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Impact and Process Evaluation of 2015 (PY8) 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 8 (PY8), which ran from June 1, 2015 to May 31, 2016. The HVAC program offered customers incentives through registered program contractor trade allies for purchases of brushless/electronically commutated motors (ECMs), air-source heat pumps (ASHPs), and central air conditioners (CACs). AIC discontinued incentives for the CACs midway through the program year. This occurred due to issues with cost-effectiveness (the 16 SEER CAC was not cost-effective) and the fact that CAC participation was at twice the predicted levels.

AIC HVAC Program registered program allies performed all equipment installations. AIC offered incentives that varied based on equipment types and baseline efficiency levels, which were deducted from the contractor installation invoice at the time of sale. AIC worked with Leidos as the HVAC program administrator, and CLEAResult (formerly Conservation Services Group [CSG]) continued to work as an implementation subcontractor, under Leidos' management.

The evaluation of the PY8 HVAC Program involved both process and impact assessments. Key findings from the PY8 evaluation are presented below.

Impact Results

Table 1 summarizes the net electricity and demand savings from the PY8 HVAC Program. The evaluation team followed the Illinois Statewide TRM (IL-TRM) Version 4.0 protocol and used equipment information from the program tracking data to calculate unique savings values for every measure reported. The program achieved ex ante gross savings of 5,961 MWh and ex post gross savings of 5,928 MWh, which resulted in a 99.5% gross realization rate for energy. The program also achieved ex post demand savings of 2.19 MW (compared to ex ante demand savings of 2.38 MW) resulting in a gross realization rate of 91.8%. We then applied the Illinois Stakeholder Advisory Group (SAG)-approved measure-specific net-to-gross ratios (NTGRs) to the ex post gross impacts to get the ex post net impacts. Overall, the program NTGR for energy was 0.726 and the program NTGR for demand was 0.708. These 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). The program achieved ex post net savings of 4,302 MWh and 1,550 kW.

Table 1. PY8 Net HVAC Program Impacts

	Ex Ante Gross	Gross Realization Rate	Ex Post Gross	NTGR	Ex Post Net
Energy Savings (MWh)					
Total MWh	5,961	99.5%	5,928	0.726	4,302
Demand Savings (MW)					
Total MW	2.38	91.8%	2.19	0.708	1,550

Program and measure-level realization rates varied for numerous reasons, including the following:

- Mischaracterization of heating and cooling zones for a number of sites

- Discrepancies in the reported equipment attributes (e.g., capacity, Seasonal Energy Efficiency Ratio [SEER], Energy Efficiency Ratio [EER], Heating Seasonal Performance Factor [HSPF]) when compared to the Air Conditioning, Heating and Refrigeration Institute (AHRI) database[1]
- Disagreements between the program tracking database and the input values used in the ex ante saving calculations.
- Improper or incomplete application of IL-TRM V4.0-approved methodology for ductless mini-split heat pumps (DMSHPs), which require a different savings approach than traditional ASHPs
- Application of deemed efficiency values for early replacement (ER) equipment, rather than using the actual efficiency of the replaced equipment, in the ex ante savings calculations.
- Overlap in savings due to the interaction between ECMs and the efficiency ratings (SEER, EER, HSPF) of new CACs and ASHPs. Of the 3,693 ECM projects, 63.4% also included a new CAC or ASHP. The efficiency ratings of these equipment types already account for the unit being operated with a furnace ECM, limiting the savings that can be claimed for an ECM installation.

The evaluation team based ex post results on actual equipment characteristics (as recorded in the program tracking data and on participants' local climate zones). The ex post results also included an adjustment factor, developed by the evaluation team, based on an in-depth AHRI matching process to account for differences between the tracking database reported equipment characteristics and actual equipment characteristics identified in the AHRI database. The team determined net savings by applying measure-specific NTGRs agreed upon by the SAG.

Process Results

Overall, PY8 achieved strong program participation but fell short of reaching AIC's net energy savings target of 5,329 MWh. AIC reported that program processes remained the same as those for PY7, and that contractor relationships and communication among program implementers (AIC, Leidos, and CLEAResult) were effective for handling program eligible measure and incentive changes.

The HVAC program experienced a stable transition from PY7 to PY8, as program staff continued offering the same measures despite updating incentive levels. AIC increased incentive levels for ASHP measures, but reduced them for ECM and CAC measure offerings. Though the removal of CAC measures midway through the program year somewhat disrupted processes (e.g., creation of new forms, communication with contractors), program implementers confirmed that clear and preemptive communication with program allies allowed the process to proceed smoothly and the program to continue through the rest of PY8 without exceeding budget limits. The removal of this measure likely impacted overall PY8 HVAC savings, since the measure experienced participation increases towards the end of previous program years.

One area of improvement identified by the evaluation team related to the program tracking database. During the impact evaluation, a large percentage of AHRI numbers recorded in the program data could not be matched against the AHRI database (approximately 28% of unique AHRI numbers and 19% of all AHRI numbers). For those AHRI numbers that were found in the AHRI database, the evaluation team noted a number

[1] The AHRI database can be accessed online at https://www.ahridirectory.org/ahridirectory/pages/home.aspx

of discrepancies between the equipment characteristics recorded in the AHRI database and the program tracking data. These discrepancies were addressed during the ex post savings evaluation.

In terms of meeting energy savings targets, the HVAC program achieved 4,302 net MWh of energy savings, representing 81% of its 5,329 MWh target and a 15.0% decline in MWh savings from PY7. Participation showed that a total of 7,016 measures were installed through the program, representing a 12.3% increase over PY7.

Key Findings and Recommendations

Based on the evaluation activities, the evaluation team determined that AIC, Leidos, and CLEAResult implemented the HVAC Program effectively through program changes, managing the budget marketing, and internal communication appropriately. The program, however, fell short of its savings goal, likely due to the loss of CAC measures (which realized high participation levels during the first part of the program year).

The evaluation team offers the following key findings and recommendations for AIC's consideration:

- **Key Finding #1:** AIC has made significant changes to program eligible measures and incentives over the past two years. As the drivers of program awareness (based on findings from previous evaluations), contractors may have feedback on how the program changes over the past two years have affected them and their ability to market and sell energy efficient HVAC equipment to customers.
  - **Recommendation:** Conduct trade ally interviews to gather feedback on how program process and measure changes have impacted contractors, and to identify opportunities to improve the partnership between program staff and trade allies.
- **Key Finding #2:** 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. Also, ensure sufficient quality control in reviewing information entered into the tracking database to ensure consistent and accurate data is recorded.
- **Key Finding #3**: The evaluation team found that while a measure in the IL-TRM V4.0 outlines savings for furnace blower motors, it does not account for the installation of an ECM along with a new CAC or ASHP. The team believes that savings from this measure may overlap with savings from the installation of a new ASHP or CAC. The overlap occurs because the presence of an ECM is already accounted for in the efficiency ratings (SEER, EER, HSPF) of the new equipment.
  - **Recommendation:** Provide ECM incentives only to those installations where a new CAC or ASHP has not been installed.
  - **Recommendation:** Consider further research to assess incremental ECM savings for use when being installed with a new CAC or ASHP.
- **Key Finding #4:** The evaluation team identified a number of DMSHPs entered in the PY8 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 V4.0, but rather the DMSHP algorithm and track the additional required savings inputs

which include percent load displaced, annual household heating load, home type, and whether the DMSHP is replacing or supplementing an existing system.

- **Key Finding #5:** PY8 ex ante savings do not align with the IL-TRM V4.0-approved methodology for some measure types.
  - **Recommendation:** Review the tracking database calculations and assumptions to ensure the ex ante savings methodology aligns with the approved methodology outlined in the IL-TRM V4.0. In some cases, especially for early replacement measures, the IL-TRM V4.0 recommends the use of existing equipment efficiency values (SEER, EER, HSPF) rather than a default value, when existing equipment information is available.
- **Key Finding #6:** The program tracking database is ambiguous about whether new ASHP equipment 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 PY8 Ameren Illinois Company (AIC) Heating and Cooling (HVAC) Program involved both process and impact assessments. The process evaluation included a review of program materials and interviews with program implementation staff. To conduct the impact evaluation, the team reviewed the tracking database and applied the Illinois Statewide TRM (IL-TRM) Version 4.0. For net impacts, the team applied net-to-gross ratios (NTGRs) agreed upon by the Illinois Stakeholder Advisory Group (SAG). We also conducted three forward looking studies: (1) metering two groups of heat pump participants, those with gas backup heat and those with electric resistance backup heat; (2) a hedonic analysis of incremental costs of energy efficient equipment to isolate energy efficiency upgrades from other features in air-source heat pumps (ASHPs) and central air conditioners (CACs); and (3) an assessment of retrofit electronically commutated motor (ECM) incremental costs. The incremental costs studies have been reported separately and is included in Appendix A. The metering study final report will be delivered in 2017.

2.1 Research Objectives

For PY8, the evaluation team gathered data and conducted analysis to answer the following impact questions about the HVAC Program:

- What were the estimated gross energy and demand impacts from this program?
- What were the estimated net energy and demand impacts from this program?
- What were the incremental costs associated with high-efficiency HVAC equipment?

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

- Did program implementation change compared to PY7? If so, how, why, and was this change advantageous?
- How did the program processes and implementation team perform during PY8?
- Did customer and contractor participation meet expectations? If not, how and why was it different from expectations?
- What were the participant characteristics (measures and Seasonal Energy Efficiency Ratio [SEER] level installed) for PY8? Did ratios of early replacement (ER) vs. replace on burnout (RB) change from PY7?
- Were the HVAC Program's operational and delivery processes adequately documented? Were program materials sufficiently up to date to reflect program changes for PY8?

2.2 Evaluation Tasks

Table 2 summarizes PY8 evaluation actives conducted for the HVAC Program.

Table 2. PY8 HVAC Program Evaluation Methods

Activity	PY8 Process	PY8 Impact	Forward Looking	Details
In-Depth Program Staff Interviews	✓		✓	Interviewed AIC, CLEAResult, and Leidos managers to understand goals, progress to date, program changes from PY7 and over the PY8 period, 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.
Metering Studies			✓	For approximately one year (ending February 2017), 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 will aid in determining region-specific SEER, Heating Seasonal Performance Factor (HSPF), ECM fan energy savings, and peak demand impacts for central HVAC systems.
Incremental Cost Analysis			✓	Analyzed incremental costs for ASHP, CAC, and ductless mini-split heat pump (DMSHP) equipment, based on tonnage and SEER levels, and using data gathered from distributor specification sheets and brief distributor interviews. Analyzed ECM retrofit incremental costs via an online pricing analysis and interviews with contractors.

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 PY8 period. The evaluation team also inquired about data tracking and customer outreach related to the program. As part of this task, the team interviewed members of the AIC program team, along with representatives from the program administrator (Leidos) and the implementation subcontractor (CLEAResult).

Table 3. Staff Interviews Completed

	AIC Staff	Leidos Staff	CLEAResult Staff	Total
Interviews Completed	2	2	2	6
Date Completed	May 4, 2016	July 1, 2016	July 8, 2016	

2.2.2 Review of Program Materials

In order 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 PY8 implementation plan
- The residential marketing plan

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

2.2.3 Metering Studies

In February 2016, the evaluation team installed meters on multispeed (or variable speed) central ASHPs and CACs. The meters recorded energy consumption for the entire system, including the variable speed fan (for ECMs) and backup electric resistance strip heat (for ASHPs). Relatively new to the market, variable speed central HVAC systems represent the highest-efficiency CAC and ASHP systems in the HVAC Program.

Additionally, in March 2016, the team installed meters on single-speed CACs (the most common system type in the HVAC Program) to record system energy consumption, including standard efficiency fans (for non-ECMs).

Collected meter data will aid in understanding the region's actual seasonal operating efficiencies (SEER and HSPF). The study also will compare energy-use patterns and energy-consumption differences between ECM and non-ECM fans, and the evaluation team will use the results to suggest possible modifications to the IL-TRM V7.0. To collect data from all seasons, metering will continue into the 2016/2017 winter season, and in May 2017 the evaluation team will report results from the metering studies.

2.2.4 Incremental Cost Analysis

The evaluation team submitted a separate report on incremental costs; Appendix A summarizes the methodology and findings from this memo.

2.2.5 Impact Analysis

Gross Impacts

For PY8, the evaluation team determined ex post gross impacts by using the program tracking database and the appropriate savings algorithm (as specified in the IL-TRM V4.0). The specific inputs and algorithms for each measure are outlined in Appendix D.

The IL-TRM V4.0 recommends using different full-load hour (FLH) values in the energy savings algorithm for five different locations and includes two tables (IL-TRM V4.0 Table 3.7 and 3.8) that list every county and its respective climate zone. The tracking database includes an address and zip code for every measure installation, but does not include the county or climate zone information. To determine the 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 IL-TRM V4.0, the team looked up the county's climate zone for every measure installation.

To determine savings, the evaluation team followed the algorithms outlined in the IL-TRM V4.0, with three exceptions. For ER measures, the IL-TRM V4.0 recommends using SEER and Energy Efficiency Ratio (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, though it 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 V4.0 discusses this algorithm in the ASHP section, but the evaluation team extended its use to CACs and ductless mini splits. If the existing equipment efficiency is not recorded or is unrealistic and results in a calculated EER lower than 5.1, the team used the TRM-recommended value instead of the calculated value.

The second exception occurred with ductless mini-split heat pumps. A small portion of measures rebated through the ASHP and CAC program channels were actually DMSHPs. Though this equipment is not a traditional ASHP, the evaluation team determined net and gross savings for these measures. The IL-TRM V4.0 does not outline a savings methodology for DMSHPs installed in homes with existing gas heating systems. The team evaluated savings for units installed in homes with an existing gas heating system using the same methodology and inputs outlined above for split central ASHP systems. For DMSHP systems installed in homes with an existing electric resistance heating system, the team evaluated savings using the algorithms outlined in the IL-TRM V4.0 for DMSHPs, applying the following assumptions depending on the installation scenario:

- The existing HVAC system is a ducted ASHP rated at 13.0 SEER, 11.2 EER, and 7.7 HSPF. The DMSHP measure is designed to calculate electric savings for supplementing an existing HVAC system with a DMSHP. The evaluation team assumed that customers receiving a new DMSHP did not receive a new ASHP in the same year, so any existing system was installed prior to January 1, 2015 and was compliant with the previous federal efficiency standard.

- Equipment larger than two tons offset 100% of the home's heating load. This engineering judgement was made following a review of the percent load displaced (PLD) factor outlined in the IL-TRM V4.0 and comparing the size of rebated DMSHPs to rebated ASHPs. The relationship between the PLD and the DMSHP size appeared asymptotic. A simple extrapolation would cap savings at 50% to 60% of the total household heating load, even though the DMSHP could be large (four to five tons) and account for all heating energy consumption in the home. Further, the team found that the DMSHPs larger than two tons were, on average, larger than the average ASHP rebated in PY8.

- Units installed in homes without existing cooling systems did not receive cooling savings (this assumption is outlined in the IL-TRM V4.0).

- A 0.641 NTGR was applied for this measure. As the PY8 evaluation plan did not define a NTGR for this measure, the team used a NTGR for SEER 16+ ASHP measures. These measures are similar in terms of equipment replaced and efficiency of the newly installed equipment.

As the inputs required by the IL-TRM V4.0 to calculate savings for ductless units (percent load displaced, annual household heating load, home type, and whether the equipment is supplementing or replacing an existing system) were not tracked during the PY8 HVAC program, the above assumptions allowed the team to make conservative savings estimates for these equipment.

Finally, the IL-TRM V4.0 includes savings estimates for ECMs but the TRM savings are based on a different set of installation conditions than were required by the program. The savings outlined in the IL-TRM V4.0 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 V4.0 assumes that the furnace uses natural gas and is the home's primary heat source. It also assumes that there are no other changes to the home's HVAC system, such as the installation of a new CAC or ASHP. The evaluation team found that approximately 66% of the ECMs rebated through the program were installed in conjunction with either a new CAC or ASHP.

As a result, the evaluation team did not assign ECM savings strictly as outlined in the IL-TRM V4.0. If the new ECM was installed in a home and no other changes were made to the existing HVAC system, the ECM was eligible for all savings as outlined in the IL-TRM V4.0. For instances where the new ECM was installed in

conjunction with a new CAC, the team evaluated full savings for the CAC installation but limited ECM savings to only include savings from the heating and shoulder seasons, as the cooling savings were already accounted for in the CAC efficiency. Similarly, ECMs installed with new ASHPs were only eligible for savings in the shoulder seasons. This is a result of the ASHP heating and cooling efficiencies already accounting for the new ECM.

Net Impacts

The evaluation team applied NTGRs approved by the SAG to PY8 program savings. Table 4 summarizes the NTGRs used in the net impact analysis.

Table 4. SAG-Approved PY8 NTGRs

Measure Type	Electric NTGR	Gas NTGR
<SEER 16 CAC/HP (RB)	0.601	N/A
SEER 16+ CAC/HP (RB)[a]	0.641	N/A
<SEER 16 CAC/HP (ER)	0.631	N/A
SEER 16+ CAC/HP (ER)	0.761	N/A
Brushless Motors (ECMs)	0.761	0.761

[a] The evaluation team also applied this NTGR to ductless mini-split measures.

2.3 Sources and Mitigation of Error

Table 5 provides a summary of possible sources of error associated with data collection conducted for the HVAC Program. Detailed discussions follow for each item below.

Table 5. Possible Sources of Error

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

Throughout planning and implementing for the PY8 evaluation, the evaluation team took a number of steps to mitigate against potential sources of error.

Survey Error for Interviews

- **Sampling Error:** The evaluation team attempted a census, precluding any sampling errors.
- **Non-Sampling Error**: 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.

Gross Impact Calculations

- **Air Conditioning, Heating and Refrigeration Institute (AHRI) Equipment Characteristics Review:** The evaluation team queried all AHRI numbers in the tracking data against the AHRI database, using a

proprietary web-scraping process to compare characteristic values recorded in the AHRI database to reported values in the tracking data. This review identified discrepancies in the tracking data, resulting in an adjustment factor that was applied to the ex post savings to more accurately represent the installed equipment.

- **Tracking Data Review:** If a parameter value in the tracking database fell outside the expected range of values, the team corrected the value. For example, if the capacity value was 360,000 British thermal units (BTUs) (equivalent to a 30-ton system), the team looked up the capacity using the AHRI certificate number, confirming that the value should have been 36,000 BTUs. The team then corrected erroneous values.

- **Data Processing Error**: To calculate gross impacts, the team applied IL-TRM V4.0 calculations to participant data in the tracking database. Then, to minimize data processing errors, the team had all calculations reviewed by a company senior staff peer reviewer, verifying that the team accurately performed the calculations.

Net Impact Calculations

- **Data Processing Error**: The evaluation team applied the prospective deemed NTGRs to estimate program net impacts. To minimize data processing errors, the team had a senior staff member review and verify all calculations.

Incremental Cost Analysis

- **Non-Response Sampling Error:** The evaluation team had substantial difficulty collecting data from HVAC distributors due to concerns about sharing proprietary pricing information. As a result, our sample of HVAC systems may not be representative of the population of HVAC systems sold by all distributors. The team included statistical controls to account for potential differences between distributors.

- **Non-Sampling Error:**

  - **Self-Selection Bias.** Distributors volunteered to provide pricing data, or pricing data was publicly available online. Thus, the results are subject to self-selection bias. This bias would assert itself if distributors who agreed to participate in the study were different than those who refused in a way that is correlated with the study findings. Given the difficulty of recruiting distributors for this type of study, the response rate to a random selection of distributors was low, opening the study to this type of bias. This is inherently a difficult type of bias to control. To the evaluation team, however, there is no obvious reason to expect a relationship between willingness to participate and the incremental cost of increased SEER ratings. In addition, the team provided incentives for each distributor ($500) to encourage participation and included statistical controls to account for potential differences between distributors.

- **Data Processing Error**: To estimate incremental cost, the team developed statistical models using distributor specification data. To minimize data processing errors, the team had all specification data, statistical models, and assumptions reviewed by a company senior HVAC expert and a company senior statistician, verifying that assumptions and modeling conform to engineering and statistics best practices.

3. Detailed Evaluation Findings

3.1 Program Description

In June 2009, AIC began offering HVAC incentives. Over the last seven years, AIC modified incentive amounts and equipment requirements, and updated measures offered as federal standards for equipment efficiency and cost-effectiveness inputs changed. CLEAResult (as CSG until 2015) has implemented the program since 2009.[2] In PY7, Leidos became the program administrator, with CLEAResult working as an implementation subcontractor. Together with AIC, these implementation partners worked to design and implement the program; recruit, support, and train contractors; and track and report program progress.

In PY8, the HVAC Program offered incentives for purchases of high-efficiency ASHPs, CACs, and ECMs (installed by an HVAC Program-registered trade ally). Program requirements included sizing specifications, efficiency standards, and other features (e.g., a matching indoor and outdoor coil requirement for new air conditioning equipment). As shown in Table 6, PY8 incentives for CAC equipment and ECMs decreased from PY7 levels, while ASHP incentives increased to match PY6 levels.

Since PY4, AIC has not changed the incentive design, passing 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 (ER) or as a standard RB project. By offering these incentives, AIC sought to persuade customers to purchase higher-efficiency equipment than they might install otherwise.

To be considered 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. In PY8, AIC offered three different measures, with incentives depending on the new equipment's SEER level and the replaced equipment's condition (see Table 6). While the program offered CAC measures at the beginning of the program year, participation was far beyond predicted levels, and the program phased out the measure after participation slowed in the winter months. After February 2016, the program created and distributed new incentive forms, with all CAC measures removed from program offerings.

[2] CLEAResult purchased CSG's assets in April 2015.

Table 6. Changes in Incentive Levels from PY3 to PY8

Measure	Details	PY3	PY4	PY5/PY6	PY7	PY8	PY7-PY8 Change
ASHPs							
ASHP SEER 14.5–14.9	New efficient equipment replacing > SEER 10	$110	$150	$150	Not Offered	Not Offered	N/A
	ER[a] of SEER 10 or less	$400	$400	$450	Not Offered	Not Offered	N/A
ASHP SEER 15.0–15.9[b] (No 15.0 baseline in PY4)	New efficient equipment replacing > SEER 10	$110	$150	$200	Not Offered	Not Offered	N/A
	ER of SEER 10 or less	$400	$400	$500	Not Offered	Not Offered	N/A
ASHP SEER 16+	New efficient equipment replacing > SEER 10	$200	$200	$300	$200	$300	$100
	ER of SEER 10 or less	$600	$600	$600	$500	$600	$100
CACs[a]							
CAC SEER 14.5–14.9	New efficient equipment replacing > SEER 10	$100	$100	$150	$100	$50	-$50
	ER of SEER 10 or less	$250	$250	$450	$400	$200	-$200
CAC SEER 15.0–15.9	New efficient equipment replacing > SEER 10	$100	$100	$200	$150	$75	-$75
	ER of SEER 10 or less	$250	$250	$500	$450	$250	-$200
CAC SEER 16+	New efficient equipment replacing > SEER 10	$125	$125	$300	$200	$100	-$100
	ER of SEER 10 or less	$350	$350	$600	$500	$300	-$200
ECMs							
Brushless ECM Furnace	New furnace equipped w/brushless DC motor	Not Offered	Not Offered	$80	$200	$100	-$100

[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 flyers, bill inserts, and direct mailings, along with some digital and social media advertising. Program trade allies also drove the marketing efforts. CLEAResult divides the AIC account territory into northern and southern regions, assigning one account representative for each region to provide outreach and program support to contractors and distributors. Additionally, CLEAResult provided training seminars for registered program allies. In PY8, these seminars focused on program changes (e.g., reviewing updated application forms, the removal of CAC measures later in the program year), rather than technical topics.

3.2 Process Findings

3.2.1 Program Implementation

Over PY8, program staff reported that program processes were very effective, partly due to minimizing program changes during the transition from PY7. Other than incentive levels and eligible measures, there were no changes to the program design. According to program staff, that stability allowed trade allies to report high comfort levels in promoting the program to customers.

After a full year in partnership, the program implementer noted that the working relationship with the program administrator had improved since PY7 due to improved reporting functions, more ease in discussing program implementation, and greater understanding of each other's expectations. The program implementer continued to be responsible for the two regional (North and South) account managers, technical reviews of applications, implementing inspections, and managing program trade allies and their training. The program administrator continued to input and track data through the AMPlify system, manage quality control checks, and drive program marketing.

While most processes remained the same, program staff updated all program paperwork to improve efficiency. This included consolidating reservation and incentive forms into a single document and updating trade ally forms to create less paperwork and redundancy in entering information.

Marketing Changes for PY8

For PY8, program marketing materials drove promotion through registered program allies. The PY8 Energy Efficiency Marketing Plan call-to-action was "Find a Contractor" at ActOnEnergy.com. Since previous evaluations noted that the majority of program participation was driven by program allies, the program administrator worked to ensure there were sufficient numbers of active program allies promoting the program, and the program implementer provided sales and marketing training and promotional materials for those allies.

For the PY8 period, marketing initiatives included updated website and forms, a new program overview flyer, bill inserts (targeting the heating and cooling seasons), direct mail (for Fall 2015), and social media and digital advertising (as needed). AIC also included case studies, based on previous program participants, as a marketing initiative in PY8.

Marketing Materials for PY8

The marketing campaign targeted the heating and cooling seasons with separate mailings:

- In June 2015, AIC sent a bill insert to promote CAC measures.
- In November 2015, AIC mailed a postcard that focused on ASHP offerings (see Figure 1).
- In February 2016, mailed a flyer that promoted the HVAC program overall.

The June and November seasonal mailings included the maximum incentive available, a brief statement on the benefits of new energy-efficient units, and both a phone number and website address to learn more about the program. While the graphics were simplistic, they were on topic and did not distract from the message. The June bill insert also included the phrase "Ameren Illinois ActOnEnergy," which provided clarification that ActOnEnergy (the web address provided) is part of AIC and not a separate organization. None of the mailings, however, focused on finding a contractor, which was stated as the call-to-action for the portfolio-level campaign as described in the PY8 Energy Efficiency Marketing Plan.

Figure 1. PY8 Postcard (Front Side) from November 2015

The February 2016 flyer, promoting the HVAC program overall, included simple and visually appealing graphics along with information on eligibility, benefits of participation, and program participation steps. Further, the front and back of the flyer included the website and phone number for the program. The information provided included incentive amounts for ASHPs and ECMs, and an explanation of the meaning of "SEER" and "HSPF". As with the November postcard, the flyer did not include "Ameren Illinois ActOnEnergy" in the body of the message.

The evaluation team reviewed the new case study developed in PY8, which AIC included on the program web page. The case study provided an easy-to-read customer experience, combined with key pieces of information (e.g., program measures and incentive levels, how to search for contractors, how to qualify, and a visual graphic of how much annual energy use declined for the family). While anecdotal, this covered a great deal of information, and included a discussion about smart thermostat usage allowing customers to track and compare energy usage and costs.

Program Application Forms

The PY8 application form (which was updated after removal of the CAC measures to take out that section of the document) included all key information-gathering fields including customer and trade ally information as well as information about the equipment (e.g., measure type, manufacturer, model, and AHRI SEER/EER). As discussed, the form served both for project reservations (for ER projects) and incentive requests, including information on timing for ER projects and signatures (i.e. the reservation form must be submitted prior to beginning any work).

Compared to PY7, this represents a consolidation of the reservation and incentive application forms to avoid sending in duplicate information. Because of this consolidation, one section of the previous application form was left out of the new form that asked how the customer heard about the program. While less important to the application process, this information could have provided some insight into the effectiveness of the residential program's marketing campaign.

Data Tracking

In PY8, the program administrator was responsible for entering all data into the program's AMPlify system from data provided by the implementer. According to the program implementer, this will change in PY9 to improve data management. In PY8, the program implementer entered data into their own system, which was then uploaded to the AMPlify system. The PY9 change will provide the program implementer with direct access to AMPlify for direct entry of data instead of through monthly updates to the program administrator.

This will simplify the review process for the implementer and hopefully reduce redundancy in data entry. For AIC and the program administrator, the ability to have data entered directly into AMPlify will allow real-time tracking, as opposed to waiting for monthly uploads. At the same time, as cross-program data-tracking integration improves, the program administrator will have access to TRM calculations (not a statewide average) to provide better data based on zip codes. This could potentially assist with targeting marketing campaigns (e.g., to identify underserved areas).

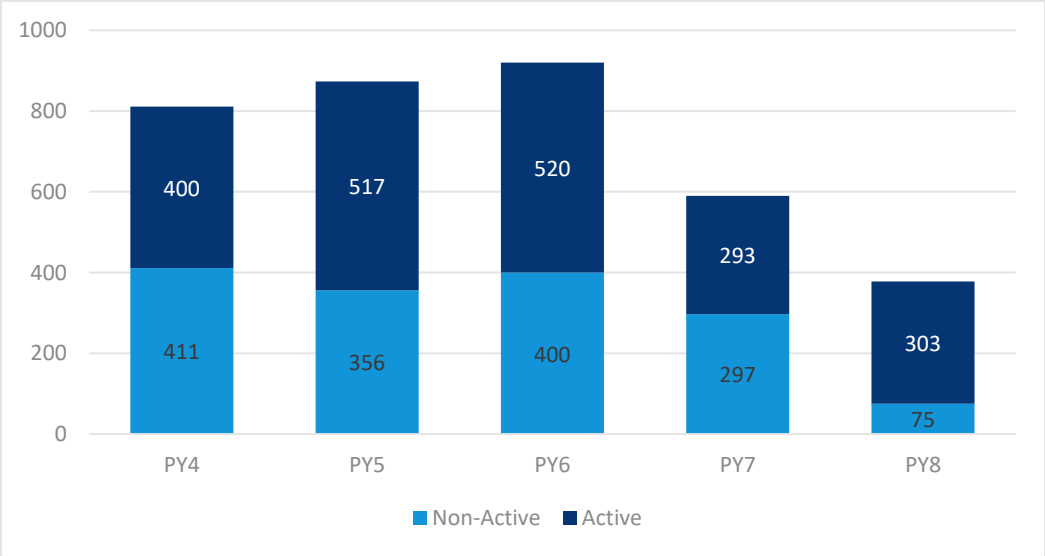
3.2.2 HVAC Program Trade Allies in PY8

Program implementation staff confirmed that the overall requirements to become a trade ally in PY8 remained the same as PY7. Program staff, however, asked all trade allies to resubmit their participation agreements (including certificates of insurance) to the program implementer to ensure that records on active trade allies were up to date, and that program staff had the trade allies' updated certificates of insurance on file.

In addition to resubmitting their application forms, the PY8 program required trade allies to take the latest program training sessions and/or submit an incentive application form within one year of submitting the application to be considered an "active trade ally". This action sought to ensure AIC maintained an accurate list of active trade allies.

Overall, AIC reported 303 active registered contractors and 75 non-active registered contractors (having neither participated in a training event or submitted an incentive application within one year) for PY8, totaling 378 registered contractors. As shown in Figure 2, this shows a 3.4% increase of active contractors over PY7, and a notable decrease in non-active contractors.

Figure 2. Contractor Participation from PY4 to PY8



3.2.3 Customer Participation

PY8 Participation

In terms of unique participants, PY8 program participation increased over PY7 levels, particularly in ECMs (despite a decrease in incentive levels from $200 to $100). As shown in Table 7, while overall unique participation rose by 16%, participation in CACs and ASHPs measures only increased 1%, compared to a 33% increase in ECMs over PY7.

Table 7. Program Participation (Unique Participants) PY5 to PY8

Measure Type	Program Participation (N) PY5	Program Participation (N) PY6	Program Participation (N) PY7	Program Participation (N) PY8	Percent Change (PY7-PY8)
CAC/ASHPs	4,408	6,547	3,303	3,340	+1%
ECM Fans	1,943	4,149	2,765	3,684	+33%
Total	**6,351**	**10,696**	**6,068**	**7,024**	**+16%**

Participation Characteristics

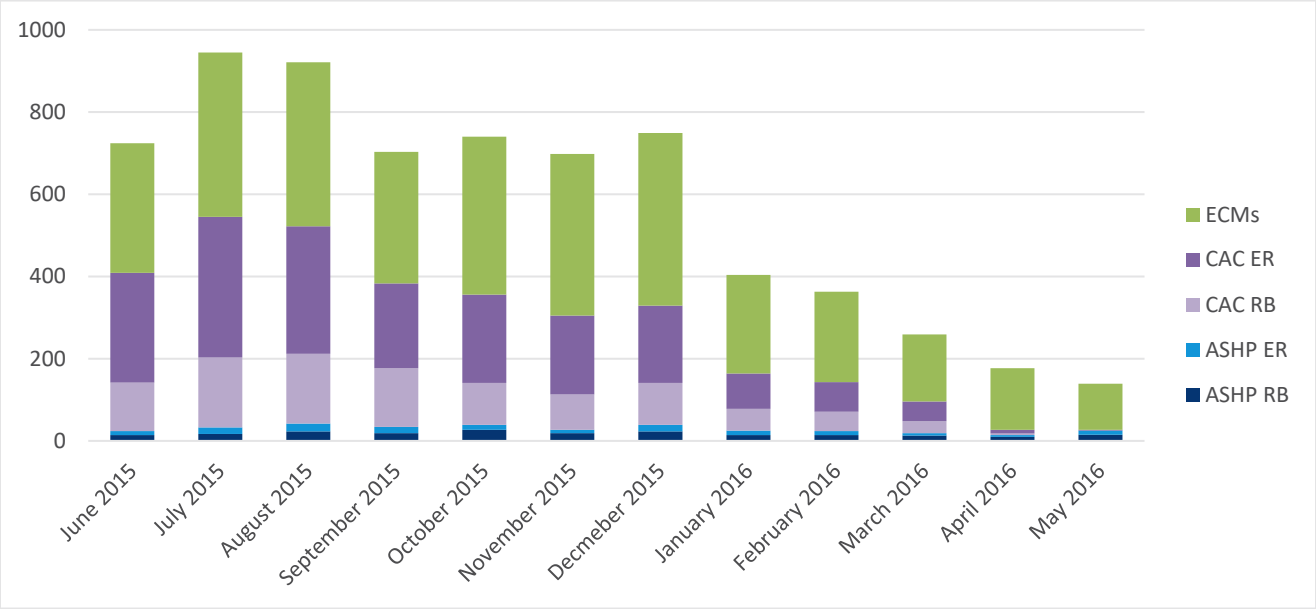
In PY8, the HVAC program experienced strong participation during the first half of the program year (through December), particularly in the CAC measures, which were discontinued in February 2016.[3] The unexpectedly high participation for CACs (despite decreased incentive levels) proved problematic for the program's annual budget. Additionally, the HVAC Program had already met forecasted participation targets for CACs, (particularly SEER 16+ CACs) for the three-year (PY7–PY9) planning cycle. The implementation team considered dropping

[3] To slow participation, AIC cut CAC incentives in half in January, then completely removed all CAC measures in February.

only the SEER 16+ option and leaving the lower-tier CAC measures, but decided to avoid confusion and remove all CAC measures from program offerings for the rest of PY8 and going forward.

As shown in Figure 3, the removal of CAC measures from the program offering resulted in a steady decrease in overall participation of that measure during the latter half of PY8.[4] ECM participation also declined steadily starting in January 2016.

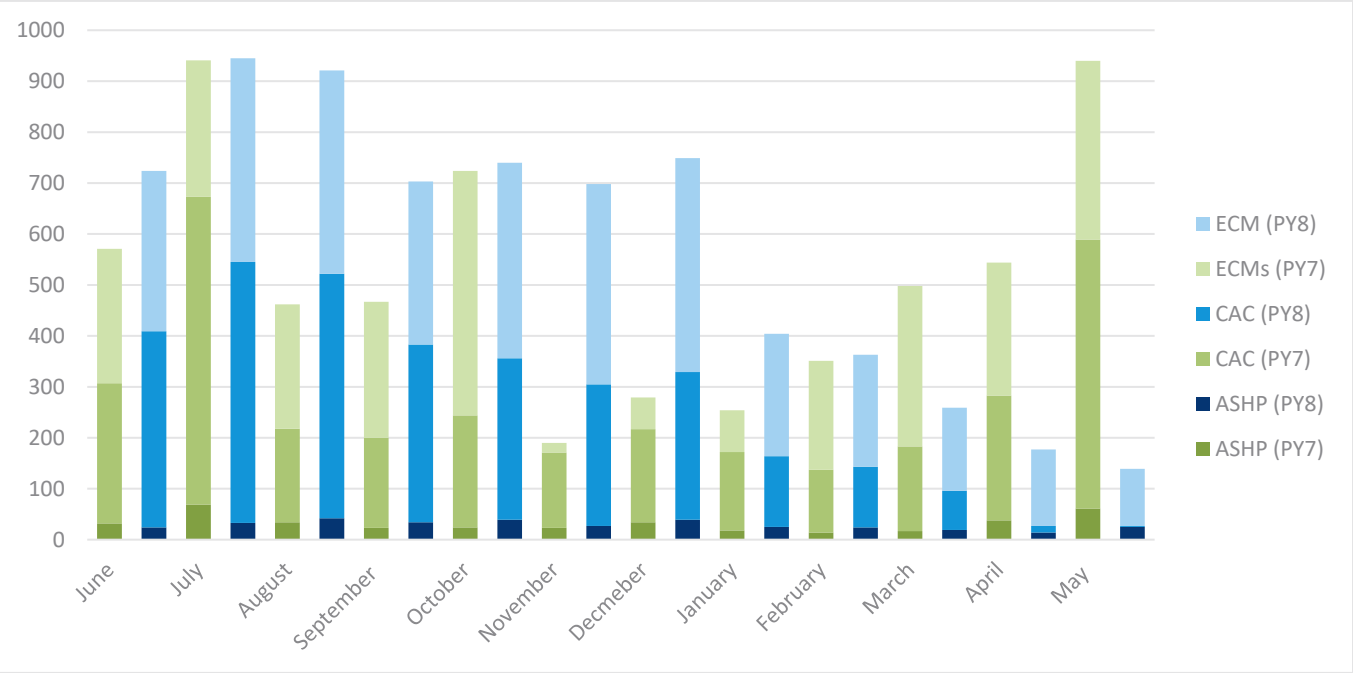
Figure 3. Monthly Participation for PY8 Measures



As shown in Figure 4, the loss of CAC measures was particularly notable in the final months of PY8, where in PY7 the measure had experienced a second peak. Additionally, ECM participation did not rise toward the end of the program year as in PY7, despite overall strong participation in that measure over PY8. Compared to PY7, the HVAC program was not able to benefit from that second period of high participation. However, prior to removal of CAC measures, PY8 experienced strong participation, with participation higher in August-September and in November-December when compared to the previous year.

[4] Ameren continued to honor the small number of CAC applications they received after officially dropping the measure.

Figure 4. Monthly Participation—PY7 versus PY8



Implementation staff noted some concerns that the Illinois state budget crisis would affect program participation through customers feeling insecure about jobs or financial assistance programs funded by the state. Despite the effect on state employees and programs, program staff did not report notable program impacts from the crisis.

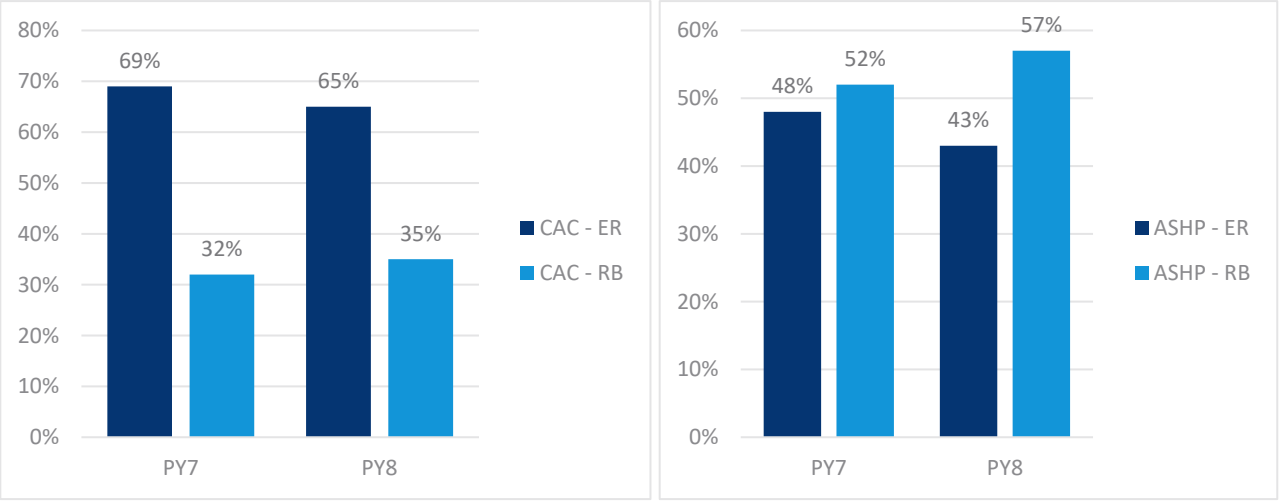
Overall, 3,693 ECM measures were installed in PY8, with 2,939 CACs and 361 ASHPs installed. As shown in Table 8, 37% of all CAC measures were 16+ SEER ER units, with 43% of ASHP measures being 16+ SEER ER units. Since PY8 did not include lower-tier ASHP units, average SEER ranged from 16.6 to 17.2 for ASHP units installed, with average SEER for CAC units ranging from 14.5 to 16.5.

Table 8. PY8 Equipment Characteristics

Measure Type	Count of Reported Measures	Average SEER	Average EER	Average HSPF
ASHP 16+ SEER	205	17.2	12.4	9.5
ASHP ER 16+ SEER - Replaces ASHP	62	17.0	12.7	9.2
ASHP ER 16+ SEER - Replaces Resistance	94	16.6	12.7	9.2
CAC 14.5-14.9 SEER	160	14.5	12.1	N/A
CAC 15.0-15.9 SEER	234	15.4	12.7	N/A
CAC 16+ SEER	621	16.7	12.9	N/A
CAC ER 14.5-14.9 SEER	376	14.7	12.3	N/A
CAC ER 15.0-15.9 SEER	466	15.2	12.6	N/A
CAC ER 16+ SEER	1,082	16.5	12.9	N/A

As shown in Figure 5, PY8 realized a distribution of ER versus RB participation similar to PY7, although ER participation for CACs and ASHPs decreased slightly in PY8.

Figure 5. Early Replacement (ER) vs Replace on Burnout (RB) Measures for PY7 and PY8



3.3 Impact Assessment

3.3.1 Gross Impacts

The evaluation team used tracking data and algorithms in the IL-TRM V4.0 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 V4.0. 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 1.3% of measures could not be determined due to insufficient information available in the tracking data regarding measure installation locations. The team applied a measure-level average savings to the 1.3% of measure 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 with sufficient data available in the tracking database, in accordance with the IL-TRM V4.0 and with additional assumptions as appropriate. Second, we 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 accurate ex post savings, reflecting the actual characteristics of the installed equipment. Finally, the team estimated ex post savings for incomplete measures (1.3% of measures) by applying the average savings value for equipment within the same measure and efficiency category.

Using a proprietary web-scraping tool, the team attempted to query the 2,378 unique AHRI numbers recorded in the program tracking data in an effort to verify the recorded equipment characteristics, but could find only 1,720 (72%) 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 81% of all program equipment. Characteristics for the remaining 19% of program equipment could not be verified using the AHRI database because the recorded AHRI number was not found in the AHRI database, either as a result of an incorrect AHRI number being recorded or a piece of equipment being mischaracterized.

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 underestimated potential savings. Table 9 shows the savings correction factors.

Table 9. Gross Savings Correction Factors (SCFs)

Measure Type	Ex Post		
	Cooling kWh SCF	Cooling kW SCF	Heating kWh SCF
ASHP 16+ SEER	0.998	1.022	1.047
ASHP ER 16+ SEER - Replaces ASHP	1.021	1.030	1.000
ASHP ER 16+ SEER - Replaces Resistance	1.007	0.996	1.000
CAC 14.5-14.9 SEER	1.020	1.017	N/A
CAC 15.0-15.9 SEER	1.018	1.015	N/A
CAC 16+ SEER	1.003	1.002	N/A
CAC ER 14.5-14.9 SEER	1.006	0.989	N/A
CAC ER 15.0-15.9 SEER	1.005	1.006	N/A
CAC ER 16+ SEER	1.007	1.010	N/A

An SCF value greater than one indicates that gross savings increased, while a value of less than one indicates gross savings adjusted downwards. Nearly all adjustments resulted in increased savings.

Table 10 shows annual ex ante and ex post energy savings, demand savings, and realization rates for RB CACs, ER CACs, RB ASHPs, ER ASHPs, and ECM furnace fan measure categories. The evaluation team combined measures in these categories to coincide with the SAG NTGR measure categories. The table includes a line item for DMSHPs identified during the tracking data review. Measure-level energy realization rates varied from 73% to 130%, resulting in a program gross realization rate of 99.5%. Measure-level demand savings realization rates varied from 29% to 133%, and the overall gross demand realization rate was 91.8%.

Table 10. Measure Level Counts, 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*	
	Annual Gross Savings		Annual Gross Savings			
	kWh	kW	kWh	kW	kWh	kW
CAC	365,299.68	206.16	367,076.13	207.24	100.5%	100.5%
CAC ER	1,694,244.65	1,188.85	2,205,897.00	1,584.68	130.2%	133.3%
ASHP	193,474.61	13.47	223,797.18	14.43	115.7%	107.1%
ASHP ER	1,027,822.35	141.64	1,174,837.45	141.93	114.3%	100.2%
ECM	2,660,294.00	831.03	1,932,229.00	239.90	72.6%	28.9%
DMSHP	19,762.02	2.20	24,464.34	0.76	123.8%	34.3%
Total	**5,960,897**	**2,383**	**5,928,301**	**2,189**	**99.5%**	**91.8%**

[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 ECM measure was the single largest measure category in PY8, accounting for approximately 45% of the program's ex ante savings and similarly had the largest impact on the program realization rate. During the impact analysis, the team found that the program requirements for this measure did not align with the installation conditions outlined in IL-TRM V4.0. The team found that approximately 66% of the ECMs rebated through the program were installed in conjunction with either a new CAC or ASHP. Efficiency levels of new CACs and ASHPs are determined through a set of tests outlined by the AHRI that assess the equipment under a number of different environmental and operation conditions, including operation of the CAC or ASHP with an indoor ECM. Following the testing, final equipment efficiencies (SEER, EER, and HSPF) are determined that account for the interaction between the ECM and the new equipment or system.

As a result, the evaluation team did not assign ECM savings strictly as outlined in the IL-TRM V4.0, opting to use additional criteria to determine the appropriate level of savings and avoid potential savings overlap of the ECM measure with the CAC or ASHP measures. The result is that the team assigned zero cooling savings for the ECM installation in homes that received rebates for both a new CAC and a new ECM. These projects still received ECM savings for the heating and shoulder seasons. Similarly, ECMs installed in projects in conjunction with a new ASHP were not assigned ECM savings in either the heating or cooling seasons, but were assigned savings for the shoulder seasons.

The changes above are the primary drivers of the ECM measure's low realization rates. The demand realization rate is substantially lower than the energy realization rate because demand savings are only realized in the cooling season. Using the approach outlined above, approximately 66% of all ECM installations did not receive any savings during the cooling season, whereas only 3% of installations did not receive savings during the heating season.

The DMSHP measure accounts for a very small proportion of overall program savings (0.4%), but exhibits one of the largest deviations from a 100% realization rate for energy and demand savings. This primarily results from the program not applying the DMSHP methodology to estimate ex ante savings and not collecting required data to evaluate savings for this measure. The ASHP and CAC rebate channels rebated a number of DMSHPs although the information gathered by the implementation team during the process corresponded to the ASHP or CAC measure rather than the DMSHP measure. The evaluation team used the DMSHP methodology outlined in the IL-TRM V4.0 to evaluate savings for DMSHPs, assuming these units replaced existing ducted ASHPs.

DMSHPs achieved 34% demand realization rates as the majority of these units were installed in homes identified as not having existing cooling systems. As a result, the evaluation team did not allocate cooling energy or summer demand savings to most of these measures. Ex post energy savings were substantially higher than reported savings due to differences in which IL-TRM V4.0 savings algorithms were applied and the evaluation team's assumption that DMSHPs larger than two tons offset 100% of household heating loads. The evaluation team determined ex post savings for DMSHPs using either the ASHP methodology or the DMSHP methodology based on the existing heating system, whereas ex ante savings were based only on the ASHP methodology.

Table 11 summarizes results from the evaluation team's energy savings analysis, showing measure counts, ex ante savings, ex post savings, and gross realization rates for each measure type.

Table 11. Measure Level Counts, Gross Ex Ante and Ex Post Energy Savings (kWh) and Gross Realization Rates, by Measure Type

Measure Type	Count of Reported Measures	Total Ex Ante Reported kWh	Total Ex Post Reported kWh	Gross Realization Rate
ASHP 16+ SEER	205	193,475	223,797	115.7%
ASHP ER 16+ SEER— Replaces ASHP	62	277,081	371,744	134.2%
ASHP ER 16+ SEER— Replaces Resistance	94	750,742	803,093	107.0%
CAC 14.5-14.9 SEER	160	32,829	33,335	101.5%
CAC 15.0-15.9 SEER	234	71,374	72,598	101.7%
CAC 16+ SEER	621	261,096	261,144	100.0%
CAC ER 14.5-14.9 SEER	376	279,144	375,534	134.5%
CAC ER 15.0-15.9 SEER	466	396,419	517,384	130.5%
CAC ER 16+ SEER	1,082	1,018,681	1,312,980	128.9%
ECM - Brushless Motor— with Furnace	3,693	2,660,294	1,932,229	72.6%
Ductless Heat Pump	23	19,762	24,464	123.8%
Grand Total	**7,016**	**5,960,897**	**5,928,301**	**99.5%**

The evaluation team estimated savings for every reported measure by following the IL-TRM V4.0 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 (1.3% of all projects) had insufficient information about the installation location. The team applied average measure-level savings to these measures.
- A number of projects (1.4% 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.
- The tracking database indicated a different existing heating equipment type than assumed in the ex ante savings estimates, for ASHPs (1.3% of all projects; 24.9% of ASHP projects). In some cases, this resulted in increased ex post savings (when the team determined the home used existing electric baseboard equipment rather than an existing ASHP). At times, this led to decreased ex post savings.

- As established in IL-TRM V4.0, 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 unrealistically low, the team used the deemed efficiency value instead.[5] In all cases, ex ante savings used the IL-TRM V4.0 deemed value. The existing equipment efficiency differed from the IL-TRM V4.0's deemed value for approximately 20.1% of all projects, along with 67.7% of early replacement ASHP and CAC projects.

- For CACs and 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 2.5% of all projects and 5.4% of all ASHP and CAC projects.

- For CACs and ASHPs, a number of discrepancies arose in the project documentation provided (9.4% of all projects; 20.0% of all ASHP and CAC projects). In a significant number of cases, equipment characteristics used to calculate ex ante savings did not match the equipment characteristics recorded elsewhere in the tracking data.

- For ECMs, a large number of disagreements arose between ex ante and ex post determination of existing cooling equipment, a value found in the program tracking database. The ex ante savings were based on a certain type of existing cooling equipment; however, a different type was noted in the tracking database. This issue impacted approximately 38.6% of all ECM measures (20.3% 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 CAC or ASHP. ECMs installed with a new CAC were only allocated savings for the heating and shoulder seasons. ECMs installed with a new ASHP were only allocated savings for the shoulder seasons.

Table 12 summarizes results from the evaluation team's demand savings analysis, showing measure types, measure counts, ex ante savings, ex post savings, and gross realization rates.

[5] Except where existing EER values were unknown. In such instances, the evaluation team used the algorithm outlined in the IL-TRM V4.0 to convert SEER to EER. If the calculated EER value was unrealistically low (lower than 5.1), the team instead used the TRM deemed value.

Table 12. Measure Level Counts, Gross Ex Ante and Ex Post Demand Savings (kW) and Realization Rates, by Measure Type

Measure Type	Count of Reported Measures	Total Ex Ante Reported kW	Total Ex Post Reported kW	Gross Realization Rate
ASHP 16+ SEER	205	13	14	107.1%
ASHP ER 16+ SEER - Replaces ASHP	62	57	58	100.6%
ASHP ER 16+ SEER - Replaces Resistance	94	84	84	99.9%
CAC 14.5-14.9 SEER	160	23	23	101.7%
CAC 15.0-15.9 SEER	234	48	48	100.8%
CAC 16+ SEER	621	136	136	100.2%
CAC ER 14.5-14.9 SEER	376	202	271	134.1%
CAC ER 15.0-15.9 SEER	466	290	386	132.8%
CAC ER 16+ SEER	1,082	696	927	133.3%
ECM - Brushless Motor - with Furnace	3,693	831	240	28.9%
Ductless Heat Pump	23	2	1	34.3%
Grand Total	**7,016**	**2,383**	**2,189**	**91.8%**

The evaluation team estimated savings for every reported measure by following the IL-TRM V4.0 methodology and applying appropriate savings correction factors, based on the AHRI database review. Demand 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).

3.3.2 Net Impacts

Table 13 shows program net ex ante and ex post savings, determined by applying SAG-approved NTGR values. Applying the NTGRs to the HVAC Program shown below resulted in overall, savings-weighted, PY8 HVAC NTGRs of 0.726 for kWh, 0.708 for kW, and 0.761 for therms.[6] The energy and demand NTGR values differ because of the specific measure mix and variation in measure-level savings within the program. Each measure was

[6] Therms were only calculated for brushless motor (ECM) measures. Due to decreased motor waste heat, the heating system actually uses more fuel than a system with a traditional motor.

evaluated using a single NTGR for both energy and demand, but when rolled up to the program level, the result is a savings-weighted program-level NTGR value.

Table 13. 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
<SEER 16 CAC/HP (RB)	0.601	62,626	42	63,665	43
SEER 16+ CAC/HP (RB)	0.641	291,380	96	310,847	96
<SEER 16 CAC/HP (ER)	0.631	426,280	311	563,431	415
SEER 16+ CAC/HP (ER)	0.761	1,557,389	637	1,893,229	814
Brushless Motors	0.761	2,024,484	632	1,470,426	183
Ductless Heat Pump	0.641	12,667	1	15,682	0
Total		**4,362,160**	**1,719**	**4,301,598**	**1,550**

[a] Net realization rate = ex post annual net savings ÷ ex post annual gross savings. Table 14 provides the total ex post annual gross natural gas savings value while Table 15 provides the total ex post annual net natural gas savings value. The evaluation team calculated the realization rate before rounding ex post and ex ante values.

4. Conclusions and Recommendations

In terms of customer participation and program management, in PY8 the HVAC program went smoothly, though it attained only 80% of its energy savings target. AIC also removed the CAC measures in February 2016, which affected participation towards the end of the program year. However, the program showed an overall increase in participation compared to PY7, particularly in ECMs. Program staff reported smooth transitions both between program years and mid-cycle changes in program offerings, due to improved communication and having settled in to the partnership between the program administrator and program implementer.

The evaluation team identified issues with the HVAC program database provided for PY8. Based on the evaluation findings, the evaluation team offers several suggestions for improving the HVAC program in upcoming program cycles.

- **Key Finding #1:** Overall, the PY8 HVAC program showed increased participation, but achieved lower annual energy savings compared to PY7. Since PY6, AIC has made changes to the program offerings, Leidos took over as program administrator, and application forms have been revised. While program staff have provided feedback, since there has been no trade ally survey or interview effort since PY6, there has been no opportunity to evaluate how trade allies have responded to these changes. Trade ally feedback, at this time, could greatly enhance future program design.
  - **Recommendation:** Conduct trade ally interviews to review trade ally experiences with the program through the changes of the past few years. Interviews would also provide feedback on the updated reservation and incentive forms and to identify opportunities for improved cooperation between trade allies and AIC.
- **Key Finding #2:** The program tracking database contained a large number of contradictory, missing, or inaccurate data. Only 72% of the unique AHRI numbers recorded in the database could be matched to the AHRI database, either as a result of an incorrect AHRI number being recorded or a mischaracterization of equipment type. Additionally, a significant portion of ex ante savings calculations (9.4% of projects) were calculated with values different than were available in the program data.
  - **Recommendation:** Include an additional step in the data entry and review process that compares information submitted in the rebate forms against the AHRI database, and discrepancies are corrected before being entered into the final program tracking database. This would help ensure that equipment and project characteristics entered into the tracking database align with the values actually used to calculate ex ante savings for the project.
  - **Recommendation:** Implement a more thorough quality assurance process to ensure that equipment characteristic and project location data is accurate and consistent across all pieces of the tracking database (all tables and workbooks). Through the PY8 analysis, the evaluation team identified several instances where information recorded in the data entry process was either missing or different than that used to calculate ex ante savings.
- **Key Finding #3:** The evaluation team found that while there is a measure in the IL-TRM V4.0 that outlines savings for furnace blower motors (ECMs), the measure does not account for the installation of a new ECM along with a new CAC or ASHP. The team believes that savings from the ECM measure may overlap with savings from a new CAC or ASHP because the increased efficiency associated with an ECM is already accounted for in the efficiency ratings (SEER, EER, HSPF) of the new CAC or ASHP.

  - **Recommendation:** Provide ECM incentives only to those installations where a new CAC or ASHP has not been installed.

  - **Recommendation:** Conduct additional research to determine whether the ECM savings outlined in IL-TRM V4.0 are appropriate and applicable when installing an ECM with a new CAC or ASHP. Further, the team recommends that the TRM be updated and clarified as necessary to reflect the additional research.

- **Key Finding #4:** The evaluation team identified a number of DMSHPs entered in the PY8 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 traditional ASHP. The data collected through the standard rebate channels do not provide all information necessary to evaluate savings for these equipment using the IL-TRM V4.0 methodology.

  - **Recommendation:** Ex ante savings estimates for DMSHP's should not use the ASHP approach from the IL-TRM V4.0. IL-TRM V4.0 outlines DMSHPs as a unique measure with a set of DMSHP-specific savings inputs that include percent load displaced, annual household heating load, home type, and whether the DMSHP is replacing or supplementing an existing system.

- **Key Finding #5:** PY8 ex ante savings do not align with the IL-TRM V4.0-approved methodology for some measure and delivery types.

  - **Recommendation:** To ensure accuracy of savings, review the tracking database calculations and assumptions to ensure the ex ante savings methodology aligns with the approved methodology outlined in the IL-TRM V4.0. In some cases, especially for early replacement measures, the IL-TRM V4.0 recommends the use of existing equipment efficiency values (SEER, EER, HSPF) rather than a default TRM value when existing equipment information is available.

- **Key Finding #6:** The program tracking database is ambiguous about whether new ASHP equipment 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. Incremental Cost Analysis

*This draft is in progress, and will be updated when the memo is finalized

AIC%20PY7%20Incre
mental%20Cost%20

Appendix B. Data Collection Instruments

AIC PY8 HVAC
Interview Guide AK.d

Appendix C. ECM Natural Gas Impacts

According to the IL-TRM V4.0, installing an ECM in a home increases the heating load due to reduced waste heat. Table 14 shows total gross ex ante and ex post therm savings attributable to ECM installations.

Table 14. Summary of Database Analysis Results—Therm Savings[a]

Measure	# ECM Fans Installed in Gas Furnaces	Ex Ante	Ex Post Per-Unit Gross Savings	Ex Post	Annual Gross Realization Rate
		Annual Gross Savings		Annual Gross Savings	
ECM	3,693	0	-14.7	-54,174	N/A

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

Table 15 shows ECM net ex ante and ex post savings, determined by applying the NTGR value agreed upon by SAG.

Table 15. 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	-	- 41,226
Total		**-**	**- 41,226**

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

Appendix D. Residential Heating and Cooling Program Assumptions and Algorithms

D.1 Air Source Heat Pumps

The evaluation team used the following equations from the IL-TRM V4.0 to estimate energy and demand savings for residential air source heat pumps.

Equation 1. Air Source Heat Pump Energy Savings Algorithm

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

Equation 2. Air Source Heat Pump Demand Savings Algorithm

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

Table 16 provides the assumptions used to estimate ex post savings for residential air source heat pump measures.

Table 16. 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 V4.0 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).	IL-TRM V4.0.
	TOS:[b] 14	IL-TRM V4.0 (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 V4.0 to determine heating climate zone (1-5).
$Capacity_{heating}$	Equipment Nameplate	Tracking database.
$HSPF_{base}$	ER: [a] Varies If replacing ASHP: 5.44 (IL-TRM V4.0). If replacing electric heat: 3.41 (IL-TRM V4.0). Actual reported (tracking database).	IL-TRM V4.0.
	TOS:[b] 8.2	IL-TRM V4.0 (federal standard).

Parameter	Value	Data Source
$HSPF_{ee}$	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).	IL-TRM V4.0
	TOS[b]: 11.8	IL-TRM V4.0 (federal standard).
EER_{ee}	Equipment Nameplate	Tracking database.
CF_{pjm}	46.6%	IL-TRM V4.0.
CF_{peak}	72%	IL-TRM V4.0.

[a] ER
[b] Time of sale

The full load heating and cooling hours, by climate zone, are shown in Table 17.

Table 17. FLH Values from the IL-TRM V4.0

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**

D.2 Central Air Conditioners

The evaluation team used the following equations from the IL-TRM V4.0 to estimate energy and demand savings for residential central air conditioners.

Equation 3. Central Air Conditioner Energy Savings Algorithm

$$\boldsymbol{\Delta kWh = (FLHcool * Btu/hr * (1/SEERbase - 1/SEERee))/1000}$$

Equation 4. Central Air Conditioner Demand Savings Algorithm

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

Table 18 provides the assumptions used to estimate ex post savings for central air conditioner measures.

Table 18. Ex Post Assumptions for Central Air Conditioners

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 V4.0 to determine cooling climate zone (1-5).
$Capacity_{cooling}$	Equipment Nameplate	Tracking database.
$SEER_{base}$	ER:[a] Actual or 10 if unknown	IL-TRM V4.0.
	TOS:[b] 13	IL-TRM V4.0 (federal standard).
$SEER_{ee}$	Equipment Nameplate	Tracking database.
EER_{base}	ER [a]: Actual or 9.2 if unknown Or algorithm (if SEER is provided).	IL-TRM V4.0.
	TOS[b]: 11.8	IL-TRM V4.0 (federal standard).
EER_{ee}	Equipment Nameplate	Tracking database.
CF_{pjm}	46.6%	IL-TRM V4.0.
CF_{peak}	72%	IL-TRM V4.0.

[a] ER
[b] Time of sale

The full load heating and cooling hours, by climate zone, are shown in Table 19.

Table 19. FLH Values from the IL-TRM V4.0

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**

D.3 Furnace Blower Motors (ECMs)

The evaluation team used the following equations from the IL-TRM V4.0 to estimate energy and demand savings for ECMs.

Equation 5. ECM Energy Savings Algorithm

$$\Delta kWh = Heating\ Savings + Cooling\ Savings + Shoulder\ Season\ Savings$$

Equation 6. ECM Demand Savings Algorithm

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

Table 20 provides the assumptions used to estimate ex post savings for ECM measures.

Table 20. 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 V4.0 to determine cooling climate zone (1-5).
ECM Heating Savings	418 kWh	IL-TRM V4.0.
ECM Cooling Savings	With AC: 263 kWh No AC: 175 kWh Unknown: 241 kWh	IL-TRM V4.0. Presence of a central air conditioner determined from the tracking database.
ECM Shoulder Savings	51 kWh	IL-TRM V4.0.
CF_{pjm}	46.6%	IL-TRM V4.0.
CF_{peak}	72%	IL-TRM V4.0.

The full load heating and cooling hours, by climate zone, are shown in Table 21.

Table 21. FLH Values from the IL-TRM V4.0

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

D.4 Ductless Heat Pumps

The evaluation team used the following equations from the IL-TRM V4.0 to estimate energy and demand savings for residential ductless heat pumps.

Equation 7. Ductless Heat Pump Energy Savings Algorithm

$$\Delta kWh = PLD * AHHL * HF * (1/HSPFexist - 1/HSPFee) * 3.413 + Capacity\_cooling * HF * (1/SEERexist - 1/SEERee) * EFLHcool$$

Equation 8. Ductless Heat Pump Demand Savings Algorithm

$$\Delta kW = (Capacity\_cooling * HF * (1/EER\_exist - 1/EER\_ee)) / 1000) * CF$$

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

Table 22. Ex Post Assumptions for Ductless Heat Pumps

Parameter	Value	Data Source
PLD	Varies by climate zone and system size. If the system size exceeds the values outlined in the IL-TRM V4.0, the team assumed the PLD to be 100%.	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 V4.0 to determine cooling climate zone (1-5). System size is from the tracking database.
AHHL	Varies by climate zone and existing system type.	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 V4.0 to determine cooling climate zone (1-5). Existing system type is from the tracking database.
HF	Single-Family: 100% Multi-Family: 65%	Tracking database.
$Capacity_{cooling}$	Equipment Nameplate	Tracking database.
$SEER_{base}$	13.0	Engineering assumption based on IL-TRM V4.0.
$SEER_{ee}$	Equipment Nameplate	Tracking database.
EER_{base}	11.20	Engineering assumption based on IL-TRM V4.0.
EER_{ee}	Equipment Nameplate	Tracking database.
$HSPF_{base}$	7.7	Engineering assumption based on IL-TRM V4.0.
$HSPF_{ee}$	Equipment Nameplate	Tracking database.
CF_{pjm}	46.6%	IL-TRM V4.0.
CF_{peak}	72%	IL-TRM V4.0.

The full load cooling hours, by climate zone, are shown in Table 23.

Table 23. FLH Values from the IL-TRM V4.0

Climate Zone	City	Cooling FLH
1	Rockford	220
2	Chicago	210
3	Springfield	319
4	Belleville	428
5	Marion	374
	Weighted Average	**248**

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