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Impact and Process Evaluation of 2016 (PY9) Ameren Illinois Company HVAC Program

Final

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1. Executive Summary

This report presents results from the evaluation of the Ameren Illinois Company (AIC) Residential Heating and Cooling Program (HVAC program) for Program Year 9 (PY9), which ran from June 1, 2016 to May 31, 2017. The HVAC program offered customers incentives through registered program allies for purchases of brushless/electronically commutated motors (ECMs), air-source heat pumps (ASHPs), programmable thermostats, and smart thermostats, with pool pump incentives added at the end of the program year.

Registered program allies performed all equipment installations except for thermostats, which were offered as a self-install option. AIC offered incentives that varied, based on equipment types and baseline efficiency levels. The incentives for all equipment installed by a program ally were deducted from the contractor installation invoice at the time of sale. AIC worked with Leidos as the HVAC program administrator. CLEAResult continued to work as an implementation subcontractor under Leidos' management.

The evaluation of the PY9 HVAC program involved both process and impact assessments as well as a metering study to inform future versions of the Illinois Statewide Technical Reference Manual (IL-TRM). Key findings from the PY9 evaluation are presented below.

Program Impacts

Table 1 summarizes the net electricity and demand savings from the PY9 HVAC program. The evaluation team followed the IL-TRM Version 5.0 protocol (Version 6.0 for pool pumps, as the protocol wasn't available in Version 5.0) and used equipment information from the program tracking data to calculate unique savings values for every measure reported. The program reported ex ante gross savings of 5,089 MWh and achieved ex post gross savings of 5,048 MWh, which resulted in a 99.2% gross realization rate for energy. The program also achieved ex post demand savings of 1.023 MW and 92,833 therms (compared with reported ex ante demand savings of 1.053 MW and therms savings of 102,771) resulting in gross realization rates of 97.2% and 90.3% for demand and natural gas, respectively. We then applied the measure-specific net-to-gross ratios (NTGRs), agreed upon by the Illinois Stakeholder Advisory Group (SAG), to the ex post gross impacts to get the ex post net impacts. The program achieved ex post net savings of 3,960 MWh and 0.802 MW.

Table 1. PY9 Net HVAC Program Impacts

	Ex Ante Gross	Gross Realization Rate	Ex Post Gross	NTGR[a]	Ex Post Net
Energy Savings (MWh)					
Total MWh	5,089	99.2%	5,070	0.781	3,960
Demand Savings (MW)					
Total MW	1.053	97.2%	1.023	0.784	0.802
Therm Savings					
Total Therms	102,771	90.3%	92,833	0.900	83,550

[a] The energy and demand NTG values differ because of the specific measure mix and variation in measure-level savings within the program (e.g., the ECM measure does not contribute significant demand savings).

Overall program and measure-level realization rates for energy and demand were very close to 100%, and the measure level realization rates for therms ranged from 90.2% to 90.8%.

In terms of meeting energy savings targets, the HVAC program achieved 3,960 net MWh of energy savings, representing just over its 3,954 MWh target (100.2%), and 83,550 net therms savings, representing 535% of

its 15,603 therms target. Participation showed that a total of 5,083 measures were installed through the program, representing a 28% decrease over the PY8 total (7,016).

Key Findings

PY9 HVAC program participation was lower than expected. A bonus incentive was introduced for ASHP measures in January 2017 to encourage participation, and smart thermostat measures were added to the program in February 2017. These changes helped boost participation in these categories. However, ECM participation fell short of PY8 levels. The PY9 program also included the addition of a pool pump incentive in the last two months of the program year.

Overall, the program saw a smooth transition between PY8 and PY9, despite the arrival of new project managers at Leidos and CLEAResult. Program staff reported that consistent program processes and strong communication between all partners contributed to the smooth transition. Although most aspects of the program remained consistent with previous years, the program did add a technical review team to streamline the application review process and added additional fields for program allies to fill out on application forms.

Overall, the evaluation team determined that AIC, Leidos, and CLEAResult effectively implemented the HVAC program by making effective program changes, managing the budget, reacting to low participation (by adding bonus incentives and new measures as needed), and maintaining internal communication. The program also met MWh savings goals, and it exceeded therms goals, despite limited offerings.

The evaluation team offers the following key findings and recommendations for AIC's consideration. All key findings are based on PY9 evaluation activities, however Key Findings #3-6 were also presented in the PY8 evaluation report, which was published after the PY9 program had already launched.

- **Key Finding #1:** Program staff and contractors noted that there was not always a lot of lead time before program changes (particularly those that took place mid-year) such as the addition of the smart thermostat and pool pump incentives. Additionally, many contractors (6 of 14) indicated that they would like to see improved communication from AIC as a key way to improve the relationship between AIC and program allies. Several contractors also indicated that they would like presenters at program ally events to be more capable of answering their questions and concerns. Although program staff worked to provide as much time before program changes as possible (and gave grace time to allow for processing of existing projects before dropping the replace-on-burnout [RB] air source heat pump [ASHP] measure), contractors indicated that timely communication continues to be an area with room for improvement.
  - **Recommendation:** Improve communication with contractors by increasing outreach on possible upcoming program changes, and provide educational opportunities throughout the year to teach program allies how to sell the program.
  - **Recommendation:** Ensure that staff who run program ally events can answer technical questions, or train them where to direct complex questions on topics not covered at the training or event.
- **Key Finding #2:** Contractors' main criticism of the HVAC program focused on insufficient program measure offerings, with 8 of 14 less than satisfied with this aspect of the program. Contractors are most dissatisfied with this program aspect and reported additional measures would encourage customers to be more efficient.
  - **Recommendation:** Although AIC must consider issues of cost-effectiveness and getting the most energy savings per incentive dollar spent, engaged and satisfied contractors can support AIC's

overall program efforts. Cadmus suggests AIC consider how it can provide limited support for dropped measures or add new measures to the program to keep it interesting for contractors. For instance, consider providing small incentives to the contractors for selling high efficiency equipment, rather than rebates to consumers.

- **Key Finding #3:** The evaluation team identified multiple incidences of missing or incorrect information in the tracking database.
  - **Recommendation:** Add an additional step in the data entry process to compare the rebate forms to the AHRI database as an accuracy check. Also, ensure sufficient quality control in reviewing information entered into the tracking database to ensure consistent and accurate data is recorded. For smart thermostats, also collect the existing thermostat type (manual or programmable).
- **Key Finding #4:** The evaluation team found that while a measure in the IL-TRM V5.0 outlines savings for furnace blower motors, it does not account for the installation of an ECM along with a new ASHP. The team believes that savings from ECMs may overlap with savings from the installation of a new ASHP. The overlap occurs because the presence of an ECM is already accounted for in the efficiency ratings (SEER, EER, HSPF) of the new ASHP.
  - **Recommendation:** Provide ECM incentives only to those installations where a new ASHP has not been installed.
  - **Recommendation:** Consider further research to assess incremental ECM savings for use when being installed with a new ASHP.
- **Key Finding #5:** The evaluation team identified a number of DMSHPs entered in the PY9 tracking database. While this type of ASHP is not excluded based on the program requirements, it does require a different savings algorithm than is used for a traditional ASHP.
  - **Recommendation:** Ex ante savings estimates for DMSHPs should not use the ASHP approach from the IL-TRM V5.0, but rather the DMSHP algorithm from chapter 5.3.12 (in IL-TRM V5.0 or IL-TRM V6.0).
- **Key Finding #6:** The program tracking database is ambiguous about whether new ASHPs are installed into an existing system, with a gas furnace for backup heat, or as a separate standalone system in which the ASHP is the only heating unit. In cold climates, the backup system will turn on to provide heating when the ASHP is unable to meet the heating load of the home.
  - **Recommendation:** Add a flag to the tracking data that indicates whether ASHPs are installed in systems with fossil fuel backup heating equipment (such as a gas furnace or boiler).

2. Evaluation Approach

The evaluation of the PY9 Ameren Illinois Company (AIC) Heating and Cooling (HVAC) Program involved both process and impact assessments. The process evaluation included a basic review of program materials, interviews with program implementation staff, and program ally interviews. To conduct the impact evaluation, the team reviewed the tracking database and applied the Illinois Statewide Technical Reference Manual (IL-TRM) Version 5.0. For net impacts, the team applied net-to-gross ratios (NTGRs) agreed upon by the Illinois Stakeholder Advisory Group (SAG). The team also conducted a forward-looking metering study of two groups of heat pump participants: those with gas backup heat and those with electric resistance backup heat. The metering study final report was provided separately.

2.1 Research Objectives

For PY9, the evaluation team gathered and analyzed data to answer the following impact questions about the HVAC program:

- What were the program's estimated gross energy and demand impacts?
- What were the program's estimated net energy and demand impacts?

In addition, the team addressed the following process-related questions:

- Did the number of participants meet expectations? If not, how and why did it differ from expectations?
- Were contractors satisfied with the program in PY9? How do they feel about program changes?
- Did contractors and distributors observe a change in market shares of energy-efficient equipment during the time that the program has been offered?

In addition, the HVAC metering study (delivered in a separate report) answered the following forward-looking questions:

- What is the region's actual seasonal operating efficiency of participating multispeed CACs and heat pumps?
- How do energy-use patterns and energy consumption differ between ECM and non-ECM fans?

2.2 Evaluation Tasks

Table 2 summarizes the PY9 evaluation activities conducted for the HVAC program. We describe each activity in detail following the table.

Table 2. PY9 HVAC Program Evaluation Methods

Activity	PY9 Process	PY9 Impact	Forward Looking	Details
In-Depth Program Staff Interviews	✓		✓	Interviewed AIC and Leidos managers to understand goals, progress to date, program changes from PY8 to PY9, successes and challenges, and future goals.
Program Materials and Data Review		✓		Reviewed all program materials and the tracking database to ensure collection of appropriate data to inform the evaluation.
Trade Ally Interviews	✓			Interviewed program trade allies to collect feedback regarding the effect of program changes on trade ally engagement. Also collected nonparticipant spillover (NPSO) inputs from program-affiliated distributors.
Metering Studies			✓	Collected cooling and heating energy consumption for multispeed (or variable speed) central ASHPs and cooling energy consumption for variable speed CACs. Collected variable speed fan power and energy consumption. Also collected cooling energy consumption and fan power of minimum efficiency CACs with single-speed fans. These data aid in determining region-specific SEER, heating seasonal performance factor (HSPF), ECM fan energy savings, and peak demand impacts for central HVAC systems.

2.2.1 Program Staff Interviews

Interviews with key program staff sought to gain information about the program's design and implementation as well as processes and performance over the PY9 period. The evaluation team also inquired about data tracking, program changes, and contractor outreach related to the program. The team interviewed a representative of the AIC program team, the program administrator (Leidos), and the implementation subcontractor (CLEAResult).

Table 3. Staff Interviews Completed

	AIC Staff	Leidos Staff	CLEAResult Staff	Total
Interviews Completed	1	1	1	3
Date Completed	July 25, 2017	August 2, 2017	September 26, 2017	

2.2.2 Trade Ally Interviews

We gathered process and impact information from contractors and distributors who work with the program. Overall, we interviewed 14 contractors regarding their program experience, program impacts, and suggestions for improving the working relationship between AIC and program allies. We also reached out to local distributors to gather information to inform a non-participant spillover review (NPSO).

Table 4. Trade Ally Interviews Completed

	Contractors	Distributors	Total
Interviews Completed	14	1	15

Due to low response, the findings from the one distributor who was interviewed are not included in this report.

2.2.3 Review of Program Materials

To analyze the program processes and implementation, the evaluation team reviewed program materials for clarity, comprehensiveness, and (when appropriate) visual and messaging elements. Materials reviewed included the following:

- Program application forms
- Program marketing materials
- The PY9 implementation plan
- The residential marketing plan

The evaluation team also reviewed the program database to examine its completeness and to evaluate savings.

2.2.4 Metering Study

The findings from the metering study were provided separately.

2.2.5 Impact Analysis

Gross Impacts

For PY9, the evaluation team determined gross impacts by using the program tracking database and the appropriate savings algorithm (as specified in IL-TRM V5.0). The specific inputs and algorithms for each measure are outlined in Appendix B.

The IL-TRM recommends using different full-load hour (FLH) values in the energy savings algorithm for five different locations and includes two tables (IL-TRM V5.0 Tables 3.7 and 3.8) that list every county and its respective climate zone for heating and cooling degree-days. The tracking database includes an address and zip code for every measure installation, but does not include the county. To determine the heating and cooling climate zone for each measure reported, the evaluation team determined the Illinois County using the zip code in the tracking database. Applying Table 3.7 and Table 3.8 in the TRM, the team looked up the county's climate zone for every measure installation.

Air Source Heat Pumps

To determine savings for ASHPs, the evaluation team followed the algorithms outlined in the IL-TRM V5.0, with a couple of exceptions. For early replacement (ER) measures, the IL-TRM recommends using SEER and EER ratings of existing equipment when available, rather than simply using deemed values from the TRM. The tracking database includes SEER ratings of existing equipment but does not provide EER ratings. Wherever possible, the team calculated an existing EER value from the existing equipment's rated SEER value using the following algorithm:

$$EER = -0.02 \times SEER^2 + 1.12 \times SEER$$

The IL-TRM discusses this algorithm in the ASHP section, but the evaluation team extended its use to ductless mini-split heat pumps (DMSHPs). To be conservative, the team used the TRM-recommended value instead of the calculated value if the calculations produced an EER lower than the TRM-recommended value for a given measure.

The second exception occurred with DMSHPs. A small portion of measures rebated through the ASHP program channel actually were DMSHPs. Though this equipment is not a traditional ASHP, the evaluation team determined net and gross savings for these measures. The team evaluated gross savings for DMSHPs using the algorithms outlined in the IL-TRM V5.0 for DMSHPs, applying the following assumptions depending on the installation scenario:

- Units installed in homes without existing cooling systems did not receive cooling savings (this assumption is outlined in the IL-TRM).
- Units installed in homes with existing gas heating systems did not receive heating savings (the IL-TRM defines the baseline equipment as permanent electric resistance or ducted ASHP).
- The team applied a 0.761 NTGR for this measure (as the PY9 evaluation plan did not define an NTGR for this measure, the team used an NTGR for ASHP measures; these measures are similar in terms of equipment replaced and efficiency of the newly installed equipment).

Electronically Commutated Motors

Although IL-TRM V5.0 includes savings estimates for ECMs, the IL-TRM savings are based on a different set of installation conditions than were required by the program. The savings outlined in IL-TRM V5.0 are intended for the installation of a new furnace with an ECM in place of a new furnace with a lower efficiency motor. Further, the IL-TRM assumes that the home's primary heat source is a gas furnace and that there are no other changes to the home's HVAC system, such as the installation of a new ASHP. The evaluation team found six ECMs rebated through the program that were installed in conjunction with a new ASHP and did not fit the IL-TRM ECM protocol.

As a result, the evaluation team did not assign ECM savings strictly as outlined in the IL-TRM. If the new ECM was installed with no other changes to the home's existing HVAC system, the ECM was eligible for all savings, as outlined in the IL-TRM. For instances in which the new ECM was installed in conjunction with a new ASHP, the team evaluated full savings for the ASHP installation, but limited ECM savings to include only savings from the shoulder seasons, because the heating and cooling savings were already accounted for in the ASHP efficiency.

Programmable and Smart Thermostats

The evaluation team followed the algorithms outlined in the IL-TRM V5.0 using heating system fuel and household type (single or multifamily) information from the tracking database. The tracking database did not include the existing thermostat type, so savings calculations for smart thermostats use the IL-TRM's blended average heating reduction percentage for an unknown existing thermostat type. By definition, programmable thermostats use a manual thermostat baseline.

Pool Pumps

The IL-TRM V5.0 does not have a section that covers savings calculations for high-efficiency pool pumps. However, this measure was added for V6.0 of the IL-TRM, so the evaluation team used this new methodology to estimate ex ante savings.

Net Impacts

The evaluation team applied NTGRs approved by SAG to PY9 program savings. Table 5 summarizes the NTGRs used in the net impact analysis. Applying the NTGRs to the measures listed below resulted in an overall savings-weighted PY9 HVAC NTGR of 76.4% for kWh, 77.9% for kW, and 101.9% for therms.

Table 5. SAG-Approved PY9 NTGRs

Measure Type	NTGR
ASHP	76.1%
Pool Pump	80.0%
ECM	76.1%
Thermostat	90.0%

2.3 Sources and Mitigation of Error

Table 6 provides a summary of possible sources of error associated with data collection conducted for the HVAC program. Detailed discussions follow for each item.

Table 6. Possible Sources of Error

Research Task	Survey Error		Non-Survey Error
	Sampling Error	Non-Sampling Error	
Program Staff Interviews	N/A, census attempt	Non-response and self-selection bias Data processing error	N/A
Trade Ally Interviews/Surveys	Yes	Non-response and self-selection bias Data processing error	N/A
Gross Impact Calculations	N/A	N/A	Analysis Error
Net Impact Calculations	N/A	N/A	Analysis Error

The evaluation team took steps to mitigate against potential sources of error throughout the planning and implementation of the PY9 evaluation.

2.3.1 Survey Error for Program Staff / Trade Ally Interviews

- **Sampling Error:** The team contacted representatives from all three program staff organizations managing the program. For the trade allies, the team utilized the entire sample provided to ensure that all trade ally contractors had a chance to participate.
- **Non-Sampling Error**
  - **Non-response and self-selection bias:** The team sought to balance bias by interviewing AIC staff, the program administrator, and the program implementer. To further minimize bias, the team compared interview feedback to program results in the database, along with information drawn from the previous years' evaluations. For trade allies, we attempted to control non-response and self-selection error by offering an incentive, sending reminders to the whole sample, and scheduling calls with flexibility to encourage participation from the whole sample.

- **Data processing error:** We had one staff member conduct the interviews for each group (staff and contractors) in order to make sure the person recording data was both familiar with the guide and to have consistency in recording response. This way, questions were asked the same way. The team also compared responses to other sources of information.

2.3.2 Non-Survey Error

- Analysis Errors
  - **Gross Impact Calculations:** To minimize data processing errors and to verify computation accuracy, the evaluation team had all calculations reviewed by a team member who did not perform the original calculations.
  - **Net Impact Calculations:** To estimate the program's net impacts, the team applied deemed NTGRs to the gross impact calculations. For prospective NTG research, the team followed free-ridership and spillover calculation methods provided in the IL-TRM V5.0. These methods have been designed to help evaluators understand the program's influence on builders to achieve program efficiency levels for homes within and outside the program.

3. Detailed Evaluation Findings

3.1 Program Description

In June 2009, AIC began offering HVAC incentives. Over the years, AIC has modified the program offerings and incentive levels in response to changes in federal standards for equipment efficiency and cost-effectiveness analysis. CLEAResult (operating as CSG until 2015) has implemented the program since 2009. In PY7, Leidos became the program administrator, with CLEAResult working as the implementation subcontractor. Under the guidance of AIC, these implementation partners worked to design, market, and implement the program; recruit, support, and train contractors; and track and report program progress.

During the PY9 program year, the HVAC program offered incentives for high-efficiency ASHP's, ECMs, thermostats (programmable and smart), and pool pumps.[1] Program requirements included sizing specifications, efficiency standards, and other features (e.g., a matching indoor and outdoor coil requirement for new air conditioning equipment).

Since PY4, AIC has not changed the incentive design and has passed the incentive through registered trade allies as direct discounts for residential customers. The incentive appears as a line-item deduction on contractors' installation invoices. Measures could be installed to replace working units or as a standard replace-on-burnout (RB) project. By offering these incentives, AIC sought to persuade customers to purchase higher-efficiency equipment than they might install otherwise.

To be considered early replacement (ER), a unit being replaced had to be verifiably operable and rated SEER 10 or less. Through this offering, the program encouraged customers to retire existing inefficient equipment for newer, more-efficient units. As shown in Table 7, the central air conditioner (CAC) measures for PY9 were eliminated for both standard RB and ER tiers, while a new option was added to replace existing and verifiably working CAC equipment with ASHP units rated SEER 16+ for homes with electric resistance heating.

Table 7. Changes in Incentive Levels from PY3 to PY9

Measure	Details	PY3	PY4	PY5/ PY6	PY7	PY8	PY9	PY8-PY9 Change
Air-Source Heat Pumps								
ASHP SEER 14.5–14.9	New efficient equipment replacing > SEER 10	$110	$150	$150	Not Offered	Not Offered	Not Offered	N/A
	ERa of SEER 10 or less	$400	$400	$450	Not Offered	Not Offered	Not Offered	N/A
ASHP SEER 15.0–15.9b (No 15.0 baseline in PY4)	New efficient equipment replacing > SEER 10	$110	$150	$200	Not Offered	Not Offered	Not Offered	N/A
	ER of SEER 10 or less	$400	$400	$500	Not Offered	Not Offered	Not Offered	N/A

[1] Smart thermostats and pool pumps were not part of the original offerings, but were added to the measure mix during the program year.

Measure	Details	PY3	PY4	PY5/ PY6	PY7	PY8	PY9	PY8-PY9 Change
ASHP SEER 16+	New efficient equipment replacing > SEER 10	$200	$200	$300	$200	$300	$300	$0
	ER of SEER 10 or less	$600	$600	$600	$500	$600	$600	$0
	ER CAC w/ ASHP for electric- resistance heat source home	Not Offered	Not Offered	Not Offered	Not Offered	Not Offered	$1,200	$1,200
Central Air Conditioners								
CAC SEER 14.5–14.9	New efficient equipment replacing > SEER 10	$100	$100	$150	$100	$50	Not Offered	-$50
	ER of SEER 10 or less	$250	$250	$450	$400	$200	Not Offered	-$200
CAC SEER 15.0–15.9	New efficient equipment replacing > SEER 10	$100	$100	$200	$150	$75	Not Offered	-$75
	ER of SEER 10 or less	$250	$250	$500	$450	$250	Not Offered	-$250
CAC SEER 16+	New efficient equipment replacing > SEER 10	$125	$125	$300	$200	$100	Not Offered	-$100
	ER of SEER 10 or less	$350	$350	$600	$500	$300	Not Offered	-$300
Electronically Commutated Motors								
Brushless ECM Furnace	New furnace equipped w/brushless DC motor	Not Offered	Not Offered	$80	$200	$100	$150	$50
Other Measures								
Programmable Thermostats	Replacing a manual thermostat	Not Offered	Not Offered	Not Offered	Not Offered	Not Offered	$25	$25
Smart Thermostats	Replacing a manual or programmable thermostat	Not Offered	Not Offered	Not Offered	Not Offered	Not Offered	$100	$100
Pool Pumps	ENERGY STAR® certified variable speed pump replacing single speed pump	Not Offered	Not Offered	Not Offered	Not Offered	Not Offered	$400	$400

a Early replacement
b All CAC incentives were removed and incentive request forms updated in February 2016.

Program managers marketed the program to customers through fliers, bill inserts, case studies, and direct mailings, along with some digital and social media advertising (Facebook ads, display ads, and Twitter). Program trade allies also drove the marketing efforts through word-of-mouth and distribution of program overview fliers. Additionally, CLEAResult provided training seminars for registered program allies. These

seminars focused on program processes and changes (e.g., reviewing application forms and explaining which products are available) and measures offered through the program.

3.2 Process Findings

3.2.1 Program Implementation

Over PY9, program staff reported that program processes were effective, despite several mid-year changes, which included changes to the measures offered and a new CLEAResult program manager, who came on board in December 2016. Despite this, data processing, rebate form review, and reporting all went smoothly. Rebate forms were updated slightly to include gathering of information on existing equipment in the homes (for details that had to be entered into the database). For self-install measures (i.e., the addition of thermostats), rebates went smoothly, with a simple, one-page application and rebate submitted directly to the customer.

The rebate application review process was updated in August 2016 with the addition of a technical review team that reviewed all applications for completion and customer eligibility. This streamlined and centralized the process, and helped to reduce risk.

Program staff reported that the partnership between Leidos and CLEAResult was a great working relationship, and that each partner successfully handled its roles and responsibilities in delivering the program.

Marketing for PY9

The marketing team for the HVAC program distributed the following materials to raise awareness of the program in PY9:

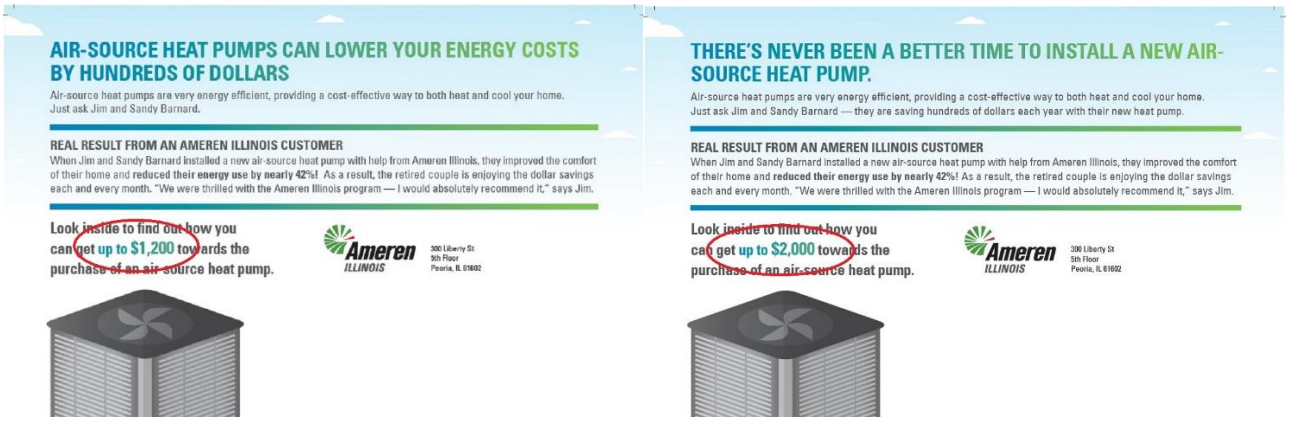
- In May of 2016, an overview flier of the heating and cooling program;
- In June 2016, a flier of the smart and programmable thermostat rebates;
- In October 2016, an ASHP direct mail postcard;
- In February 2017, a second ASHP direct mail postcard; and
- In April 2017, a smart thermostat bill insert.

The overview program flier was similar to the PY8 program overview flier and included information on eligibility, benefits of participation, the steps involved, and the website address. To improve understanding by the layperson, it included shorter definitions of SEER and HSPF with simpler language than those in the PY8 flier. The covered measures included ASHPs and ECMs only.

The second flier, which covered the programmable and smart thermostats, was more concise. Because it covered two measures that had fewer eligibility requirements, it did not include as much information, but it did include the rebate amounts, where to get the rebate forms, and the differences between thermostat types.

Because rebates for ASHP measures were increased in early 2017 to boost participation in that measure (see the Program Changes section below for details), a second ASHP program flier was distributed with an updated incentive value to reflect the bonus offering, as shown in Figure 1.

Figure 1. Air-Source Heat Pump Fliers (October and February PY9)



These fliers included information on the equipment offered, maximum incentive available, program e-mail and phone contact information, and a brief testimonial.

The smart thermostat bill insert was much more graphically eye-catching than the flier, and it focused specifically on smart thermostats. Although it included the AIC logo on the second side, only ActOnEnergy.com was identified on the front as the incentive provider. The other information provided (i.e., benefits to participation and incentive amount) were consistent with the program flier in June 2016.

Data Tracking

In PY9, CLEAResult was responsible for inputting all data directly into Leidos' AMPLIFY system, to which all three partners have access. This was an improvement over PY8, when CLEAResult had to input data into its own system, which was then uploaded to AMPLIFY. PY9 was the first year that the subcontractor had direct access to APMLIFY. CLEAResult noted that this allowed everyone to see the same data at any given time, to build reports, and to get up-to-date information.

Program Changes

There were several changes to program processes and to the program measures mix (and incentive levels) for and during PY9:

- At the beginning of PY9, all CAC measures were dropped, although a programmable thermostat was added to the measure mix.
- The standard RB ASHP measure was dropped from the program in August 2016.
- A smart thermostat incentive was added in February 2017.
- A pool pump incentive was added in May 2017. (Language was added to website in April, but the first rebates were accepted in May).

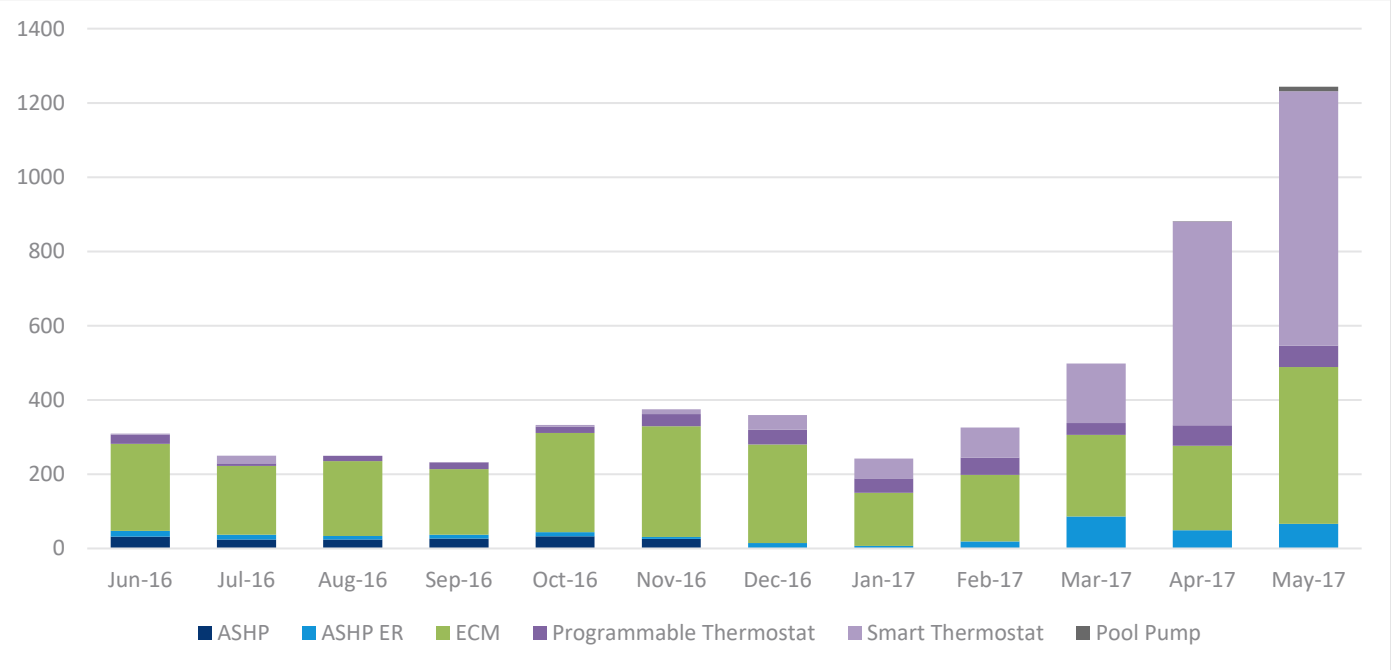
Due to low participation in the ECM and ASHP measures (due in part to a mild winter), in January 2017 the program decided to offer bonus incentives to increase participation and get the program back on track to meet goals. As shown in Table 8, this doubled or nearly doubled incentive levels.

Table 8. Mid-Year Incentive Changes in PY9

Measure	Original Incentive	Bonus Incentive
ECM	$150	$300
ASHP (ER)	$600	$1,200
ASHP (ER, electric resistance)	$1,200	$2,000

As shown in Figure 2, these bonus incentives resulted in higher ASHP ER measure installations, particularly in March, April, and May of 2017. Although ECM installations remained fairly consistent, the inclusion of smart thermostats was a notable boost to the program, with hundreds installed in the last three months of the program year. The introduction of smart thermostats also boosted therm savings far beyond the PY9 therm savings goal.

Figure 2. Monthly Participation for PY9 Measures



Changes to program processes included increasing the frequency in which reimbursements were sent out to program allies (weekly instead of twice a month) and the addition of a technical review team. This team provided additional quality control by reviewing all applications before they were paid to confirm eligibility and to watch for any red flags.

3.2.2 Program Participation

In PY9, the program measure mix was very limited, particularly at the beginning of the year, as shown in Table 9. The loss of CAC measures heavily impacted overall participation numbers. Low participation in remaining measures was boosted mid-year in the PY9 cycle due to increases in incentives mid-year. Overall, 5,083 measures were installed in PY9 to 4,889 unique participants. Program staff reported that, taking into account the limited measures offered in PY9, participation levels met their expectations.

The large drop in participation in CAC/ASHP measures is due to CAC measures being removed from the HVAC program in PY9. (In PY8, CAC measures were offered for part of the year, and they accounted for approximately 90% of unique customers in that category.) As shown in Table 9, unique participants in ASHP measures increased in PY9.

Table 9. Program Participation (Unique Participants) PY5 to PY9

Measure Type	Program Participation (N) PY5	Program Participation (N) PY6	Program Participation (N) PY7	Program Participation (N) PY8	Program Participation (N) PY9	Percent Change (PY8-PY9)
CAC	4,408	6,547	3,303	2,939	0	N/A
ASHPs				361	429	+19%
ECM Fans	1,943	4,149	2,765	3,684	2,626	-29%
Thermostats	N/A	N/A	N/A	N/A	1,821	N/A
Pool Pumps	N/A	N/A	N/A	N/A	13	N/A
Total	**6,351**	**10,696**	**6,068**	**7,024**	**4,889**	**-30%**

Overall in PY9, 5,083 measures were installed through the HVAC program to the 4,889 participants. This included 2,630 ECMs, 348 programmable thermostats, 1,662 smart thermostats, and 13 pool pumps. For ASHP, 430 measures were installed. Table 10 outlines the characteristics of the ASHP measures installed in PY9.

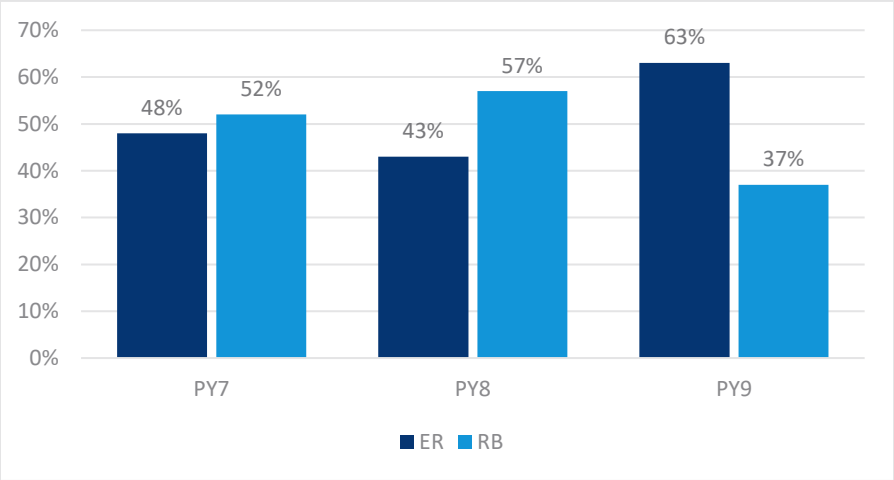
Table 10. PY9 Air-Source Heat Pump Equipment Characteristics [a]

Measure Type	Count of Reported Measures	Average SEER	Average EER	Average HSPF
ASHP 16+ SEER	141	17.9	12.8	9.7
ASHP ER 16+ SEER - Replaces ASHP	55	16.7	12.4	9.3
ASHP ER 16+ SEER - Replaces Resistance	234	16.4	12.7	9.2

[a] Averages calculated as mean values of installed measures from the database.

PY9 also saw an increase in customers taking advantage of the early replacement incentives, with well over half of incentivized ASHP measures being for ER installations (see Figure 3). This was a notable increase over both PY7 and PY8, when less than half of installed ASHP measures were for ER. This was likely affected by the removal of the standard RB incentive in August of 2016.

Figure 3. ER vs RB for ASHP Measures (PY7-PY9)

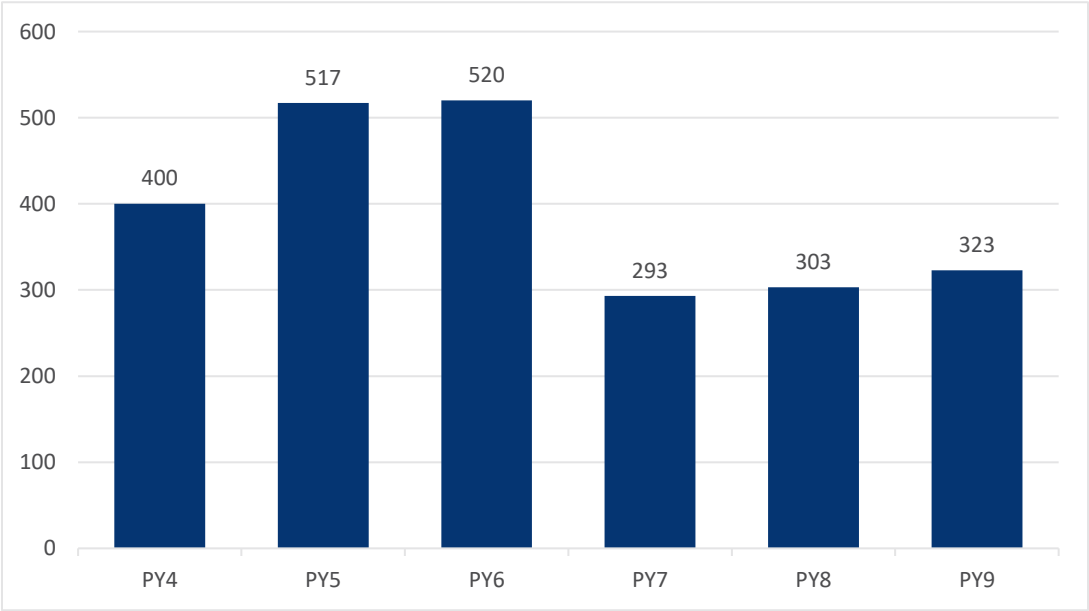


3.2.3 HVAC Program Contractors in PY9

Program implementation staff confirmed that the overall requirements to become a trade ally in PY9 remained the same as PY8. To be considered an active registered program ally, a contractor must have submitted a rebate form within 12 months and must have attended the program ally training at the beginning of the program year.

Contractors have been a key part of the HVAC program since the program design reached its current form in PY4. Since then, the number of contractors registered as program allies has fluctuated, with a peak in PY6 of 520 active registered contractors (see Figure 4). According to program staff, the PY9 participation of 323 active registered contractors was satisfactory and sufficient to drive the program.

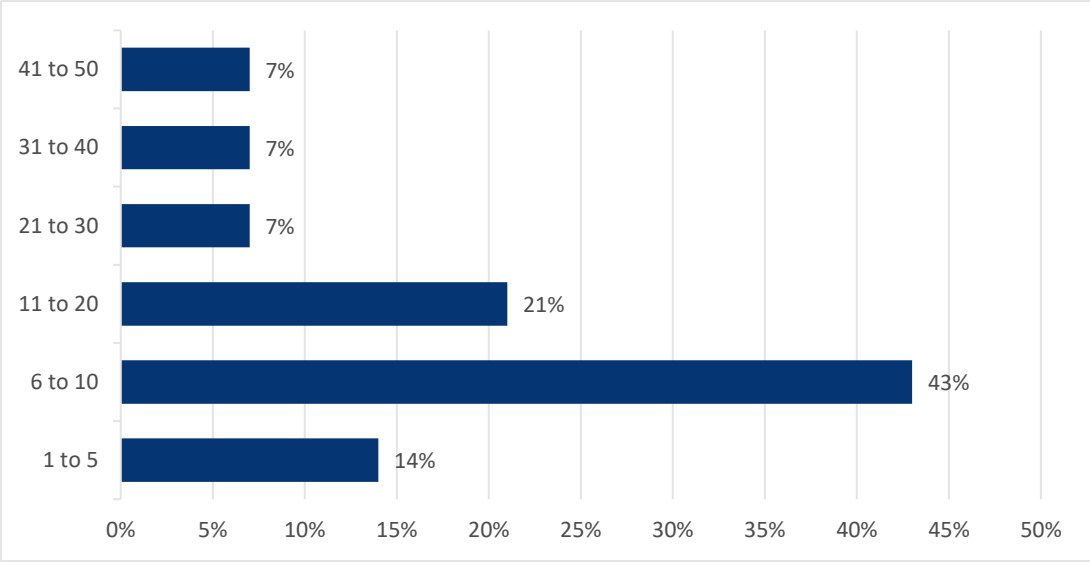
Figure 4. Registered Active Contractors From PY4 to PY9



When asked how long they had worked with the HVAC program, the majority of contractors (10) responded that they have worked with the program since the beginning (2009). One respondent had worked with the program for six years, two for two years, and one more had been active for approximately one year.

Of the respondents interviewed, the average number of employees at their company was 16, despite more than half of companies employing 10 or fewer staff (see Figure 5). Six companies had at least one staff member certified by the Building Performance Institute, and one company reported 25 BPI certified employees.

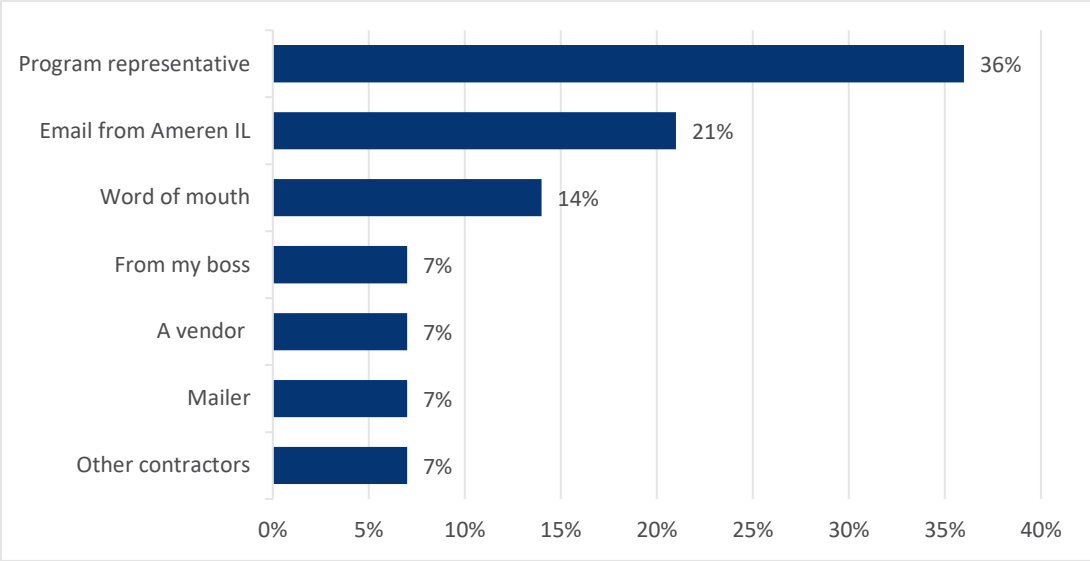
Figure 5. Number of Employees at Contractors' Companies (n=14)



Program Awareness

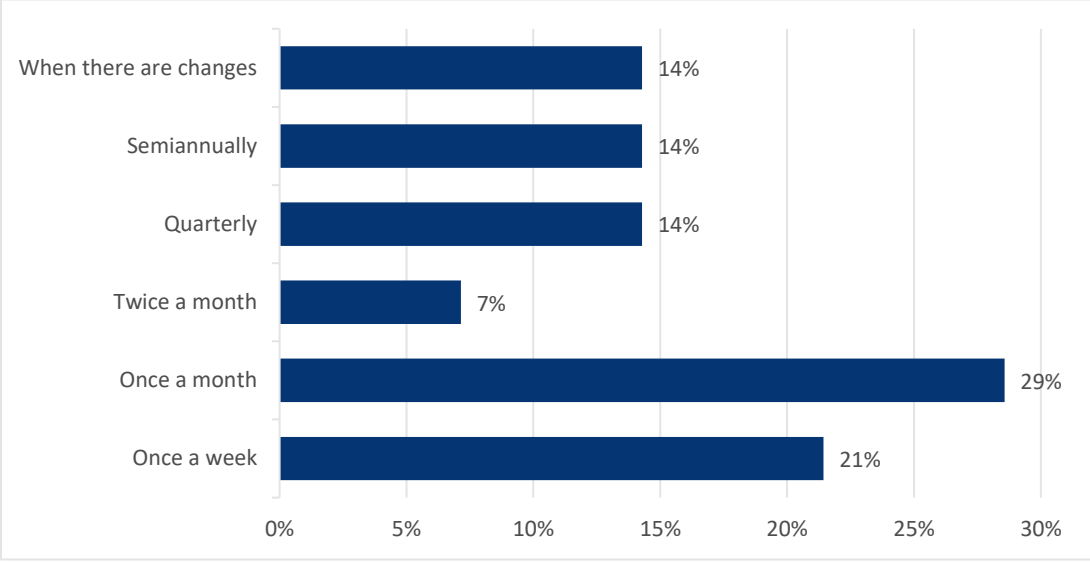
Five contractors reported they first heard about the AIC rebates from a program representative. As shown in Figure 6, contractors also heard about the program offerings through an e-mail from AIC or via word-of-mouth.

Figure 6. How Did Contractors First Hear About the Rebates Offered by AIC? (n=14)



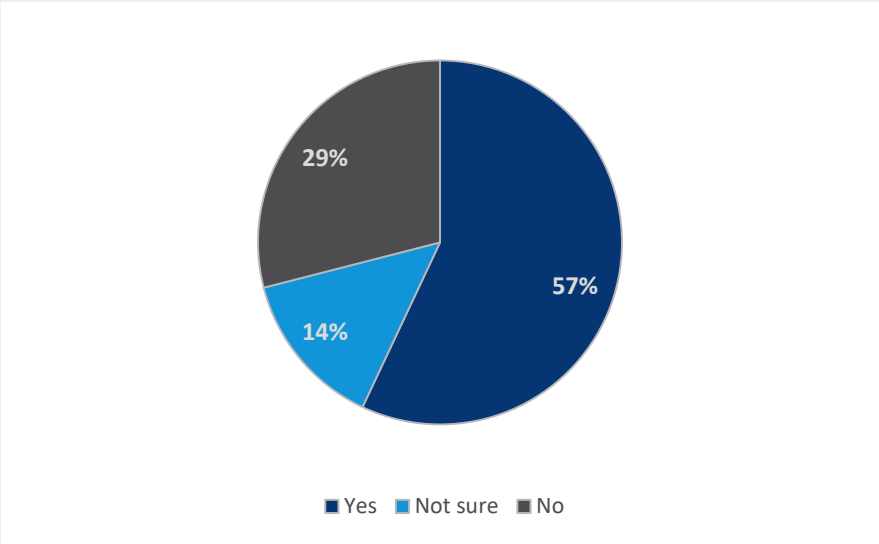
Half of the contractors (see Figure 7) reported that they received communication from program staff at least once a month. Two reported getting communication from the program twice a year. An additional two reported that they only received communication when the program reached out regarding program changes. Since all active contractors should have received the same communication, the differences here are likely influenced by recall or the quality of information provided.

Figure 7. How Often Do You Receive Communication from AIC or CLEAResult About the Program? (n= 14)



Overall, just over half of contractors reported that AIC does a good job of reaching out to contractors to recruit program allies or communicate changes (see Figure 8). However, six were either not sure or felt that AIC did not do a sufficient job of communication with contractors.

Figure 8. Does AIC Do a Good Job of Reaching Out to Contractors? (n=14)



Training Provided

AIC (through CLEAResult) provides training sessions to registered active program allies. Over the years, these sessions have included training on equipment offered, selling high-efficiency equipment, and completion of rebate forms. Of the responding contractors, more than half (8 of 14) had received training from CLEAResult. Of those contractors, 5 (out of 7) had attended within the year.

When asked to rate their satisfaction with training sessions they had attended, six (n=8) contractors were very satisfied; the remaining two reported being only somewhat satisfied with the training. When asked what aspect had been most useful to them, two respondents cited the opportunity to communicate with program staff. Contractors also appreciated training topics that helped them understand the changing paperwork requirements, and topics that helped them attain certification.

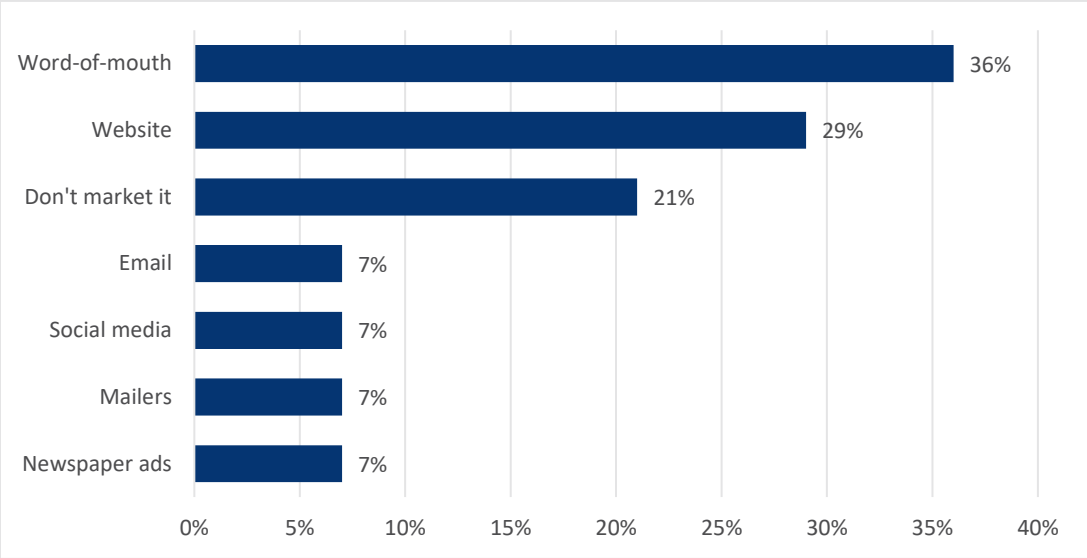
Two contractors also offered suggestions on what could be done to improve future training. Suggestions included making sure the trainers can answer the questions asked by contractors, and assuring that the sessions are relevant to what the contractors are able to offer customers.

Marketing

According to program staff, the HVAC program provides contractors with program overview fliers that cover multiple AIC programs. When asked if they had received any marketing materials from AIC to help them promote the HVAC program, 10 (n=14) of contractors said they had received materials. Of those who had received materials (n=10), four had found the materials very useful, three found them somewhat useful, and three found them to be not useful at all.

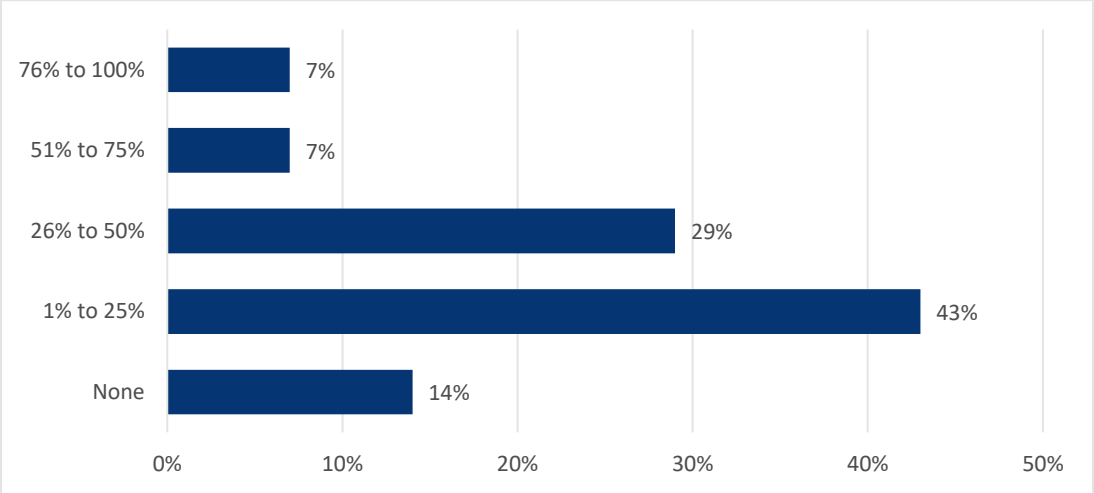
When asked how they market the program to their customers, contractors most often reported that they discussed it with their customers in person (five). As shown in Figure 9, more than a quarter included information about the program on their website (four), while three (21%) responded that they did not do anything to market the program and relied solely upon AIC marketing efforts to inform their customers about the incentives.

Figure 9. How Contractors Market the HVAC Program (n=14)



When asked how many of their customers had been previously aware of the program, most contractors responded that 50% or fewer of their customers were previously aware (see Figure 10). Only two respondents reported that more than half of their customers were aware of the incentives prior to the contractors providing them with that information.

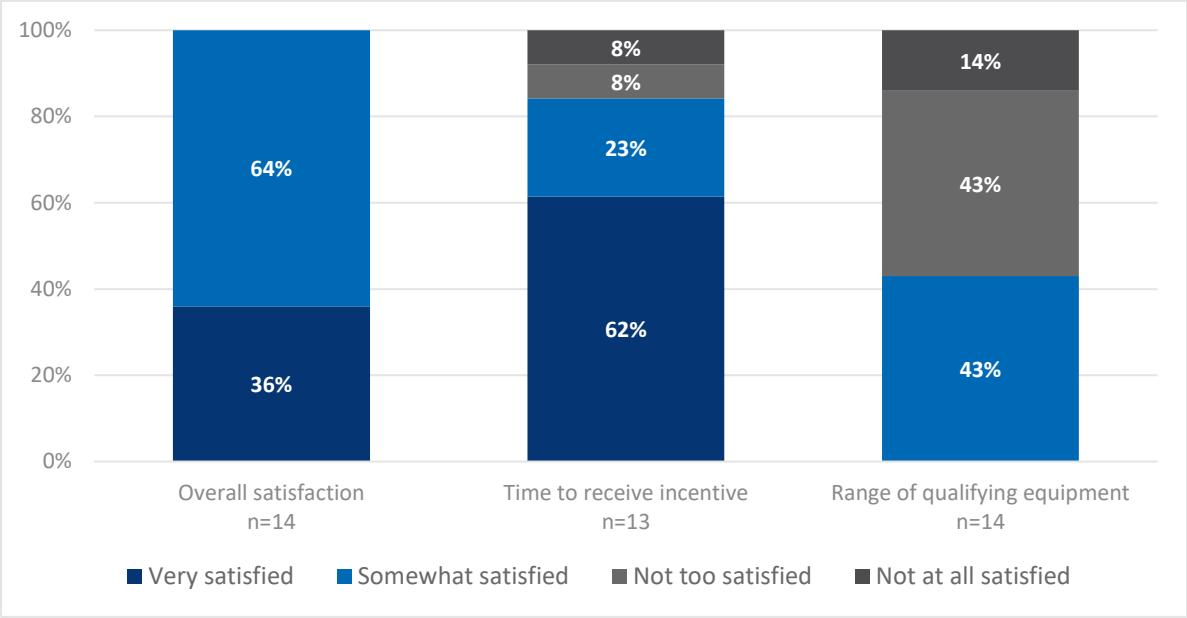
Figure 10. Percent of Contractors' Customers Aware of HVAC Program Incentives (n=14)



Satisfaction

All contractors reported being at least somewhat satisfied with the program overall (see Figure 11). Of the program aspects reviewed, contractors were least satisfied with the range of qualifying equipment, with more than half (eight) being less than satisfied, and two being not at all satisfied. Contractors reported much higher satisfaction with the time it took to receive the rebates, with well over half (eight) reporting that they were very satisfied.

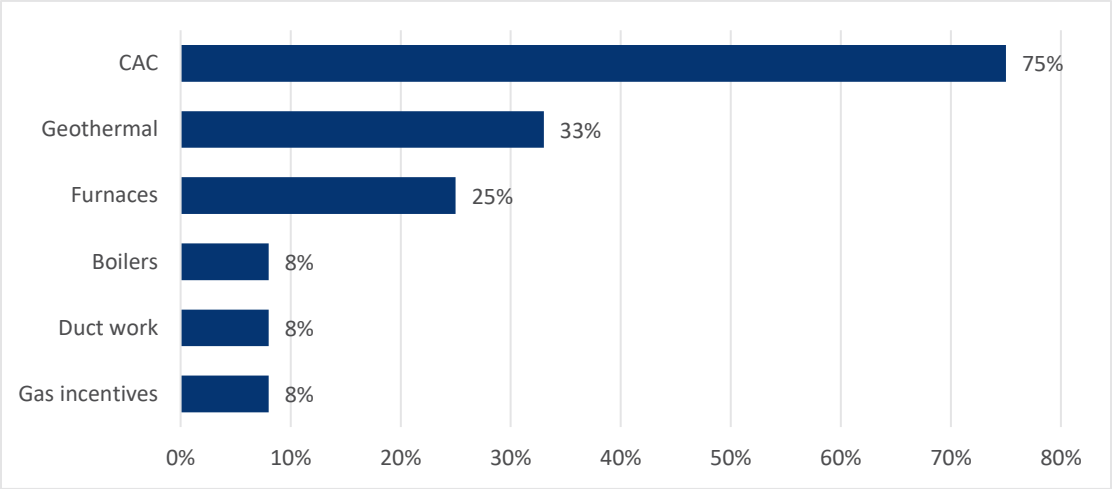
Figure 11. Contractor Satisfaction with the HVAC Program



As noted by program staff, efforts were made in PY9 to update the frequency of reimbursements to program allies—from twice a month to weekly—to help contractors maintain cash flows. However, most contractors reported that they received reimbursements within a month (11, n=14), and no contractors reported receiving reimbursements within a week.

The evaluation team investigated the low satisfaction with the range of qualifying equipment. Because many contractors had participated in the program for several years, most of them noted that program allies in prior years were able to provide incentives for a wider range of equipment—including CAC measures, gas measures, and geothermal heat pumps. Some contractors also noted that the range of efficiencies has been reduced and that the HVAC program simply doesn't offer much compared to the past. When asked what additional high-efficiency equipment they felt the program should include, three-quarters of contractors agreed that CAC measures should be reintroduced (see Figure 12), one third recommended geothermal heat pump incentives, and a quarter wanted furnaces to be incentivized.

Figure 12. Equipment Contractors Would Like to Include in the HVAC Program (n=12, r=19)



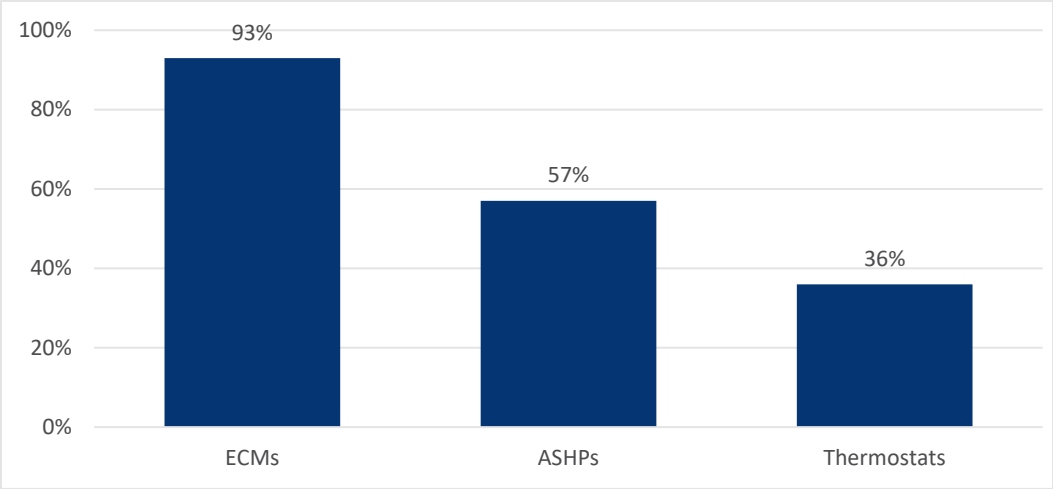
Due to the changes (both between and within program years) over the past few years, the evaluation team asked contractors if they felt that AIC had been proactive in educating contractors about program changes over the years. Most (11, n=14) contractors indicated AIC was proactive in this regard. When asked how the communication of program changes could be improved, several contractors commented that they would like to understand the reason for the program changes and be included in the conversation. Others responded that they would like more notice before the changes took effect. However, more than half (8, n=14) agreed that AIC communicated effectively to help them navigate program changes when they occur, while six responded negatively or said that they were not sure.

When asked what AIC could do to improve the program overall, contractor concerns about limited equipment offerings continued to be a focus. Every contractor recommended increasing the measures offered or being clearer about eligibility requirements and what AIC needs from contractors (on application forms).

Equipment Sales Activity

The evaluation team also asked contractors to discuss their sales within the AIC service territory. As shown in Figure 13, all but one contractor installed ECMs, eight installed ASHPs, and five installed thermostats. Overall, five said that they sold all three measure types.

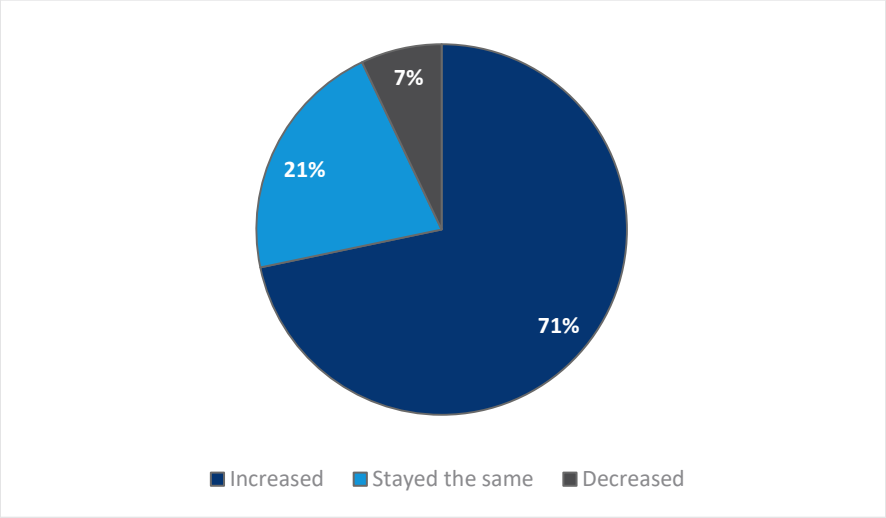
Figure 13. Equipment Contractors Install Through the HVAC Program (n=14)



When asked if they believed that the HVAC program had contributed to market transformation in their service territory (focusing specifically on equipment efficiency decision-making), 12 (n=14) said that they did. Comments from contractors on how the program contributed to market transformation included that it helped by increasing customer awareness, and then it made it easier for customers to upgrade to more efficient equipment. However, several contractors also noted that decreased incentive values and the loss of gas measures have reduced the impact of the program more recently – two specifically said the program was initially important in creating market transformation, but now it does not have much impact of purchase decisions compared to other factors.

More than half of contractors noted that they had seen an increase in the availability of 16+ SEER equipment in the AIC service territory in the last five years. Everyone who responded that availability had increased (n=10) said that the HVAC program was either very (4) or somewhat (6) important in driving that increase.

Figure 14. Availability of High Efficiency (16+ SEER) Equipment in AIC Service Territory (n=14)



Contractors also discussed equipment they recommend to their customers that are not incentivized by AIC. One contractor was under the (mistaken) impression that the HVAC program only offered heat pumps and was unaware that thermostats were incentivized. Other measures identified by contractors included CAC measures, geothermal heat pumps, boilers, and furnaces (recommended previously in Figure 12 as those measures that respondents would like to see added to the program). All the measures discussed were those previously offered by the HVAC program, but which were not included in the incentivized measures for PY9.

When asked what suggestions contractors had for AIC on how best to work with contractors going forward, eight of the 10 respondents mentioned communication. Comments included requests for better communication, advanced notice on changes to the program, being kept in the loop, and more opportunities to meet in person (trade ally meetings or on-site presentations). One contractor complained that the lack of advance notice on incentive changes proved costly because he felt compelled to pay several customers out of pocket so that they could follow through on promised price reductions. While program staff noted that they continued to offer incentives for projects already in the pipeline when changes were announced, for this contractor the grace period was insufficient. Other recommendations included working with contractors to revise incentive request forms and education from AIC on how to explain the program to customers.

Customer Barriers

The evaluation team asked contractors what they thought the main challenges were to customers when deciding whether to purchase high-efficiency HVAC equipment. Nearly all (93%, n=14) said that the initial cost was the most common barrier. Other factors included uncertainty about how long customers planned to be in the home (14%), payback periods (7%), and time investment (7%).

When asked what AIC could do to help customers be more efficient, suggestions included expanding incentive offerings, increasing the amount of incentives, improving customer education, and offering whole-home solutions.

3.3 Impact Assessment

3.3.1 Gross Impacts

The evaluation team used tracking data and algorithms in the IL-TRM V5.0 (V6.0 for pool pumps) to determine gross savings for the HVAC program. Detailed tracking information in the program database included data on unit type, size, efficiency, and measure installation locations. These served as inputs to savings algorithms in the IL-TRM V5.0. The evaluation team's review of the HVAC program tracking data indicated that the majority of claimed measures (approximately 99%) included the information necessary for calculating savings. The proper heating and cooling zones for approximately 0.2% of households could not be determined due to insufficient information available in the tracking data regarding measure installation locations and because approximately 1% of ASHP measures were lacking new AHRI EER values. The team applied a weighted average statewide value to the 0.2% of measures with insufficient location information, and it applied measure-level average values to the 1% of ASHPs with insufficient project information.

The evaluation team reported ex ante savings by summarizing data from the tracking database, while gross ex post savings were calculated in two steps. First, the team calculated ex post savings for every installed measure in the tracking database, in accordance with the IL-TRM V5.0 and with additional assumptions as appropriate. Second, the team developed and applied savings corrections to the gross savings. The savings corrections are an adjustment to the gross savings that take into account discrepancies between the information recorded in the tracking database and the actual equipment characteristics as found in the AHRI

database. The evaluation team believes that applying these corrections resulted in more appropriate ex post savings, reflecting the actual characteristics of the installed equipment.

Using a proprietary web-scraping tool, the team attempted to query the 196 unique ASHP AHRI numbers recorded in the program tracking data in an effort to verify the recorded equipment characteristics, but could find only 120 (73%) unique AHRI numbers in the AHRI database. However, due to multiple instances of the same AHRI number appearing in the dataset, the team matched approximately 84% of all program equipment. Characteristics for the remaining 16% of program equipment could not be verified using the AHRI database because the recorded AHRI number was not found in the AHRI database, either due to an incorrect AHRI number being recorded, a piece of equipment being mischaracterized, or the discontinuation of the equipment by the manufacturer.

While checking the AHRI database for program AHRI numbers reported in the tracking database, the team scraped equipment characteristic information (e.g., capacity and efficiency values) for all numbers successfully queried against the database. The team compared AHRI values against reported equipment characteristics. Looking only at equipment with an AHRI number matched to the AHRI database, the team determined that, on average, equipment characteristics in the tracking data slightly overestimated potential savings. Table 11 shows the savings correction factors.

Table 11. Gross Savings Correction Factors (SCFs)

Measure Type	Ex Post		
	Cooling kWh SCF	Cooling kW SCF	Heating kWh SCF
ASHP	0.990	0.971	1.000
ASHP ER	0.995	0.991	1.011
Ductless	1.000	1.000	0.997

A savings correction factor value greater than one indicates that gross savings increased, while a value of less than one indicates gross savings adjusted downward.

Table 12 shows annual ex ante and ex post energy savings, demand savings, and realization rates for RB ASHPs, ER ASHPs, pool pumps, ECM furnace fans, and thermostat measure categories. The table includes a line item for DMSHPs identified during the tracking data review. Measure-level energy realization rates varied from 86.7% to 116.6%, resulting in a program gross realization rate of 99.6%. Measure-level demand savings realization rates varied from 86.6% to 100.4%, and the overall gross demand realization rate was 97.2%.

Table 12. Measure Level Gross Ex Ante and Ex Post Energy Savings (kWh) and Gross Realization Rates by Measure Type

Measure	Ex Ante		Ex Post		Annual Gross Realization Rate[a]	
	Annual Gross Savings		Annual Gross Savings			
	kWh	kW	kWh	kW	kWh	kW
ASHP	132,128	11.14	133,816	11.05	101.3%	99.2%
ASHP ER	2,197,171	233.34	2,165,586	202.01	98.6%	86.6%
Pool Pump	21,425	16.99	24,981	16.52	116.6%	97.2%
ECM	1,909,787	621.50	1,909,106	623.96	100.0%	100.4%
Programmable Thermostat	53,797	N/A	46,621	N/A	86.7%	N/A
Smart Thermostat	667,987	162.48	678,539	163.17	101.6%	100.4%
DMSHPs	107,126	7.15	111,739	6.56	104.3%	91.8%
Total	**5,089,421**	**1,053**	**5,070,389**	**1,023**	**99.6%**	**97.2%**

[a] Gross realization rate = ex post gross savings ÷ ex ante gross savings. The evaluation team calculated the realization rate before rounding ex post and ex ante values.

The ASHP ER measure was the single largest measure category in PY9, accounting for approximately 43% of the program's ex ante savings, and similarly had the largest impact on the program realization rate. With the addition of standard ASHP's 3%, 46% of program ex ante savings is attributed to heat pumps. Realization rates for ASHPs range from 58% to 142%. Smaller discrepancies (typical realization rates of 92% to 108%) arose due to some combination of baseline SEER (TRM assumption vs. actual) and the single family/multifamily household designation. Where realization rates exceed 108% or fell below 92%, the tracking data showed existing unit efficiencies below the IL-TRM baseline and/or the climate zone did not match, resulting in a large increase or decrease in full load hours.

The DMSHP measure accounts for a very small proportion of overall ex ante program savings (2.1%). Primarily, realization rates differed because of the program not applying the DMSHP methodology to estimate ex ante savings. The ASHP rebate channel rebated a number of DMSHPs, although the information gathered by the implementation team during the rebate process corresponded to the ASHP measure rather than the DMSHP measure. The evaluation team used the DMSHP methodology outlined in the IL-TRM to evaluate savings for DMSHPs.

Programmable thermostats also account for only a very small proportion of overall ex ante program savings (1.1%). The majority of programmable thermostats (70%) received a 100% realization rate. The main reason for the lower overall realization rate is the way that thermostat heating savings are calculated in the IL-TRM, at the household level. For this reason, additional thermostats installed in the same household produce zero ex post heating savings. This is true for smart thermostats as well; it is offset by the fact that 11% of smart thermostats were attributed zero ex ante energy savings in the tracking data but were found to have savings for ex post.

The evaluation team estimated savings for every reported measure by following the IL-TRM V5.0 (V6.0 for pool pumps) methodology and applying appropriate savings correction factors, based on the AHRI database review. Energy realization rates varied from 100% for the following reasons:

- A small number of projects (0.2% of all projects) had insufficient information about the installation location. The team applied average measure-level savings to these measures.

- A small number of projects (0.4% of all projects) were not allocated ex ante kWh savings, kW savings, or both. These line items received zero ex ante savings in the tracking database. Wherever possible, the team estimated ex post savings for each measure.
- As established in the IL-TRM, the team used efficiency levels of existing equipment to calculate ex post savings for ER measures. If the existing equipment's efficiency levels were unknown or fell below the Il-TRM's deemed value, the team used the deemed efficiency value instead.[2] In all cases, ex ante savings used the IL-TRM deemed value.
- For ASHPs, disagreements occurred between reported and evaluated FLH values. FLH values were assigned based on the county in which the installation occurred. The team used a crosswalk file available through the U.S. Department of Housing and Urban Development to determine a county for each site based on the installation zip code. This issue affected approximately 0.5% of all projects.
- For ECMs, the evaluation team limited the amount of savings that could be claimed when the ECM was installed in conjunction with a new ASHP. ECMs installed with a new ASHP were only allocated savings for the shoulder seasons.
- For thermostats, the IL-TRM calculates heating savings at the household level. Ex ante savings values were multiplied by the quantity of thermostats installed; ex post multiplies only cooling savings by the quantity.
- Pool pumps were not included in the IL-TRM V5.0, but were added to the IL-TRM V6.0. The evaluation team used the new IL-TRM V6.0 methodology to calculate ex post impacts rather than the ENERGY STAR algorithm used to estimate ex ante savings.

Table 13 shows annual ex ante and ex post therms savings and realization rates for thermostat measures.

Table 13. Measure Level Gross Ex Ante and Ex Post Therms Savings and Realization Rates

Measure Type	Ex Ante therms	Ex Post therms	Annual Gross Realization Rate
Programmable Thermostat	14,694	13,347	90.8%
Smart Thermostat	88,078	79,486	90.2%
Total	**102,771**	**92,833**	**90.3%**

The evaluation team estimated demand savings for every reported measure by following the IL-TRM V5.0 methodology and applying appropriate savings correction factors, based on the AHRI database review. Therms were only calculated for ECM and thermostat measures. For ECMs, due to decreased motor waste heat, the heating system actually uses more fuel than a system with a traditional motor. Although the measure saves electricity. This savings penalty is not counted against the program goals and is not included in the calculation of the therms realization rate. For cost effectiveness inputs, these negative savings values are provided in **Error! Reference source not found.**. Demand and therms realization rates varied from 100% for many of the same reasons that energy realization rates varied (though not all were applicable to the demand savings calculations).

[2] The team used the deemed efficiency value except where existing EER values were unknown. In such instances, the evaluation team used the algorithm outlined in the IL-TRM to convert SEER to EER. If the calculated EER value fell below the deemed value in the TRM, the team instead used the IL-TRM deemed value.

3.3.2 Net Impacts

Table 14 shows program net ex ante and ex post savings, determined by applying SAG-approved NTGR values.

Table 14. Net Ex Ante and Ex Post Annual Savings, by Measure Type

Measures	NTGR	Ex Ante Annual Net Savings		Ex Post Annual Net Savings	
		kWh	kW	kWh	kW
ASHP	76.1%	84,694	7	101,834	8
ASHP ER	76.1%	1,408,387	150	1,648,011	154
Pool Pump	80.0%	21,425	17	19,985	13
ECM	76.1%	1,453,348	473	1,452,830	475
Programmable Thermostat	90.0%	48,308	N/A	41,959	N/A
Smart Thermostat	90.0%	581,148	141	610,685	147
Ductless	76.1%	68,668	5	85,033	5
		3,665,977	**793**	**3,960,338**	**802**
				Net Realization Rate	**1.08**

4. Conclusions and Recommendations

Overall, in PY9 the HVAC program achieved 100% of its annual MWh goal, and 326% of its annual therms goal due to the introduction of the smart thermostat measure. During the PY9 cycle, the program introduced two new measures (smart thermostats and pool pumps) while removing one measure (RB ASHPs). Due to not offering any CAC measures at all in PY9, overall participation in electric measures fell dramatically, despite a strong uptick in ASHP installations starting in January 2017 resulting from the bonus incentives offered during that period. The two new program managers (Jenny George at Leidos and Mike Snyder at CLEAResult) who took over in PY9 reported smooth transitions, due in part to the fact that the two teams work in the same building. Improvements to the review process and the incentive reimbursement periods were also noted as having positively affected program performance and satisfaction during PY9.

The evaluation team offers the following key findings and recommendations for AIC's consideration. All key findings are based on PY9 evaluation activities, however Key Findings #3-6 were also presented in the PY8 evaluation report which was published after the PY9 program had already launched.

- **Key Finding #1:** Program staff and contractors noted that there was not always a lot of lead time before program changes (particularly those that took place mid-year) such as the addition of the smart thermostat and pool pump incentives. Additionally, many contractors (six of 14) indicated that they would like to see improved communication from AIC as a key way to improve the relationship between AIC and program allies. Several contractors also indicated that they would like presenters at program ally events to be more capable of answering their questions and concerns. Although program staff worked to provide as much time before program changes as possible (and gave grace time to allow for processing of existing projects before dropping the RB ASHP measure), contractors indicated that timely communication continues to be an area with room for improvement.
  - **Recommendation:** Improve communication with contractors by increasing outreach on possible upcoming program changes, and provide educational opportunities throughout the year to teach program allies how to sell the program.
  - **Recommendation:** Ensure that staff who run program ally events can answer technical questions, or train them where to direct complex questions on topics not covered at the training or event.
- **Key Finding #2:** Contractors' main criticism of the HVAC program focused on insufficient program measure offerings, with eight of 14 less than satisfied with this aspect of the program. Contractors are most dissatisfied with this program aspect and reported additional measures would encourage customers be more efficient.
  - **Recommendation:** Although AIC must consider issues of cost-effectiveness and getting the most energy savings per incentive dollar spent, engaged and satisfied contractors can support AIC's overall program efforts. Cadmus suggests AIC consider how it can provide limited support for dropped measures or add new measures to the program to keep it interesting for contractors. For instance, consider providing small incentives to the contractors for selling high efficiency equipment, rather than rebates to consumers.
- **Key Finding #3:** The evaluation team identified multiple incidences of missing or incorrect information in the tracking database.
  - **Recommendation:** Add an additional step in the data entry process to compare the rebate forms to the AHRI database as an accuracy check. Also, ensure sufficient quality control in reviewing

information entered into the tracking database to ensure consistent and accurate data is recorded. For smart thermostats, also collect the existing thermostat type (manual or programmable).

- **Key Finding #4:** The evaluation team found that while a measure in the IL-TRM V5.0 outlines savings for furnace blower motors, it does not account for the installation of an ECM along with a new ASHP. The team believes that savings from ESMs may overlap with savings from the installation of a new ASHP. The overlap occurs because the presence of an ECM is already accounted for in the efficiency ratings (SEER, EER, HSPF) of the new ASHP.
  - **Recommendation:** Provide ECM incentives only to those installations where a new ASHP has not been installed.
  - **Recommendation:** Consider further research to assess incremental ECM savings for use when being installed with a new ASHP.
- **Key Finding #5:** The evaluation team identified a number of DMSHPs entered in the PY9 tracking database. While this type of ASHP is not excluded based on the program requirements, it does require a different savings algorithm than is used for a traditional ASHP.
  - **Recommendation:** Ex ante savings estimates for DMSHPs should not use the ASHP approach from the IL-TRM V5.0, but rather the DMSHP algorithm from chapter 5.3.12 in IL-TRM V5.0.
- **Key Finding #6:** The program tracking database is ambiguous about whether new ASHPs are installed into an existing system, with a gas furnace for backup heat, or as a separate standalone system in which the ASHP is the only heating unit. In cold climates, the backup system will turn on to provide heating when the ASHP is unable to meet the heating load of the home.
  - **Recommendation:** Add a flag to the tracking data that indicates whether ASHPs are installed in systems with fossil fuel backup heating equipment (such as a gas furnace or boiler).

Appendix A. Data Collection Instruments

PY9 Contractor Interview Guide.doc

Distributor Data Request Email and C

Appendix B. Residential HVAC Program Assumptions and Algorithms

Air Source Heat Pumps

The evaluation team used the following equations from the IL-TRM V5.0 to estimate energy and demand savings for residential air source heat pumps.

Equation 1. Air Source Heat Pump Energy Savings Algorithm

$$\Delta kWh = ((FLH\_cooling * Capacity\_cooling * (1/SEER\_base - 1/SEER\_ee)) / 1000) + ((FLH\_heat * Capacity\_heating * (1/HSPF\_base - 1/HSFP\_ee)) / 1000)$$

Equation 2. Air Source Heat Pump Demand Savings Algorithm

$$\boldsymbol{\Delta kW = (Capacity\_cooling * (1/EER\_base - 1/EER\_ee)) / 1000) * CF}$$

Table 15 provides the assumptions used to estimate ex post savings for residential air source heat pump measures.

Table 15. Ex Post Assumptions for Residential Air-Source Heat Pumps

Parameter	Value	Data Source
$FLH_{cooling}$	Location 1-5	Zip code from tracking data to determine the county using a crosswalk file developed by the U.S. Department of Housing and Urban Development. Use the county in Table 3.8 of the IL-TRM V5.0 to determine cooling climate zone (1-5).
$Capacity_{cooling}$	Equipment Nameplate	Tracking database.
$SEER_{base}$	ER:[a] Varies If ASHP replacing ASHP: 9.12. If ASHP replacing CAC: 8.6. If ASHP without cooling: 0 (negative savings).	TRM V5.0.
	TOS:[b] 14	TRM V5.0 (federal standard).
$SEER_{ee}$	Equipment Nameplate	Tracking database.
$FLH_{heating}$	Location 1-5	Zip code from tracking data to determine the county using a crosswalk file developed by the U.S. Department of Housing and Urban Development. Use the county in Table 3.7 of the IL-TRM V5.0 to determine heating climate zone (1-5).
$Capacity_{heating}$	Equipment Nameplate	Tracking database.
$HSPF_{base}$	ER: [a] Varies If replacing ASHP: 5.44 (TRM). If replacing electric heat: 3.41 (TRM). Actual reported (tracking database).	TRM V5.0.
	TOS:[b] 8.2	TRM V5.0 (federal standard).
$HSPF_{ee}$	Equipment Nameplate	Tracking database.
EER_{base}	ER [a]: Varies If ASHP replacing ASHP: 8.55. If ASHP replacing CAC: 8.15. If ASHP without cooling: 0 (negative savings). Or algorithm (if SEER is provided).	TRM V5.0
	TOS[b]: 11.8	TRM V5.0 (federal standard).
EER_{ee}	Equipment Nameplate	Tracking database.
CF_{pjm}	SF: 46.6% MF: 28.5%	TRM V5.0.
CF_{peak}	SF: 72% MF: 67%	TRM V5.0.
[a] ER [b] Time of sale		

The full-load heating and cooling hours, by climate zone, are shown in Table 16.

Table 16. FLH Values From IL-TRM V5.0

Climate Zone	City	Cooling FLH		Heating FLH
		Single-Family	Multifamily	
1	Rockford	512	467	1,969
2	Chicago	570	506	1,840
3	Springfield	730	663	1,754
4	Belleville	1,035	940	1,266
5	Marion	903	820	1,288
Weighted Average		**629**	**564**	**1,821**

Furnace Blower Motors (Electronically Commutated Motors)

The evaluation team used the following equations from the IL-TRM V5.0 to estimate energy and demand savings for ECMs.

Equation 5. ECM Energy Savings Algorithm

$$\boldsymbol{\Delta kWh = Heating\ Savings + Cooling\ Savings + Shoulder\ Season\ Savings}$$

Equation 6. ECM Demand Savings Algorithm

$$\Delta kW = Cooling\ Savings / FLH\_cooling * CF$$

Table 17 provides the assumptions used to estimate ex post savings for ECM measures.

Table 17. Ex Post Assumptions for ECMs

Parameter	Value	Data Source
$FLH_{cooling}$	Location 1-5	Zip code from tracking data to determine the county using a crosswalk file developed by the U.S. Department of Housing and Urban Development. Use the county in Table 3.8 of the IL-TRM V5.0 to determine cooling climate zone (1-5).
ECM Heating Savings	418 kWh	TRM V5.0.
ECM Cooling Savings	With AC: 263 kWh No AC: 175 kWh Unknown: 241 kWh	TRM V5.0. Presence of a central air conditioner determined from the tracking database.
ECM Shoulder Savings	51 kWh	TRM V5.0.
CF_{pjm}	46.6%	TRM V5.0.
CF_{peak}	68%	TRM V5.0.

The full load heating and cooling hours, by climate zone, are shown in Table 18.

Table 18. FLH Values From IL-TRM V5.0

Climate Zone	City	Cooling FLH
1	Rockford	512
2	Chicago	570
3	Springfield	730
4	Belleville	1,035
5	Marion	903
Weighted Average		**629**

Ductless Heat Pumps

The evaluation team used the following equations from the IL-TRM V5.0 to estimate energy and demand savings for residential ductless heat pumps.

Equation 7. Ductless Heat Pump Energy Savings Algorithm

$$\boldsymbol{\Delta kWH = \Delta kWH\ heat + \Delta kWH\ cool}$$

$$\Delta kWH\ \boldsymbol{heat} = Capacity\ heat * EFLH\ heat * (\frac{1}{HSPFexist} - \frac{1}{HSPFee})/\ 1000$$

$$\Delta kWH\ \boldsymbol{cool} = Capacity\ cool * EFLH\ cool * (\frac{1}{SEERexist} - \frac{1}{SEERee})/\ 1000$$

Equation 8. Ductless Heat Pump Demand Savings Algorithm

$$\Delta kW = (Capacity\ cool * (1/EERexist - 1/EERee)) / 1000) * CF$$

Table 19 provides the assumptions used to estimate ex post savings for residential ductless heat pump measures.

Table 19. Ex Post Assumptions for Ductless Heat Pumps

Parameter	Value	Data Source
$Capacity_{cool}$	Equipment Nameplate	Tracking database.
$Capacity_{heat}$	Equipment Nameplate	Tracking database.
$SEER_{exist}$	Varies If replacing ASHP: 9.12. If replacing CAC: 8.6. If replacing Room AC: 8.0.	TRM V5.0.
$SEER_{ee}$	Equipment Nameplate	Tracking database.
EER_{exist}	Varies If replacing ASHP: 8.55. If replacing CAC: 8.15. If replacing Room AC: 7.7.	TRM V5.0.
EER_{ee}	Equipment Nameplate	Tracking database.
$HSPF_{exist}$	Varies If replacing ASHP: 5.44. If replacing electric resistance: 3.412.	TRM V5.0.
$HSPF_{ee}$	Equipment Nameplate	Tracking database.
CF_{pjm}	28%	TRM V5.0.
CF_{peak}	43.1%	TRM V5.0.

The full load cooling hours, by climate zone, are shown in Table 20.

Table 20. FLH Values from the IL-TRM V5.0

Climate Zone	City	Cooling FLH	Heating FLH
1	Rockford	323	1,520
2	Chicago	308	1,421
3	Springfield	468	1,347
4	Belleville	629	977
5	Marion	549	994
Weighted Average		**364**	**1,406**

Pool Pumps

The evaluation team used the following equations from the IL-TRM V6.0 to estimate energy and demand savings for residential pool pumps. All inputs are deemed by the TRM. All pool pumps were variable speed.

ELECTRIC ENERGY SAVINGS[999]

ΔkWh two speed = $(((Hrs/Day_{base} * GPM_{base} * 60)/EF_{base}) - (((Hrs/Day_{2spH} * GPM_{2spH} * 60)/EF_{2spH} + ((Hrs/Day_{2spL} * GPM_{2spL} * 60)/EF_{2spL}))))/1000 * Days$

ΔkWh variable speed = $(((Hrs/Day_{base} * GPM_{base} * 60)/EF_{base}) - (((Hrs/Day_{vsH} * GPM_{vsH} * 60)/EF_{vsH} + ((Hrs/Day_{vsL} * GPM_{vsL} * 60)/EF_{vsL}))))/1000 * Days$

SUMMER COINCIDENT PEAK DEMAND SAVINGS [1001]

ΔkW two speed = $((kWh/day_{base})/(Hrs/day_{base}) - (kWh/day_{2sp})/(Hr/day_{2sp})) * CF$

ΔkW variable speed = $((kWh/day_{base})/(Hrs/day_{base}) - (kWh/day_{var})/(Hr/day_{var})) * CF$

Table 21 provides the assumptions used to estimate ex post savings for residential ductless heat pump measures.

Table 21. Ex Post Assumptions for Pool Pumps

Parameter	Value	Units	Source IL-TRM V5.0
EUL	10.0	years	Page 857 of 944
Hrs/Day base	11.4	hours	Page 858 of 944
Hrs/Day vsH	2.0	hours	Page 858 of 944
Hrs/Day vsL	16.0	hours	Page 859 of 944
GPM base	64.4	gallons	Page 858 of 944
GPM vsH	50.0	gallons	Page 858 of 944
GPM vsL	30.6	gallons	Page 859 of 944
EF base	2.1	gal/Wh	Page 858 of 944
EF vsH	3.8	gal/Wh	Page 859 of 944
EF vsL	7.3	gal/Wh	Page 859 of 944
Days	125.0	days	Page 858 of 944
kWh/day base	20.98	kWh	Page 859 of 944
kWh/day var	5.6	kWh	Page 859 of 944
Hr/day var	18.0	hours	Page 859 of 944
CF	83.1%	Percent	Page 860 of 944
conversion	60.0	min/hr	Page 858 of 944

Thermostats

The evaluation team used the following equations from the IL-TRM V5.0 to estimate energy and demand savings for programmable and smart thermostats. Savings for both are calculated using the same algorithms, although programmable thermostats do not claim cooling or demand savings.

ELECTRIC ENERGY SAVINGS

$$\Delta kWh^{443} = \Delta kWh_{heating} + \Delta kWh_{cooling}$$

$$\Delta kWh_{heating} = \%ElectricHeat * Elec\_Heating\_Consumption * Heating\_Reduction * HF * Eff\_ISR + (\Delta Therms * F_e * 29.3)$$

$$\Delta kWh_{cool} = \%AC * ((FLH * Btu/hr * 1/SEER)/1000) * Cooling\_Reduction * Eff\_ISR$$

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = (Cooling\_Reduction * Btu/hr * (1/EER))/1000 * EFF\_ISR * CF$$

NATURAL GAS ENERGY SAVINGS

$$\Delta Therms = \%FossilHeat * Gas\_Heating\_Consumption * Heating\_Reduction * HF * Eff\_ISR$$

Table 22 provides the assumptions used to estimate ex post savings for residential ductless heat pump measures.

Table 22. Ex Post Assumptions for Thermostats

Parameter	Value	Units	Source IL-TRM V5.0
EUL	10.00	years	Page 703 of 944
%ElectricHeat	Actual	Percent	Tracking Data
Elec_Heating_Consumption	varies	kWh	Page 704 of 944
Heating_Reduction	varies	Percent	Page 705 of 944
HF	varies	Percent	Page 705 of 944
Eff_ISR	100%	Percent	Page 705 of 944
Fe	3.14%	Percent	Page 705 of 944
%FossilHeat	Actual	Percent	Tracking Data
Gas_Heating_Consumption	varies	therms	Page 709 of 944
Conversion	29.3	kWh/therm	Page 705 of 944
%AC	Actual	Percent	Tracking Data
FLH	varies	Hours	Page 706 of 944
Btu/hr	33,600	Btu/hr	Page 706 of 944
SEER	Actual	SEER	Tracking Data
Cooling_Reduction	8.0%	Percent	Page 707 of 944
CF_SSP	34.0%	Percent	Page 708 of 944
CF_PJM	23.3%	Percent	Page 708 of 944

Appendix C. Cost Effectiveness Inputs

According to TRM Version 5.0, installing an ECM in a home increases the heating load due to reduced waste heat. Table 23 shows total gross ex ante and ex post therm savings attributable to ECM installations.

Table 23. Summary of Database Analysis Results—Therm Savings[a]

Measure	Count of ECM Fans Installed in Gas Furnaces	*Ex Ante* Annual Gross Savings	*Ex Post* Per-Unit Gross Savings	*Ex Post* Annual Gross Savings	Annual Gross Realization Rate
ECM	2,630	- 39,484	- 15.01	- 42,911	108.7%

[a] Negative savings represents an increase in therm consumption due to ECM installation.

Table 24 shows ECM net ex ante and ex post savings, determined by applying the NTGR value agreed upon by the SAG.

Table 24. Net Ex Ante and Ex Post Annual Savings

Measure Type	NTGR	*Ex Ante* Annual Net Savings Therms	*Ex Post* Annual Net Savings Therms
ECM	0.761	- 30,047	- 32,655

[a] Negative savings due to reduced waste heat from this measure.

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