SEER 14 Replace at Fail Elec Resist Furnace*	7.2 SEER	3.4 HSPF (COP=1)		26
ASHP—SEER 15 ER with ASHP Early Replacement	7.2 SEER	6.3 HSPF	HSPF estimated from SEER	185
ASHP—SEER 15 Replace at Fail with ASHP	13 SEER	7.7 HSPF		69
ASHP—SEER 15 ER Elec Resist Furnace Early Replacement *	7.2 SEER	3.4 HSPF (COP=1)		271

Measure	Measure Baseline Description: Cooling	Measure Baseline Description: Heating	Notes	PY15 Participants (Quantity)
ASHP—SEER 15 Replace at Fail Elec Resist Furnace*	7.2 SEER	3.4 HSPF (COP=1)		18
ASHP—SEER 16+ ER with ASHP Early Replacement	7.2 SEER	6.3 HSPF	HSPF estimated from SEER	260
ASHP—SEER 16+ Replace at Fail with ASHP	13 SEER	7.7 HSPF		235
ASHP—SEER 16+ ER Elec Resist Furnace Early Replacement*	7.2 SEER	3.4 HSPF (COP=1)		374
ASHP—SEER 16+ Replace at Fail Elec Resist Furnace*	7.2 SEER	3.4 HSPF (COP=1)		24
Dual Fuel Heat Pump SEER 14	13 SEER	7.7 HSPF		25
Dual Fuel Heat Pump SEER 15	13 SEER	7.7 HSPF		28
Dual Fuel Heat Pump SEER 16	13 SEER	7.7 HSPF		47
Dual Fuel Heat Pump SEER 17	13 SEER	7.7 HSPF		2
GSHP—SEER 14+ Early Replacement of ASHP with GSHP	7.2 SEER	6.3 HSPF	HSPF estimated from SEER	56
GSHP—SEER 14+ ER Elec Resist Furnace Early Replacement*	7.2 SEER	3.4 HSPF (COP=1)		65
GSHP—SEER 14+ Replace Elec Resist Furnace*	7.2 SEER	3.4 HSPF (COP=1)		209

*Cooling system information was unknown. The measure definition presumed the homeowner chose to switch from electric resistance heat and no cooling system criterion existed. We expected a cooling system was present and not recently installed.

As contractors did not report the HSPF nameplate values of air-source HPs replaced early by the program, we estimated HSPF values by correlating nameplate HSPF and nameplate SEER values of thousands of HP systems. The resulting HSPF for a 7.2 SEER baseline system was 6.3 HSPF.

To calculate heating savings, we used nameplate-rated HSPF and tons. We assumed the Environmental Protection Agency estimate of 2,009 full-load heating hours reasonably represented an HP's energy consumption. [8]

A DFHP system includes a heat pump and a gas furnace rather than using backup electric resistance heat. Under a certain set of conditions, the HP switches off, and the gas furnace provides heat. HVAC contractors set systems to use the gas furnace for heat when outdoor conditions fall below a certain temperature. Otherwise, the HP provides heating. Most systems utilize imbedded controls that prioritize

[8] Online: https://www.energystar.gov/sites/default/files/asset/document/ASHP_Sav_Calc.xls

gas furnace use if the HP fails to meet the thermostat setpoint in a certain amount of time. Consequently, DFHPs run less than standard ASHPs measures as the gas furnace provides a portion of heating savings.

To calculate savings for DFHPs, the Cadmus team conducted detailed analysis to estimate an appropriate EFLH value for the DFHP measure. Analysis of this value used the following methodology:

- The DFHP provided all heating BTUs above 34°F.
- The total seasonal heating capacity was 82 MMBtus (2009 EFLH x reported capacity of DFHP).
- Heat load on a home was linear from the peak heating load at the TMY3 minimum bin temperature (-3°F) to no heating required (at 64°F).

Using these stated assumptions, we determined the amount of heating capacity required above 34°F, assuming the DFHP provided 100% of this heating capacity. Specifically, we found a DFHP would provide about 38 MMBTUs of heat, resulting in an updated EFLH heating value of 930 hours.

Table 17 shows *ex ante*[9] and *ex post* values for all HP measures reported in PY15.

[9] In PY13, the Cadmus team performed a detailed engineering review of the TRM's ex ante savings estimates for each measure. The PY13 Evaluation Report describes the Cadmus team's observations and findings of the deemed savings value for each measure.
See: "Ameren Missouri CoolSavers Impact and Process Evaluation: Program Year 2013". Online: https://www.efis.psc.mo.gov/mpsc/commoncomponents/viewdocument.asp?DocId=935842419
CAC measures: pg. 40. ASHP and GSHP measures: pg. 45. Tune-up measures: pg. 46-47. ECM measures: pg. 50-51.

Table 17. *Ex Ante* and *Ex Post* Comparison for HPs

Measure	*Ex Ante* Savings/Unit	*Ex Post* Savings/Unit	Realization Rate	PY15 Participants
ASHP—SEER 14 ER with ASHP Early Replacement	4,201	4,189	99.7%	284
ASHP—SEER 14 Replace at Fail with ASHP	1,158	1,005	86.8%	102
ASHP—SEER 14 ER Elec Resist Furnace Early Replacement*	14,917	13,581	91.0%	360
ASHP—SEER 14 Replace at Fail Elec Resist Furnace*	13,426	12,105	90.2%	26
ASHP—SEER 15 ER with ASHP Early Replacement	4,683	4,785	102.2%	185
ASHP—SEER 15 Replace at Fail with ASHP	1,639	1,470	89.7%	69
ASHP—SEER 15 ER Elec Resist Furnace Early Replacement *	15,398	14,445	93.8%	271
ASHP—SEER 15 Replace at Fail Elec Resist Furnace*	13,907	13,528	97.3%	18
ASHP—SEER 16+ ER with ASHP Early Replacement	5,126	6,322	123.3%	260
ASHP—SEER 16+ Replace at Fail with ASHP	2,082	1,888	90.7%	235
ASHP—SEER 16+ ER Elec Resist Furnace Early Replacement*	15,841	15,169	95.8%	374
ASHP—SEER 16+ Replace at Fail Elec Resist Furnace*	14,350	13,120	91.4%	24
DFHP SEER 14	650	637	98.0%	25
DFHP SEER 15	1,230	1,006	81.8%	28
DFHP SEER 16	1,439	1,552	107.8%	47
DFHP SEER 17	1,651	1,849	112.0%	2
GSHP - SEER 14+ Early Replacement of ASHP with GSHP	5,126	11,657	227.4%	56
GSHP—SEER 14+ ER Elec Resist Furnace Early Replacement*	15,841	24,308	153.5%	65
GSHP—SEER 14+ Replace Elec Resist Furnace*	14,350	23,011	160.4%	209

*The Cadmus team relied on contractor-reported data to estimate the baseline efficiency and did not perform independent verifications of the baseline assumption, given the relatively low participation total.

HPs represented 21% of the new HVAC installation measures, and CACs accounted for the remainder of new HVAC installations. Although measure counts of HP installations were lower, total savings attributed to HP measures were higher, with HPs representing approximately 55% of the total new HVAC system installation savings.

The Cadmus team calculated similar *ex ante* and *ex post* savings estimates for ASHPs, with an overall realization rate of 96%. The GSHP *ex post* savings were much higher than *ex ante* savings (realization rate of 163%) as we calculated savings using the nameplate reported system size and efficiency. GSHP systems averaged 4.1 tons, with an average efficiency of 21.8 EER. (MML savings assumed efficiency of 14 EER and 3 tons.)

Tune-Up Savings

The PY13 evaluation used post-only verification and metering of tune-ups to confirm whether units were correctly tuned up and to determine energy consumption. The PY13 evaluation found metered cooling energy consumption of 2,836 kWh, normalized for TMY-3 weather. The Cadmus team used the following formula to calculate tune-up savings:

$$kWh\ Saved = \frac{kWh\ metered}{1 - \%\ EER\ improvement} - kWh\ metered$$

To determine the % EER improvement, we performed an extensive engineering review of all reported test-in and test-out contractor measurements contained in the PY15 tracking data. This used the same methodology detailed in the PY13 evaluation report, with the general methodology as follows:

- Calculate pre and post enthalpy from temperature and wet bulb measurements.
- Review pre- and post-airflow measurements for reasonableness.
- Review power estimates for reasonableness (including comparison of fan power to airflow estimate).
- Calculate pre and post EER.
- Review test conditions and remove tests below 70°F.
- Remove reported tune-ups with erroneous data.

PY15 Tune-Up Savings

In PY15, HVAC contractors did not have to perform test-in measurements for every tune-up. HVAC contractors performed TEA analysis of 10,778 HVAC systems and reported 2,213 unique sets of pre- (test-in) and post (test-out) measurements. The sample of pre- and post-tune-up test measurements exceeded the sample size recommended by the Cadmus team in PY14 (10% of all tune-ups). The team used actual test measurements reported by HVAC contractors to independently estimate pre- and post-EER for each HVAC system. To determine an overall average EER change due to tune-ups, the Cadmus team sought to use a sample of pre- and post-diagnostic tune-up measurements performed at average operating conditions for an HVAC system operating in Ameren Missouri's service territory.

For example if a tune-up was performed below 65 °F, we removed the pre- and post-EER measurements from the sample as the apparent efficiency improvement due to the tune-up work at that condition did not provide a good indication of actual efficiency improvement at more normal operating conditions

(i.e., when the heat load on the HVAC system and the outdoor temperature are both sufficient for performance testing). [10]

Table 18 shows EER percent improvements from contractors' reported measurements. Ultimately, we used approximately 1,200 reported measurements to determine savings.

Table 18. Tune-Up Savings Summary

Measure	% Improvement	*Ex Post* Savings (kWh)	*Ex Ante* (kWh)	PY15 Measures*
Refrigerant charge adjustment	28.4%	856	191	1,028
Condenser Cleaning Only	7.9%	258	515	9,250
Indoor coil cleaning	3.8%	117	638	359

*One tune-up may have multiple measures performed.

The tune-up tracking database contained a significant number of systems just receiving condenser cleaning as well as a significant number of systems receiving refrigerant charge adjustments with condenser cleaning. The Cadmus team chose to show the efficiency improvement for each treatment type included in Table 18; so the implementation team could understand typical savings estimates for the most common tune-up measures.

Evaluated energy savings estimates represented weighted savings for CACs and ASHPs. Although ICF's Optimizer Tool included a data collection field for heat system types (e.g., AC or HP), the program tracking database for tune-up measures did not discern HPs from CACs. Thus, we made the following assumptions to estimate savings for an average tune-up, which included savings from HPs in heating mode:

- 18% of system tune-ups were HPs (based on the mix of known HP and CAC installations);
- The efficiency improvement was the same in heating and cooling mode; and
- The average HSPF after the tune-up was 6.3.

Tune-Ups Performed on Systems with a Maintenance Agreement

The tracking database included a data field with the option "yes", "no", or "no entry" that indicated whether a system receiving a tune-up had an existing maintenance agreement (MA). The work performed by an HVAC contractor as part of an MA may vary, but services generally entail seasonal or annual functional testing and cleaning. Presumably, systems with an MA receiving a tune-up through the Heating and Cooling Program could have different savings potential from systems that are not regularly serviced by an HVAC contractor. To determine whether differences in savings exist, Cadmus reviewed the % EER improvement for both. Approximately 50% of the systems receiving a tune-up had "no entry".

[10] This does not indicate that these tune-ups should not have been performed. A tune-up can be successfully performed at this condition. The accuracy of the measured pre- and post- tune-up EER, however, declines at this condition.

When data were available, Cadmus reviewed the % efficiency improvement. 75% of the systems had an MA and 25% did not. For comparison, we found that 62% of the participants surveyed (see Free Ridership: Tune-Ups section) claimed they had an existing MA. This variance indicates that a higher proportion of the "blank" data fields may have been "no" but both data sources show that a larger proportion of program tune-ups were performed on systems with existing maintenance agreements.

Table 19. % Efficiency Improvement for Tune-Ups with and without Existing MA

Measure	No Existing Maintenance Agreement	Has Existing Maintenance Agreement
Test-in Efficiency	10.50 EER	11.44 EER
Test-Out Efficiency	11.56 EER	12.67 EER
% Improvement	9.9%	10.7%
% Requiring Refrigerant Charge Adjustment	22.5%	19.4%

Table 19 shows that systems with an existing MA had higher savings than systems without an MA. As evident by the percentage of systems that required refrigerant charge adjustment, a system with an MA was not more likely to be correctly charged than a system that did not have an MA. One might also infer from these data that an MA does not ensure optimal system performance.

Table 19 also shows that the test-in and test-out efficiency of systems with an MA was on average higher than systems without. Presumably, this occurred because maintenance agreements (e.g. 5 years from date of purchase) are often included with the sale of new equipment, newer equipment has higher nameplate efficiency than older equipment.

Intuitively, a system with an MA in place has lower energy savings potential than a system that does not receive regular maintenance; the findings presented in Table 19 indicate savings potential is similar for both system types.

"General" Tune-Ups and Tune-Ups with No Savings

A small number of tune-ups (n=196) reported described tune-up service work performed as "airflow correction through a filter change, fan speed adjustment, or by some other means" (e.g., cutting a hole in a return duct to increase airflow). The evaluation team categorized these as "general" tune-ups. The MML measure claimed a deemed value for this type of tune-up measure of 174 kWh. The Cadmus team accepted the TRM value for this measure as participation was low, making evaluation a low priority.

In addition, approximately 8% (n=878) of units that received a tune-up incentive received a diagnostic test, but the contractor did not perform any maintenance work. Consequently, these tune-ups received 0 *ex post* savings (but did not report *ex ante* savings). The evaluated savings values in Table 18 have been weighted, and the savings values include a proportional amount of tune-ups that did not receive savings; thus, these values include the impact of the 878 tune-ups with no work performed.

ECM Savings

The Cadmus team used a Wisconsin study[11] to estimate savings for electronically commutated furnace fan motors (ECMs) installed through the Ameren Missouri Heating and Cooling Program. ECM fans are able to reduce fan speed and power to save energy in three ways:

- Cooling mode savings
- Heating mode savings
- Circulation mode savings

The majority of ECMs (93%) were installed in conjunction with an HVAC system. An AHRI SEER rating of a cooling system often includes ECM savings in cooling mode. ICF tracked when ECMs were installed as part of the AHRI SEER rating of a new HVAC system and when they were not. If an ECM was not installed with a new HVAC system, the tracking database indicated whether it was installed into an existing HVAC system. In this instance, the Cadmus team assumed a 1 SEER efficiency improvement (~10%), attributable to installation of the ECM.[12]

The Cadmus team calculated savings in heating mode using savings estimates from the Wisconsin study. We adjusted savings by estimating the proportion of heating runtimes in Wisconsin to heating runtimes in Missouri. We assumed the HSPF rating of HPs included the benefit of the ECM fan, and we adjusted heating savings by the percentage of HPs to CACs.

The final estimate of ECM savings accounted for weather differences between Wisconsin and Missouri. Table 20 contains a summary of ECM savings. [13]

Table 20. ECM Savings Summary

Measure	*Ex Ante* (kWh)	*Ex Post* (kWh)	Number of Participants	Explanation
Concept 3 Installations Auto Fan Early Replacement	929	649	8,234	The fan replaced an existing fan.
Concept 3 Installations Auto Fan Replace at Fail	929	662	376	The fan did not replace an existing, operating fan.
Concept 3 Installations Continuous Fan Early Replacement	929	3,487	400	The fan replaced an existing fan that was on continuously.

[11] *Electricity Use by New Furnaces, A Wisconsin Field Study*: Energy Center of Wisconsin. Page 41.

[12] Review of 13 SEER systems in the AHRI tracking database showed a 1 EER improvement due to presence of an ECM fan.

[13] Concept 3 is a specific type of variable speed fan. The TRM measure name is "Concept 3" but the Heating and Cooling Program offers incentives for any central furnace ECM installation.

Summary

Table 21 lists per-unit *ex ante* and *ex post* gross savings by measure and total *ex post* savings for each measure. To estimate the program's total gross energy savings, the Cadmus team applied the per-unit values in to the program' PY15 participation rates.

Table 21. PY15 *Ex Ante and Ex Post* Per-Unit Gross Savings and Total *Ex Post* Measure Savings

Measure	PY15 Participation	Per-Unit *Ex Post* Savings (kWh/yr)	Realization Rate	Total *Ex Post* Savings[3] (kWh/yr)
HPs				
ASHP—Early Replacement of ASHP[1]	729	5,101	109.6%	3,718,745
ASHP—Early Replacement of Electric Furnace[1]	1005	14,405	93.6%	14,476,863
ASHP—Replace at failure of ASHP[1]	406	1,595	89.9%	647,581
ASHP—Replace at failure of Electric Furnace[1]	68	12,840	92.5%	873,111
Dual Fuel HP (DFHP) [1]	102	1,184	99.3%	120,734
GSHP	330	21,340	163.2%	7,042,243
CAC—Early Replacement[1]	9,619	1,799	87.7%	17,305,994
CAC—Replace on Burnout[1]	300	355	68.7%	106,576
HVAC Systems Receiving Condenser Cleaning[2]	9,250	258	50.0%	2,383,997
HVAC Systems Receiving Refrigerant Charge Adjustment[2]	1,028	856	448.4%	880,460
HVAC Systems Receiving Evaporator Cleaning[2]	359	117	18.3%	41,998
HVAC Systems Receiving General Maintenance	196	174	100.0%	34,084
ECM Auto Mode, Early Replacement	8,234	649	69.9%	5,346,006
ECM Auto Mode, Replace at failure	376	662	71.3%	248,898
ECM Continuous Mode	400	3,487	375.5%	1,394,769
Thermostat Installed with Setback Programmed (Discontinued in PY14)	5	83	15.2%	414
Total	**32,407**	**n/a**	**93.5%**	**54,622,474**

[1]Combined incentive tiers (SEER 14, SEER 15, SEER 16).

[2]Savings adjusted assuming 18% of tune-ups were ASHPs which have additional savings in heating mode.

[3]Per-Unit *ex post* savings rounded to the nearest integer; therefore, total *ex post* savings did not exactly equal the product of per unit *ex post* and participation quantity.

The demand savings calculation methodology and results are presented in Appendix A.

Net Impact Evaluation Results

The Cadmus team determined total programs net impacts by calculating total gross savings by measure and then by applying the following:

- Participant Free Ridership
- Participant Spillover
- NPSO
- HVAC NPSO

Cadmus determined participant free ridership and participant spillover ratios using 140 participant surveys completed in December 2015. We also used information from our interviews with 18 participating contractors from PY13 and 11 interviews in PY15, which served in our free ridership scoring adjustments for all Heating and Cooling Program measures. Our experience indicates contractor interview data about a participant's intent proves important, as program participants often rely on their contractor's professional judgment and knowledge.

To determine NPSO, we conducted a random survey of 175 nonparticipating Ameren Missouri customers (from Ameren Missouri's residential customer database) to assess the influence of the program on their decision to purchase or implement energy-efficient measures that received no program incentive.

To determine spillover specifically attributable to the presence of the Heating and Cooling Program, we surveyed and collected data from HVAC contractors and distributors to compare recent and historical sales data.

This section discusses the Cadmus team's methodology for calculating net savings by measure. Table 22 presents our estimates of the program's net impacts.

Table 22. PY15 Heating and Cooling Program NTG Summary

Measure Group	*Ex Post* Gross Savings (kWh/yr)	Free Ridership	Participant Spillover	NPSO	HVAC NPSO	NTG Ratio	Net Savings (kWh/yr)*
ASHP	19,837,034	6.0%	0.1%	17.8%	5.1%	117.0%	23,214,605
CAC/ECM/T-Stat	24,402,657	14.0%				109.0%	26,602,845
GHSP	7,042,243	8.0%				115.1%	8,102,920
Tune-Up	3,340,540	40.5%				82.5%	2,756,809
Program Total	54,622,474	11.9%	0.1%	17.8%	5.1%	111.1%	60,677,178

*Total may not add to sum of measure-specific kW due to rounding

Free Ridership–Ground Source and Air Source Heat Pumps

The Cadmus team used a participant self-report approach to determine free ridership ratios of 70 participants who chose to install a GSHP or ASHP. This approach relied on a standard battery of questions that defined whether the participant completed the following:

- Had already purchased the product before learning about the incentive.
- Planned to purchase the same product before learning about the incentive.
- Gave weight to advice from the contractor to purchase the equipment.
- Would have purchased equipment just as energy efficient without the incentive.
- Would have purchased the equipment at the same time as they did when going through the Heating and Cooling Program.

Based on participant responses, we applied a free ridership score ranging from 0% to 100% to each participant individually, based on their collective responses to the set of survey questions. We used the following process for determining an incentive-based measure's free ridership score:

- We categorized customers as 0% free riders if:
  - They had no plans to install the measure in the absence of the program's incentives and would not have installed the measure within one year in the program's absence;
  - They considered installing the measure before learning about the program, but would not have done so without program incentives; or
  - In the absence of program incentives, they would have purchased or installed less-efficient equipment.
- We categorized customers as 100% free riders if they would have installed the same measure at the same time without the program.
- We assigned a partial free ridership score (ranging from 12.5% to 75%) to customers who already had plans to install the measure, but who said their decisions about which product to purchase or when they would purchase it was influenced by the program. For customers highly likely to install the energy-efficient equipment right away and for whom the program had less influence over their decisions, we assigned a higher free ridership percentage than for those whom the program may not have had as large an influence (or whose purchases may have occurred later in the program's absence).

After translating survey responses into each participant's free ridership score, we calculated an average free ridership estimate, weighted by evaluated savings, for both ASHP and GSHP participants. (Appendix D, Table 41 shows the conversion of each raw survey response option into free ridership scoring matrix values; and the free ridership score combinations and scoring legend we used to categorize customer survey responses for incentive-based measures.)

GSHP and ASHP Free Ridership Results

Table 23 shows the free ridership results.

Table 23. New HVAC Installation Free Ridership Results

Program Measure	Free Ridership Estimate	Free Ridership Absolute Precision
ASHP (n= 48)	6.0%	±2.5%
GSHP (n= 22)	8.0%	±4.0%

Heat Pump Free Ridership Scoring

Appendix D, Table 44, contains: the full set of unique ASHP or GSHP measures; free ridership survey response combinations; the free ridership score assigned to each combination; and the number of responses. Responses of "yes," "no," or "partial" relate to whether the specific response indicates free ridership.

The Cadmus team found a common pattern in heat pump respondents' answers to free ridership questions:

- Twenty-seven respondents indicated they would not have installed the measure within one year from their original purchase date without the program incentive; we estimated these as 0% free riders.
- For respondents confirming they planned to replace their unit in 2015, but would not necessarily do so with a high-efficiency system, we applied a free ridership decrement equivalent to the ratio of savings from a new installation from replace-on-burnout to total savings of an early-replacement installation.

Other respondents' free ridership scores proved less straightforward to determine. We used partial score weighting, drawn from contractor interviews, to estimate a free ridership score. Contractors reported they used the program incentive to sell higher-efficiency systems.

If respondents claimed the incentive had little or no impact on their decisions to install a high-efficiency system, but also cited the contractor's influence as important, we applied a decrement to the respondent's free ridership score.

About 60% of participants claimed they planned to replace their unit in 2015, even without the program. During interviews, contractors noted that customers often were "on the fence" about decisions to install a new system when contractors arrived. Contractors said they believed that, even though program participants might claim they were going to replace their system that year, in reality, they might decide to wait and make only the minimal repairs necessary to keep the existing system operational, have their system tuned up, or do nothing.

The Cadmus team specifically asked contractors: "Of the participants receiving early-replacement incentives, what percentage do you believe made the decision to install a new unit this year because of

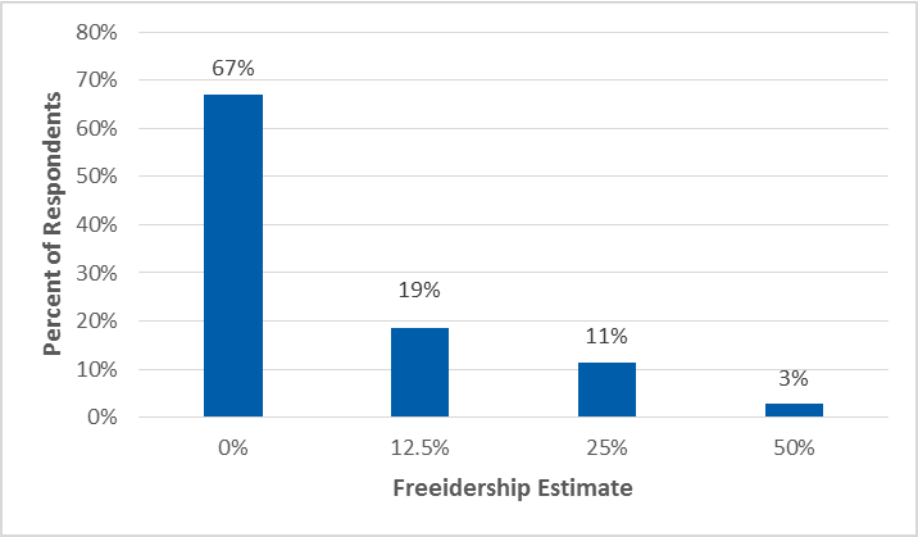
the incentive?" All contractors agreed the timing of many customers' decisions to install a new unit was influenced by the early replacement incentive.

When asked what percentage of their customers chose to replace that year, contractors typically reported about one-half to two-thirds replaced their systems due to the incentive when they otherwise would have deferred replacement. As these responses did not agree with the participants' self-reported responses (about 60% claimed they planned to replace that year, even without the incentive), we adjusted the free ridership scores. If a participant claimed an intention to install that year, but also said their contractor had an important influence on their decision to install the new system, we applied a decrement to the free ridership score; so the results would more closely align.[14]

Distribution of Heat Pump Free Ridership Scores

Figure 8 shows the distribution of assigned free ridership scores. Approximately 67% of new HVAC installation survey respondents received scores as 0% free riders, while we estimated 30% at low free ridership levels (12.5% and 25%). We assigned a moderate free ridership level (50%) for 3% of respondents, while we estimated no respondents as true free riders (100%).

Figure 8. Overall Distribution of Heat Pump Installation Free Ridership Scores



Free Ridership: Tune-Ups

The Cadmus team determined tune-up free ridership via a participant self-report approach, based on a standard battery of questions that defined whether the participant:

- Would have purchased a tune-up that was just as energy-efficient without the incentive.
- Would not have purchased the Heating and Cooling Program tune-up with the $75 discount.

[14] From 60% of participants claiming they would have replaced units this year, those noting the importance of contractors' influence received this decrement.

- Would have purchased a tune-up at the same time as they did when they went through the Heating and Cooling Program.

We then applied a free ridership score, ranging from 0% to 100%, to all participants individually, based on their collective responses to the set of survey questions. Using the following process, we determined an incentive-based measure, free ridership score:

- We categorized customers as 0% free riders in the following instances:
  - They did not plan to purchase the tune-up in the absence of program incentives, and would not have had the tune-up performed within one year, in the program's absence;
  - In the absence of program incentives, they would have a less-efficient tune-up performed; or
  - They would not have had the Heating and Cooling Program tune-up performed within the same year without the discount.
- We categorized customers as 100% free riders if we determined no differences occurred between the Heating and Cooling Program tune-up and their standard tune-up, and if they would have purchased the same Heating and Cooling Program tune-up without the discount sooner or at the same time. This could only be applied to customers receiving the "condenser cleaning only" measure. If a customer was assessed as a 100% free-rider and their HVAC system required refrigerant charge or airflow adjustment, Cadmus applied a 50% decrement to the free ridership score (see below).
- We assigned a partial free ridership score (ranging from 12.5% to 75%) to customers saying they already had planned to have a tune-up performed, but the program influenced the tune-up. For customers highly likely to have a comparable tune-up performed right away and for whom the program discount had less influence over their decision, we assigned a higher free ridership percentage than those whom the program may not have influenced as greatly (or whose tune-up purchases may have occurred later, in the absence of the discount).

The Cadmus team made scoring adjustments (50% decrement to free ridership score) for anyone with a refrigerant charge adjustment or an airflow adjustment. Although we did not have a quantitative basis for this adjustment, we considered it reasonable due to statements (such as the following) made by interviewed contractors:

- "We weren't ever checking airflow for tune-up service calls. Now that this is a requirement of the program; we check airflow every time and have realized there were issues with units we would not have discovered before."
- "Before the tune-up program, we generally did check refrigerant charge (by subcooling or superheat), but admittedly we might not have always done this, especially if we're busy and the system appears to be operating correctly."

We did not apply this adjustment to a participant receiving condenser cleaning as most contractors claimed

- "We have not changed our condenser cleaning methods because of the program."

Based on statements such as these, offered by most contractors interviewed, we assumed a program tune-up that required airflow adjustments and/or refrigerant charge adjustments saved 50% more energy than a non-program tune-up. We did not make adjustments if a participant only had condenser cleaning and no other service work performed as no basis for a difference in savings existed from this service work with and without the tune-up program.

After translating survey responses into each participant's free ridership score, we calculated a weighted-by-evaluated savings, average, free ridership estimate for the tune-up subprogram.

Appendix D shows the conversion of each raw survey response option into the free ridership scoring matrix values and shows the free ridership score combinations and scoring legend we used to categorize tune-up customer survey responses.

Tune-Up Free Ridership Results

Table 24 shows the Cadmus team's free ridership results for tune-up respondents.

Table 24. Heating and Cooling Program Tune-Up Free Ridership Results

Program Measure	Free Ridership Estimate	Free Ridership Absolute Precision
Tune-up	40.5%	±6.9%

Tune-Up Measure Free Ridership Scoring

Appendix D contains: the full set of unique, tune-up, free ridership survey response combinations; the free ridership score assigned to each combination; and the number of responses. Responses of "yes," "no," or "partial" relate to whether the specific response indicated free ridership.

A common pattern emerged in tune-up respondents' answers to free ridership questions:

- We estimated 13 respondents as 0% free riders because they indicated they would not have had the Heating and Cooling Program tune-up within the same year without the Ameren Missouri discount.
- We estimated 15 respondents as 100% free riders because the participant claimed the incentive had no impact on their decision to purchase a tune-up and because their contractor did not explain that the tune-up differed in any way from a standard tune-up. These respondents would have purchased the Heating and Cooling Program tune-up without the Ameren Missouri discount and at the same time in the absence of the Ameren Missouri discount.

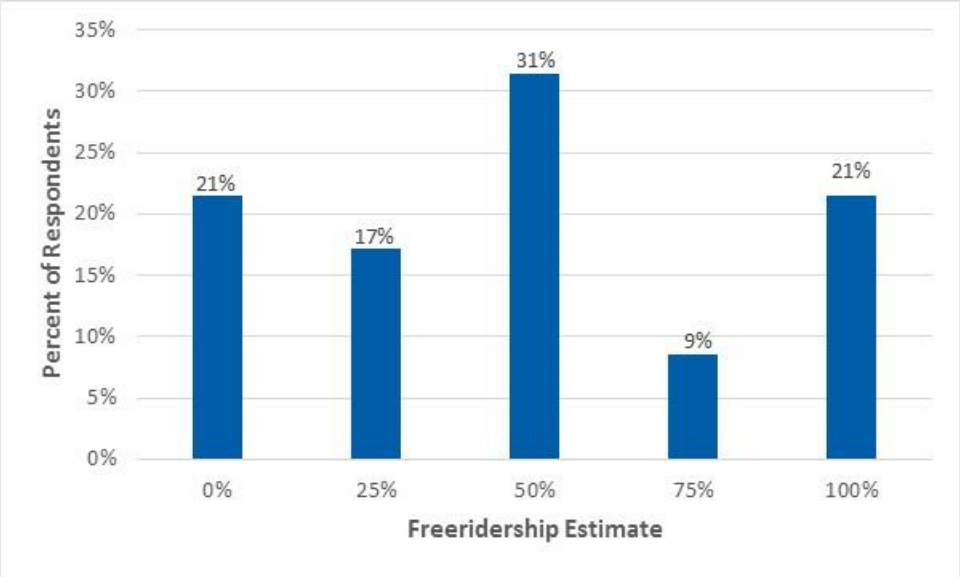
Logically, it is easiest for contractors to recruit customers with existing maintenance contracts. As a result, we assessed the free ridership scores of customers with maintenance contracts and customers

without existing contracts. We found a 44% savings-weighted free ridership score for customers on maintenance contracts, while customers without a maintenance contract had a 37% free ridership score.

Distribution of Tune-Up Free Ridership Scores

Figure 9 shows the distribution of assigned free ridership scores. Approximately 21% of tune-up survey respondents scored as 0% free riders, while almost 17% scored at low free ridership levels (12.5% and 25%). Moderate free ridership levels (50% and 75%) were estimated for 40% of respondents, while 21% of tune-up respondents were estimated as true free riders (100%).

Figure 9. Overall Distribution of Tune-Up Free Ridership Scores



Participant Spillover

The Cadmus team asked Heating and Cooling Program participants whether they had undertaken additional energy-efficient actions since participating in the program. To calculate spillover, we asked them to rate the importance of receiving funding through Ameren Missouri's Heating and Cooling Program in their decisions to purchase the subsequent energy-efficient equipment. We considered measures attributable to program spillover only where the respondent answered "important" to the question. We also eliminated responses motivated by another Ameren Missouri program incentive to avoid double-counting savings already captured by a concurrent program evaluation.

One tune-up survey respondent reported installing an additional energy-efficient measure—a high-efficiency water heater—after participating in the Heating and Cooling Program. The respondent said their experience in the Program was "important" to the subsequent decision to purchase a high-efficiency appliance rather than a standard efficiency model. No surveyed new equipment installation

participants attributed spillover measures to their experiences or to participating in the Heating and Cooling Program.

We estimated energy savings for the tune-up participant's refrigerator spillover response, and then divided total Heating and Cooling Program sample spillover savings by the total Heating and Cooling Program gross savings, drawn from the survey sample, and as described in the following equation:

$$\text{Spillover } \% = \frac{\sum[\text{Net spillover measure kWh savings for all survey respondents}]}{\sum[\text{Gross program measure kWh for all survey respondents}]}$$

This yielded a spillover estimate of 0.1% for the new HVAC aspect of the program and 0.9% spillover estimate for the HVAC tune-up. Table 25 and Table 26 present the spillover details for the new HVAC installations and HVAC tune-ups, respectively.

Table 25. New HVAC Installation Participant Spillover

Spillover Measure	Participant Spillover kWh/year Savings*	Total Survey Sample Program kWh/year Savings	Spillover
Recycled refrigerator or freezer	998*	1,009,787	0.1%
Electric Water Heater	175**		
Overall	**1,173**	**1,009,787**	**0.1%**

*Savings based on PY15 Refrigerator Recycling evaluation.

**Savings based on PY15 Efficient Products evaluation.

Table 26. HVAC Tune-Up Participant Spillover

Spillover Measure	Participant Spillover kWh/year Savings*	Total Survey Sample Program kWh/year Savings	Spillover
Electric Water Heater	175	18,514	0.9%
Overall	**175**	**18,514**	**0.9%**

*Savings based on PY15 Efficient Products evaluation.

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. [15]

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.[16] 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

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

[16] 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:[17]

- 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.

[17] 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.

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

Table 27. 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 27), 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 28):

- **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.)[18]
- **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 28**Error! Reference source not found.**. 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.

[18] 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.

Table 28. 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 Table 29from 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 **Error! Reference source not found.**) when allocating NPSO across programs.

Table 29. 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 30 and Table 31—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 30. 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,[19] all NPSO estimates have been reported as a percentage of each program's total gross energy savings.

As shown in Table 31, we allocated 9,749 MWh of NPSO to the Heating and Cooling Program, representing 79.6% of the combined residential portfolio savings and marketing expenditure. This resulted in a 17.8% adjustment to the program's PY15 NTG—findings generally similar to the PY14 NPSO analysis.

Table 31. 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%**

HVAC Nonparticipant Spillover Data Collection

In December 2015 and January 2016, Cadmus interviewed and collected data from residential HVAC contractors and distributors operating within Ameren Missouri's service territory to capture data on recent sales and the efficiency of equipment installed. We focused the data collection from PY15 participating contractors and distributors on the number of sales of various efficiency levels before and during the 2013–2015 Heating and Cooling Program (PY15 data), which we then compared similar data collected from PY13 distributors and contractors in February and March 2014 (PY13 data).

Recruitment

Cadmus selected the contractor sample from the same participant contractor list we used in 2014, and we worked with ICF to recruit regional distributors from a list of 13 unique contacts.

Participation

In total, we collected high-level sales data from 12 contractors and four distributors, and interviewed 11 contractors and seven distributors.

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

Data Summary

The following section summarizes the sales data collected from 12 HVAC contractors and four distributors as well as interview results from seven distributors.

PY15 Distributor and Contractor Data

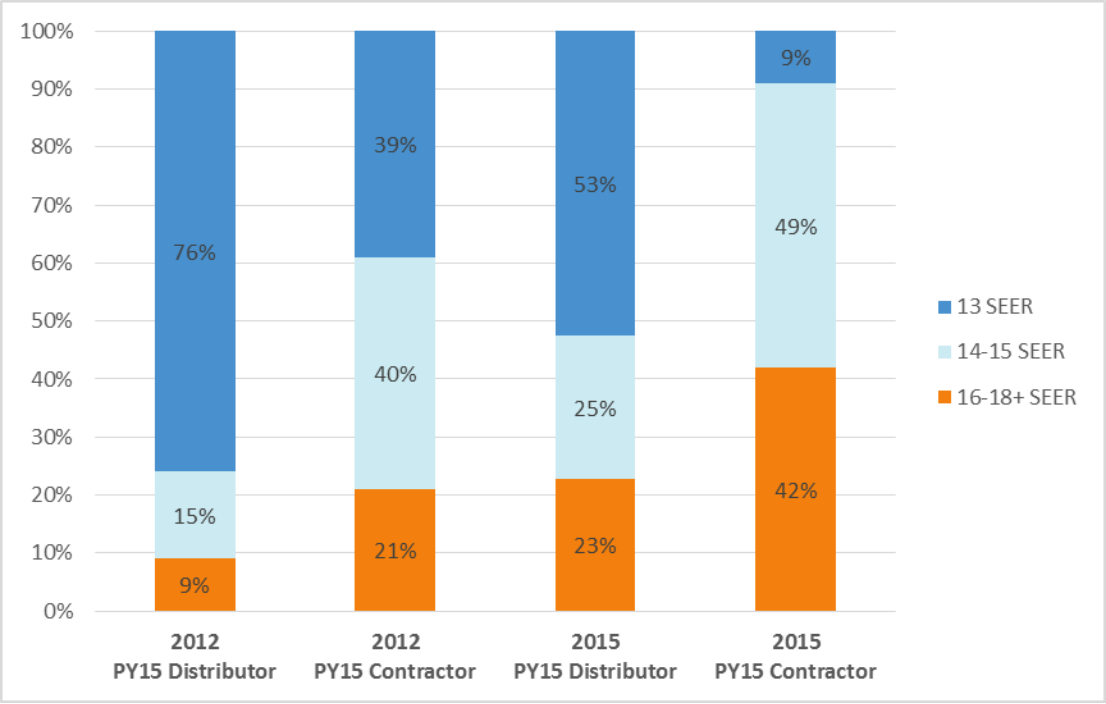
As shown in Table 32 and Figure 10, contractors reported that the share of 13 SEER units declined from 39% of their overall sales in 2012 to only 9% in 2015, while sales of both 14–15 SEER and 16–18+ SEER units increased over the same period. Distributor sales data shows a similar trend, with the reported share of 13 SEER units decreasing from 76% of overall sales in 2012 to 53% in 2015. Contractors reported higher market shares of high-efficiency equipment sales than distributors. This likely resulted from distributor sales data including sales to both participating and nonparticipating contractors, reflecting a much larger number of sales than those represented by contractors (although we asked both groups only to provide data relevant to Ameren Missouri service territory).

Table 32. Distributor and Contractor Sales by SEER Level and Year for PY15

SEER	2012* Distributor	2012 Contractor	2015 Distributor	2015 Contractor
13	76% (n=15,235)	39% (n=898)	53% (n=11,573)	9% (n=196)
14-15	15% (n=3,015)	40% (n=915)	25% (n=5,346)	49% (n=1,026)
16-18+	9% (n=1,893)	21% (n=470)	23% (n=4,870)	42% (n=870)
Total Yearly HVAC Sales (split ACs and HPs)	**100% (n=20,143)**	**100% (n=2,283)**	**100% (n=21,789)**	**100% (n=2,092)**

*One out of the four distributors did not estimate their total number of sales for 2012. We extrapolated the incomplete values for this distributor from their 2015 sales data based on the average SEER distributions

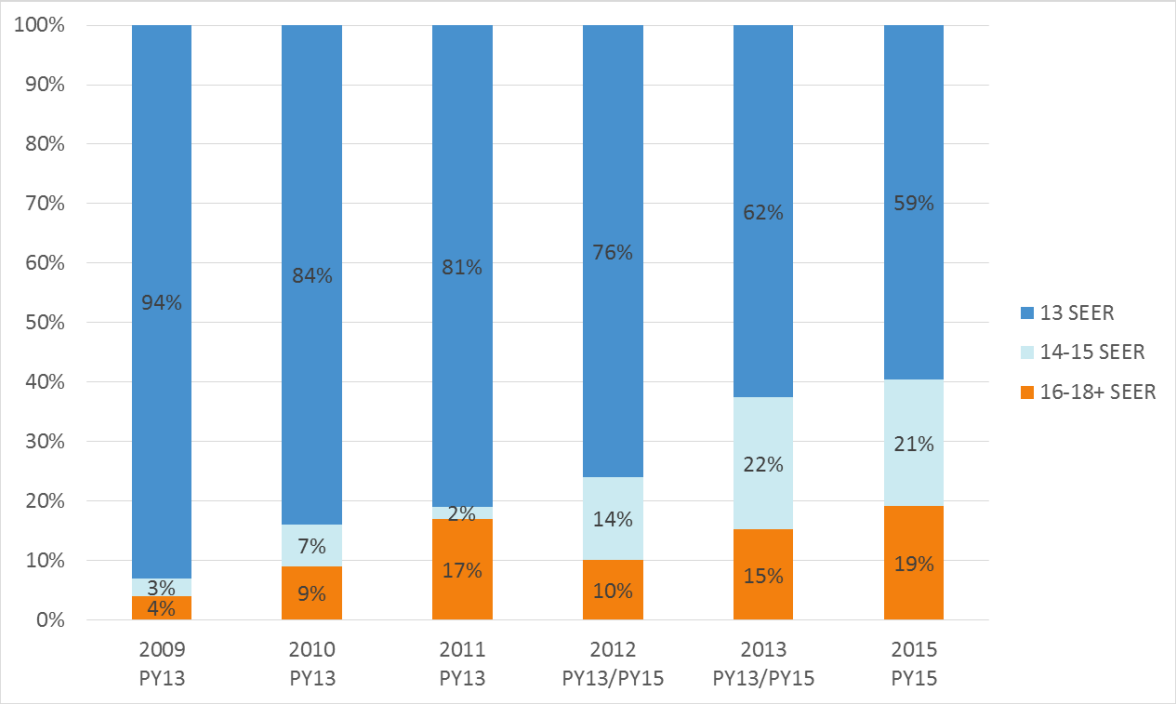
Figure 10. Distributor and Contractor Sales by SEER Level and Year for PY15



PY13 and PY15 Distributor Data

Figure 11 compares all data collected from distributors in both PY13 and PY15, revealing the number of units sold by SEER level from 2009 through 2015. The PY13 data covers the years 2009 through 2013, while the PY15 data covers 2012, 2013, and 2015. Both data sets show the percentage of 13 SEER units decreasing year-over-year, with a maximum of 94% 13 SEER units reported in 2009 and a minimum of 59% 13 SEER units reported in 2015. While we only use 2012 and 2015 for the HVAC NPSO described below, results for 2009 through 2015 show a consistent trend that reflects a lack of program activity in 2012 and increasing program effects for each year that the program continues.

Figure 11. Combined Distributor Data from PY13 and PY15 by SEER Level and Year*



*These are combined sales distribution data for PY13 (n=4,439) from one distributor and PY15 (n=63,366) from four distributors; they cannot be considered representative of all distributor types or systems, makes, and models, or of Ameren Missouri's service territory.

Distributor Interviews

The seven distributors Cadmus interviewed supported the findings from sales data collected from distributors and contractors: fewer lower-tier units were installed during the 2013–2015 program years compared to 2012. All seven distributors' reported that the Heating and Cooling Program caused an increase in the number of high-efficiency units they sold.

Additional distributor results included the following:

- Four of the seven distributors reported that their overall sales increased compared to 2012.
- All seven distributors estimated that their 2016 sales of high-efficiency units will decrease while sales of 13 SEER units will increase when the Heating and Cooling Program expires. One distributor said, "It will be a big negative for efficient units, and we might see a 20% sales decrease for those units." However, predicted efficient sales absent a program in 2016 are higher than 2012 actuals.

Results from the contractor interviews are discussed in the Process Evaluation Findings section.

HVAC Nonparticipant Spillover

To understand whether Ameren Missouri's Heating and Cooling Program generated energy efficiency improvements in addition to its HVAC Incentive Program, the Cadmus team applied the 2012 and PY15

distributors' sales data to estimate HVAC NPSO. We considered the survey responses as described in the previous sections as anecdotal evidence supporting the analysis and results.

Methodology

Using Ameren Missouri's total customer count and the CAC/HP saturation percentage, we estimated the market for CAC and HP units replaced annually by assuming burnout occurred linearly throughout the effective useful life of all the units. As shown in Table 33, Cadmus estimated the market size for CACs and HPs as approximately 50,312 units.

Table 33. Total CAC and HP Market

Line	Input	Value	Source
1	Residential Customers	1,040,928	Provided by Ameren Missouri, June 2013 (used in LightSavers ME analysis)
2	CAC/HP Saturation	87%	Provided by Ameren Missouri
3	Effective Useful Life	18	Ameren Missouri TRM (for New Systems, pg. 11)
4	Annual Turnover Percentage - 1/EUL (# of units that burn out each year)	5.6%	1/Line 3
5	"Replaceable" Units/Year	50,312	Line 1 * Line 2 * Line 4

To determine the total NPSO generated by the program between 2012 and 2015, we used the input variables shown in Table 34.

Table 34. NPSO Input Variables Summary

Variable	Input	Value	Notes
A	Annual CAC Market per Year	50,312	See Table 33
B	Annual Change in Distributor Sales Above 13 SEER	36.0%	2012-2015 Distributor Data
C	PY12 CAC/HP Participation (early replacement and burnout)	0-	No Program in 2012
D	PY15 Program Sales	11,046	Cadmus, Ameren Missouri Heating and Cooling Program Impact and Process Evaluation: Program Year 2015, May 15, 2015 (Table 1)
E	Weighted Average CAC/HP Naturally Occurring Free Ridership	16.5%	Cadmus, Ameren Missouri Heating and Cooling Program Impact and Process Evaluation: Program Year 2015, May 15, 2015 (Table 1)
F	Weighted Average CAC/HP Unit Savings for Burnout(kWh/unit)	482	Cadmus, Ameren Missouri Heating and Cooling Program Impact and Process Evaluation: Program Year 2015, May 15, 2015 (Table 1)
H	Overall Program Savings (kWh)	54,622,474	Cadmus, Ameren Missouri Heating and Cooling Program Impact and Process Evaluation: Program Year 2015 (Table 1).

To estimate the HVAC NPSO percentage (Variable O in Table 35), the Cadmus team used the input variables from Table 34 to estimate the increase in annual market sales for CAC and HP units greater than 13 SEER, then differentiated between increases in program and non-program sales, as shown in Table 35.

Table 35. NPSO Analysis

Variable	Input	Value	Source
I	Increase in Annual Market for SEER >13	18,137	A * B
J	Increase in Program Sales (PY12-PY15)	11,046	D – C
K	Increase in Nonprogram Sales (PY12-PY15)	7,091	I – J
L	Count of Naturally Occurring Sales	1,174	K * E
M	Count of HVAC NPSO Sales	5,918	K – L
N	HVAC NPSO Savings (kWh)	2,854,780	M * F
O	% HVAC NPSO	5.1%	N / H

Using this information, the Cadmus team estimated the overall HVAC NPSO as 5.1% of total PY15 reported *ex ante* gross savings; as shown in Table 35, this value represents over 2,854 MWh of savings. We considered the survey responses from distributors and contractors discussed above in light of this analysis and determined they were consistent with and supported the analysis and results provided here.

NTG Summary

To estimate PY15 NTG ratios, the Cadmus team used the following formula:

NTG = 1.0 – Free Ridership + Participant Spillover + Nonparticipant Spillover + HVAC Nonparticipant Spillover

Table 36 shows net impact calculations and findings.

Table 36. PY15 Heating and Cooling Program NTG Summary

Measure Group	*Ex Post* Gross Savings (kWh/yr)	Free Ridership	Participant Spillover	NPSO	HVAC NPSO	NTG Ratio	Net Savings (kWh/yr)*
ASHP	19,837,034	6.0%	0.1%	17.8%	5.1%	117.0%	23,214,605
CAC/ECM/T-Stat	24,402,657	14.0%				109.0%	26,602,845
GHSP	7,042,243	8.0%				115.1%	8,102,920
Tune-Up	3,340,540	40.5%				82.5%	2,756,809
Program Total	54,622,474	11.9%	0.1%	17.8%	5.1%	111.1%	60,677,178

*Total may not add to sum of measure-specific kW due to rounding

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:[20]

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

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

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

Table 37. Assumptions and Source for Cost-Effectiveness Analysis

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

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

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

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

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

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

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

The residential portfolio summary report provides further details.

Table 38 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).[21] As shown, the Heating and Cooling Program passed four of the five standard tests (but did not pass the RIM test). The program produced Annual Net Shared Benefits of $13,292,564, significantly lower than in PY14. This is primarily due to the updated lower avoided energy costs which are significantly lower than those assumed in PY14.

Table 38. Heating and Cooling Program Cost-Effectiveness Results (PY15)

	UCT	TRC	RIM	Societal	PART	Annual Net Shared Benefits*
HVAC	2.19	1.05	0.46	1.20	2.64	$13,292,564

* 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).

[21] net avoided costs minus program costs

Appendix A. Ex Post Demand Reductions

Using the following equation, the Cadmus team determined *ex post* demand savings for all central air conditioning, heat pump, and tune-up measures reported in the Heating and Cooling Program:

$$kW\ saved\ = 12\frac{kBTU}{ton} \times tons \times \left(\frac{1}{EER_{base}} - \frac{1}{EER_{efficient}}\right) \times cf$$

We used the metered coincidence factor (73.9%) determined in the PY13 evaluation.

For ECM measures installed in conjunction with a heat pump or CAC system, the evaluation team determined *ex post* demand savings of 0 kW. No demand savings resulted from ECM fan measures because the efficiency rating of the HVAC unit included the efficiency improvement from the ECM fan. Approximately 7% of ECMs incented by the program were not installed with an HVAC system but were installed with a CAC system. For these installations, the Cadmus team used the demand savings algorithm above. We assumed a 1 EER efficiency improvement (~10%), attributable to installation of the ECM.[22] Table 39 shows the evaluated measure-level gross and net demand savings.

[22] A review of 13 SEER systems in the AHRI tracking database shows a 1 EER improvement due to the presence of an ECM fan.

Table 39. PY15 Summary: Demand Savings

Measure	PY15 Participation	Per-Unit *Ex Post* Savings (kW/yr)	Total *Net* Savings ** (kW/yr)
HPs			
Air Source HP (ASHP)—Early Replacement of ASHP*	729	2.045	1,744.4
ASHP—Early Replacement of Electric Furnace*	1005	1.458	1,714.4
ASHP—Replace at failure of ASHP*	406	0.143	68.0
ASHP—Replace at failure of Electric Furnace*	68	0.200	15.9
Dual Fuel HP (DFHP)*	102	0.262	31.2
Ground Source HP (GSHP)	330	2.514	954.5
CACs			
CAC—Early Replacement*	9,619	2.095	21,967.5
CAC—Replace on Burnout*	300	0.227	74.1
Tune-ups			
HVAC Systems Receiving Condenser Cleaning	9,250	0.208	1,590.7
HVAC Systems Receiving Refrigerant Charge Adjustment	1,028	0.721	611.6
HVAC Systems Receiving Evaporator Cleaning	359	0.103	30.5
HVAC Systems Receiving General Maintenance	196	0.103	16.7
ECM			
ECM Auto Mode, Early Replacement	8,234	0.013	119.6
ECM Auto Mode, Replace at failure	376	0.028	11.5
ECM Continuous Mode	400	0.002	0.8
Thermostats			
Thermostat Installed with Setback Programmed (Discontinued in PY14)	5	0.1	0.1
Total	**32,407**	**n/a**	**28,951**

*Combined incentive tiers (SEER 14, SEER 15, SEER 16).

** Accounts for line losses; total may not add to sum of measure-specific kW due to rounding

Appendix B. Stakeholder Interview Guide

Respondent name:_____

Respondent phone: ____

Interview date: _ Interviewer initials: ____

In PY15 Cadmus will interview both Ameren Missouri and ICF Heating and Cooling Program managers. The interview will focus on changes to the program design. The interview will also assess the program at year end and identify recommendations for improving subsequent programs.

Introduction

1. What are your main responsibilities for the Heating and Cooling Program?
2. How is communication, both formal and informal, between ICF and Ameren Missouri conducted?
3. How does ICF communicate with HVAC contractors?

Program Design and Implementation

4. What would you say is working particularly well this year? Why is that?
5. Conversely, what is not working as well as anticipated? Why is that?
6. What are some of the other program changes from PY14 to PY15? (Incentive changes, drop of programmable thermostat, other?)

Program Goals

7. What are the program's participation and savings goals for PY15?
8. Does the program have any process or non-impact goals for PY15? (Probe: increased awareness, market transformation, spillover measures such as duct sealing or insulation)?
9. In your opinion, how has the program performed in PY15 (in terms of both process and savings/participation goals)?
10. Why do you think this is?

Contractor Training and Participation

11. ICF offers program training for contractors. Do you believe these trainings are effective? In what way?
12. The program also offers a technical training for contractors that is not a requirement of program participation. Do you believe this is effective?
13. Do you believe contractor participation is on track?
14. Have contractors dropped out of the program? Why?

15. To what extent do you believe the training, and involvement in the program, is impacting the region's standard HVAC diagnostic, sizing, and efficiency practices?

Quality Control

16. In your own words, please explain how the program's quality control process works.
17. Does Ameren Missouri perform any ride-alongs or independent quality control checks? Please explain.

Measures

18. In your opinion, should any additional measures be considered for inclusion in future programs? If so, what measures? Did HVAC contractors regularly request a specific measure not included in the program? If so, what measure? Did home-owners?
19. Conversely, should any current measures be excluded?
20. How were incentive amounts and changes to incentive amounts determined?

Marketing Efforts

21. What kind of marketing have you done in PY15? How does this compare to previous years?
22. We recognize that marketing methods are designed to work in concert and collectively encourage participation, but do you feel that any of these strategies have been particularly effective or ineffective so far?
23. Do you have any ideas for improving marketing in the future?

Customer and Contractor Feedback

24. Are there any recurring or common customer praises or complaints? If so, what are they?
25. How are customers' problems and questions dealt with?
26. Have you had many customers or contractors dissatisfied with the program? If so, why?
27. Have any contactors elected to drop out of the program or have any contractors mentioned they do not plan to participate? If so, why?

Summary

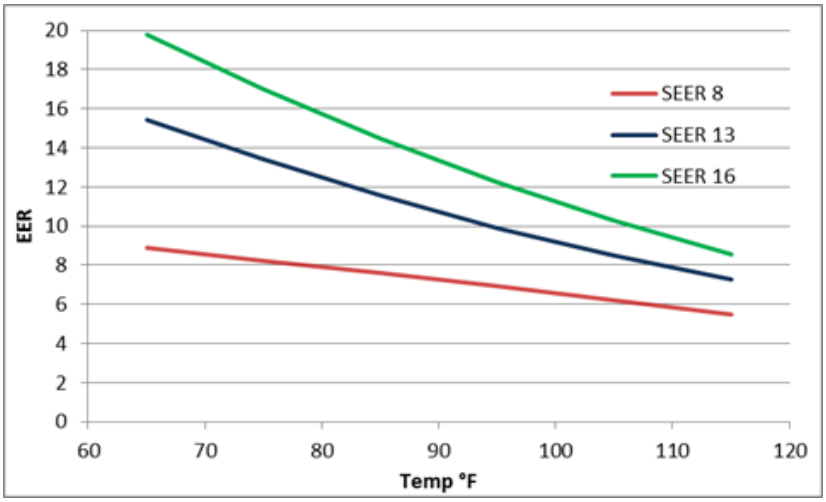
28. From your perspective, what are the biggest challenges facing the program in PY5?
29. Is there anything else you'd like us to know about your experience administrating/implementing the program so far this year?
30. Cadmus main activity this year is to conduct Heating and Cooling Program participant and participating contractor surveys. Is there anything specific you were hoping to learn from this continued effort?
31. Is there anything else you'd like us to know?

Appendix C. Detailed Engineering Calculations and Explanations

Early Replacement Baseline Efficiency

The Heating and Cooling Program tracking database includes SEER ratings of the replaced unit for new HVAC installation early replacement measures. It also includes the estimated age of the unit replaced. Following our savings methodology, which calculates savings from meter data for every metered interval, we required a function that estimated EER at variable outdoor temperatures. Manufacturer data does not reflect actual performance of an existing, older unit; so the team developed a new SEER estimate to calculate early replacement savings. A baseline EER versus a temperature curve was developed from the PY10 metering study, which metered actual EER versus outdoor temperatures of 25 existing units. Figure 12 shows two examples of manufacturer's curves and another example of an average SEER 8 curve from PY10 meter data. The EER of the HVAC systems metered in PY10 is plotted versus outdoor temperatures. The resulting curve is more linear than the EER versus temperature curves of high-efficiency systems.

Figure 12. Efficiency Curve Examples



Cadmus averaged contractor-reported SEER values to establish an early replacement average SEER baseline.

We reviewed SEER values reported by contractors to ensure we used nameplate SEER ratings in all cases; so we could then determine and apply a degradation factor uniformly to nameplate SEER values. We believed some reported SEER values were estimates, which included an assumed degradation; others were guesses or were simply erroneous. We used the following rationale to adjust reported SEER ratings:

- In 1992, the minimum-required SEER rating was set to 10. Therefore, the nameplate SEER rating of units sold from 1992 to 2006 should be no lower than 10. If a value in this range was less than

10 SEER, we changed it to 10. If it was above 10, we left it unchanged, based on the knowledge that units above the then-federal minimum were sold.

- In 2006, the minimum-required SEER rating was set to 13. Therefore, any rating below 13 SEER for a unit sold after 2006 was set to 13. If it was above 13, we left it unchanged, based on the knowledge that units above the then-federal minimum were sold.
- Prior to 1992, the consensus is the average was around 6 SEER.[23]

We then looked at degradation of efficiency by age. PY10 data included pre-tune-up data, nameplate efficiency, and equipment age for 3,900 units. These data allowed us to calculate a degradation factor that included age and maintenance-related degradation. The average age of a unit replaced through the PY15 Heating and Cooling Program was 18.9 years, and the average age of the systems replaced through the PY10 program was 19.2 years (in 2011)—that is, very similar numbers. After making the adjustments described above for the Heating and Cooling Program early replacement systems, an average recorded nameplate SEER was 9.8. The average nameplate SEER rating for the PY10 systems was 10.24.

The PY10 program verified initial operating conditions by testing a unit's EER and correcting it to ARI conditions. The PY15 Heating and Cooling Program did not verify initial operating conditions. We correlated the nameplate EER (also at ARI conditions) to test-in EER to determine efficiency degradation using the following equation:

$$efficiency\ degradation\ \% = \frac{EER_{test-in}}{EER_{nameplate}}$$

To calculate early replacement baseline SEER values reported in the Heating and Cooling Program, we adopted the following assumptions:

- The % degradation of nameplate EER represents the % degradation of nameplate SEER.
- HVAC systems in the PY10 and PY15 programs had equivalent efficiency degradation per year of operation in Ameren Missouri's service territory.

HVAC systems tested in the PY10 program averaged degradation of 1.44% per year. Applying that efficiency degradation to the PY15 SEER values resulted in a pre-tune-up SEER rating of 7.2, as shown in Table 40. We believe 7.2 SEER serves as a good representative estimate of the actual operating efficiency of existing systems replaced through the Heating and Cooling Program.

Table 40. Heating and Cooling Program Reported Efficiency and Efficiency Degradation Factor

Parameter	PY10 Program	PY15 Program
Average unit age	19.2	18.9
Average Nameplate SEER	10.2	9.8
Average Nameplate EER	8.8	Not available
Pre-tune up (degraded) EER	6.4	Not tested

[23] http://www.consumerenergycenter.org/residential/heating_cooling/heating_cooling.html

Total degradation	27.6%	Calculated from PY10 data
Average annual degradation	1.44%`	Calculated from PY10 data
Extrapolated baseline operating SEER	NA	7.2 SEER

Appendix D. Free Ridership Scoring Tables

Ground Source and Air Source Heat Pump Free Ridership Scoring Tables

Table 41 illustrates how initial survey responses are translated into whether the response is "yes," "no," or "partially" indicative of free ridership (in parentheses).

Table 41. Raw Survey Responses Translation to Free Ridership Scoring Matrix Terminology

G5. You installed a [MEASUREEFFICIENCY] heat pump. Why did you choose to install this particular system?	G6. Before you knew about the incentive from Ameren Missouri, were you already planning to install new heating or cooling equipment in 2015?	G7. [READ IF G6= 1] Without Ameren Missouri's rebate, would you have installed a system...? [READ LIST]	G8. [READ IF G7 = 1,2] Would you have installed the same type of heat pump?	G11. How important was the Ameren Missouri rebate on your decision to purchase and install this heat pump?	G12. How important was the advice from the contractor in your decision to purchase and install this heat pump? Would you say...
Yes (Yes)	I wanted the cheapest option available (Yes)	Sooner (Yes)	Yes (Yes)	Not at all important (Yes)	Very important (No)
No (No)	I wanted the most efficient option possible (Yes)	At the same time (Yes)	No (No)	Not very important (Partial)	Somewhat important (Partial)
Don't Know (Partial)	I researched my options and decided this was the right balance of efficiency and cost (Yes)	Later in the same year (Partial)	Don't Know (Partial)	Somewhat important (Partial)	Not very important (Partial)
Refused (Partial)	My contractor convinced me this was the right balance of efficiency and cost	In one or two years (No)	Refused (Partial)	Very important (No)	Not at all important (Yes)
	I heard Ameren provided an incentive for this SEER (No)	In three to five years (No)		Don't Know (Partial)	Don't Know (Partial)
	It's the same efficiency as my old unit (Yes)	After more than 5 years? (No)		Refused (Partial)	Refused (Partial)
	I wanted something more efficient than my old unit (Yes)	Don't Know (Partial)			
	Don't Know (Partial)	Refused (Partial)			
	Refused (Partial)				

Table 42 shows how the string of responses from Table 41 is then translated into a free ridership score.

Table 42. Sample of Free Ridership Scores

G5. You installed a [MEASUREEFFICIENCY] heat pump. Why did you choose to install this particular syster	G6. Before you knew about the incentive from Ameren Missouri, were you already planning to install new heating or cooling equipment in 2015?	G7. [READ IF G6= 1] Without Ameren Missouri's rebate, would you have installed a system...? [READ LIST]	G8. [READ IF G7 = 1,2] Would you have installed the same type of heat pump	G11. How important was the Ameren Missouri rebate on your decision to purchase and install this heat pump?	G12. How important was the advice from the contractor in your decision to purchase and install this heat pump? Would you s	FR Sc	Count	Formula
Yes	Yes	Yes	Yes	Yes	Yes	100%	0	100%
Yes	Yes	Yes	Yes	Yes	Partial	75%	0	75%
Yes	Yes	Yes	Yes	Yes	No	50%	1	50%
Yes	Yes	Yes	Yes	Partial	Yes	75%	0	75%
Yes	Yes	Yes	Yes	Partial	Partial	50%	1	50%
Yes	Yes	Yes	Yes	Partial	No	25%	4	25%
Yes	Yes	Yes	Yes	No	Yes	50%	0	50%
Yes	Yes	Yes	Yes	No	Partial	25%	1	25%
Yes	Yes	Yes	Yes	No	No	12.5%	0	12.5%
Yes	Yes	Yes	Partial	Yes	Yes	75%	0	75%
Yes	Yes	Yes	Partial	Yes	Partial	50%	0	50%
Yes	Yes	Yes	Partial	Yes	No	25%	0	25%
Yes	Yes	Yes	Partial	Partial	Yes	50%	0	50%
Yes	Yes	Yes	Partial	Partial	Partial	25%	0	25%
Yes	Yes	Yes	Partial	Partial	No	12.5%	1	12.5%
Yes	Yes	Yes	Partial	No	Yes	25%	0	25%
Yes	Yes	Yes	Partial	No	Partial	12.5%	0	12.5%
Yes	Yes	Yes	Partial	No	No	0%	0	0%
Yes	Yes	Yes	No	Yes	Yes	50%	0	50%
Yes	Yes	Yes	No	Yes	Partial	25%	0	25%
Yes	Yes	Yes	No	Yes	No	12.5%	0	12.5%
Yes	Yes	Yes	No	Partial	Yes	25%	0	25%
Yes	Yes	Yes	No	Partial	Partial	12.5%	0	12.5%
Yes	Yes	Yes	No	Partial	No	0%	0	0%
Yes	Yes	Yes	No	No	Yes	12.5%	0	12.5%
Yes	Yes	Yes	No	No	Partial	0%	1	0%
Yes	Yes	Yes	No	No	No	0%	1	0%
Yes	Yes	Partial	Yes	Yes	Yes	75%	0	75%
Yes	Yes	Partial	Yes	Yes	Partial	50%	0	50%
Yes	Yes	Partial	Yes	Yes	No	25%	0	25%
Yes	Yes	Partial	Yes	Partial	Yes	50%	0	50%
Yes	Yes	Partial	Yes	Partial	Partial	25%	0	25%
Yes	Yes	Partial	Yes	Partial	No	12.5%	2	13%
Yes	Yes	Partial	Yes	No	Yes	25%	0	25%
Yes	Yes	Partial	Yes	No	Partial	12.5%	0	13%
Yes	Yes	Partial	Yes	No	No	0%	0	0%

Each participant free ridership score starts with 100%, which we decrement based on their responses to the nine questions as shown in Table 43.

Table 43. Heat Pump Installation Free Ridership Scoring Legend

Q#	Decrement
FR1	50% decrement for "No," 25% decrement for "Partial"
FR2	50% decrement for "No," 25% decrement for "Partial"
FR3	100% decrement for "No," 25% decrement for "Partial"
FR4	50% decrement for "No," 25% decrement for "Partial"
FR5	50% decrement for "No," 25% decrement for "Partial"
FR6	50% decrement for "No," 25% decrement for "Partial"

Below, we illustrate the unique response combinations from new heat pump installation applicants answering the Ameren Missouri Heating and Cooling Program free ridership survey questions (actual responses mapped to "yes," "no," or "partial," as indicative of free ridership); the free ridership score assigned to each combination; and the number of responses (see Table 44).

Table 44. Frequency of Heat Pump Installation Free Ridership Scoring Combinations

G5. You installed a [MEASUREEFFICIENCY] heat pump. Why did you choose to install this particular system?	G6. Before you knew about the incentive from Ameren Missouri, were you already planning to install new heating or cooling equipment in 2015?	G7. [READ IF G6= 1] Without Ameren Missouri's rebate, would you have installed a system...? [READ LIST]	G8. [READ IF G7 = 1,2] Would you have installed the same type of heat pump?	G11. How important was the Ameren Missouri rebate on your decision to purchase and install this heat pump?	G12. How important was the advice from the contractor in your decision to purchase and install this heat pump? Would you say...	FR Score	Count
Yes	Yes	Yes	Yes	Yes	No	50%	1
Yes	Yes	Yes	Yes	Partial	Partial	50%	1
Yes	Yes	Yes	Yes	Partial	No	25%	4
Yes	Yes	Yes	Yes	No	Partial	25%	1
Yes	Yes	Yes	Partial	Partial	No	12.5%	1
Yes	Yes	Yes	No	No	Partial	0%	1
Yes	Yes	Yes	No	No	No	0%	1
Yes	Yes	Partial	Yes	Partial	No	12.5%	2
Yes	Yes	Partial	Partial	Partial	Partial	12.5%	1
Yes	Yes	Partial	x	No	No	0%	1
Yes	Yes	No	x	x	x	0%	1
Yes	No	x	x	Partial	Partial	12.5%	1
Yes	No	x	x	Partial	No	0%	1
Yes	No	x	x	No	Partial	0%	3
Partial	Yes	Yes	Yes	Partial	Partial	25%	1
Partial	Yes	Yes	Yes	Partial	No	12.5%	1
Partial	Yes	Yes	Yes	No	Partial	12.5%	1
Partial	Yes	Yes	Yes	No	No	0%	1
Partial	Yes	Yes	Partial	Partial	Partial	12.5%	1
Partial	Yes	Yes	No	No	No	0%	1
Partial	Yes	Partial	x	No	No	0%	1
Partial	No	x	x	Partial	Partial	0%	1
Partial	No	x	x	Partial	No	0%	1
Partial	No	x	x	No	Partial	0%	1
Partial	No	x	x	No	No	0%	2
No	Yes	Yes	Yes	Yes	Partial	25%	2
No	Yes	Yes	Yes	Yes	No	12.5%	2
No	Yes	Yes	Yes	Partial	Partial	12.5%	3
No	Yes	Yes	Yes	Partial	No	0%	4
No	Yes	Yes	Yes	No	No	0%	4
No	Yes	Yes	Partial	Partial	No	0%	3
No	Yes	Partial	Yes	Partial	Partial	0%	1
No	Yes	Partial	x	Partial	Partial	0%	2
No	Yes	Partial	x	No	No	0%	1
No	Yes	No	x	x	x	0%	1
No	No	x	x	Yes	Partial	0%	2
No	No	x	x	Partial	Yes	0%	1
No	No	x	x	Partial	Partial	0%	1
No	No	x	x	Partial	No	0%	4
No	No	x	x	No	Partial	0%	1
No	No	x	x	No	No	0%	6

Tune-Up Free Ridership Scoring Tables

Table 45 illustrates how initial survey responses are translated into whether the response is "yes," "no," or "partially" indicative of free ridership (in parentheses).

Table 45. Raw Survey Responses Translation to Free Ridership Scoring Matrix Terminology

E4. When you first heard of the Ameren Missouri discount, had you already scheduled your tune-up or annual check-up?	**E5.** To confirm, you scheduled the tune-up or check-up and then found out about the Ameren Missouri discount, is that correct?	**E5-1.** Did the contractor explain what was different about Ameren Missouri's diagnostic tune-up from their standard tune-up?	**E6. [IF E5=1]** What did they say was different? [Check all that apply] 1.Checked airflow 2.Checked/adjusted refrigerant charge 3. Cleaned indoor coil 4. Cleaned outdoor coil 5. Uses diagnostic tool 6. More in-depth check	**E7.** If the $75 discount provided by Ameren Missouri had not been available, would you have still purchased a tune-up at full cost?	**E8.** Without the discount, would you have had a tune-up performed…? **[READ LIST]**
Yes (Yes)	Yes (No)	Yes (Yes)	Response 1-5: Yes (Partial1)	Purchased a tune-up at full cost (Yes)	At the same time (Yes)
No (No)	No (No)	No (No)	Response 5-6: Yes (Partial2)	Purchased a less in-depth or cheaper tune-up (No)	Later in the same year (Partial)
Don't Know (Partial)	Don't Know (Partial)	Explained there was no difference (No)	Response 1-5 and 5-6: Yes (Partial 2)	Done nothing at all (Partial)	In one or two years (No)
Refused (Partial)	Refused (Partial)	Don't Know (Partial)	Don't Know (No)	Don't Know (Partial)	In three to five years (No)
		Refused (Partial)	Refused (No)	Refused (Partial)	Or would not have done at all? (No)
					Don't Know (Partial)
					Refused (Partial)

Table 46 shows how the string of responses from Table 45 is then translated into a free ridership score.

Table 46. Sample of Tune-Up Free Ridership Scores

E4. When you first heard of the Ameren discount, had you already scheduled your tune-up or annual check-up?	E5. To confirm, you scheduled the tune-up or check-up and then found out about the Ameren discount, is that correct?	E5-1. Did the contractor explain what was different about Ameren's diagnostic tune-up from their standard tune-up?	E6. [IF E5=1] What did they say was different? [Check all that apply] 1.Checked airflow 2.Checked/adjusted refrigerant charge 3. Cleaned indoor coil 4. Cleaned outdoor coil 5. Uses diagnostic tool 6. More in-depth check	E7. If the $75 discount provided by Ameren had not been available, would you have still purchased a tune-up at full cost?	E8. Without the discount, would you have had a tune-up performed...? [READ LIST]	FR Score
Yes	Yes	x	x	x	x	100%
Yes	No	Yes	Yes	Yes	Yes	100%
Yes	No	Yes	Yes	Yes	Partial	75%
Yes	No	Yes	Yes	Yes	No	0%
Yes	No	Yes	Yes	Partial	Yes	75%
Yes	No	Yes	Yes	Partial	Partial	50%
Yes	No	Yes	Yes	Partial	No	0%
Yes	No	Yes	Yes	No	Yes	50%
Yes	No	Yes	Yes	No	Partial	25%
Yes	No	Yes	Yes	No	No	0%
Yes	No	Yes	Partial1	Yes	Yes	75%
Yes	No	Yes	Partial1	Yes	Partial	50%
Yes	No	Yes	Partial1	Yes	No	0%
Yes	No	Yes	Partial1	Partial	Yes	50%
Yes	No	Yes	Partial1	Partial	Partial	25%
Yes	No	Yes	Partial1	Partial	No	0%
Yes	No	Yes	Partial1	No	Yes	25%
Yes	No	Yes	Partial1	No	Partial	0%
Yes	No	Yes	Partial1	No	No	0%
Yes	No	Yes	Partial2	Yes	Yes	50%
Yes	No	Yes	Partial2	Yes	Partial	25%
Yes	No	Yes	Partial2	Yes	No	0%
Yes	No	Yes	Partial2	Partial	Yes	25%
Yes	No	Yes	Partial2	Partial	Partial	0%
Yes	No	Yes	Partial2	Partial	No	0%
Yes	No	Yes	Partial2	No	Yes	0%
Yes	No	Yes	Partial2	No	Partial	0%
Yes	No	Yes	Partial2	No	No	0%
Yes	No	Yes	No	Yes	Yes	25%
Yes	No	Yes	No	Yes	Partial	0%
Yes	No	Yes	No	Yes	No	0%
Yes	No	Yes	No	Partial	Yes	0%
Yes	No	Yes	No	Partial	Partial	0%

Each participant free ridership score starts with 100%, which we decrement based on the participant's responses to the nine questions as shown in Table 47.

Table 47. Tune-Up Free Ridership Scoring Legend

Q#	Decrement
FR1	0% decrement for "No," Partial level not needed
FR2	0% decrement for "No," Partial level not needed
FR3	0% decrement for "No," Partial level not needed
FR4	75% decrement for "Partial 2," 25% decrement for "Partial1, 0% decrement for "No"
FR5	50% decrement for "No," 25% decrement for "Partial"
FR6	100% decrement for "No," 25% decrement for "Partial"

Below, we illustrate the unique response combinations from new HVAC installation applicants answering the HVAC free ridership survey questions (actual responses mapped to "yes," "no," or "partial," as indicative of free ridership); the initial free ridership score assigned to each combination; and the number of responses. The table does not reflect scoring adjustments that were made to respondents who received a refrigerant charge adjustment or airflow adjustment.

Table 48. Frequency of Tune-Up Free Ridership Scoring Combinations

E4. When you first heard of the Ameren Missouri rebate, had you already scheduled your tune-up or annual check-up?	E5. To confirm, you scheduled the tune-up or check-up and then found out about the Ameren Missouri discount, is that correct?	E5-1. Did your contractor explain what was different about Ameren Missouri's TEA [Tune-Up Plus Efficiency Analysis] from their standard tune-up?	E6. [IF E5-1=1] What did they say was different?	E7. If the $75 rebate provided by Ameren Missouri had not been available, would you have still:	E8. Without the rebate, would you have had a tune-up performed...?	FR Score	Count
Yes	No	Yes	Partial1	Yes	Yes	75%	1
Yes	No	Yes	Partial1	No	Yes	25%	1
Yes	No	Yes	Partial2	Yes	Yes	50%	4
Yes	No	Yes	No	Yes	Yes	25%	2
Yes	No	Yes	No	Partial	Yes	0%	1
Yes	No	No	x	Yes	Yes	100%	8
Yes	No	No	x	Yes	Partial	75%	2
Yes	No	No	x	Partial	Yes	75%	1
Yes	No	No	x	No	Yes	50%	5
Yes	No	No	x	No	No	0%	1
No	x	Yes	Partial2	Yes	Yes	50%	5
No	x	Yes	Partial2	Partial	Yes	25%	2
No	x	Yes	Partial2	Partial	Partial	0%	1
No	x	Yes	Partial2	No	Yes	0%	4
No	x	Yes	Partial2	No	Partial	0%	1
No	x	Yes	Partial2	No	No	0%	1
No	x	Yes	No	Yes	Yes	25%	2
No	x	Yes	No	No	Yes	0%	3
No	x	No	x	Yes	Yes	100%	7
No	x	No	x	Partial	Yes	75%	2
No	x	No	x	Partial	Partial	50%	3
No	x	No	x	No	Yes	50%	5
No	x	No	x	No	Partial	25%	5
No	x	No	x	No	No	0%	3

Appendix E. Participant Survey Instruments

The following survey instruments are attached:

- Heat Pump PY15 Participant Survey

PY15 HVAC Heat Pump Participant Su

- Diagnostic Tune-Up PY15 Participant Survey

PY15 HVAC Tune-up Participant Survey

Appendix F. Contractor Interview Guide

The following survey instruments are attached:

- HVAC PY15 Contractor Interview Guide

PY 15 HVAC
Contractor Interview