Ameren Missouri HVAC Program Impact and Process Evaluation: Program Year 2014

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Executive Summary

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

Program Description

In PY14, Ameren Missouri changed the name of the program from CoolSavers (used in PY13) to the HVAC Program. The HVAC Program offers 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 offers incentives for the following:

- Diagnostic testing and tuning of existing HVAC systems to manufacturer specifications;
- Installing variable-speed fan motors; and
- Installing programmable thermostats[1].

ICF International (ICF) implements the HVAC Program.

Key Impact Evaluation Findings

This section presents the Cadmus team's key impact findings for PY14.

Gross Impacts

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 PY14 to estimate evaluated (*ex post*) per-unit savings. Through an engineering analysis, we determined the program realized 90.5% percent of the expected (*ex ante)* gross savings assumed in Ameren Missouri's Technical Resource Manual (TRM). The PY14 analysis produced a result similar to but higher than last year's, when we determined an 86.4% program-level realization rate.

[1] The program dropped this measure mid-way through the program year.

Table 1. PY14 Participation, Per-Unit *Ex Post* Gross Savings, Realization Rate

Measure	PY14 Participation	Per-Unit *Ex Post* Savings (kWh/yr)	Realization Rate	Total *Ex Post* Savings *** (kWh/yr)
HPs				
Air Source HP (ASHP)—Early Replacement of ASHP*	558	5,321	113.2%	2,969,219
ASHP—Early Replacement of Electric Furnace*	509	15,243	98.6%	7,758,688
ASHP—Replace at failure of ASHP*	155	1,516	90.2%	234,914
ASHP—Replace at failure of Electric Furnace*	70	13,173	95.6%	922,131
Dual Fuel HP (DFHP)*	70	1,165	93.4%	81,517
Ground Source HP (GSHP)	138	27,427	181.6%	3,784,876
CACs				
CAC—Early Replacement*	7,077	1,821	88.3%	12,889,769
CAC—Replace on Burnout*	211	355	67.4%	74,831
Diagnostic Tune-Up				
HVAC Systems Receiving Condenser Cleaning**	7,536	140	27.3%	1,057,642
HVAC Systems Receiving Refrigerant Charge Adjustment**	971	549	287.7%	533,483
HVAC Systems Receiving Evaporator Cleaning**	555	224	35.1%	124,231
HVAC Systems Receiving General Maintenance	119	140	80.7%	16,701
Electronically Commutated Motor (ECM)				
ECM Auto Mode, Early Replacement	5,587	648	69.7%	3,617,751
ECM Auto Mode, Replace at failure	287	665	71.6%	190,830
ECM Continuous Mode	464	3,488	375.6%	1,618,200
Programmable Thermostat				
Thermostat Installed with Setback Programmed	1,562	83	15.2%	129,212
Total	**25,869**	**n/a**	**90.5%**	**36,003,993**

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

**Savings adjusted assuming 12% of tune-ups were ASHPs which have additional savings in heating mode.

***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.

Net Savings

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

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

For the PY14 evaluation, we estimated the first three NTG elements, but not market effects. Because the program will likely to generate market effects—program staff work closely with local contractors and distributors to improve installation and stocking practices—we will estimate market effects as part of the PY15 evaluation.

As shown in Table 2, the Cadmus team determined an overall weighted NTG of 95.4% for the program, which can be attributed to the following three main findings:

- The program exhibited 14% free ridership for new CAC installations, as determined by analyzing responses from participant and contractors surveys. Tune-up free ridership was higher (41.7%). Overall, free ridership – a decrement to NTG – was 17% in PY14, down from PY13 (23%).
- 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 $882,000) generated 12.3% nonparticipant spillover (NPSO), an increase to NTG.

Table 2. PY14 Net Impact Results Summary

Measure Group	*Ex Post* Gross Savings (kWh/yr)	Free Ridership	Participant Spillover	NPSO	NTG Ratio	Net Savings (kWh/yr)*
HPs	15,751,344	17.8%	0.1%	12.3%	94.5%	14,893,742
CACs	12,964,600	14.0%			98.3%	12,757,167
Diagnostic Tune-Up	1,732,057	41.7%			70.6%	1,224,564
ECMs	5,426,780	14.0%			98.3%	5,339,952
Programmable T-Stats	129,212	14.0%			98.3%	127,144
Program Total	**36,003,993**	**17.0%**	**0.1%**	**12.3%**	**95.4%**	**34,342,569**

Combining the measure-specific *ex post* results from the previous two tables revealed the PY14 HVAC Program achieved 93.7% of its proposed net energy savings target for PY14 (36,643 MWh). In addition, the program achieved 71.3% of its proposed net demand savings target for PY14 (24,303 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.

Table 3. PY14 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)	36,643	39,777	36,004	34,343	93.7%
Demand (kW)	24,303	14,106	18,111	17,043	70.1%

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

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

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

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

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

Key Conclusions and Recommendations

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

Conclusion 1. Contractor reported tune-up data quality has improved from PY13 to PY14. To determine savings for each tune-up, the Cadmus Team uses a minimum of 20 diagnostic measurements recorded and reported by participating HVAC contractors. Consequently measurement or reporting error is possible for every tune-up. The Team reviewed all measurements reported and flagged values that appeared to be erroneous or outside of acceptable limits. Despite the high probability of error, the Team estimated that 84% of tune-ups had complete data sets with usable values. Many of the data issues were minor (e.g. *temperature measurements entered into wrong field*). The final dataset used to estimate savings was robust (greater than 2,000) with fewer tune-ups removed due to data issues than in PY13 (30% removed in PY13). Although the number of tune-ups removed from analysis continues to improve, less than accurate diagnostic measurements can affect savings estimates or affect tune-up settings.

> **Recommendation 1. 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 supply and return temperature differential.

Conclusion 2. Service work performed through the HVAC tune-up measure indicates a downward trend in energy-savings potential. The Cadmus team's review of tune-up participant data found 11% of

PY14 systems required refrigerant charge adjustments—a lower rate than PY13 (16%) and much lower than the PY11 CheckMe! Program (35%).

> **Recommendation 2. Consider including additional multifamily-style buildings.** Currently, the HVAC 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.

Conclusion 3. Free ridership decreased from PY13 to PY14. In PY13 the Team found free ridership (25%) was similar to or lower than other HVAC programs. The free ridership in PY14 declined to 17% overall for the HVAC Program. Although the Team does not have quantifiable evidence to assess the reasons for decline in free ridership, we believe the continued marketing efforts, increase in program familiarity over time, and high satisfaction rating are factors that help to promote the program to Ameren Missouri customers who otherwise would not have chosen to participate.

> **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 HVAC Program measure offerings. If customers with electric heat are targeted by the program, the free ridership rate could continue to decline in PY15.

Conclusion 4. Program participation has increased from PY13 to PY14. Gross evaluated savings increased from PY13 to PY14 by 43%. The proportion of heat pumps to central ACs also increased (from 12.5% in PY13 to 17% in PY14). The Team believes the increase is attributable to the same factors that result in a decrease in free ridership: marketing techniques and positive customer experiences. Participating contractors also play a key role in promotion and success of the program. All of the largest active contractors in PY13 continued to participate in the program in PY14.

> **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 program design changes. Contractor's 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 heat pumps), or assess the impact of the changing efficiency standards.

Cadmus also examined the actions taken on the PY13 evaluation's recommendations to track what has and has not been implemented from them. Ameren Missouri implemented all but two of the PY13 recommendations. The Team agrees with the explanations thus we have not repeated these recommendations in PY14. These findings are in Table 4.

Table 4. PY13 Evaluation Recommendation Tracking

PY13 Recommendation	Cadmus Findings	Explanation
Adopt the ex post savings values and continue to maintain the commissioning requirements of new HVAC installations.	Implemented	Implementation team's program planning was done utilizing information from the 2013 evaluation, and commissioning requirements were maintained.
The CoolSavers implementation team should prioritize its plan to test the operating efficiency of a sample of existing systems prior to early replacement, which will improve confidence in the baseline value.	Not implemented	The existing baseline is based on contractor reported nameplate SEER and degradation derived from data collected during the CheckMe! program, which required pre-replacement testing of systems. Given the current program design (not requiring initial testing of systems) and the associated logistical difficulties in collecting that data, there was concern that sampling could lend itself to bias and be less reliable than the CheckMe! derived data, and this sampling was not performed.
ICF should continue to provide training, mentoring, and relatively quick feedback for contractors who provide incomplete or erroneous data. We also recommend ICF work with the Cadmus team to develop standard protocols for approving and reporting EER values used to estimate savings.	Implemented	Training, mentoring, and feedback to contractors continued throughout 2014. Data errors as identified by Cadmus decreased by 1/3, from 30% to 20%, from 2013 to 2014 while tune up volume more than doubled.
Amend the measure requirements to allow HPs with gas backup heat with an appropriate incentive offering.	Implemented	A Dual Fuel Heat Pump measure for air source heat pumps was developed and approved by stakeholders. The new rebate was offered to customers starting May 5, 2014.

PY13 Recommendation	Cadmus Findings	Explanation
Leave the tune-up protocol and incentive offering largely unchanged, but consider a slight modification to the incentive structure. To increase participation, Ameren Missouri could, for example, offer $65 for a tune-up that does not require a refrigerant charge adjustment and $85 for a tune-up that requires a refrigerant charge adjustment. This change could provide these benefits: • Help offset the cost of additional refrigerant; • Not deter contractors from participating; and • Encourage contractors to look for units with lower-operating efficiency.	Not Implemented	The incentive structure was maintained at one incentive level. The program was designed with a single incentive amount for tune up services in order encourage high levels of contractor and customer participation given high program goals. A more complex incentive structure under the prior CheckMe! program was identified as a barrier to contractor and customer participation.
Require contractors to report whether the tuned-up system was covered under an existing maintenance agreement for every system serviced to enable analysis of the differences between these types of participants with improved confidence.	Implemented	Fields were added to the program forms to collect this data.
Reduce free ridership by performing targeted marketing that addresses the following: Identify and solicit customers with high electric heating and electric cooling loads (identified through billing analysis) using bill stuffers or other mechanisms. This will allow ICF to target customers with wasteful energy habits or with inefficient HVAC systems.	Implemented	Both ICF and Ameren Missouri performed analyses to determine high-propensity customers for targeted marketing. The high-propensity data was used in marketing campaigns throughout the year.
Since contractors are a major channel for customer outreach, consider development of a formal co-op marketing package or toolkit for distribution to participating contractors.	Implemented	A formal co-op marketing package was offered to participating contractors in the spring of 2014 and again in 2015.
Continue to target customers for this program (and others, as applicable), based on propensity modeling.	Implemented	Both ICF and Ameren Missouri performed analyses to determine high-propensity customers for targeted marketing. The high-propensity data was used in marketing campaigns throughout the year.

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 (HVAC Program) for a three-year period. This annual report covers the impact and process evaluation findings for Program Year 2014 (PY14), the period from January 1, 2014, through December 31, 2014.

Program Description

The HVAC Program offers incentives to Ameren Missouri customers living in single-family homes, condos, or townhomes for installing high-efficiency central air conditioners (CAC) or heat pumps (HP) through a participating program contractor. The program also offers incentives for the following:

- Tuning an existing HVAC system to manufacturer specifications;
- Installing variable-speed fan motors; and
- Installing programmable thermostats.[2]

In PY14, Ameren Missouri changed the name of the program from CoolSavers (used in PY13) to the HVAC Program. To participate, a residential customer must have a measure installation performed by a participating contractor listed on Ameren Missouri's Website.[3] The participating contractor submits all required paperwork for incentive processing. To become a participating contractor, an HVAC company representative need only attend a program training session conducted by ICF International (ICF), the implementer.

Program Activity

In PY14, 15,838 participants received a total of 25,869 measures through the HVAC Program (many program participants received multiple rebates). This represented a 28% increase in rebates from PY13. Table 5 summarizes results from the three primary measure types.

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

Measure	Number of Systems/Measures	Homes Receiving More than One of This Measure
Air Source HPs (ASHP)	1,362	5.1%
CACs	7,288	6.3%
Tune-Ups*	8,894	24.0%

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

[2] The program dropped this measure mid-way through the program year.

[3] http://www.ameren.com/sites/AUE/MyHome/ResEfficiency/Pages/EnergyEfficiencyLookup.aspx

Evaluation Methodology

In evaluating Ameren Missouri's HVAC Program, the Cadmus team identified the following objectives for PY14.

Impact Evaluation Priorities

- Conduct a detailed engineering review of tune-up efficiency measurements.
- Reexamine savings from variable-speed fan motors and programmable thermostats.
- Assess of free ridership, spillover, and long-term market effects to calculate net savings.

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.
- Identify primary market barriers, and offer suggestions for effectively overcoming barriers through program design and delivery improvements.

Table 6 lists evaluation activities conducted in PY14 to reach the above objectives, followed by a brief summaries of each activity.

Table 6.PY14 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 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.
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

In conjunction with the TRM review, the Cadmus team reviewed the program's online reporting database (Vision) used by ICF. Specifically, we assessed whether ICF gathered the data necessary for an accurate evaluation —which included an assessment of data quality and completeness.

ICF provided two databases: Vision and the "OCC Savings[4]" database, an Excel file used to track diagnostic tune-up data from each tune-up performed.

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

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

The OCC savings database (which is 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)
- Pre and post HVAC cooling capacity
- Pre and post HVAC system power
- HVAC system size

Stakeholder Interviews

For the HVAC Program PY14 evaluation, the Cadmus team interviewed Ameren Missouri and ICF program managers, as shown in Table 7Table 7. 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 interview guide.

Table 7. Completed Stakeholder Interviews

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

[4] ICF's nomenclature for this database.

Participant Surveys

In December PY14, the Cadmus team conducted two telephone surveys of HVAC Program participants, completing 140 surveys, as shown in Table 8. 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 F provides copies of the survey instruments used. The average participation month for respondents who received a tune-up rebate was June and the average participation month for respondents who received an HVAC replacement rebate was July resulting in a time lapse of 6 to 7 months between participation and the survey.

Table 8.HVAC Program Participant Survey Summary

Target Audience	Survey Method	Field Dates	Completed Surveys
Replacement Participants	Phone	12/05-12/07	70
Tune-up Participants	Phone	12/05-12/07	70
Total	**-**	**-**	**140**

Survey Timing

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 time of participation. With greater recall, survey results most accurately reflect a participant's experience with a program and 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 estimate spillover. 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 time of participation to capture later installations, retention, and spillover. Conducting multiple participant surveys, however, is subject to 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 of Ameren Missouri-specific inputs available. These algorithms yielded estimates of the difference between the energy usage of rebated products and usage of similar products meeting the minimum federal standard for efficiency. Table 9 provides a brief overview of the engineering methodology used to estimate savings.

Table 9. 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) and age of existing system	6.3 HSPF estimated from SEER and database correlating HSPF to SEER	Metered cooling from PY13 updated with PY14 tracking data; Engineering estimate of heating savings for PY14
ASHP—Early Replacement of Electric Furnace	7.2 SEER from Cadmus meter data (PY10) and age of existing system	Electric furnace (HSPF =3.412)	Metered cooling from PY13 updated with PY14 tracking data; Engineering estimate of heating savings for PY14
ASHP—Replace at failure of ASHP	13 SEER –federal minimum	7.7 HSPF – federal minimum	Metered cooling from PY13 updated with PY14 tracking data; Engineering estimate of heating savings for PY14
ASHP—Replace at failure of Electric Furnace	13 SEER –federal minimum	Electric furnace (HSPF =3.412; COP = 1)	Metered cooling from PY13 updated with PY14 tracking data; Engineering estimate of heating savings for PY14
Ground Source HP (GSHP)	7.2 SEER from Cadmus meter data (PY10) and age of existing system	Electric furnace (HSPF =3.412; COP = 1)	Metered cooling from PY13 updated with PY14 tracking data; Engineering estimate of heating savings for PY14
CAC—Early Replacement	7.2 SEER from Cadmus meter data (PY10) and age of existing system	N/A	Metered cooling from PY13 updated with PY14 tracking data
CAC—Replace on Burnout	13 SEER –federal minimum	N/A	Metered cooling from PY13 updated with PY14 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	PY10 evaluated results	PY10 evaluated results	
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

Measure	Baseline (Cooling)	Baseline (Heating)	Type of Savings Calculation
ECM Installed (not in conjunction with HVAC system)	Engineering estimate	Engineering estimate	Engineering estimate
Thermostat Installed with Setback Programmed	TRM with weighted mix of HVAC systems and % of observed setbacks from meter data	TRM with weighted mix of HVAC systems and % of observed setbacks from meter data (from cooling only)	TRM values adjusted with observed metered temperatures and mix of HVAC systems

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

Cost-Effective Analysis

Using final PY14 HVAC participation data, implementation data, and the *ex post* gross and net savings estimates presented in this report, Morgan Marketing Partners (MMP) determined the program's cost-effectiveness using DSMore.[5] 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 program satisfy the requirements noted in Table 10. The table indicates the data our team used to satisfy these impact CSR evaluation requirements for the HVAC Program. We provide a summary of the process CSR requirements in Table 13 at the end of the Process Evaluation section

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

Table 10. Summary Responses to CSR Impact Evaluation Requirements

CSR Requirement	Method Used	Description of Program Method
Approach: The evaluation must use one or both of the following comparisons to determine the program impact:		
Comparisons of pre-adoption and post-adoption loads of program participants, corrected for the effects of weather and other intertemporal differences	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 sub-metered 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 and 2014 to
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 HVAC Program.

HVAC Program Design and Delivery

According to stakeholders, Ameren Missouri and ICF collaborated to design the HVAC Program to achieve meet 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 PY14, including the following:

- Changing the program name from CoolSavers to the HVAC Program;
- Nearly doubling the incentive for geothermal HPs;
- Increasing the incentive for early replacement CACs;
- Increasing various incentives for all types of ASHP installations;
- Addition of a dual fuel HP (DFHP) measure; and
- Removal of the programmable thermostat incentive.

HVAC Installation

Table 11 summarizes incentives offered by the HVAC Program for installations of AHRI[6]-rated air conditioner and heat pump systems. The program offered higher rebates if the existing system operated and was replaced before its end of life (early replacement). As shown in the table, the majority of installations in PY14 were early replacements. A low proportion of new CAC installations (3%) and new ASHP installations (17%) received an incentive for replacement after failure of the previous HVAC system.

Table 11. Rebated HVAC System Measure Summary

Qualifying Products	PY13 Rebate Amount	PY14 Rebate Amount	% of PY14 Early Replacement
CAC (SEER 14, 15, 16+)	Up to $425	Up to $475	97.1%
ASHP (SEER 14,15, 16+)*	Up to $650	Up to $800	82.6%

[6] Air-Conditioning, Heating, and Refrigeration Institute

Stakeholders reported the current HVAC Program delivery and design is appropriate for contractors and customers. Changing the name from CoolSavers to the HVAC Program fit with the general program design: to keep things simple. For example, a customer might have high electric heating bills and need a HP pump, making CoolSavers inconsistent with the potential participant's needs.

Other HVAC Program Measures

Table 12 shows other measures offered through the HVAC Program. The vast majority (94%) of ECM installations occurred in conjunction with a new HVAC installation measure, and almost all programmable thermostats were installed with new systems. Ameren Missouri discontinued the Programmable Thermostat incentive after May 5, 2014.

Table 12. HVAC Tune-up

Measure	Rebate
CAC or air-source HP tune-up	$75
ECM	up to $100
Programmable thermostat	$20

Stakeholders reported current measure offerings in the HVAC Program appropriate, based on recent evaluation results and program participation. Although some measures experienced low participation rates, including them presented no substantial implementations costs, and they contributed to the breadth of the program's offerings. Currently the geothermal HP measure provides an incentive only for a geothermal HP replacing all-electric heat. Because this scenario is uncommon[7], geothermal HP replacement participation is relatively low. Stakeholders noted the program should add an incentive for geothermal HPs that replace existing geothermal HPs to the list of eligible program measures in PY15. ICF suggested the program should consider offering a Wi-Fi enabled thermostat.

Communication and Program Processes

The Cadmus team found stakeholders generally agreed on most issues and found the program ran effectively during PY14.

In PY14, ICF initiated a contractor newsletter to provide a formal, consistent communication channel, used to send relevant information to contractors about the program. This information included reminders and program design changes. ICF also initiated a contractor advisory group, designed to meet quarterly. The group included contractors of varying participation rates and size, as selected by ICF. Selection specifically included contractors that historically reported problems with the program as well

[7] Although the Team did not perform specific research in Ameren Missouri, GSHP measure installation is relatively low in the U.S. compared to ASHP installation or installation of a CAC with some other heat source. GSHP installation costs are usually 3-4 times the cost of ASHP installation because a contractor typically has to dig a well or trench. GSHP installations are more common in new construction because this offers the best opportunity to install the ground loop. Presumably, there are relatively few home-owners using all-electric heat who are willing to invest in a GSHP installation.

as those previously electing not to participate. Stakeholders found the forum helpful for allowing ICF to better understand HVAC contractors' needs. Per ICF, at least 10 contractors participated in the advisory group and PY14 meetings, which were very well attended.

In addition to the advisory group, ICF plans to host a year-end dinner for contractors. At this event, ICF will specifically recognize those with the highest participation rates. Additionally, ICF sent reports to participating contractors, showing the value of their program participation in the program (e.g., "your customers received $xx due to your participation in Ameren Missouri's HVAC Program").

ICF continued to develop relationships with local HVAC system distributors. According to ICF, distributors reported greater than 50% of HVAC systems sold were at the federal minimum efficiency level (13 SEER). ICF pushed distributors to provide more affordable, program-eligible HVAC systems (14+ SEER). 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.

Program Implementation Challenges

In the second quarter of PY14, several HVAC contractors informed Ameren Missouri of their dissatisfaction with the tune-up measure's test-in requirement. They said the requirement to test efficiency before beginning service work would deter their participation and inferred the same would be true of many participating contractors.

Ameren Missouri engaged the Cadmus team to better understand the evaluation requirements and data needed to assess tune-up impacts. Ultimately, ICF reduced the test-in requirements; so only a sample (at least 1,000) of tune-up systems required testing. This change eased the amount of data reporting required of contractors while maintaining the sample of diagnostic data necessary for evaluation. ICF enacted the reduced requirement of test-in measurements in August of 2014.

Stakeholders expressed concerns about the three-year program's aggressive goals, primarily annual net demand and energy-savings goals for PY14. The HVAC Program sought to recruit 500 contractors; though it met that goal in PY14, a smaller amount (approximately 300 contractors) actively participated during PY14. ICF was unable to fully assess why some contractors became inactive but offered the following possibilities:

- They no longer wish to participate
- Their business is mainly commercial
- They primarily work with new construction
- They do not install many HVAC systems or have gone out of business

Program Marketing

According to the Cadmus team's assessment of PY14 marketing expenditures, Ameren Missouri marketed the HVAC Program more aggressively than all of its residential energy-efficiency programs

combined (58% of total PY14 marketing). The following list represents some of the primary methods Ameren Missouri and ICF used to market the HVAC Program in PY14:

- 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
- Internet radio ads (e.g., Pandora)
- Television commercials

Ameren Missouri also conducted a spring baseball ticket giveaway and hosted live radio segments. Additionally, ICF continued work with distributors, encouraging them to use Ameren Missouri's branding on qualifying HVAC systems. Stakeholders agreed the marketing effort's timing was well thought out this year. For example, Ameren Missouri marketed HPs early on, when the weather remained cold, and again in late fall. Ameren Missouri increased spending from $825,000 in PY13 to $882,000 in PY14.

Program Satisfaction

The Cadmus team surveyed program participants receiving a tune-up or installing a new HVAC system. Surveys asked program participants to rate satisfaction with the following three elements:

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

Overall, participants expressed satisfaction with all program aspects and with Ameren Missouri.

Overall Program Satisfaction

Most tune-up participants described themselves as very satisfied with the program overall (77%), while most remaining participants (19%) were somewhat satisfied; few (4%) were unhappy with the program. Most early replacement participants described themselves as very satisfied with the program overall (82%), while most remaining participants (16%) were somewhat satisfied, and one participant was unhappy with the program.

The Cadmus team asked tune-up and new HVAC installation participants: "What suggestions, if any, do you have for improving the program?"

Fifteen percent of the new replacement HVAC participants suggested that Ameren Missouri should improve its marketing and outreach effort or should make a more concerted effort to provide energy-

saving tips. The remainder of participants either did not offer suggestions or recommended larger incentives. Two participants said the installation contractor explained the efficiency of their new HVAC system was higher than the actual efficiency of the system installed. Consequently, they received a smaller incentive than expected. Both expressed unhappiness with their contractors and with rebate processing times. Most tune-up rebate recipients did not offer suggestions for program improvements. Of 13 participants offering suggestions, four respondents cited some type of customer awareness improvement or wanted Ameren Missouri to provide additional information about service work performed (e.g., "it be nice if we got a diagnostics information like something in the mail showing results of the tune-up"). Three respondents said they would prefer receiving a line-item deduction on their bills for the tune-ups, rather than receiving a check in the mail.

Satisfaction with the Participating Contractor

Of participants installing a new HVAC system, 90% described themselves as very satisfied with the contractor performing the installation, and the rest described themselves as somewhat satisfied. Of participants having their HVAC systems tuned-up, 77% described themselves as very satisfied with the contractor performing the installation, and 4% described themselves as unhappy with their contractor, citing specific reasons unrelated to the program (e.g., "they broke something and charged us for it").

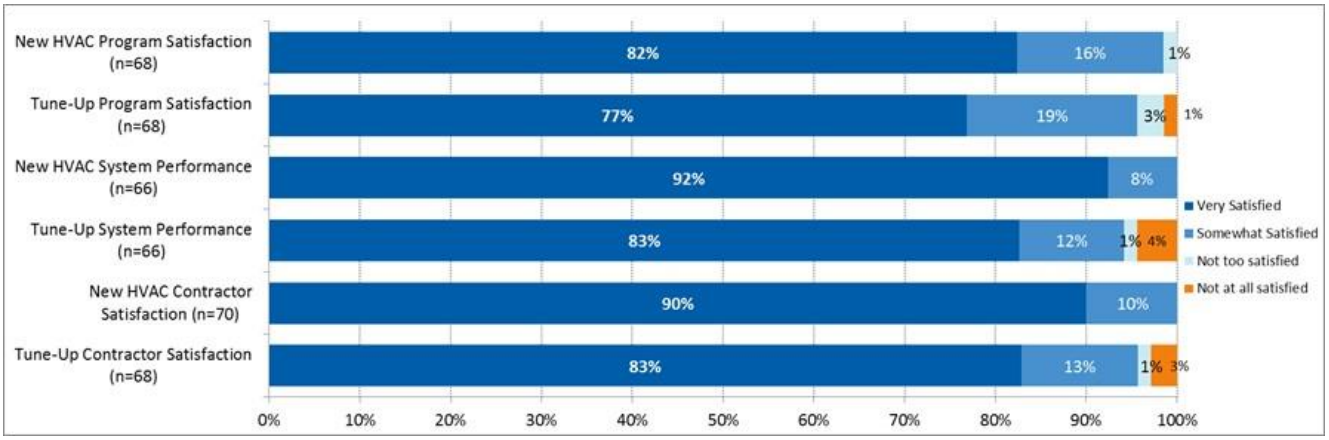
Satisfaction with the System/Measure Performance

Most tune-up participants described themselves as very satisfied with the performance of their HVAC systems after a tune-up (83%), while 12% of remaining participants were somewhat satisfied and 5% were not too satisfied. The majority of those claiming they were very satisfied explained that the system worked as they expected it to or worked even better than before, and several believed they saw a significant decrease in their energy bills.

Only a small portion (4%) of participants noted confusion with the program rebate process, citing specific issues they had with their contractor. These issues do not appear to relate to confusion about the HVAC program measures or offerings.

Most early replacement participants described themselves as very satisfied with their new HVAC system (92%), while most remaining participants (8%) were somewhat satisfied. Most participants explained they were happy with their new systems due to improved comfort in the home or from a decrease in their monthly utility bills.

Figure 1. Satisfaction with Program, HVAC System/Service, and HVAC Contractor for New and Tuned-UP HVAC Units



CSR Summary

According to the Missouri Code of State Regulations (CSR),[8] 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 13. This table offers a summary response for each specified CSR requirements.

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

Table 13. 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 is inadequate information and/or knowledge regarding the energy-saving benefits of proper HVAC maintenance and high-efficiency HVAC systems for cooling and electric heating. Additionally, the investment/cost of installing a new HVAC unit deters customers from ultimately making the decision to purchase until absolutely necessary. Further, when customers replace a system, the greater upfront cost of high-efficiency systems can cause them to purchase a lower-efficiency unit, even if the lifetime operating costs of the system are 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 is appropriately defined and comprehensively serves for the single-family residential market. The program could include multi-family homes to increase participation. Specifically, the HVAC Program is designed to help customers maintain the efficiency of operable systems (through tune-ups), and offers 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 targets the primary end-use technologies within the targeted market segment.

CSR Requirement Number	CSR Requirement Description	Summary Response
4	Are the communication channels and delivery mechanisms appropriate for the target market segment?	Yes, current communication channels are appropriate as the program uses both mass media marketing to generate demand and interest in the program as well as targeted marketing through trained local HVAC contractors.
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 current marketing materials allocate 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 number of participants surveyed in PY14 who suggested increasing program marketing declined from PY13 to PY14. This is an indication that marketing is effectively reaching more Ameren Missouri customers but should continue in PY15.

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 PY14 to estimate evaluated (*ex post*) per-unit savings. Table 14 summarizes the PY13 meter data results.

Table 14. 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 HVAC Program required cooling and heating savings estimates. The Cadmus team assumed the U.S. Department of Energy (DOE)[9] (equivalent full load hour) EFLH value for St. Louis (2,009 hours) provided a reasonable estimate of heating savings. Where necessary (e.g., 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 last year's metering study, we 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:

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

[9] EPA's ENERGY STAR Calculator.

Using detailed manufacturer data (shown in Figure 2), we developed an energy efficiency ratio (EER) versus outdoor temperature correlation for each new high-efficiency HVAC system metered. We used a synthetic baseline curve (described in Appendix D), 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.

Figure 2. 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 16. 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 PY14 (see Table 15).

Table 15. PY14 SEER and Tons Averages

Measure	*SEER*	*Tons*	PY13 Metered SEER	PY13 Metered Tons
CAC—SEER 14	14.2	3.02		
CAC—SEER 15	15.2	3.30		
CAC—SEER 16	16.3	3.09		
ASHP—SEER 14	14.2	2.89		
ASHP—SEER 15	15.1	3.08		
ASHP—SEER 16	17.3	3.23		
Average (All Systems)	**15.3**	**3.1**	**15.1**	**3.1**

We adjusted savings for these systems, determined through metering and analysis (1,805 kWh), 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 PY14 were within 2% of the PY13 estimates because the average efficiency and system sizes were very similar.

Table 16. *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	1,641	86.4%	2,574
CAC—SEER 14 Replace at Fail	409	327	80.1%	109
CAC—SEER 15 ER	2,057	1,926	93.6%	1,387
CAC—SEER 15 Replace at Fail	566	384	67.8%	41
CAC—SEER 16+ ER	2,202	1,924	87.4%	3,116
CAC—SEER 16+ Replace at Fail	710	384	54.0%	61

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 17 shows HP measures, baseline assumptions for HPs installed through the HVAC Program, and participation totals for each measure.

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

Measure	Measure Baseline Description: Cooling	Measure Baseline Description: Heating	Notes	PY14 Participants
ASHP—SEER 14 ER with ASHP Early Replacement	7.2 SEER	6.3 HSPF	HSPF estimated from SEER	154
ASHP—SEER 14 Replace at Fail with ASHP	13 SEER	7.7 HSPF		43
ASHP—SEER 14 ER Elec Resist Furnace Early Replacement*	7.2 SEER	3.4 HSPF (COP=1)		119
ASHP—SEER 14 Replace at Fail Elec Resist Furnace*	7.2 SEER	3.4 HSPF (COP=1)		31
ASHP—SEER 15 ER with ASHP Early Replacement	7.2 SEER	6.3 HSPF	HSPF estimated from SEER	213
ASHP—SEER 15 Replace at Fail with ASHP	13 SEER	7.7 HSPF		51
ASHP—SEER 15 ER Elec Resist Furnace Early Replacement *	7.2 SEER	3.4 HSPF (COP=1)		195

Measure	Measure Baseline Description: Cooling	Measure Baseline Description: Heating	Notes	PY14 Participants
ASHP—SEER 15 Replace at Fail Elec Resist Furnace*	7.2 SEER	3.4 HSPF (COP=1)		26
ASHP—SEER 16+ ER with ASHP Early Replacement	7.2 SEER	6.3 HSPF	HSPF estimated from SEER	191
ASHP—SEER 16+ Replace at Fail with ASHP	13 SEER	7.7 HSPF		61
ASHP—SEER 16+ ER Elec Resist Furnace Early Replacement*	7.2 SEER	3.4 HSPF (COP=1)		195
ASHP—SEER 16+ Replace at Fail Elec Resist Furnace*	7.2 SEER	3.4 HSPF (COP=1)		13
GSHP—SEER 14+ ER Elec Resist Furnace Early Replacement*	7.2 SEER	3.4 HSPF (COP=1)		70
GSHP—SEER 14+ Replace Elec Resist Furnace*	7.2 SEER	3.4 HSPF (COP=1)		68

*Information about cooling system 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 EPA estimate of 2,009 full-load heating hours reasonably represented an HP's energy consumption.

The PY14 HVAC Program included a new measure, DFHPs, which 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 fell below a certain temperature. Otherwise the HP provides heating.

Most systems utilize imbedded controls that prioritize 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. Although DFHP measures accounted for less than 1% of reported savings, the Cadmus team conducted detailed analysis to estimate an appropriate EFLH value for the DFHP measure, which may increase participation and impacts in future program years. Analysis of the DFHP EFLH value used the following methodology:

- The DFHP provides all heating BTUs above 34°F.
- The total seasonal heating capacity is 82MMBtus (2009 EFLH x reported capacity of DFHP).

- Heat load on a home is 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, and assumed 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 value of 930 hours.

Table 18 shows *ex ante* and *ex post* values for all HP measures reported in PY14.

Table 18. *Ex Ante* and *Ex Post* Comparison for HPs

Measure	*Ex Ante* Savings/Unit	*Ex Post* Savings/Unit	Realization Rate	PY14 Participants
ASHP—SEER 14 ER with ASHP Early Replacement	4,201	4,327	103.0%	154
ASHP—SEER 14 Replace at Fail with ASHP	1,158	1,043	90.1%	43
ASHP—SEER 14 ER Elec Resist Furnace Early Replacement	14,917	13,115	87.9%	119
ASHP—SEER 14 Replace at Fail Elec Resist Furnace	13,426	11,992	89.3%	31
ASHP—SEER 15 ER with ASHP Early Replacement	4,683	4,984	106.4%	213
ASHP—SEER 15 Replace at Fail with ASHP	1,639	1,520	92.8%	51
ASHP—SEER 15 ER Elec Resist Furnace Early Replacement	15,398	15,147	98.4%	195
ASHP—SEER 15 Replace at Fail Elec Resist Furnace	13,907	13,975	100.5%	26
ASHP—SEER 16+ ER with ASHP Early Replacement	5,126	6,499	126.8%	191
ASHP—SEER 16+ Replace at Fail with ASHP	2,082	1,845	88.6%	61
ASHP—SEER 16+ ER Elec Resist Furnace Early Replacement	15,841	16,638	105.0%	195
ASHP—SEER 16+ Replace at Fail Elec Resist Furnace	14,350	16,132	112.4%	10
GSHP—SEER 14+ ER Elec Resist Furnace Early Replacement*	15,841	28,555	180.3%	70
GSHP—SEER 14+ Replace Elec Resist Furnace*	14,350	26,265	183.0%	68
DFHP – SEER 14	650	659	101.3%	12
DFHP – SEER 15	1,230	1,158	94.1%	22
DFHP – SEER 16	1,439	1,348	93.7%	33
DFHP – SEER 17	1,651	1,214	73.5%	3

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

Heat pumps represented 17.1% of the new HVAC installation measures, and CACs accounted for the remainder of new HVAC installations. Although measure counts of HP installations were much lower, total savings attributed to HP measures were much higher, with HPs representing nearly 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 114%. Differences in savings could be attributed to the following:

- Metered cooling savings findings;
- Use of actual unit size (tons) and nameplate HSPF and SEER values; and
- Use of the HSPF baseline value, calculated from the early replacement SEER value.

The GSHP *ex post* savings were much higher than *ex ante* savings as we calculated savings using the nameplate reported system size and efficiency. GSHP systems averaged 4.1 tons, with an average efficiency of 24.5 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 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 PY14 tracking data. This used the same methodology described in detail 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.

In PY14, HVAC contractors did not have to perform test-in measurements for every tune-up. The Team aimed to develop a sample of pre- and post-diagnostic tune-up measurements that were performed at average operating conditions for an HVAC system operating in Ameren Missouri service territory. For example if a tune-up was performed at 65 °F we removed this from the sample because the apparent

efficiency improvement due to the tune-up work at that condition does not provide a good indication of actual efficiency improvement at more normal operating conditions[10] (i.e. when there's significant heat load on the unit). The Cadmus team precluded tune-ups either because reported measurements included erroneous data or because the outdoor temperature was too low. Table 19 shows the EER percent improvement from contractors' reported measurements. Ultimately, the Cadmus team used approximately 2,000 reported measurements to determine savings.

Table 19. Tune-Up Savings Summary

Measure	% Improvement	*Ex Post* CAC Savings (kWh)	*Ex Post* HP Savings (kWh)	*Ex Post* CAC and HP Savings (kWh)	*Ex Ante* (kWh)	PY14 Measures*
Refrigerant charge adjustment	18.6%	510	1,197	592	191	971
Condenser Cleaning Only	4.7%	130	306	151	515	7,536
Indoor coil cleaning	From PY10: (51 kWh/ton)	211	466	241	638	555

*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 in Table 19; so the implementation team can 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 (AC or HP), the program tracking database or tune-up measures did not discern HPs from CACs. We made the following assumptions to estimate savings for an average tune-up, which included savings from HPs in heating mode:

- Twelve percent % of system tune-ups were HPs (a conservative value, based on the mix of known HP and CAC installations);
- The efficiency improvement was the same in heating and cooling mode; and

[10] The current diagnostic tune-up testing limit of outdoor temperature is 65 °F. This is the acceptable threshold for assessing refrigerant charge and airflow but testing at this temperature does not provide a good estimate of actual savings due to a tune-up on a system that runs at much higher (on average) outdoor temperatures.

- The average HSPF after the tune-up was 6.3.

A small number of tune-ups (n=119) 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 condenser cleaning or refrigerant charge adjustment). The MML measure claimed a deemed value for a generic tune-up measure such as this 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 10% (n=873) of units assessed for a potential tune-up did not result in tune-up work being performed. Consequently, these tune-ups received 0 *ex post* savings (but did not report *ex ante* savings).

ECM Savings

The Cadmus team used a Wisconsin study[11] to estimate savings for ECMs installed through the Ameren Missouri HVAC Program. ECM fans typically save energy in three ways:

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

The vast majority of ECMs (93.6%) were installed in conjunction with an HVAC system. An AHRI SEER rating of a cooling system often includes ECM savings in cooling mode. ICF tracks when ECMs are installed as part of the AHRI SEER rating of a new HVAC system and when they are not. If an ECM is not installed with a new HVAC system, the tracking database indicates whether it was installed into an existing HVAC system. In this instance, the 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.

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[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.

Table 20. ECM Savings Summary

Measure	*Ex Ante* (kWh)	*Ex Post* (kWh)	Number of Participants	Explanation
Concept 3 Installations Auto Fan Early Replacement	929	648	5,671	The fan replaced an existing fan.
Concept 3 Installations Auto Fan Replace at Fail	929	665	294	The fan did not replace an existing, operating fan.
Concept 3 Installations Continuous Fan Early Replacement	3,597	3,332	475	The fan replaced an existing fan that was on continuously.

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' PY14 participation rates.

Table 21. PY14 *Ex Ante and Ex Post* Per-Unit Gross Savings and Total *Ex Post* Measure Savings

Measure	PY14 Participation	Per-Unit *Ex Ante* Savings (kWh/yr)	Per-Unit *Ex Post* Savings (kWh/yr)	Realization Rate	Total *Ex Post* Savings**** (kWh/yr)
ASHP—Early Replacement of ASHP*	558	4,745	5,321	113.2%	2,969,219
ASHP—Early Replacement of Electric Furnace*	509	15,469	15,243	98.6%	7,758,688
ASHP—Replace at failure of ASHP*	155	1,562	1,516	90.2%	234,914
ASHP—Replace at failure of Electric Furnace*	70	13,869	13,173	95.6%	922,131
DFHP	70	1,247	1,165	93.4%	81,517
GSHP	138	15,291	27,427	181.6%	3,784,876
CAC—Early Replacement*	7,077	2,075	1,821	88.3%	12,889,769
CAC—Replace on Burnout*	211	522	355	67.4%	74,831
HVAC Systems Receiving Condenser Cleaning**	7,536	515	140	27.3%	1,057,642
HVAC Systems Receiving Refrigerant Charge Adjustment**	971	191	549	287.7%	533,483
HVAC Systems Receiving Evaporator Cleaning**	555	638	224	35.1%	124,231
HVAC Systems Receiving General Maintenance	119	174	140	80.7%	16,701

Measure	PY14 Participation	Per-Unit *Ex Ante* Savings (kWh/yr)	Per-Unit *Ex Post* Savings (kWh/yr)	Realization Rate	Total *Ex Post* Savings**** (kWh/yr)
Concept 3 Installations Auto Fan Early Replacement (w/ HVAC system)***	5,587	929	648	69.7%	3,617,751
Concept 3 Installations Auto, Replace at Fail***	287	929	665	71.6%	190,830
Concept 3 Installations, Continuous Use***	464	3,597	3,332	375.6%	1,618,200
Thermostat Installed with Setback Programmed	1,562	543	83	15.2%	129,212
Total	**25,869**			**90.5%**	**36,003,993**

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

**Savings adjusted to calculate savings per tune-up measure, not tuned-up system (matching reported measure total)

***Weighted savings included cooling savings from ECM installations with CACs outside of the HVAC Program

****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.

Net Impact Evaluation Results

The Cadmus team determined NTG ratios using 140 participant surveys—70 installing new high-efficiency CACs and 70 with existing systems tuned up—completed in December 2014. We also used information from our interviews with 18 participating contractors from PY13, which served in in our free ridership scoring adjustments for all HVAC 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.

As ECM fan measures were combined with new HVAC install measures 94% of the time, we applied NTG results from the new HVAC installs to the ECM measure. We also applied NTG results from the new HVAC install measure surveys to the programmable thermostat measure, as that equipment had to be installed in conjunction with a new CAC.

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. PY14 HVAC Program NTG Summary

Measure Group	*Ex Post* Gross Savings (kWh/yr)	Free Ridership	Participant Spillover	NPSO	NTG Ratio
HPs	15,751,344	17.8%			94.5%
CACs	12,964,600	14.0%			98.3%
Diagnostic Tune-Up	1,732,057	41.7%	0.1%	12.3%	70.6%
ECMs	5,426,780	14.0%			98.3%
Programmable T-Stats	129,212	14.0%			98.3%
Program Total	**36,003,993**	**17.0%**	**0.1%**	**12.3%**	**95.4%**

Free Ridership–New HVAC Installation Measure

The Cadmus team used a participant self-report approach to determine new HVAC installation free ridership. 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 HVAC 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 the new HVAC installation subprogram. (Appendix E, Table 36 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.)

New HVAC Installation Free Ridership Results

Table 23 shows free ridership results for new HVAC installations.

Table 23. New HVAC Installation Free Ridership Results

Program Measure	Free Ridership Estimate	Free Ridership Absolute Precision
New HVAC Installation	14.0%	±5.4%

New HVAC Installation Measure Free Ridership Scoring

Appendix E, Table 39, contains: the full set of unique new HVAC installation measure; 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.

We found a common pattern in new HVAC installation respondents' answers to free ridership questions:

- Fourteen respondents indicated they would not have installed the measure to the same efficiency level without the program incentive; we estimated these 14 as 0% free riders.

- We designated five additional respondents as 0% free riders as they would not have purchased the equipment within the same year without the Ameren Missouri rebate.
- We estimated three respondents as 100% free riders because they would have purchased equipment to the same efficiency level and at the same time in the HVAC Program rebates' absence.
- For respondents confirming they planned to replace their unit this year, 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[13] 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 PY13 contractor interviews, to estimate a free ridership score. Contractors reported they used the program incentive to sell higher-efficiency systems. The following statements generally described the majority of contractors' thoughts about the program's influence:

- "We no longer sell 13 SEER systems because the early replacement incentives make a 14 SEER system about the same cost as a 13 SEER system."
- "We have always installed high-efficiency and promote it as an option to customers. Probably about half of the participants would have installed a 13 SEER."
- "Before the program, approximately 90% of our installations were 13 SEER. The incentive has significantly decreased our sale of 13 SEER units."

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 81% of participants claimed they planned to replace their unit this year, 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 this 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.

We 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.

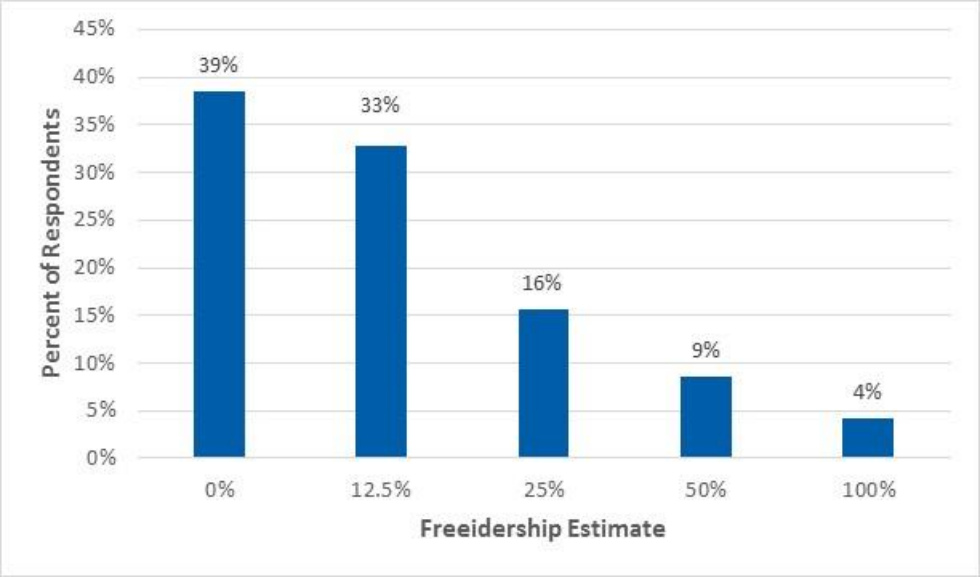
[13] Gross savings for replace on burnout were based on an assumption that a federal minimum efficiency (13 SEER) system would have been installed. Gross savings for early replacement measure were based on the efficiency of the existing HVAC system.

When asked what percentage of their customers chose to replace this year, contractors typically reported that about one-half to two-thirds replaced their systems due to the incentive, when they otherwise would have deferred replacement. As these responses do not agree with the participants' self-reported responses (about 81% claimed they planned to replace this year, even without the incentive), we adjusted free ridership scores. If a participant claimed an intention to install this 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 New HVAC Installation Free Ridership Scores

Figure 3 shows the distribution of assigned free ridership scores. Approximately 39% of new HVAC installation survey respondents received scores as 0% free riders, while we estimated 49% at low free ridership levels (12.5% and 25%). We assigned moderate free ridership levels (50%) for 9% of respondents, while we estimated 4% of new HVAC installation respondents as true free riders (100%).

Figure 3. Overall Distribution of New HVAC 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 HVAC 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 HVAC 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 performed a less-efficient tune-up performed; or
  - They would not have had the HVAC 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 HVAC Program tune-up and their standard tune-up, and if they would have purchased the same HVAC 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.
- 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).

We made changed scoring adjustments for anyone with a refrigerant charge adjustment or an airflow adjustment. A 50% multiplier applied to the participants' free ridership score if they had a refrigerant charge adjustment or 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 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 adjustment and/or refrigerant charge adjustment 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, because no basis for a difference in savings exists 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 E 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. HVAC Program Tune-Up Free Ridership Results

Program Measure	Free Ridership Estimate	Free Ridership Absolute Precision
Tune-up	41.7%	±7.3%

Tune-Up Measure Free Ridership Scoring

Appendix E 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 indicates free ridership.

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

- We estimated 27 respondents as 0% free riders as they indicated they would not have had the HVAC Program tune-up within the same year without the Ameren Missouri discount.
- We estimated 17 respondents as 100% free riders because the contractor did not explain how the HVAC Program tune-up differed from a standard tune-up. These respondents would have purchased the HVAC Program tune-up without the Ameren Missouri discount and at the same time in the absence of the Ameren Missouri discount.

We reduced two respondents initially estimated as 100% free riders to 50% free riders due to their verbatim answers regarding how important the Ameren Missouri discount was to their decisions to have an HVAC Program diagnostic tune-up performed instead of a standard tune-up. Verbatim responses from these two participants included the following:

- "[the program] really motivates you to have the tune up done and with the discount they have along with it"
- "I probably would of been hesitant but the rebate helped me decide"

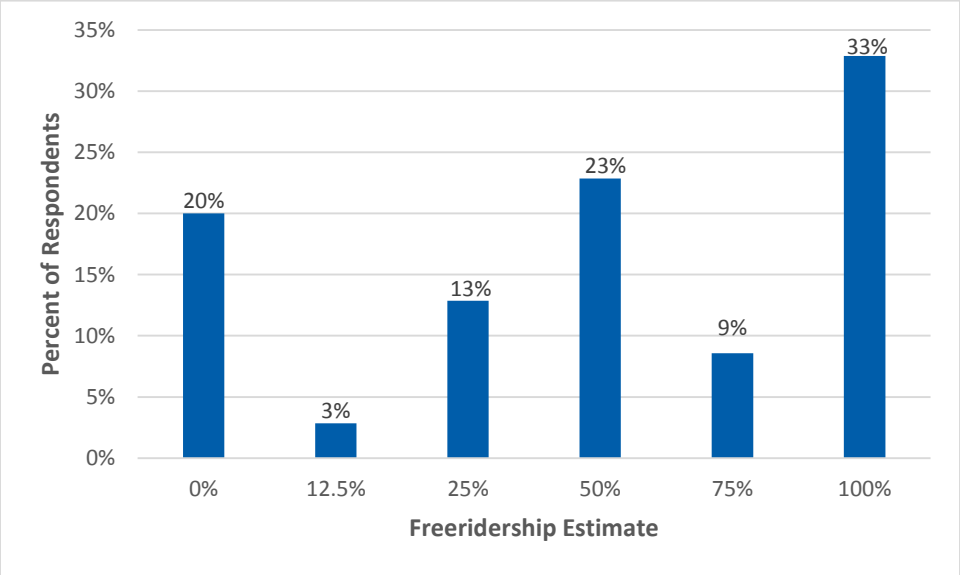
Logically, it is easiest for contractors to recruit customers with existing maintenance contracts. As a result, we assessed the freeridership scores of customers with maintenance contracts and customers

without existing contracts. We found a 45% savings-weighted free ridership score for customers on maintenance contracts, while customers without a maintenance contracts had a 41% free ridership score.

Distribution of Tune-Up Free Ridership Scores

Figure 4 shows the distribution of assigned free ridership scores. Approximately 20% of tune-up survey respondents scored as 0% free riders, while 16% scored at low free ridership levels (12.5% and 25%). Moderate free ridership levels (50% and 75%) were estimated for 31% of respondents, while 33% of tune-up respondents were estimated as true free riders (100%).

Figure 4. Overall Distribution of Tune-Up Free Ridership Scores



Participant Spillover

The Cadmus team asked HVAC 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 HVAC 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 the 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 refrigerator – after participating in the HVAC Program. The respondent said their experience in the HVAC Program was "important" to the subsequent decision to purchase a high-efficiency appliance rather than a standard efficiency model. No surveyed new HVAC installation participants attributed spillover measures to their experience or to participating in the HVAC Program.

We estimated energy savings for the tune-up participant's refrigerator spillover response, and then divided total HVAC Program sample spillover savings by the total HVAC 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 HVAC Program. Table 25 presents the spillover details.

Table 25. New HVAC Installation Participant Spillover

Spillover Measure	Participant Spillover kWh/year Savings*	Total Survey Sample Program kWh/year Savings	Spillover
Refrigerator	101	281,804	0.1%**
Overall	**101**	**281,804**	**0.1%****

*Savings based on PY13 ApplianceSavers evaluation.

**True estimate is 0.04%.

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—NPSO—results in energy savings caused by but not rebated through a utility's DSM activity.

During PY14, Ameren Missouri spent over $1.53 million dollars to market individual, residential, efficiency programs and the portfolio-wide Act on Energy campaign. This amount almost equaled Ameren Missouri's PY13 marketing expenditure ($1.55M).

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 PY13. We will repeat the survey in PY15 to compare differences in awareness and energy-efficiency actions between the first and last year of Ameren Missouri's three-year program implementation cycle.

While Cadmus did not conduct a similar general population survey in PY14, we believe—given Ameren Missouri's continued program activity and comparable marketing expenditure—that the PY13 survey results can be used to estimate NPSO that probably occurred in PY14.

Methodology

In PY13, the Cadmus team randomly selected and surveyed 401 customers, using Ameren Missouri's entire residential customer information system as the sample frame. We determined our sample

contained a small number of customers (n=36) self-reporting that they participated in an Ameren Missouri residential program during PY13. When estimating NPSO, we excluded these customers from analysis, focusing on 365 identified nonparticipants; this avoided potentially double-counting of program savings and/or program-specific spillover.

We also limited the NPSO analysis to the same efficiency measures rebated through Ameren Missouri programs (known as "like" spillover). Examples 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 represent electric spillover savings, Cadmus asked customers questions about fuel type for water heaters, heating systems, and cooling systems. Only savings associated with measures where there was a corresponding electric water heater, electric heat, or central air conditioning were counted as spillover in the analysis. To confirm a relationship between Ameren Missouri's energy-efficiency programs and the Act On Energy awareness campaign and actions taken by nonparticipants, the Cadmus team's survey asked about nonparticipants' familiarity with Ameren Missouri's energy-efficiency programs and Act On Energy. To be included in the NPSO analysis, nonparticipating respondents had to indicate the following:

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

Results

Of 365 nonparticipants surveyed, 11 cited Ameren Missouri's marketing as very important or somewhat important in their decisions to purchase non-rebated, high-efficiency measures during 2013:[15]

- Among nonparticipants citing their knowledge of Ameren Missouri's energy-efficiency programs or the Act On Energy campaign as very important, we counted *ex post,* gross, per-unit savings, determined through the PY13 evaluation towards the NPSO analysis.
- If nonparticipants reported Ameren Missouri as 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 Act On Energy as not very important or not at all important to their efficiency actions.

[15] This translates to approximately 3% of the general population, with a range of 90% confidence of 1.54% to 4.49%. Despite the range, the 3% middle point remains the most likely value. With 3% of the population undertaking actions on their own, the sample size of nearly 10,000 surveys would be needed to detect such a level with ±10%—clearly a prohibitive undertaking.

Table 26 shows measures and PY13 gross evaluated kWh savings attributed to Ameren Missouri, with average savings per spillover measure of 242 kWh.

Table 26. NPSO Response Summary

Individual Reported Spillover Measures	Influence of Ameren Missouri Information on Purchase	PY13 Measure Savings (kWh)*	Allocated Savings	Total kWh Savings	Avg kWh Per Spillover Measure
Water Heater	Very	245.7†	100%	245.7	
Central Air Conditioner (CAC)	Somewhat	288*	50%	144.0	
Installed Programmable Thermostat	Somewhat	105†	50%	52.7	
Installed Programmable Thermostat	Somewhat	105†	50%	52.7	
Installed Programmable Thermostat	Somewhat	105†	50%	52.7	
Installed Programmable Thermostat	Somewhat	105†	50%	52.7	A
Installed Programmable Thermostat	Somewhat	105†	50%	52.7	
Removed Refrigerator	Very	1,013ˆ	100%	1,013	
Scheduled CAC Tune-Up	Somewhat	993**	50%	496.5	
Water Heat Pipe Wrap	Very	363.8†	100	363.8	
Windows	Somewhat	271***	50%	136	
Total (n=11)				**2,662**	**242**

†Based on savings calculated for the Efficient Products program.

*Assumption used for the HVAC Program's gross evaluated savings, based on a 2.5-ton unit rated at 15 SEER, with a baseline of 13 SEER.

ˆBased on savings calculated for the Appliance Recycling program.

**Assumption used for the HVAC Program's gross evaluated savings, based on a 3-ton unit and a 7.7% efficiency improvement in heating and cooling for condenser cleaning.

***Based on savings calculated for 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 11 measures assessed for NPSO. Thus, the estimate of 242 kWh 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 2013, we used the following variables (as shown in Table 27):

- **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.
- **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 2014 program year *ex ante* gross savings for Appliance Recycling, HVAC, Lighting, Home Energy Performance, and Efficient Products. (Similarly to PY13, the PY14 analysis did not include the Low Income and New Homes programs.)[16]
- **G** (representing NPSO as a percentage of total evaluated savings) is the nonparticipant percentage used in the NTG calculations.

Using this information, the Cadmus team estimated overall, portfolio-level NPSO at 3.6% of total PY14 reported *ex ante* gross savings, as shown in Table 27. While, in percentage terms, a larger amount than last year (2.8% in PY13), this NPSO value represents the same number of MWH NPSO savings (7,592); it is only larger because total reported gross savings were lower in PY14. As discussed, the program's marketing expenditure in PY14—the primary driver of NPSO—was nearly identical ($1.55M vs. $1.53M) between PY13 and PY14.

Table 27. NPSO Analysis

Variable	Metric	Value	Source
A	Average kWh Savings per Spillover Measure	242	Survey Data/Impact Evaluation
B	Number of Like Spillover Nonparticipant Measures	11	Survey data
C	Number Contacted	365	Survey disposition
D	Total Residential Population	1,040,928	Customer database
E	Non-Part SO MWh Savings Applied to Population	7,592	(((B÷C)×A) × D)/1000
F	Total Reported Savings (MWh)	210,530	2014 Program Evaluations
G	NPSO as Percent of Total Evaluated Savings	3.6%	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 the 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 a 3.6% 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.

[16] The Cadmus team excluded the Low Income program and the New Homes program, as both exclusively employ very targeted marketing. Hence, marketing for these programs would likely generate little NPSO. For Low Income, the program works directly with property managers of low-income buildings. For New Homes, most program marketing targets regional builders.

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 CAC, based on energy-efficiency messaging from Ameren Missouri. Using this approach, we would assign NPSO savings associated with an HVAC 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. Specifically, while our study found all 11 respondents reporting NPSO were familiar with Act on Energy or Ameren Missouri's energy-efficiency messaging, only nine could cite specific program names. Further, just over one-half of the customers (six of 11) reporting NPSO measures were unfamiliar with the program or the programs corresponding to the measure they installed. These findings indicate Ameren Missouri generated NPSO through the cumulative effects of various program-specific and portfolio-level marketing efforts. Mapping NPSO measures solely to the program offering that measure could undervalue overall impacts of cumulative and sustained energy-efficiency messaging.
3. **Marketing Budget and Program Size.** The final allocation approach the Cadmus team considered—and eventually chose to use—assigns overall NPSO as a function of each program's marketing and program budget. This approach remains consistent with the theory that NPSO results from the cumulative effect of program-specific and Act On Energy marketing and program activity over a period of time, not necessarily by a single, program-specific marketing effort. 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 7,592 MWh NPSO to Ameren Missouri's residential programs (excluding Low Income and New Homes). As noted, we considered the PY14 program size (in terms of total gross *ex post* MWh savings) and each program's marketing budget (as shown in Table 28) when allocating NPSO across programs.

Table 28. Program-Specific Savings and Marketing

Program	Program *Ex Post* Gross Savings (MWh)	Percentage of Portfolio Savings	Total Marketing	Percentage of Total Marketing
Appliance Recycling	8,176	3.9%	$471,192	30.8%
HVAC	42,214	20.1%	$882,041	57.7%
Lighting	147,749	70.2%	$87,684	5.7%
Home Energy Performance	650	0.3%	$36,627	2.4%
Efficient Products	11,741	5.6%	$50,655	3.3%
Total	**210,530**	**100%**	**$1,528,199**	**100%**

The results of this approach—shown in Table 29 and Table 30—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 29. 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
Appliance Recycling	3.9%	30.8%	1.2%	7.0%
HVAC	20.1%	57.7%	11.6%	68.1%
Lighting	70.2%	5.7%	4.0%	23.7%
Home Energy Performance	0.3%	2.4%	0.007%	0.04%
Efficient Products	5.6%	3.3%	0.2%	1.1%
Total	**100%**	**100%**	**17.0%**	**100%**

Analysis credited two programs with the greatest NPSO: HVAC (accounting for over one-half of all marketing dollars) at 5,171 MWh; and Lighting (accounting for 70% of total energy savings) at 1,799 MWh. As NPSO impacts program-specific NTG results,[17] all NPSO estimates have been reported as a percentage of each program's total gross energy savings.

As shown in Table 30, the Cadmus team allocated 5,171 MWh of NPSO to the HVAC Program, representing 68.1% of the combined residential portfolio savings and marketing expenditure. This resulted in a 12.3% adjustment to the program's PY14 NTG—findings generally similar to the PY13 NPSO analysis.

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

Table 30. 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
Appliance Recycling	8,176		7.0%	535	6.5%
HVAC	42,214		68.1%	5,171	12.3%
Lighting	147,749	**7,592**	23.7%	1,799	1.2%
Home Energy Performance	650		0.04%	3	0.5%
Efficient Products	11,741		1.1%	83	0.7%
Total	**210,530**		**100%**	**7,592**	**3.6%**

NTG Summary

To estimate PY14 NTG ratios, the Cadmus team used the following formula:

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

For the PY14 evaluation, we estimated the first three NTG elements, but not the market effects. As the program will likely to generate market effects—program staff will work closely with local contractors and distributors to improve installation and stocking practices, we plan to estimate the market effect as part of the PY14 evaluation.

Free riders are customers who would have purchased the same high-efficiency CAC or had their existing system tuned up similarly, independently of the program. They account for some costs but none of the program benefits, thereby decreasing the program's net savings. We estimated free ridership by asking survey respondents a battery of questions regarding their purchasing decisions.

Spillover is defined as additional savings generated when program participants undertake additional energy-efficient measures or activities without financial assistance due to their experience participating in a program. Unlike free ridership, no program costs are associated with spillover savings, but energy-saving benefits result that increase the HVAC Program's net savings. Similarly to free ridership, we estimated spillover using a battery of survey questions that assessed whether their energy-efficient actions were: influenced by participation in the HVAC Program; and not encouraged through incentives of another Ameren Missouri program. This section discusses the Cadmus team's methodology for calculating net savings by measure; Table 31 shows net impact calculations.

Table 31. PY14 HVAC Program NTG Summary

Program Measure	Percent of Program Energy Savings*	Free Ridership	Participant Spillover	NPSO	NTG Ratio†
New HVAC Install and ECM	94.8%	15.8%**	0.04%	12.3%	96.6%
Tune-Up	4.8%	41.7%			70.7%
Programmable Thermostats	0.4%	14.0%			98.4%
Overall	100.0%	**17.0%**	**0.04%**	**12.3%**	**95.4%**

*Based on the Cadmus team's PY14 gross evaluated savings.

**Includes application of deemed 30% freeridership estimate to GSHP program savings.

Cost-Effectiveness Results

To analyze the PY14 HVAC Program's cost-effectiveness, MMP utilized DSMore, assessing cost-effectiveness using the following five tests, as defined by the California Standard Practice Manual:[18]

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

DSMore takes hourly prices and hourly energy savings from specific measures installed through the HVAC Program, and correlates prices and savings to 30 years of historic weather data. Using long-term weather ensures the model captures low probability, high consequence weather events and appropriately values them. As a result, the model's produces an accurate evaluation of demand-side efficiency measures relative to other alternative supply options.

Table 32 lists key assumptions the Cadmus team used in the analysis, and the source of each assumption.

Table 32. Key Assumptions for Cost-effectiveness Analysis

Assumptions	Source
Discount Rate = 6.95%	Ameren Missouri 2012 MEEIA Filing (2013 – 2015 Energy Efficiency Plan)
Line Losses = 5.72%	
Summer Peak occurred during the 16th hour of a July day, on average.	
Avoided Electric T&D = $31.01/kW	
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.	

In addition, MMP leveraged the "Batch Tools" (model inputs) used by Ameren Missouri in its original analysis, as input into the *ex post* DSMore analysis. By starting with the original DSMore Batch Tool used by Ameren Missouri and modifying it only with new data from the evaluation (e.g., PY14-specific HVAC Program participation counts, per-unit gross savings, and NTG), consistency was assured. In particular, measure load shapes drove assumptions in the model, telling the model when to apply savings during the day. This assured the load shape for that end use matched the system peak impacts of that end use

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

and provided the correct summer coincident savings. MMP used measure lifetime assumptions and incremental costs based the program's database, the Ameren Missouri TRM, or the original Batch Tool.

A key step in the analysis process was acquiring PY14 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 is unnecessary for cost-effectiveness modeling as the results are based on the program overall. MMP applied administrative costs (e.g., evaluation, potential study costs, and data tracking) in the portfolio summary analysis, not by program, as they apply to the whole residential effort.

As determined through a consensus building process with stakeholders, all cost-effectiveness results shown include the program's share of portfolio-level or indirect costs. Each program's share of these costs was determined using the present value of each program's UCT lifetime benefits (i.e., the present value of avoided generation costs as well as deferral of capacity capital and transmission and distribution capital costs). The residential portfolio summary report provides further details.

Table 33 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 UCT net lifetime benefits (net avoided costs minus program costs). As shown, the HVAC Program passed four of the five standard tests. The program did not pass the RIM test. The net lifetime benefits are $26,009,258 according to the UCT test.

Table 33. Cost-Effectiveness Results (PY14)

	UCT	TRC	RIM	Societal	PART	Net Lifetime Benefits
HVAC	4.24	2.28	0.81	2.77	3.40	$26,009,258

Appendix A. *Ex Post* Demand Reductions

Using the following equation, the Cadmus team determined *ex post* demand savings for all CAC and HP measures reported in the HVAC 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%) observed during the peak period, which occurred on August 30 during the hour from 4:00 to 5:00 p.m.

For ECM measures installed in conjunction with an HVAC 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. The PY13 tracking database did not report whether an ECM was installed with an existing CAC, but the PY14 tracking database included this information. Approximately 6% 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.[19]

For the thermostat setback and generic tune-up measure, the Cadmus team determined *ex post* demand reductions using the *ex post* energy savings estimated in this PY14 report and DSMore (using load shapes provided by Ameren Missouri). Table 34 lists demand savings by measure type.

Table 34. PY14 Summary: Ex Post Per-Unit Demand Reductions

Measure	PY14 Participation	Ex Ante (kW)	Total *Ex Post* Savings (kW)*
HPs	1,362	1,498	1,869
CACs	7,288	9,084	14,193
Diagnostic Tune-Up	9,181	1,732	1,541
ECMs	6,338	1,699	69
Programmable T-Stats	1,562	-31	32
GSHPs	138	125	407
Total	**25,869**	**14,106**	**18,111**

***Includes savings for early replacement measures, based on six-year remaining useful life.

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

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Appendix B. Stakeholder Interview Guide

Respondent name:____

Respondent phone: ___

Interview date: Interviewer initials: ___

In PY14 Cadmus will interview both Ameren Missouri and ICF HVAC 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 HVAC 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 type of affect, if any, has the name change from "Ameren Missouri CoolSavers" to "Ameren Missouri HVAC" program had?
7. What are some of the other program changes from PY5 to PY6? (Incentive changes, drop of programmable thermostat, other?)

Program Goals

8. What are the program's participation and savings goals for PY6?
9. Does the program have any process or non-impact goals for PY6? (Probe: increased awareness, market transformation, spillover measures such as duct sealing or insulation)?
10. In your opinion, how has the program performed in PY6 (in terms of both process and savings/participation goals)?
11. Why do you think this is?

Contractor Training and Participation

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

15. Have contractors dropped out of the program? Why?
16. 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

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

Measures

19. 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?
20. Conversely, should any current measures be excluded?
21. How were incentive amounts and changes to incentive amounts determined?

Marketing Efforts

22. What kind of marketing have you done in PY6? How does this compare to previous program years?
23. 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?
24. Do you have any ideas for improving marketing in the future?

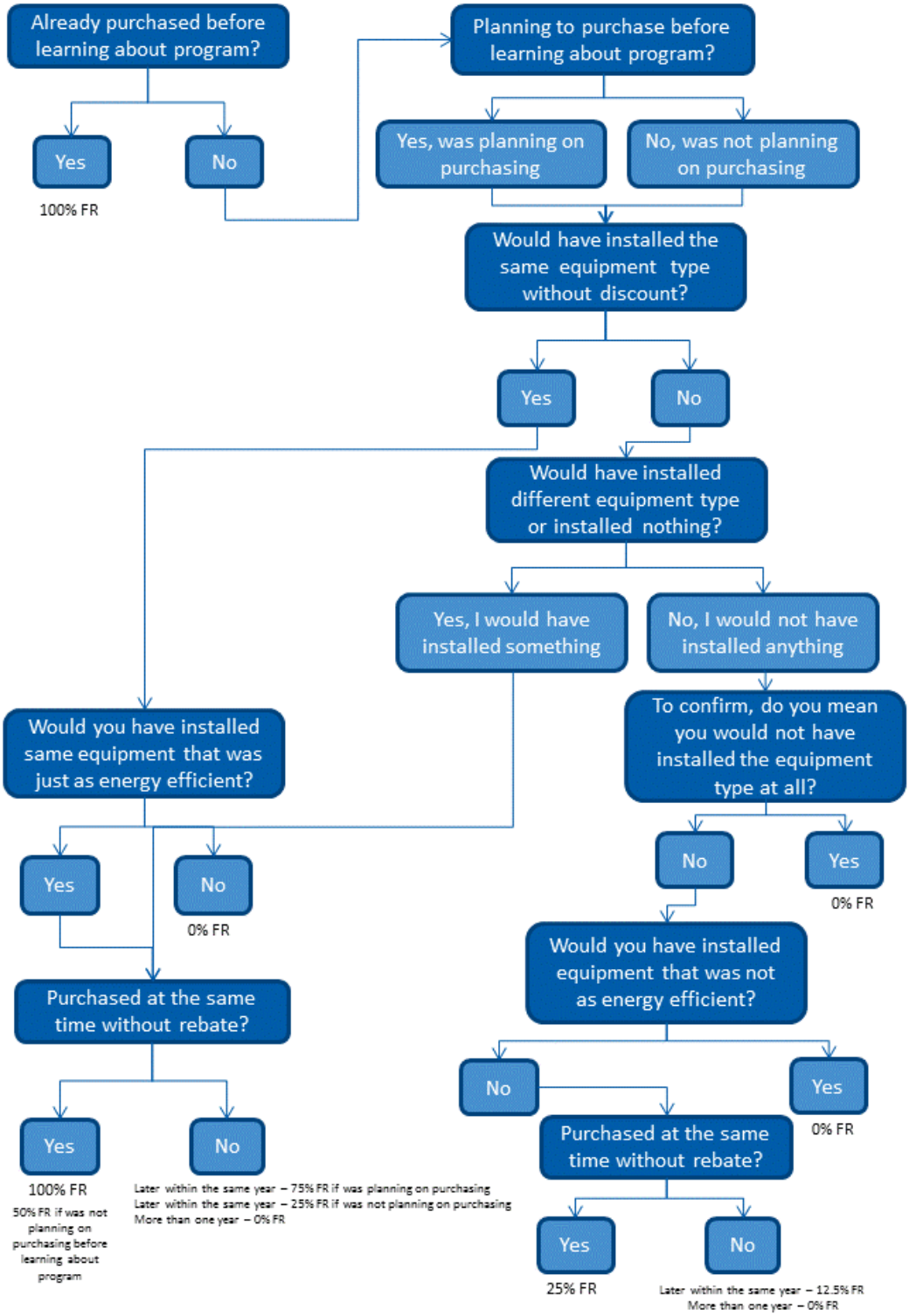
Customer and Contractor Feedback

25. Are there any recurring or common customer praises or complaints? If so, what are they?
26. How are customers' problems and questions dealt with?
27. Have you had many customers or contractors dissatisfied with the program? If so, why?
28. 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

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

Appendix C. Free Ridership Scoring Flow Chart

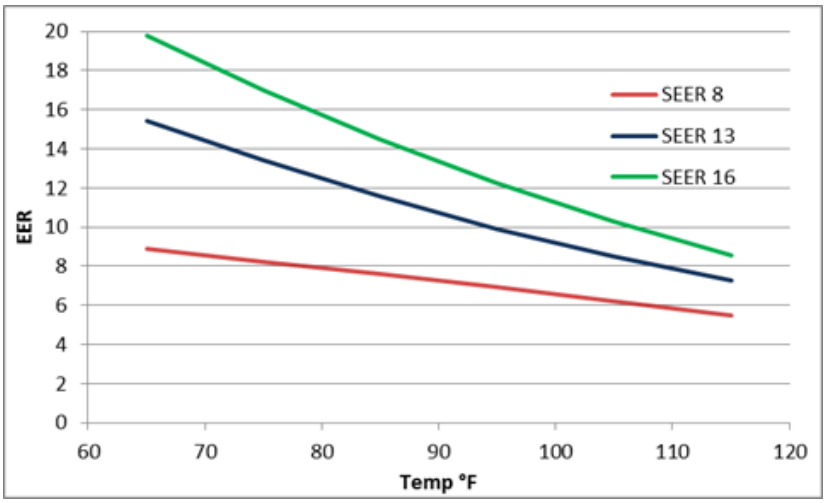


Appendix D. Detailed Engineering Calculations and Explanations

Early Replacement Baseline Efficiency

The HVAC 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 5 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 5. 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 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.[20]

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 an HVAC Program unit was 19.1 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 HVAC Program early replacement systems, an average recorded nameplate SEER was 9.9. 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 PY14 HVAC 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 HVAC Program, we adopted the following assumptions:

- The % degradation of nameplate EER represents the % degradation of nameplate SEER.
- HVAC systems in the PY10 and PY14 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 PY14 SEER values resulted in a pre-tune-up SEER rating of 7.2, as shown in Table 35. We believe 7.2 SEER serves as a good representative estimate of the actual operating efficiency of existing systems replaced through the HVAC Program.

Table 35. HVAC Program Reported Efficiency and Efficiency Degradation Factor

Parameter	PY10 Program	PY14 HVAC Program
Average unit age	19.2	19.1
Average Nameplate SEER	10.2	9.9
Average Nameplate EER	8.8	Not available
Pre-tune up (degraded) EER	6.4	Not tested
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

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

Appendix E. Free Ridership Scoring Tables

New HVAC Installation Free Ridership Scoring Tables

Table 36 illustrates how initial survey responses are translated into whether the response is "yes," "no," or "partially" indicative of free ridership (in parentheses).

Table 36. Raw Survey Responses Translation to Free Ridership Scoring Matrix Terminology

G1. [IF MEASURETYPE = "CAC"] Before you knew about the incentive from Ameren, were you already planning to install a new HVAC system this summer?	**G2.** Do you know the efficiency or SEER rating of your HVAC system installed?	**G3. [IF G2 RESPONSE WITHIN 0.5 OF [SEER RATING], OTHERWISE SKIP TO G6]** Before you knew about the incentive from Ameren, did you already know what SEER you were interested in purchasing?	**G4. [IF G3 = Yes]** Why did you want to install a **[G3 RESPONSE]** unit? **[Do not read; mark all that apply]**	**G5. [IF G3 = Yes]** How important was the Ameren incentive on your decision to purchase this **[SEERRATING]** system instead?	**G6. [IF G2 = Yes]** How important was the advice from the contractor in your decision to purchase a high-efficiency HVAC system? Would you say… **[READ LIST]**?	**G7. [IF G2 or G3 = No]** How important was the Ameren incentive on your decision to purchase your high efficiency **[MEASURETYPE]** system?	**G8.** Without Ameren's rebate, would you have installed a lower efficiency system, the same efficiency system, or a higher efficiency system…? **[READ LIST]**	**G9.** Without Ameren's rebate, would you have installed your new system…? **[READ LIST]**
Yes (Yes)	Yes (Yes)	Yes (Yes)	I wanted the cheapest option available (Yes)	Not at all important (Yes)	Very important (No)	Not at all important (Yes)	Lower efficiency (No)	Sooner (Yes)
No (No)	No (No)	No (No)	I wanted the most efficient option possible (Yes)	Not very important (Partial)	Somewhat important (Partial)	Not very important (Partial)	Same efficiency (Yes)	At the same time (Yes)
Don't Know (Partial)	Don't Know (Partial)	Don't Know (Partial)	I researched my options and decided this was the right balance of efficiency and cost (Yes)	Somewhat important (Partial)	Not very important (Partial)	Somewhat important (Partial)	Higher efficiency (Yes)	Later in the same year (Partial)
Refused (Partial)	Refused (Partial)	Refused (Partial)	My contractor convinced me this was the right balance of efficiency and cost (No)	Very important (No)	Not at all important (Yes)	Very important (No)	Don't Know (Partial)	In one or two years (No)
			I heard Ameren provided an incentive for this SEER (No)	Don't Know (Partial)	Don't Know (Partial)	Don't Know (Partial)	Refused (Partial)	In three to five years (No)
			It's the same efficiency as my old unit (Yes)	Refused (Partial)	Refused (Partial)	Refused (Partial)		After more than 5 years? (No)
			I wanted something more efficient than my old unit (Yes)					Don't Know (Partial)
			Don't Know (Partial)					Refused (Partial)
			Refused (Partial)					

Table 37 shows how the string of responses from Table 36 is then translated into a free ridership score.

Table 37. Sample of Free Ridership Scores

G1. [IF MEASURETYPE = "CAC"] Before you knew about the incentive from Ameren, were you already planning to install a new HVAC system this summer?	**G2.** Do you know the efficiency or SEER rating of your HVAC system installed?	**G3. [IF G2 RESPONSE WITHIN 0.5 OF [SEER RATING], OTHERWISE SKIP TO G6]** Before you knew about the incentive from Ameren, did you already know what SEER you were interested in purchasing?	**G4. [IF G3 = 1]** Why did you want to install a **[G3 RESPONSE]** unit? **[Do not read; mark all that apply]**	**G5. [IF G3 = 1]** How important was the Ameren incentive on your decision to purchase this **[SEERRATING]** system instead?	**G6. [IF G2 = 1]** How important was the advice from the contractor in your decision to purchase a high-efficiency HVAC system? Would you say… **[READ LIST]**?	**G7. [IF G2 or G3 = 2]** How important was the Ameren incentive on your decision to purchase your high efficiency **[MEASURETYPE]** system?	**G8.** Without Ameren's rebate, would you have installed a lower efficiency system, the same efficiency system, or a higher efficiency system…? **[READ LIST]**	**G9.** Without Ameren's rebate, would you have installed your new system…? **[READ LIST]**	**FR Score**
Yes	Yes	Yes	Yes	Yes	Yes	x	Yes	Yes	100%
Yes	Yes	Yes	Yes	Yes	Yes	x	Yes	Partial	75%
Yes	Yes	Yes	Yes	Yes	Yes	x	Yes	No	0%
Yes	Yes	Yes	Yes	Yes	Yes	x	Partial	Yes	75%
Yes	Yes	Yes	Yes	Yes	Yes	x	Partial	Partial	50%
Yes	Yes	Yes	Yes	Yes	Yes	x	Partial	No	0%
Yes	Yes	Yes	Yes	Yes	Yes	x	No	x	0%
Yes	Yes	Yes	Yes	Yes	Partial	x	Yes	Yes	75%
Yes	Yes	Yes	Yes	Yes	Partial	x	Yes	Partial	50%
Yes	Yes	Yes	Yes	Yes	Partial	x	Yes	No	0%
Yes	Yes	Yes	Yes	Yes	Partial	x	Partial	Yes	50%
Yes	Yes	Yes	Yes	Yes	Partial	x	Partial	Partial	25%
Yes	Yes	Yes	Yes	Yes	Partial	x	Partial	No	0%
Yes	Yes	Yes	Yes	Yes	Partial	x	No	x	0%
Yes	Yes	Yes	Yes	Yes	No	x	Yes	Yes	50%
Yes	Yes	Yes	Yes	Yes	No	x	Yes	Partial	25%
Yes	Yes	Yes	Yes	Yes	No	x	Yes	No	0%
Yes	Yes	Yes	Yes	Yes	No	x	Partial	Yes	25%
Yes	Yes	Yes	Yes	Yes	No	x	Partial	Partial	12.5%
Yes	Yes	Yes	Yes	Yes	No	x	Partial	No	0%
Yes	Yes	Yes	Yes	Yes	No	x	No	x	0%
Yes	Yes	Yes	Yes	Partial	Yes	x	Yes	Yes	50%
Yes	Yes	Yes	Yes	Partial	Yes	x	Yes	Partial	25%
Yes	Yes	Yes	Yes	Partial	Yes	x	Yes	No	0%
Yes	Yes	Yes	Yes	Partial	Yes	x	Partial	Yes	25%
Yes	Yes	Yes	Yes	Partial	Yes	x	Partial	Partial	12.5%
Yes	Yes	Yes	Yes	Partial	Yes	x	Partial	No	0%
Yes	Yes	Yes	Yes	Partial	Yes	x	No	x	0%
Yes	Yes	Yes	Yes	Partial	Partial	x	Yes	Yes	25%
Yes	Yes	Yes	Yes	Partial	Partial	x	Yes	Partial	12.5%
Yes	Yes	Yes	Yes	Partial	Partial	x	Yes	No	0%
Yes	Yes	Yes	Yes	Partial	Partial	x	Partial	Yes	12.5%
Yes	Yes	Yes	Yes	Partial	Partial	x	Partial	Partial	0%
Yes	Yes	Yes	Yes	Partial	Partial	x	Partial	No	0%
Yes	Yes	Yes	Yes	Partial	Partial	x	No	x	0%
Yes	Yes	Yes	Yes	Partial	No	x	Yes	Yes	12.5%
Yes	Yes	Yes	Yes	Partial	No	x	Yes	Partial	0%
Yes	Yes	Yes	Yes	Partial	No	x	Yes	No	0%
Yes	Yes	Yes	Yes	Partial	No	x	Partial	Yes	0%
Yes	Yes	Yes	Yes	Partial	No	x	Partial	Partial	0%
Yes	Yes	Yes	Yes	Partial	No	x	Partial	No	0%
Yes	Yes	Yes	Yes	Partial	No	x	No	x	0%

Each participant free ridership score starts with 100%, which we decrement based on their responses to the nine questions as shown in Table 38.

Table 38. New HVAC 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	25% 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"
FR7	50% decrement for "No," 25% decrement for "Partial"
FR8	100% decrement for "No," 25% decrement for "Partial"
FR9	100% decrement for "No," 25% decrement for "Partial"

Below, we illustrate the unique response combinations from new HVAC installation applicants answering the Ameren Missouri HVAC 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 39).

Table 39. Frequency of New HVAC Installation Free Ridership Scoring Combinations

G1. [IF MEASURETYPE = "CAC"] Before you knew about the incentive from Ameren, were you already planning to install a new HVAC system this summer?	**G2.** Do you know the efficiency or SEER rating of your HVAC system installed?	**G3. [IF G2 RESPONSE WITHIN 0.5 OF [SEER RATING], OTHERWISE SKIP TO G6]** Before you knew about the incentive from Ameren, did you already know what SEER you were interested in purchasing?	**G4. [IF G3 = 1]** Why did you want to install a **[G3 RESPONSE]** unit? **[Do not read; mark all that apply]**	**G5. [IF G3 = 1]** How important was the Ameren incentive on your decision to purchase this **[SEERRATING]** system instead?	**G6. [IF G2 = 1]** How important was the advice from the contractor in your decision to purchase a high-efficiency HVAC system? Would you say… **[READ LIST]**?	**G7. [IF G2 or G3 = 2]** How important was the Ameren incentive on your decision to purchase your high efficiency **[MEASURETYPE]** system?	**G8.** Without Ameren's rebate, would you have installed a lower efficiency system, the same efficiency system, or a higher efficiency system…? **[READ LIST]**	**G9.** Without Ameren's rebate, would you have installed your new system…? **[READ LIST]**	**FR Score**	**Count**
Yes	Yes	Yes	Yes	Yes	Partial	x	Yes	Yes	75%	1
Yes	Yes	Yes	Yes	Partial	Partial	x	Partial	Yes	12.5%	1
Yes	Yes	Yes	Yes	Partial	No	x	Yes	Yes	12.5%	1
Yes	Yes	Yes	Yes	No	No	x	Yes	Yes	12.5%	1
Yes	Yes	Yes	No	No	No	x	Yes	Yes	0%	1
Partial	Yes	No	x	x	x	Partial	Yes	Yes	12.5%	2
Partial	Yes	No	x	x	x	Partial	Yes	No	0%	1
Partial	Yes	No	x	x	x	No	Yes	No	0%	1
Partial	Yes	No	x	x	x	No	Partial	Yes	0%	1
Yes	Yes	x	x	x	x	x	Yes	Yes	100%	4
Yes	Yes	x	x	x	x	x	No	x	0%	2
Partial	Partial	x	x	x	x	x	Yes	Yes	50%	5
Partial	Partial	x	x	x	x	x	Yes	Partial	25%	1
Partial	Partial	x	x	x	x	x	Yes	No	0%	2
Partial	Partial	x	x	x	x	x	Partial	Partial	12.5%	1
Partial	Partial	x	x	x	x	x	No	x	0%	5
Partial	No	x	x	x	x	Yes	Yes	Yes	25%	4
Partial	No	x	x	x	x	Yes	Yes	No	0%	1
Partial	No	x	x	x	x	Yes	No	x	0%	1
Partial	No	x	x	x	x	Partial	Yes	Yes	12.5%	9
Partial	No	x	x	x	x	No	Yes	Yes	0%	1
Partial	No	x	x	x	x	No	Yes	No	0%	1
Partial	No	x	x	x	x	No	Partial	Yes	0%	1
Partial	No	x	x	x	x	No	No	x	0%	2
No	Partial	x	x	x	x	x	Partial	Partial	0%	1
No	Yes	Yes	Yes	Partial	No	x	Yes	No	0%	1
Yes	Yes	No	x	x	x	Yes	Yes	Yes	50%	1
Yes	Yes	No	x	x	x	Partial	Yes	Yes	25%	2
Yes	Partial	x	x	x	x	x	Yes	Yes	75%	3
Yes	Partial	x	x	x	x	x	No	x	0%	1
Yes	No	x	x	x	x	Yes	Yes	Yes	50%	2
Yes	No	x	x	x	x	Yes	No	x	0%	1
Yes	No	x	x	x	x	Partial	Yes	Yes	25%	3
Yes	No	x	x	x	x	Partial	Yes	Partial	12.5%	1
Yes	No	x	x	x	x	Partial	Partial	Yes	12.5%	1
Yes	No	x	x	x	x	Partial	No	x	0%	1
Yes	No	x	x	x	x	No	Yes	Yes	12.5%	2
Yes	No	x	x	x	x	No	Partial	Yes	0%	1
Yes	No	x	x	x	x	No	No	x	0%	2
No	Yes	x	x	x	x	x	Yes	Yes	50%	2
x	Yes	x	x	x	x	x	Yes	Yes	100%	1
x	Partial	x	x	x	x	x	Yes	Partial	50%	1
x	No	x	x	x	x	No	No	x	0%	2

TUNE-UP FREE RIDERSHIP SCORING TABLES

Table 40 illustrates how initial survey responses are translated into whether the response is "yes," "no," or "partially" indicative of free ridership (in parentheses).

Table 40. Raw Survey Responses Translation to Free Ridership Scoring Matrix Terminology

F3. When you first heard of the Ameren discount, had you already scheduled your tune-up?	F4. To confirm, you scheduled the tune-up and then found out about the Ameren discount, is that correct?	F5. Did the contractor explain what was different about a CoolSavers tune-up from their standard tune-up?	F6. [IF F3=Yes] What did they say was different? [Check all that apply] 1Checked airflow 2.Checked/adjusted refrigerant charge 3. Cleaned indoor coil 4. Cleaned outdoor coil 5. Other	F7. If the $75 discount provided by Ameren had not been available, would you have still purchased the CoolSavers tune-up?	F8. Without the discount, would you have had the CoolSavers tune-up performed…? [READ LIST]
Yes (Yes)	Yes (No)	Yes (Yes)	1 Mention (Yes)	Yes, would have purchased CoolSavers tune-up (Yes)	Sooner (Yes)
No (No)	No (No)	No (No)	2 Mentions (Partial1)	No, would not have purchased the CoolSavers tune-up (No)	At the same time (Yes)
Don't Know (Partial)	Don't Know (Partial)	Explained there was no difference (No)	3 Mentions (Partial2)	Don't Know (Partial)	Later in the same year (Partial)
Refused (Partial)	Refused (Partial)	Don't Know (Partial)	4 Mentions (No)	Refused (Partial)	In one or two years (No)
		Refused (Partial)	5 Mentions (No)		In three to five years (No)
			Don't Know (Partial2)		Or would not have done at all? (No)
			Refused (Partial2)		Don't Know (Partial)
					Refused (Partial)

Table 41 shows how the string of responses from Table 40 is then translated into a free ridership score.

Table 41. Sample of Tune-Up Free Ridership Scores

G1. [IF MEASURETYPE = "CAC"] Before you knew about the incentive from Ameren, were you already planning to install a new HVAC system this summer?	**G2.** Do you know the efficiency or SEER rating of your HVAC system installed?	**G3. [IF G2 RESPONSE WITHIN 0.5 OF [SEER RATING], OTHERWISE SKIP TO G6]** Before you knew about the incentive from Ameren, did you already know what SEER you were interested in purchasing?	**G4. [IF G3 = 1]** Why did you want to install a **[G3 RESPONSE]** unit? **[Do not read; mark all that apply]**	**G5. [IF G3 = 1]** How important was the Ameren incentive on your decision to purchase this **[SEERRATING]** system instead?	**G6. [IF G2 = 1]** How important was the advice from the contractor in your decision to purchase a high-efficiency HVAC system? Would you say… **[READ LIST]**?	**G7. [IF G2 or G3 = 2]** How important was the Ameren incentive on your decision to purchase your high efficiency **[MEASURETYPE]** system?	**G8.** Without Ameren's rebate, would you have installed a lower efficiency system, the same efficiency system, or a higher efficiency system…? **[READ LIST]**	**G9.** Without Ameren's rebate, would you have installed your new system…? **[READ LIST]**	**FR Score**
Yes	Yes	Yes	Yes	Yes	Yes	x	Yes	Yes	100%
Yes	Yes	Yes	Yes	Yes	Yes	x	Yes	Partial	75%
Yes	Yes	Yes	Yes	Yes	Yes	x	Yes	No	0%
Yes	Yes	Yes	Yes	Yes	Yes	x	Partial	Yes	75%
Yes	Yes	Yes	Yes	Yes	Yes	x	Partial	Partial	50%
Yes	Yes	Yes	Yes	Yes	Yes	x	Partial	No	0%
Yes	Yes	Yes	Yes	Yes	Yes	x	No	x	0%
Yes	Yes	Yes	Yes	Yes	Partial	x	Yes	Yes	75%
Yes	Yes	Yes	Yes	Yes	Partial	x	Yes	Partial	50%
Yes	Yes	Yes	Yes	Yes	Partial	x	Yes	No	0%
Yes	Yes	Yes	Yes	Yes	Partial	x	Partial	Yes	50%
Yes	Yes	Yes	Yes	Yes	Partial	x	Partial	Partial	25%
Yes	Yes	Yes	Yes	Yes	Partial	x	Partial	No	0%
Yes	Yes	Yes	Yes	Yes	Partial	x	No	x	0%
Yes	Yes	Yes	Yes	Yes	No	x	Yes	Yes	50%
Yes	Yes	Yes	Yes	Yes	No	x	Yes	Partial	25%
Yes	Yes	Yes	Yes	Yes	No	x	Yes	No	0%
Yes	Yes	Yes	Yes	Yes	No	x	Partial	Yes	25%
Yes	Yes	Yes	Yes	Yes	No	x	Partial	Partial	12.5%
Yes	Yes	Yes	Yes	Yes	No	x	Partial	No	0%
Yes	Yes	Yes	Yes	Yes	No	x	No	x	0%
Yes	Yes	Yes	Yes	Partial	Yes	x	Yes	Yes	50%
Yes	Yes	Yes	Yes	Partial	Yes	x	Yes	Partial	25%
Yes	Yes	Yes	Yes	Partial	Yes	x	Yes	No	0%
Yes	Yes	Yes	Yes	Partial	Yes	x	Partial	Yes	25%
Yes	Yes	Yes	Yes	Partial	Yes	x	Partial	Partial	12.5%
Yes	Yes	Yes	Yes	Partial	Yes	x	Partial	No	0%
Yes	Yes	Yes	Yes	Partial	Yes	x	No	x	0%
Yes	Yes	Yes	Yes	Partial	Partial	x	Yes	Yes	25%
Yes	Yes	Yes	Yes	Partial	Partial	x	Yes	Partial	12.5%
Yes	Yes	Yes	Yes	Partial	Partial	x	Yes	No	0%
Yes	Yes	Yes	Yes	Partial	Partial	x	Partial	Yes	12.5%
Yes	Yes	Yes	Yes	Partial	Partial	x	Partial	Partial	0%
Yes	Yes	Yes	Yes	Partial	Partial	x	Partial	No	0%
Yes	Yes	Yes	Yes	Partial	Partial	x	No	x	0%
Yes	Yes	Yes	Yes	Partial	No	x	Yes	Yes	12.5%
Yes	Yes	Yes	Yes	Partial	No	x	Yes	Partial	0%
Yes	Yes	Yes	Yes	Partial	No	x	Yes	No	0%
Yes	Yes	Yes	Yes	Partial	No	x	Partial	Yes	0%
Yes	Yes	Yes	Yes	Partial	No	x	Partial	Partial	0%
Yes	Yes	Yes	Yes	Partial	No	x	Partial	No	0%
Yes	Yes	Yes	Yes	Partial	No	x	No	x	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 42.

Table 42. 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 "No," 50% decrement for "Partial2," 25% decrement for "Partial1"
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 43. Frequency of Tune-Up Free Ridership Scoring Combinations

F3. When you first heard of the Ameren discount, had you already scheduled your tune-up?	F4. To confirm, you scheduled the tune-up and then found out about the Ameren discount, is that correct?	F5. Did the contractor explain what was different about a CoolSavers tune-up from their standard tune-up?	F6. [IF F3=1] What did they say was different? [Check all that apply]	F7. If the $75 discount provided by Ameren had not been available, would you have still purchased the CoolSavers tune-up?	F8. Without the discount, would you have had the CoolSavers tune-up performed…? [READ LIST]	FR Score	Count
Yes	No	Yes	Yes	Yes	Yes	100%	5
Yes	No	Yes	Yes	Yes	Partial	75%	1
Yes	No	Yes	Yes	Yes	No	0%	1
Yes	No	Yes	Yes	Partial	Yes	75%	1
Yes	No	Yes	Yes	No	Yes	50%	1
Yes	No	Yes	Partial1	Yes	Yes	75%	1
Yes	No	Yes	Partial2	Yes	Yes	50%	6
Yes	No	Yes	Partial2	Yes	No	0%	1
Yes	No	Yes	Partial2	Partial	No	0%	1
Yes	No	Yes	Partial2	No	No	0%	1
Yes	No	No	x	Yes	Yes	100%	12
Yes	No	No	x	Yes	Partial	75.0%	1
Yes	No	No	x	Yes	No	0%	1
Yes	No	No	x	No	Partial	25%	1
Yes	No	No	x	No	No	0%	4
No	x	Yes	Yes	Yes	Yes	100%	1
No	x	Yes	Yes	Yes	Partial	75%	2
No	x	Yes	Yes	Partial	No	0%	1
No	x	Yes	Yes	No	No	0%	4
No	x	Yes	Partial1	No	No	0%	1
No	x	Yes	Partial2	Yes	Yes	50%	2
No	x	Yes	Partial2	No	No	0%	2
No	x	Yes	No	Yes	Yes	25%	1
No	x	No	x	Yes	Yes	100%	9
No	x	No	x	Yes	Partial	75%	3
No	x	No	x	Yes	No	0%	2
No	x	No	x	Partial	Yes	75%	1
No	x	No	x	Partial	Partial	50%	1
No	x	No	x	Partial	No	0%	2
No	x	No	x	No	Yes	50%	1
No	x	No	x	No	Partial	25%	2
No	x	No	x	No	No	0%	4

Appendix F. Participant Survey Instruments

The following survey instruments are attached:

- HVAC PY14 Participant Survey
- Diagnostic Tune-Up PY14 Participant Survey

Appendix G. Bibliography

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