IMPACT AND PROCESS EVALUATION OF AMEREN ILLINOIS COMPANY'S RESIDENTIAL HVAC PROGRAM (PY5)

Final

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Table of Contents

TABLE OF TABLES

TABLE OF FIGURES

1. Executive Summary

The Ameren Illinois Company (AIC) Residential Heating and Cooling Program (HVAC Program) offers customer incentives for the purchase of high-efficiency furnaces, brushless/electronically commutated motors (ECMs), boilers, air source heat pumps (ASHPs), ground source heat pumps (GSHPs), or central air conditioners (CACs), all of which must be installed by an HVAC Registered Program Ally. Incentive levels vary according to equipment types and baseline efficiency levels. In PY5, Ameren introduced:

- Higher incentives for most equipment
- Tiered incentives by efficiency level for the CAC and heat pump measures
- A brushless motor incentive (offered with the high-efficiency furnace)
- Early replacement (ER) incentives for boilers and furnaces, in addition to the current incentives

AIC expected this program to produce 6% of the overall PY5 portfolio's electric savings and 25% of the overall PY5 portfolio's therm savings.

This report addresses AIC's PY5, covering the period of June 1, 2012, through May 31, 2013. To support this study, the evaluation team conducted:

- Participant satisfaction surveys
- Non-active registered (NAR) contractor surveys
- Measure installation verifications through phone interviews
- A review of program rebate invoices
- A detailed database analysis

Additionally, the evaluation team installed meters beginning in PY4, which provided information for updating per-unit savings estimates for the next TRM review. In particular, the meter data included total-unit energy consumption, heating and cooling cycle times, and backup heat use. Appendix B provides the metering study results.

Impact Results

Our assessment of the HVAC Program indicates that program tracking accurately captures the number of program participants and measures installed through the program. The detailed tracking information in the database includes information such as unit type, size, efficiency, and measure installation locations. These serve as inputs to the savings algorithms in the Illinois Statewide Technical Resource Manual (TRM), dated June 2012.

As reported in the tracking database, *ex ante* savings were not based on TRM calculations, but rather assumed a fixed-unit savings value based on past evaluation results. The evaluation team calculated *ex post* savings for every installed measure, in accordance with the TRM.

Table 1 below shows the number of program participants by measure type, and the number of measures verified through phone surveys and program rebate documents.

Table 1. Summary of PY5 Verification Results

Measure Type	Program Participation (N)	Number of Phone Surveys	Number Verified through Phone Surveys	Number of Document Reviews	Number Verified through Document Review	Gross Verification Rate
Gas Furnace Installations (95/97 AFUE)	5,869	60	60	35	35	100%
Gas Boilers	61	30	30	0	0	100%
CAC/ASHPs	4,408	120	120	28 CACs 2 ASHPs	28 CACs 2 ASHPs	100%
ECM Fans	1,943	30	30	0	0	100%
GSHPs	228	0	0	5	5	100%

The phone survey responses and document reviews indicate that the installed equipment matches the measures reported in the database. Table 2 shows *ex ante* and *ex post* per-unit savings by measure type.

Table 2. Summary of Database Analysis Results

Measure	Ex Ante Annual Per-Unit Gross Savings			Ex Post Annual Per-Unit Gross Savings			Per-Unit Annual Gross Realization Rate*		
	kW	kWh	Therms	kW	kWh	Therms	kW	kWh	Therms
CAC	0.292	300		0.301	350		102.9%	116.7%	
CAC ER	1.296	1,235		1.356	1,421		104.6%	115.0%	
ASHP	0.319	1,061		0.360	1,567		112.8%	147.7%	
ASHP ER	1.284	5,907		1.420	4,974		110.6%	84.2%	
GSHP	0.594	3,814		1.742	5,623		293.0%	147.4%	
ECM	0.315	720		0.291	724		92.5%	100.6%	
Gas Furnace			137			134			97.9%
Gas Furnace ER			337			352			104.5%
Gas Boiler			192			154			80.4%
Gas Boiler ER			539			603			112.0%

*Per-Unit Gross Realization Rate=*Ex Post* Per-Unit Gross Savings/*Ex Ante* Per-Unit Gross Savings.

Some *ex post* per-unit savings exceed *ex ante* estimates. This is because AIC estimated *ex ante* savings for each measure based on the minimum new-measure efficiency, and we estimated savings using TRM algorithms for the actual measures installed. For example, incentivized furnaces in the 97 AFUE furnace category may be installing higher-efficiency units than the minimum 97 AFUE requirement, which yields higher savings in our *ex post* calculations. Other reasons for differences may be due to differing assumptions on climate zones compared to where this mix of program participants is located.

As specified by the net-to-gross ratio (NTGR) framework provided in the ICC Order for Docket 10-0568, net savings are estimated using NTGRs of 0.59 for electric measures (ASHPs, CACs, ECMs, and GSHPs), 1.02 for gas furnaces, and 1.01 for gas boilers (which included spillover). These values were derived from the PY3 evaluation results.

Table 3 shows the total program's net first-year savings impacts.

Table 3. PY5 HVAC Program First-Year Savings Net Impacts

Measure	NTGR	*Ex Ante* Annual Net Savings			*Ex Post* Annual Net Savings		
		kW	MWha	Therms	kW	MWha	Therms
CAC/ASHP	0.59	2,548	3,439	N/A	2,693	3,662	N/A
ECM Fans	0.59	623	1,427	N/A	525	960	N/A
GSHP	0.59	80	515	N/A	232	750	N/A
Gas Furnace	1.02	N/A	N/A	947,849	N/A	N/A	941,722
Gas Boiler	1.01	N/A	N/A	21,278	N/A	N/A	22,943
	Total	**3,252**	**5,381**	**969,127**	**3,451**	**5,372**	**964,664**
				Net Realization Rate[b]	***1.06***	***1.00***	***1.00***

[a] Totals may not equal sum of measures due to rounding.

[b] Net Realization Rate=*Ex Post* Net Savings/*Ex Ante* Net Savings.

Process Results

The process evaluation included four research tasks:

- Implementer and AIC staff interviews, which helped the evaluation team better understand the HVAC Program and its operations
- A customer satisfaction free ridership and participant spillover survey
- A NAR contractor survey to gather information on program barriers, market effects, and spillover

- A review of AIC's HVAC Program marketing materials to determine whether they were being developed in line with best practices

Based on these evaluation tasks, we determined that the program operates effectively within the constraints of balancing the portfolio budget. AIC and CSG (its implementation contractor) actively manage the portfolio budget by monitoring program response and adjusting marketing and incentives accordingly. AIC expressed satisfaction with its implementer, and customers report they are satisfied with the overall program, HVAC contractors, and incentives. Most (84%) customers said their experience with the HVAC Program would greatly increase their likelihood of participating in another AIC program. AIC and CSG have incorporated many past evaluation recommendations into the PY5 program.

CSG significantly increased contractor outreach compared to previous years, with March to May 2013 showing significant growth in customer participation (up to 200% of monthly targets), and nearly 20% growth in active contractors joining the program. CSG dedicates two account managers to this program, and they conduct outreach by attending contractor and distributor meetings, and marketing the program to contractors through e-blasts, postcards, and print media. CSG showcases high performers through meetings and e-blasts to encourage competition among contractors.

CSG provides informative, well-structured monthly and weekly reports to AIC. Combined, CSG's weekly and monthly reports provide a good summary of program status, including MWh, therms, and incentive dollars; progress toward goals; and contractor and customer marketing activities. AIC staff expressed interest in having more advance notice of contractor meetings.

Many NAR contractors indicated that their lack of activity resulted from reasons outside of program control, and most did not offer suggestions for improvements. However, some suggestions included streamlining the rebate process, and increasing outreach and support through direct communications by the representative to the contractor and the provision of information brochures.

Despite a delayed launch of the furnace ERs and ECMs due to higher-than-expected participation in other residential programs,[1] customer participation did not continue to fall as it had in PY4, when reductions in federal tax incentives resulted in lower participation. In the last few months of PY5, participation increased significantly. AIC and CSG staff theorized that this increase may be because the HVAC Program is recovering from the effects of both the economic slowdown and changing tax breaks (where tax credits as high as $1,500 dropped to $300 or less for most measures).

The evaluation team offers the following recommendations for AIC to consider:

- **Continue efforts to integrate all program-tracking data into a single database and ensure that key HVAC data fields have been completed.** The following values, which are necessary to estimate savings using TRM algorithms, have often been missing in the tracking database:
  - EER of CACs and heat pumps
  - Heating seasonal performance factors (HSPF) of heat pumps
  - Heating and cooling capacity (in Btuh) of ASHPs and GSHPs
  - Partial-load and full-load heating and cooling efficiency of GSHPs

[1] According to program staff, AIC delayed the introduction of ER gas equipment until November 2012 to balance the availability of funding between this program and the Home Energy Performance (HEP) Program.

We also recommend flagging the following measure combinations:

- Gas furnace combined with an ECM measure
- AC or heat pumps also receiving an ECM
- Heat pumps installed with a gas furnace
- Any combination heating and cooling replacement with one or both ER incentives

➢ **Cross-market other AIC programs to HVAC contractors to encourage customer participation.** Many NAR contractors recommended including efficient tank and tankless water heaters in the equipment mix—indicating that they were unaware that rebates are available through other AIC programs. AIC could provide information on other ActOnEnergy programs to contractors to leave with their customers.

➢ **Track marketing efforts.** CSG indicates that it does not track the effects of individual marketing efforts and campaigns. We recommend developing and implementing simple tracking methods and metrics. These approaches could help program managers plan and execute more cost-effective marketing. Tracking methods could include:

- Utilize a website statistics analytics tool, such as Google Analytics, to determine trends in visitor counts, key sources driving users to the program pages, and visitor interactions with the page.
- Use campaign-specific or seasonally unique website URLs to track the performance of individual tactics, messaging, or collateral pieces.

➢ **Track open rates** (percentage of emails opened) of Program Ally-directed emails to determine if certain messaging within emails achieves better response rates.

➢ **Investigate opportunities to further engage low-activity and NAR contractors.** While CSG has made great progress through contractor outreach, a significant number of low- or no-activity contractors remain. To increase this group's participation, CSG may consider the following:

- Providing an easily accessible list of incentives, either through a table on the website or as a monthly mailing of incentive levels for contractors that are not online.
- Offering simplified incentive application processing for small "mom and pop" contractors. For example, consider how to allow customers to submit the forms and contractor receipts directly, or allow the contractors to call in the necessary information to obtain the incentive.
- Simplifying the re-registration process to encourage contractors to rejoin if they have been dropped from the program. Contacting contractors by phone and helping them complete registration forms might encourage participation.
- Expanding the recognition program to further incent peer competition and motivate contractor participation.

➢ **Develop an HVAC Program manual.** Best practices (www.eebestpractices.com) include maintaining an up-to-date manual. This benefits the utility and implementer, as the manual would document all program management elements and retain institutional memory in-house. Manuals can be used to train new staff and provide a guide for daily operations, if existing staff become unavailable for a time. Manuals also clarify activities and roles. They can demonstrate the incorporation of best practice elements in the program.

➢ **Document and seek feedback on contractor training materials**. While the training deck was clear and concise, utilized consistent branding, and received a favorable review from NAR contractors, the webinar was not available on the website (nor available for our review). Having the webinar recorded and available on the website for contractors to review at their convenience could improve contractor education and participation. The webinar could include information about other AIC programs, and showcase materials available to help registered contractors market the program. AIC could also consider implementing a short survey at the end of the training programs to identify possible opportunities for improvements. Further, AIC could consider making the training mandatory for participating contractors. It could increase contractor engagement and reduce the number of NAR contractors.

- **Refine the formatting for selected marketing materials.** The review of the HVAC Program marketing materials indicated that they currently follow a majority of marketing best practices. However, formatting for some materials could be improved to optimize readability and visual appeal.

- **CSG could add more detailed information to reports**. In monthly reports, CSG should provide details regarding contractor outreach and communications, including all meetings held in the prior month or to be held in the month going forward. This would allow AIC to send representatives to meetings in the area, and to track specific contractor outreach activities on a month-to-month basis.

- **Develop a protocol to verify a sample of all types of installed equipment.** While CSG reviews all documentation to ensure that the correct equipment receives incentives, no physical verification occurs for non-ER equipment. Field verification of the installation quality of the HVAC system will hold contractors accountable for their work. Most utilities target verification of at least 5% of installed HVAC equipment (in the field or via telephone). Currently, field verification only applies to ER equipment.

- **Consider mini-split heat pumps for targeted homes (converting electric baseboard homes).** The program currently only targets homes with central HVAC systems. Several contractors suggested adding mini-split heat pump incentives. Significant energy savings can be achieved when a mini-split heat pump replaces or serves as a supplementary heat source for a home using all-electric resistance baseboard heat. Although overall electric baseboard heat has a low saturation (4%),[2] they are most applicable to multifamily or low-income homes, and may be a good fit for programs targeting those customer segments.

[2] Based on Energy Information Administration, 2009 Residential Energy Consumption Survey: http://www.eia.gov/consumption/residential/data/2009/xls/HC6.9%20Space%20Heating%20in%20Midwest%20Region.xls.

2. Introduction

This report presents the PY5 evaluation findings for AIC's HVAC Program. CSG implements the program, which offers incentives for purchases of high-efficiency furnaces, boilers, ASHPs, GSHPs, ECM fans, or CACs installed by an HVAC Registered Program Ally. Applicable federal equipment standards serve as baseline efficiency conditions for new heating and cooling systems. For ER measures, the existing system efficiency serves as the baseline.

Incentive levels vary according to equipment types and the efficiency levels of existing equipment, and AIC customers receive an incentive for installation of new equipment that appears as a line-item deduction on contractors' installation invoices. Offering the incentive intends to persuade customers to purchase more-efficient equipment than they might otherwise install. In PY5, AIC introduced the ECM brushless motor to the mix of measures.

The program also includes an ER incentive, aimed at customers with operating but inefficient equipment. Through this offering, the program encourages customers to retire equipment for newer, more-efficient units. In PY5, AIC introduced an ER incentive for furnaces and boilers, increased rebates overall, and added additional tiers of rebates to its offerings. Incentives must pass from HVAC contractors to consumers, and the incentive appears as a line-item deduction on contractors' installation invoices. Table 4 presents incentives available across PY4 and PY5.

Table 4. Rebate Changes between PY4 and PY5

Measure	Details	PY4 Incentive	PY5 Incentive	Change in Incentive
ASHPs				
ASHP SEER 14.5-14.9	New efficient equipment replacing >SEER 10	$150	$150	$0
	Early replacement of SEER 10 or less	$400	$450	$50
ASHP SEER 15.0-15.9* (No 15.0 baseline in PY4)	New efficient equipment replacing >SEER 10	$150	$200	$50
	Early replacement of SEER 10 or less	$400	$500	$100
ASHP SEER 16+	New efficient equipment replacing >SEER 10	$200	$300	$100
	Early replacement of SEER 10 or less	$600	$600	$0
GSHPs				
Ground Source HP	Installing a new GSHP	$600	$600	$0
CACs				
CAC SEER 14.5-14.9	New efficient equipment replacing >SEER 10	$100	$150	$50
	Early replacement of SEER 10 or less	$250	$450	$200
CAC SEER 15.0-15.9* (No 15.0 baseline in PY4)	New efficient equipment replacing >SEER 10	$100	$200	$100
	Early replacement of SEER 10 or less	$250	$500	$250
CAC SEER 16+	New efficient equipment replacing >SEER 10	$125	$300	$175
	Early replacement of SEER 10 or less	$350	$600	$250
Gas Furnaces				
Gas Furnace[3] 92% AFUE	New efficient equipment replacement	$125	not offered	N/A
Gas Furnace ≥95%AFUE	New efficient equipment replacement	$200	$200	$0
	Early replacement	not offered	$400	$400
Gas Furnace ≥97% AFUE	New efficient equipment replacement	$200	$300	$300
	Early replacement	not offered	$500	$500

Measure	Details	PY4 Incentive	PY5 Incentive	Change in Incentive
ECMs				
Brushless ECM Furnace	New furnace equipped w/brushless DC motor	not offered	$80	$80
Gas Boilers				
Gas Boiler ≥90% AFUE	New efficient equipment replacement	$500	$400	-$100
	Early replacement	not offered	$800	$800
Gas Boiler ≥95% AFUE	New efficient equipment replacement	$500	$500	$500
	Early replacement	not offered	$1,000	$1,000

*These row categories were included for PY4 to have a separate row for the new PY5 rebate.

AIC began offering HVAC incentives in June 2009. To date, the program registered a total of 873 trade allies (up from 811 in PY4), with 517 considered active (meaning they submitted an application during the last 12 months), an increase from 400 in PY4.

During PY5, CSG and AIC continued to market the program to customers, primarily through bill inserts and direct mailings, along with some radio and print media. CSG also actively reached out to and supported registered contractors, using established marketing networks by hosting informational meetings and participating in regional trade shows to increase visibility. CSG provided training, brochures, and marketing materials to support participating HVAC contractors.

Contractors need not take the training to participate. Training informs contractors how to use the program, offers marketing tips, and encourages use of industry best practices and North American Technician Excellence (NATE) certification.[3] To become a Registered Program Ally, contractors must submit insurance documentation, proof of workman's compensation, and W-9 forms.[4]

[3] NATE is the nation's largest nonprofit certification organization for HVAC and refrigeration technicians. NATE is a technician certification organization that is governed, owned, operated, developed, and supported by the HVACR industry (http://www.natex.org/about-nate/).

[4] The State of Illinois does not require HVAC contractors to be licensed.

3. Evaluation Methods

3.1 Data Sources and Analytical Methods

The evaluation team used process and impact evaluation tools to assess the PY5 HVAC Program. Table 5 summarizes PY5 evaluation research activities.

Table 5. Summary of Evaluation Methods

Task	PY5 Impact	PY5 Process	Forward Looking	Details
Program Staff In-Depth Interviews		√	√	Interviewed AIC and CSG managers to understand goals, progress to date, program changes from PY4, successes, challenges, and future plans.
Document Review	√	√		Reviewed rebate applications to verify tracking database information, and reviewed program marketing documentation.
Participant Survey	√	√	√	Surveyed 210 participants to verify installation, assess program satisfaction, and assess NTGR. Stratified surveys to attain a representative sample across CACs, heat pumps, and furnaces.
Non-Active Registered Contractor Survey	√	√	√	Assessed spillover, reasons for nonparticipation, baseline dual replacement activity, and the program's influence on the market from 65 contractors.
Site Visits			√	Collected meter data from 48 cooling systems and 48 heating systems. Assessed AIC contractor installation practice quality.
Engineering Analysis and Database Review	√	√		Summarized database information to determine program participation, develop key statistics about the program, and calculate savings impacts using TRM.

3.1.1 Process Analysis

The evaluation team analyzed program materials and used information gathered from stakeholder interviews to understand program processes and to identify improvement opportunities. The HVAC Program implementation model still accurately reflects current program implementation steps and actors. AIC has not changed the participation process since PY4.

Data gathered from the participant survey aided in assessing how customers learned of the program and how satisfied they remain with the program. Data gathered from the NAR survey provided insights into NAR contractor activity, spillover, and baseline activity related to simultaneous replacements of heating and cooling systems, when one system fails but the other remains working.

Stakeholder Interviews

To assess the program's effectiveness and implementation, the evaluation team conducted interviews with AIC's program manager and CSG's HVAC implementation manager. Stakeholder interviews addressed the program's design, changes made to design and operations (and the reasons why), marketing efforts, implementation barriers, and communications.

Participating Customer Survey

In December 2012 and March/April 2013, the evaluation team conducted a telephone survey of 210 customers who purchased new HVAC products and received incentives offered through the HVAC Program during PY5. The survey split the group into two different waves to reach customers soon after their purchases. Surveys also verified program participation and product installation, and assessed participants' satisfaction with the program, which contractors they used, and what incentives they received.

The evaluation team selected the sample size to produce performance metric estimates at the 90% confidence and ±15% precision at the measure category level and ±5.7% precision overall. We segmented the survey participants into the following strata to determine whether free ridership varied by major equipment category, and, for cooling equipment, whether it varied by ER versus replace on burnout (RB):

- ER CACs and Heat Pumps, SEER <16
- RB CACs and Heat Pumps, SEER <16
- ER CACs and Heat Pumps, SEER 16+
- RB CACs and Heat Pumps, SEER 16+
- 95%-96.5% efficient gas furnaces and 90%-96.5%+ gas boilers
- 97%+ gas furnaces or boilers

At the time of the survey few early-replacement gas heating system customers had participated, so we did not separate heating systems by ER versus RB.

NAR Contractor Survey

Between April 22 and May 3, 2013, the evaluation team conducted a telephone survey of all 424 NAR contractors provided by CSG. We stratified the list into 179 registered contractors that had never submitted a rebate application, and 245 that participated in previous program years but not from April 2012 to March 2013.[5]

Within each NAR contractor stratum, we exhausted the list in an attempt to obtain 70 completed interviews—achieving 65. The evaluation team made four to eight attempts to reach each contractor, and offered them each a $25 gift card to participate in the survey. We designed the

[5] NAR contractors had not participated in the program during the previous 12 months. Since the survey was conducted in April, the inactivity period covered the 12 months prior to that date, not the dates of the PY (June–May).

surveys to assess contractor awareness, program experience, baseline equipment replacement practices, and/or reasons for nonparticipation.

Marketing Materials Review

The HVAC Program's marketing efforts include the program website, direct marketing to customers, and marketing support materials for contractors.

The evaluation team reviewed all marketing and communications materials (provided by AIC) to assess the clarity and effectiveness of each piece vis-à-vis its intended purpose and audience. To do so, we reviewed materials based on the following six best practice elements for marketing materials:[6]

- Clear and comprehensive program information
- Messaging that is compelling and appropriate for the target audience
- Branding or a "look and feel" consistent with other program materials
- Professionalism in communications (e.g., easy to read, properly formatted, free of errors)
- Presence of a clear call-to-action
- Presence of easy next steps for participation

Database Analysis

CSG tracks retail sales of efficient products using a database that ties payment requests to identified transactions, and tracks the following:

- Program activity by product
- Program activity on an aggregated basis of products incented and dollars spent
- Program activity by various identified components (e.g., product, fuel type, month)

CSG also tracks contractor activity to separate NAR from active contractors and distributors. Fields in the database shared with the evaluation team included the following:

- HVAC company and contractor contact information
- HVAC company by the number of gas and electric applications and type of units sold
- Date of entry to the program and date of last participation

The database also records whether the contractor participated in trainings or the PY5 rollout meeting, and whether they signed the additional agreement regarding use of the AIC logo.

[6] The evaluation team developed these best practice elements based on findings from numerous evaluations of utility marketing efforts and materials, and from the Association of Energy Services Professionals' presentations, members' portal, and strategic marketing course.

The evaluation team reviewed the database's content, quality of data entry, and energy savings assumptions, and summarized and analyzed the transactions to compute relevant totals for PY5.

3.1.2 Impact Analysis

Document Review

To verify savings, the evaluation team selected a random sample of 35 gas and 35 electric PY5 program participants for document review. Each electric customer application (either HP or CAC) required an Air Conditioning, Heating, and Refrigeration Institute (AHRI) certificate to receive an incentive. The evaluation team searched for AHRI numbers in the online database to identify values that did not match the equipment specified on the rebate applications.

Finally, the team reviewed the efficiency estimates for any ER measures receiving a document review, examining values serving as inputs to TRM algorithms used to estimate savings. These values include:

- Location (ZIP code)
- Efficiency (AFUE or SEER)
- Heating capacity (BTUhs)
- Cooling capacity (tons)

The evaluation team also reviewed the invoices to confirm that model numbers match the values reported in the HVAC Program database and the numbers in the AHRI database. Phone interviews used questions asking program participants about the system they installed, confirming whether it matched the reported measure. The evaluation team could verify the measure type, but not the specific details necessary to accurately calculate savings. The phone verification only indicated whether the type of measure reported was accurate, with a verification rate of 100%.

Engineering Review and Analysis of Database

The evaluation team used all applicable algorithms and methodologies from the Illinois Statewide TRM, effective June 1, 2012, to estimate the savings of measures reported.

Selecting Appropriate Weather Zone

The evaluation team used the ZIP codes for each reported measure to determine the appropriate weather zone for each site. We mapped GIS coordinates of each ZIP code, and calculated the distance to each weather zone, selecting the weather zone with the shortest distance to each ZIP code. The TRM provided the following values for the five weather zones shown in Table 6 below.

Table 6. TRM Weather Zone Full-Load Hours and Gas Consumption

Weather Zone (City Based Upon)	FLH Cool	FLH Heat	Gas Boiler Load (Therms)	Gas Furnace Heating Load (Therms)
1 (Rockford)	512	1,969	1,275	843
2 (Chicago)	570	1,840	1,218	806
3 (Springfield)	730	1,754	1,043	690
4 (Belleville)	1,035	1,266	805	532
5 (Marion)	903	1,288	819	542
Weighted Average*	629	1,821	1,158	766
*Weighting based on the number of occupied residential housing units in each zone.				

The TRM uses full-load heating and cooling hours to estimate electric energy savings. It uses gas consumption values in therms to estimate savings from high-efficiency furnace and boiler measures.

Approximately 3% of measures lacked ZIP codes or could not be mapped to the closest weather station. When this occurred, the team used the weighted average, specified in Table 6 above, as directed by the TRM savings calculation methodology.

Calculating Central AC Savings

CACs RB

To calculate energy savings from CACs, the team used the federal minimum efficiency values of 13 SEER and 11 EER in the TRM algorithms:

Equation 1.

$$\Delta kWh = \frac{FLH_{cool} * Btuh * \left(\frac{1}{SEER_{Base}} - \frac{1}{SEER_{EE}}\right)}{1{,}000}$$

Equation 2.

$$\Delta kW = \frac{Btuh * \left(\frac{1}{SEER_{Base}} - \frac{1}{SEER_{EE}}\right)}{1{,}000} * CF$$

The team used the actual reported AHRI SEER value, cooling Btuh's (or tons x 12,000 Btuh/ton), and the appropriate full-load cooling hour value, selected using the method described above. EER was required to estimate demand savings. If the program-tracking database did not report the EER, the team used the following algorithm, provided in the TRM, to estimate EER from SEER:

Equation 3.

$$\text{EER} = -0.02 * SEER^2 + (1.12 * \text{SEER})$$

ER CACs

To calculate energy savings from ER CACs, the team used the baseline efficiency (SEER) reported in the tracking database—a nameplate efficiency estimate of the existing system, recorded by the HVAC contractor submitting the rebate. We assumed nameplate efficiency would be reasonably conservative, as HVAC system efficiency degrades over time. If the baseline SEER value could not be determined, the team used the average of the reported existing SEER values (which averaged 8.5 for CACs). We believe this is a conservative estimate because in many cases if SEER was not recorded it was because it was not readable. The team believes use of the average of known existing SEER values is conservative since it is likely the oldest units that are least readable.. We applied Equations 1 and 2 above to estimate savings.

To estimate savings of the new system, the team used the actual reported AHRI SEER value, cooling Btuh (or tons x 12,000 Btuh/ton), and the appropriate full-load cooling hour value, selected using the method described above. Estimating demand savings required EER. If the program-tracking database did not report the EER, the team used Equation 3 above, which estimates EER from SEER.

Calculating Central ASHP Savings

Central Heat Pumps RB

To calculate energy savings from ASHPs, the team used the federal minimum efficiency values of 13 SEER, 11.2 EER, and 7.7 HSPF in the TRM algorithms, as in shown in Equations 4 and 5 below:

Equation 4.

$$\Delta kWh = \frac{FLH_{cool} * Capacity_{cooling} * \left(\frac{1}{SEER_{Base}} - \frac{1}{SEER_{EE}}\right)}{1{,}000} + \frac{FLH_{heat} * Capacity_{heating} * \left(\frac{1}{HSPF_{Base}} - \frac{1}{HSPF_{EE}}\right)}{1{,}000}$$

Equation 5.

$$\Delta kW = \frac{Btuh * \left(\frac{1}{EER_{Base}} - \frac{1}{EER_{EE}}\right)}{1{,}000} * CF$$

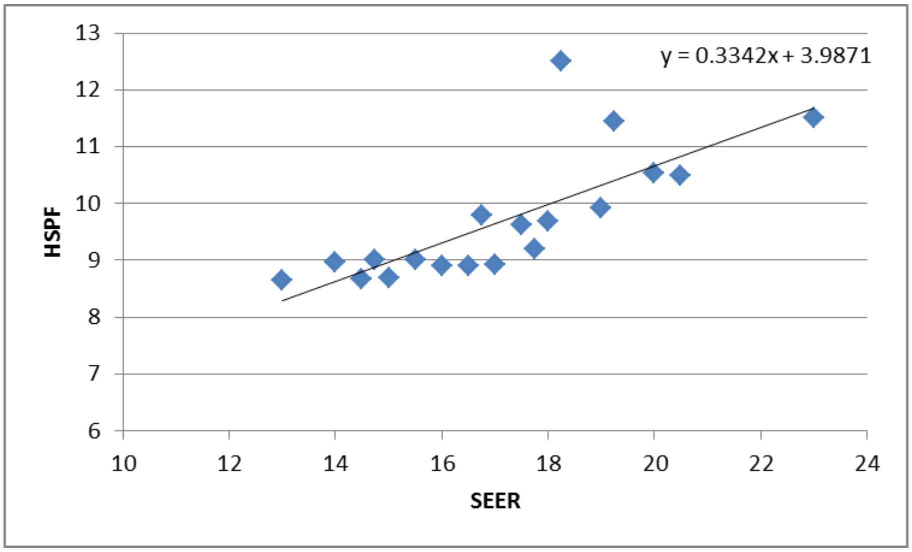
The team used the actual reported AHRI SEER value, cooling and heating Btuh (or tons x 12,000 Btuh/ton), and the appropriate full-load cooling and heating hour values, selected using the method described above. Only about 40% of the measures reported HSPF, a value needed to estimate savings. Hence, the team estimated HSPF using the following method.

The team grouped SEER values by 0.25 SEER point,[7] and plotted SEER values versus the average HSPF for each SEER group to develop a linear regression. We used SEER and HSPF values from 221 reported measures to estimate the HSPF of 301 measures that reported SEER but not HSPF. Figure 1 below shows the linear regression model. If the measure replaced electric resistance heat, the team used an HSPF of 3.412.[8]

[7] We rounded SEER values not in increments of 0.25 to the nearest 0.25 SEER point; a 16.2 SEER system was rounded to 16.25.

[8] Electric resistance heat has a Coefficient of Performance (COP) of 1.0: all energy consumption turns into usable heat, which is equivalent to 3.412 BTUh/watt-hr.

Figure 1. Rated SEER versus HSPF from the Database



The team required EER to estimate demand savings. If the program-tracking database did not report EER, the team used the algorithm provided in the TRM, which estimates EER from SEER using Equation 3 above.

ER Central Heat Pumps

To calculate energy savings from central ASHPs, the evaluation team used the baseline efficiency (SEER) reported in the tracking database (the nameplate efficiency estimate of the existing system as recorded by the HVAC contractor submitting the rebate). We assumed the nameplate efficiency provided a reasonably conservative estimate, as HVAC system efficiencies degrade over time. If SEER was not known, the team used the average of the reported existing SEER values (which averaged 8.6 for ASHPs). We believe this is a conservative estimate because in many cases if SEER was not recorded it was because it was not readable. The team believes use of the average of known existing SEER values is conservative since it is likely that the oldest units are also the least readable.

As existing system HSPF was not reported, the evaluation team used the regression in Figure 1 with reported existing equipment SEER values to calculate HSPF. The average resulting HSPF value was 6.89. The TRM requires use of “the actual HSPF rating where it is possible to measure or reasonably estimate.” Otherwise, the TRM advises the use of a “default of 6.8 HSPF, a VEIC estimate based on minimum Federal Standard between 1992 and 2006.” The use of the regression above results in a very similar, but more representative HSPF estimate. We used an HSPF of 3.412 if the measure replaced electric resistance heat. We used Equations 4 and 5 above to estimate savings.

To estimate savings of the new system, the evaluation team used the actual reported AHRI SEER value, cooling Btuh (or tons x 12,000 Btuh/ton), and the appropriate full-load cooling and heating hour values, selected using the method described above.

If the new system's HSPF was not reported, the evaluation team used the linear regression of SEER versus HSPF (shown in Figure 1 above). Estimating demand savings requires the EER. If the program-tracking database did not report the EER, the evaluation team used the algorithm provided in the TRM, which estimates EER from SEER.

Calculating GSHP Savings

To calculate energy savings from GSHPs, the evaluation team used the federal minimum efficiency values of 13 SEER, 11 EER, and 7.7 HSPF in the following TRM algorithms:

Equation 6.

$$\Delta kWh = \frac{FLH_{cool} * Btuh_{cooling} * \left(\frac{1}{SEER_{Base}} - \frac{1}{SEER_{EE}} * 1.02\right)}{1{,}000} + \frac{FLH_{heat} * Btuh_{heating} * \left(\frac{1}{HSPF_{Base}} - \frac{1}{COP_{EE}} * 3.412\right)}{1{,}000}$$

Equation 7.

$$\Delta kW = \frac{Btuh_{cooling} * \left(\frac{1}{EER_{Base}} - \frac{1}{EER_{EE}}\right)}{1{,}000} * CF$$

The method described above provided full-load heating and cooling hours. The evaluation team used the reported COP and EER values of the new systems to estimate savings for each measure reported.

Calculating ECM Fan Savings

As the program-tracking database included project IDs and service account information, participants receiving multiple measures could be identified—a necessary step for any participant receiving both an ECM fan and a high-efficiency furnace. The TRM requires an adjustment to therms saved due to the reduced waste heat of an ECM during the heating season, specifying the equation as:

Equation 8.

$$\Delta therm = -ECM_{Heating\ savings} * 0.03412\ Therms/kWh$$

The evaluation team identified each gas furnace measure that also received an ECM fan incentive, and subtracted the interactive effects defined by Equation 8 above.

To calculate electric energy savings from ECM measures, the evaluation team used the TRM algorithm:

Equation 9.

$$\Delta kWh = ECM_{heating\ \ savings}\, ECM_{cooling\ savings} + ECM_{shoulder\ \ savings}$$

Heating savings were fixed at 418 kWh, shoulder season savings were fixed at 51 kWh, and cooling savings were either 263 kWh (if installed with a central cooling system) or 175 kWh (without a cooling system). If unknown, cooling savings equaled the weighted average of 241 kWh. The evaluation team used either 263 kWh (if the tracking database indicated the presence of a central cooling system) or 241 kWh (if the presence of a central cooling system could not be determined).

The following TRM algorithm was used to determine demand savings:

Equation 10.

$$\Delta kWh = \frac{Cooling\ Savings}{FLH_{Cooling}} * CF$$

Using the method described above, the evaluation team determined the weather zone for every ECM measure, based on the associated ZIP code, to determine the full-load cooling hours.

Calculating Gas Furnace and Boiler Savings

The TRM estimated therms savings for gas boilers using the algorithm:

Equation 11.

$$\Delta therms = Gas_{Boiler_{Load}} * \left(\frac{1}{AFUE_{Base}} - \frac{1}{AFUE_{EE}}\right)$$

It estimated therms savings for gas furnaces using the algorithm:

Equation 12.

$$\Delta therms = Gas_{Frurnacer_{Load}} * \left(\frac{1}{AFUE_{Base}} - \frac{1}{AFUE_{EE}}\right)$$

Table 6 above provides gas boiler and furnace load therm estimates. The evaluation team mapped weather zones associated with the ZIP codes reported for every measure included using the previously described method. We used the actual reported AFUE to estimate savings. Gas furnaces and boilers had a baseline AFUE of 0.8, as specified in the TRM.

For ER measures, the evaluation team used AFUE estimates of 0.60 for boilers and 0.70 for gas furnaces. From PY3-PY5, CSG reported 66 existing boilers with operating efficiencies averaging 0.60 AFUE. The evaluation team considers this a reasonable value for an existing boiler operating and replaced before the end of its useful life.

During the same period, CSG reported the AFUE of existing systems for 2,559 gas furnaces, with an average AFUE of 0.64. Our data review indicates that many reported AFUE values were derived from contractor estimates and may not be reliable (e.g. one contractor reported a 20% AFUE). The evaluation team performed an engineering review of reported baseline AFUE values by looking at the age of the unit, typical degradation over time, and efficiency standards for the age of the unit. Any values that were unreasonably low or high were removed from the database. The remaining values were averaged to estimate a baseline efficiency for early replacement furnaces. The resulting efficiency was 62.5 AFUE. According to ACEEE, a furnace installed before 1992 probably has an efficiency of approximately 65 AFUE. The average AFUE is similar to this value so we believe it is a fair representation of the baseline efficiency of an existing gas furnace.

Net Impacts

As specified by the NTGR framework described in the ICC Order for Docket 10-0568, net savings were estimated using NTGRs of 0.59 for electric measures (ASHPs, CACs, GSHPs, and ECMs), 1.02 for gas furnaces, and 1.01 for gas boilers.[9] These values were based on the PY3 evaluation results and are used for both early-replacement and replace-on-burnout measures.

3.2 Sampling and Survey Completes

The following sections summarize the:

- Telephone survey and sampling approach; and
- Document reviews and database verifications completed.

The evaluation team conducted each verification activity separately (i.e., telephone surveys, document reviews, and the database review used different participants).

3.2.1 Participant Telephone Surveys

The evaluation team used telephone surveys to assess program satisfaction and to obtain customer feedback about decision-making and program characteristics The survey used a sample size of 210 electric and gas participants to meet the 90% confidence at ±5.7% precision threshold overall.

Table 7 shows the number of telephone surveys by project type: 45% of surveyed customers purchased both gas and electric measures (not including ECM motor customers).

[9] PY3 NTGR estimates for all measures included spillover.

Table 7. Completed HVAC Program Satisfaction Surveys

Measure Type	Population (at the Time of Sampling)*	Fall 2012	Spring 2013	Telephone Survey Completes (Total)
Gas Furnace 97% AFUE	368	12	18	30
Gas—All Others	4,060	12	18	30
Electric CAC/HP Early Replacement < SEER 16	548	22	8	30
Electric CAC/HP Early Replacement > SEER 16	467	22	8	30
Electric CAC/HP RB < SEER 16	567	22	8	30
Electric CAC/HP RB > SEER 16	509	22	8	30
Electric—Brushless Motor	1,218	12	18	30
Total	**7,737**	**124**	**86**	**210**

*Survey sampling occurred in October and March (see the next section).

Survey Dispositions and Response Rates

The evaluation team fielded the HVAC Program participant survey in two waves: December 11 to December 20, 2012, and March 27 to April 4, 2013. Table 8 provides the final survey dispositions.

Table 8. HVAC Combined Customer Survey Dispositions

Disposition	N
Completed Interviews (I)*	210
Partial Interviews (P)	46
Eligible Non-Interviews	785
Refusal (R)	*268*
Respondent never available (NC)	*175*
Telephone answering device (NC)	*339*
Language problem	*3*
Not Eligible (e)	311
Duplicate number	*2*
Fax/data line	*6*
Non-working	*181*
Wrong Number	*43*
Business/government/other	*19*
No eligible respondent	*5*
Quota filled	*55*
Unknown Eligibility Non-Interview (U)	460
No answer	*426*
Call blocking	*1*
Busy	*14*
Not attempted or worked	*19*
Total Numbers Used	**1,812**

* Letters in parentheses are used in the equations that follow.

Table 9 provides response and cooperation rates. The survey response rate equaled the number of completed interviews divided by the total number of potentially eligible respondents in the sample.

We calculated the response rate using the standards and formulas set forth by The American Association for Public Opinion Research (AAPOR).[10]

Table 9. HVAC Participant Survey Response and Cooperation Rates

AAPOR Rate	Results
Response Rate	15%
Cooperation Rate	40%

For various reasons, we could not determine the eligibility of all sample units through the survey process, and chose to use AAPOR Response Rate 3 (RR3). RR3 included an estimate of eligibility for the unknown sample units. The equations used to calculate RR3 follow below. Table 8 above includes the definitions of the letters used in the equations.

Equation 1 $E = (I + R + NC) / (I + R + NC + e)$

Equation 2 $RR3 = I / ((I + R + NC) + (E*U))$

The evaluation team also calculated a cooperation rate—the number of completed interviews divided by the total number of eligible sample units actually contacted. In essence, the cooperation rate provided the percentage of participants completing an interview out of all participants with whom we actually spoke. We used AAPOR Cooperation Rate 3 (COOP3), calculated as:

Equation 3 $COOP3 = I / (I + P + R)$

NAR Contractor Survey

The evaluation team used telephone surveys to assess contractor awareness, program experience, baseline equipment replacement practices, spillover, market effects, and reasons for low or nonparticipation. The surveys received an overall 24% response rate. Table 10 provides results by strata. Table 11 below provides survey disposition and response rate details.

Table 10. Completed NAR Contractor Surveys

NAR Contractor Group	Population	Target Complete	Actual Complete
Stratum 1: Never active	179	*35*	23
Stratum 2: Not active in PY5	245	*35*	42
Total	**424**	**70**	**65**

The evaluation team initially attempted to complete 70 interviews out of the total 424 NAR contractors available. We had to call each contractor multiple times to achieve 65 completes, and were not able to complete all 70 planned.

Because we called the full NAR contractor population we did not pull a sample, and therefore could not have sampling error.

[10] The American Association for Public Opinion Research. *Standard Definitions: Final Dispositions of Case Codes and Outcome Rates for Surveys.* Revised 2011. Available online: http://www.aapor.org/AM/Template.cfm?Section=Standard_Definitions2&Template=/CM/ContentDisplay.cfm&ContentID=3156.

Survey Dispositions and Response Rate

The evaluation team fielded the survey with HVAC contractors from April 22 through May 3, 2013. Table 11 below provides the final survey dispositions.

Table 11. HVAC Contractor Survey Dispositions

Disposition	N
Completed Interviews (I)[a]	80
Usable Interviews	65[b]
Partial Interviews (P)	6
Eligible Non-Interviews	234
Refusal (R)	*73*
Respondent never available (NC)	*70*
Telephone answering device (NC)	*91*
Not Eligible (e)	76
Duplicate number	*2*
Fax/data line	*8*
Non-working	*41*
Wrong number	*17*
Business/government/other	*3*
No eligible respondent	*5*
Unknown Eligibility Non-Interview (U)	19
No answer	*17*
Call blocking	*1*
Busy	*1*
Total Numbers Used	**415[c]**

a The equations below use the letters in parentheses.

b We discarded 15 interviews after determining that contractors did not understand certain questions. We reworded those questions for the remaining interviews. A final count of 65 usable, complete interviews resulted.

c We removed nine numbers from the original sample, as one did not have a phone number and the remaining eight were duplicates.

Table 12 provides the response and cooperation rates. The survey response rate equals the number of completed interviews divided by the total number of potentially eligible respondents in the sample. We calculated the response rate using standards and formulas set forth by AAPOR.[11]

[11] The American Association for Public Opinion Research. *Standard Definitions: Final Dispositions of Case Codes and Outcome Rates for Surveys.* Revised 2011. Available online: http://www.aapor.org/AM/Template.cfm?Section=Standard_Definitions2&Template=/CM/ContentDisplay.cfm&ContentID=3156.

Table 12. HVAC Program NAR Contractor Survey Response and Cooperation Rates

AAPOR Rate	Results
Response Rate	24%
Cooperation Rate	50%

For various reasons, we could not determine the eligibility of all sample units through the survey process; hence, we chose to use AAPOR Response Rate 3 (RR3). RR3 included an estimate of eligibility for these unknown sample units. The equations used to calculate RR3 follow (Table 11 above provides the definitions of the letters used in the formulas):

Equation 4 E = (I + R + NC) / (I + R + NC + e)

Equation 5 RR3 = I / ((I + R + NC) + (E*U))

We also calculated a cooperation rate: the number of completed interviews divided by the total number of eligible sample units actually contacted. Essentially, the cooperation rate provided the percentage of participants completing an interview out of all participants with whom we actually spoke. We used AAPOR Cooperation Rate 3 (COOP3), calculated as:

Equation 6 COOP3 = I / (I + P+ R)

3.2.2 Document Verification

To verify savings, the evaluation team selected a random sample of 35 electric and 35 gas customers for a document review. Table 13 shows the number of samples chosen from each measure type.

Table 13. Completed Document Reviews

Measure Type	Projects	Document Reviews
Central AC	3,871	28
ASHP	543	2
GSHP	227	5
Gas Furnace	5,869	35
Total	**10,510**	**70**

4. Results and Findings

4.1 Process Findings

The evaluation team addressed the following researchable questions, as specified in the evaluation plan:

- Is the program meeting its goals?
- Are program design and implementation processes effective?
- Are marketing materials designed according to best practices?
- Did this program motivate or was this program's participation motivated by participation in other AIC programs?
- How satisfied are participants with the program?
- What participation barriers exist?
- What have been the program's market effects? Has progress been made toward market transformation?

We also investigated the following additional areas, which were not included in the evaluation plan:

- What is the baseline for contractor recommendations of simultaneous equipment replacement?
- To what degree would equipment rebates influence this baseline of dual replacement activity?

4.1.1 Program Accomplishments

The evaluation team reviewed program goals and provided a summary of results to date, using the program database and the implementation plan prepared prior to PY4. Per program staff, while the implementation plan set forth program-specific targets, these did not prove critical to achieve as long as the complete portfolio of programs met its goals. Targets included gas savings, electric savings, and incentive dollars spent.

Program staff reported that the HVAC Program met 70% of its gas targets (1.3M therms) and 88% of its electric targets (6,089 MWh) in PY5. Program staff considered the targets reasonable this year, though target achievability may have been impacted by the late launch of the new PY5 measures (gas furnace and boiler ER incentives and the furnace fan ECM). Both AIC's gas and electric offerings maintained about the same levels of customer participation as in PY4. As shown in Table 14 below, the number of incentives AIC provided for these measures in PY4 dropped significantly compared to PY3. In PY3 (which included CY2010), customers could obtain federal tax credits up to $1,500 for heating and cooling equipment; this American Recovery and Reinvestment Act (ARRA) tax credit level remained available for 2009 and 2010, but fell in 2011 to a maximum of $500. Table 14 also shows the proportion of incentives going to early-replacement (ER) measures.

Table 14. Program Participation and Ratio of ER to Total Measures PY3-PY5[a]

Measure Type	PY3	PY4	PY5
CAC/ASHP Measures	11,939	4,502	4,408
% Early-Replacement	82%	74%	69%
Gas Measures	8,995	5,610	5,930
% Early-Replacement	NA	NA	11%[b]
Total	**20,934**	**10,112**	**10,338**

a This table focuses on measures with ER incentives. Therefore, it does not include measures without ER options (GSHP, ECMs, and Visa Incentives).
b Gas ER measures were introduced in November, with an average of 20% from November 2012 to May 2013.

Figure 2 presents the PY5 monthly participation summary for all gas and electric measures. Furnaces and CACs dominated the measure mix, as in PY4. According to program staff, AIC delayed the introduction of ER gas equipment until November 2012 to balance the availability of funding between this program and the Home Energy Performance (HEP) Program. HEP experienced an unexpected surge in participation at the beginning of the program year, resulting in AIC's concerns about meeting customer expectations.

Figure 2. All Measures AIC HVAC Program Summary

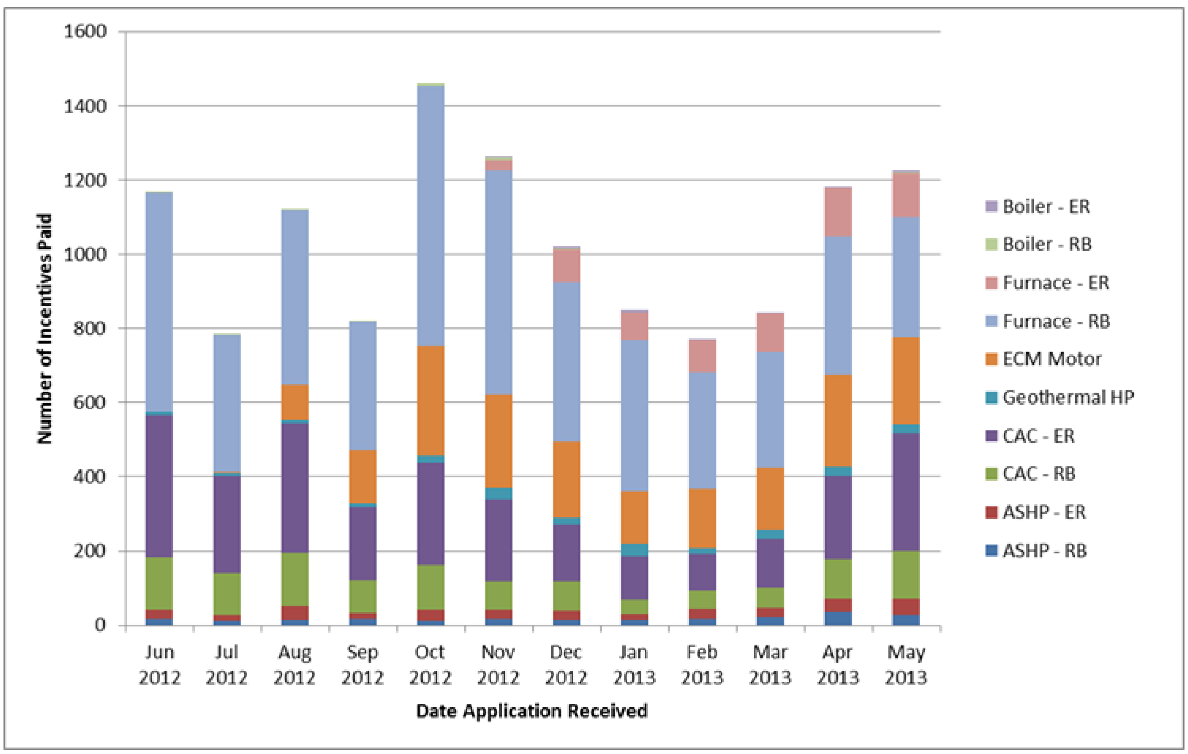


Figure 3 presents PY5 monthly participation by gas measure. Much like PY4, the majority of measures were 95 AFUE furnaces. Program participation appeared to peak twice during the year, in June and October. Program staff reported that early-replacement gas measures were launched in November. Since that time, these measures slowly increased as a proportion of total gas measures, from 5% to 28% by May 2013. Late in 2012, 90% AFUE boilers, which had been removed for PY5, were added back. According to CSG, the AHRI downgraded the 95% AFUE standard to 90% AFUE, due to a problem with variance in equipment testing.

Figure 3. PY5 Monthly Participation—Gas

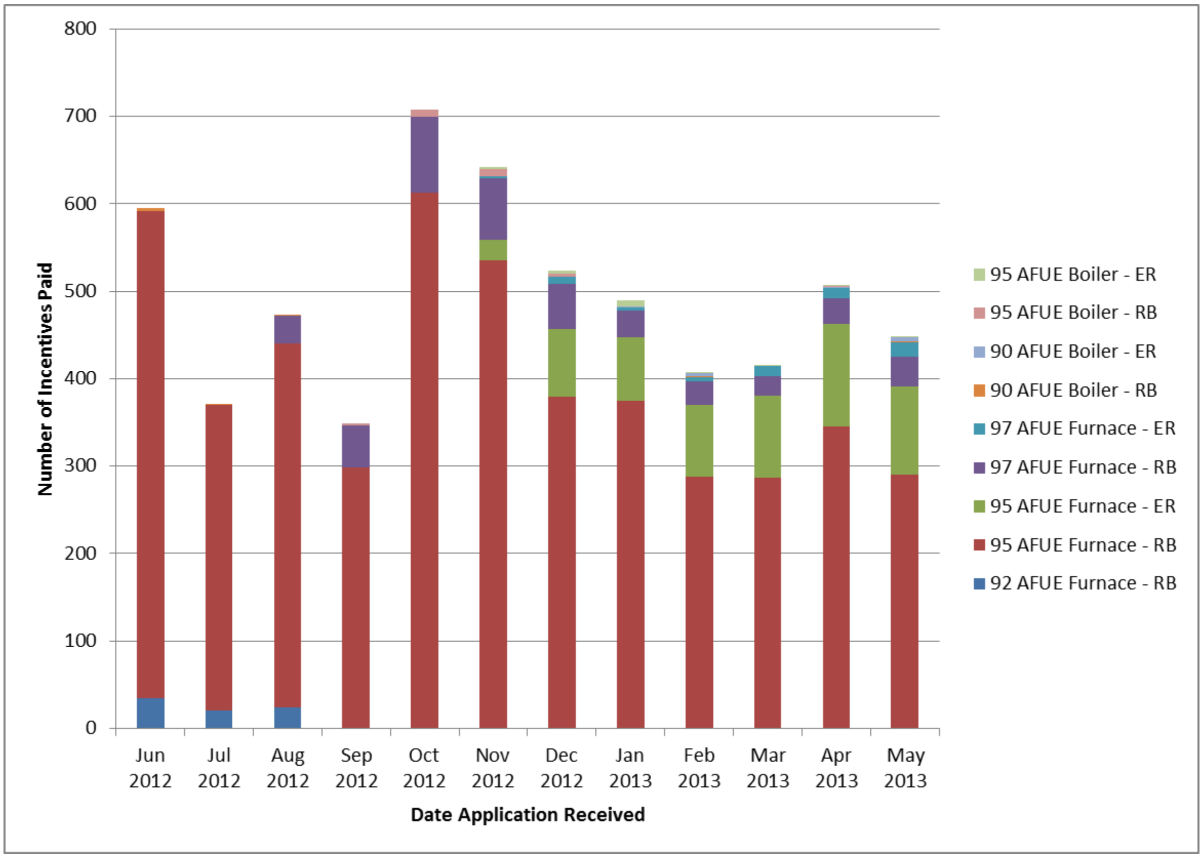


Figure 4 below shows PY5 monthly participation for electric measures. Participation peaked in May and October; the addition of the ECM likely added the second peak, as these units are associated with furnaces. Without the ECM, peaks occurred in June and August, likely driven by summer purchases of air conditioning equipment. ER CACs maintained about 70% of the CAC mix, and ER ASHPs maintained (although somewhat less consistently) about 60% of the ASHP mix.

Figure 4. PY5 Monthly Participation—Electric

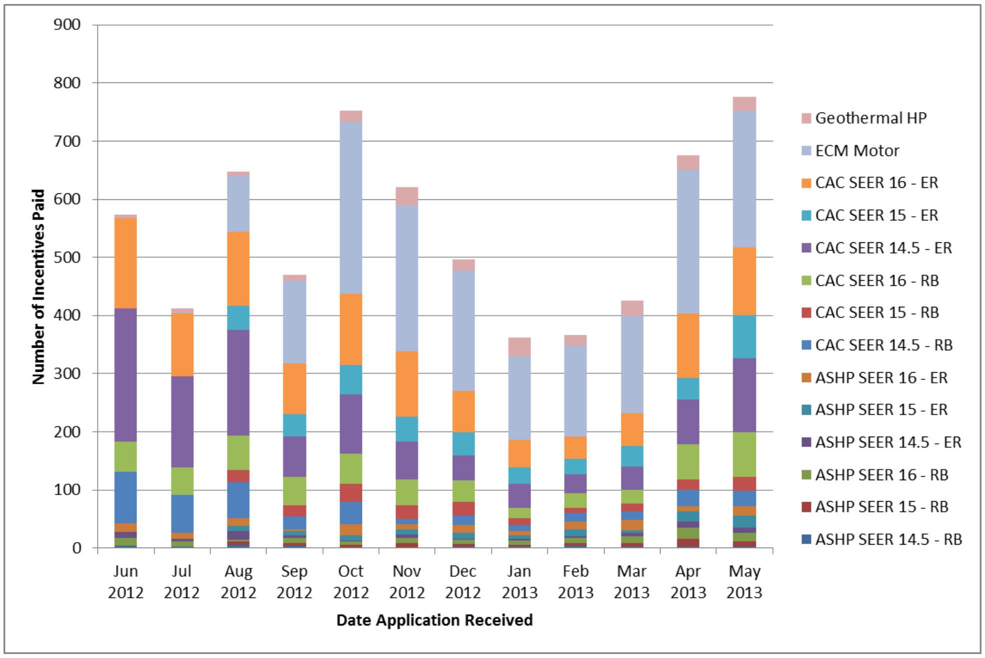
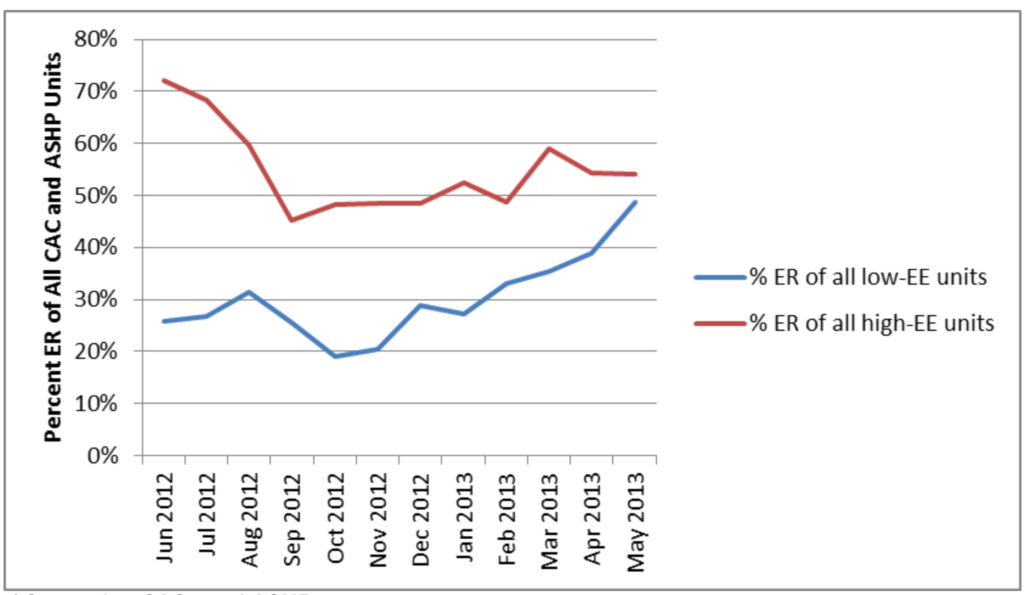


Figure 5 presents combined overall gas and electric measure monthly participation trends for lower-efficiency and high-efficiency ERs versus RBs in PY5 as a percentage of the total. We combined all ER and RB gas and electric units, only splitting out higher- and lower-efficiency levels (high-EE vs. low-EE). The lower-EE category includes 90 AFUE boilers, 92 and 95 AFUE furnaces, and all HPs and CACs below 16 SEER. The high-EE category for PY5 includes 95 AFUE boilers, 97 AFUE furnaces, and the 16+ SEER CACs or ASHPs.

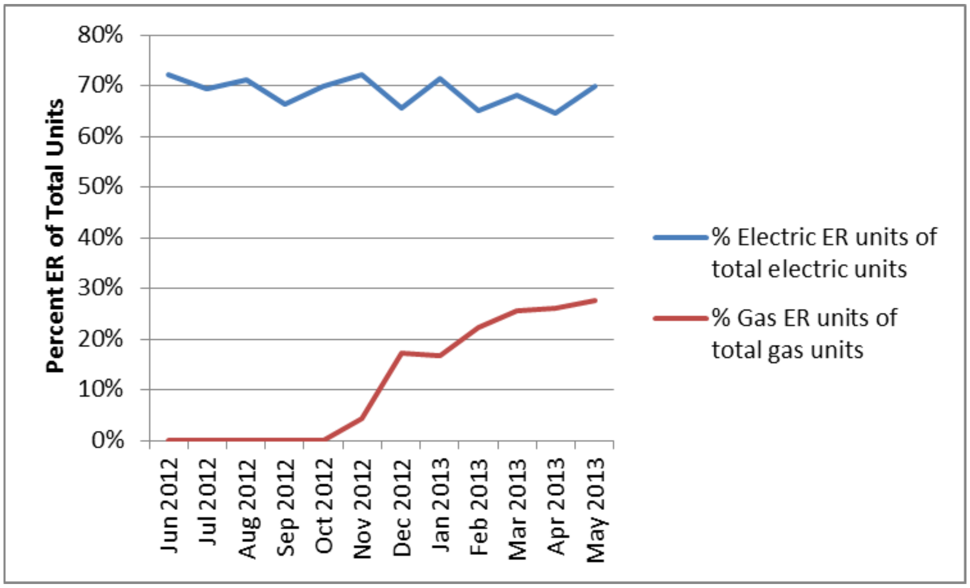
Figure 5. Percent ER Units of Total Low-EE and High-EE Measures by Month*



*Only using CACs and ASHPs.

This data indicates that high-efficiency ER units are a higher percentage of total sales of high-efficiency units, but lower-efficiency ER units have gained popularity. However, the rise between November 2012 and May 2013 may result from the introduction of the ER gas measures, which the 95 AFUE furnace dominated (as shown in Figure 3). On average, ER units accounted for 11% and 69% of gas and electric measures,[12] respectively (as shown in Table 14 above). By comparison, ER units accounted for about 74% of electric measures purchased by participating customers in PY4.[13]

Figure 6. Percent ER Units of Total Electric and Gas Measures by Month



4.1.2 Program Awareness and Satisfaction

To assess program awareness and satisfaction, the evaluation team examined customer and NAR contractor survey results, discussed customer complaint management with program implementers, and investigated AIC's satisfaction with its implementation contractor.

Seventy-five percent (75%) of PY5 HVAC Program customers learned of the program through their contractors, either directly or through a contractor letter. Though a slightly lower result than in the previous year (83%), this still remains higher than in PY3. Figure 7 below summarizes how customers learned of the program.

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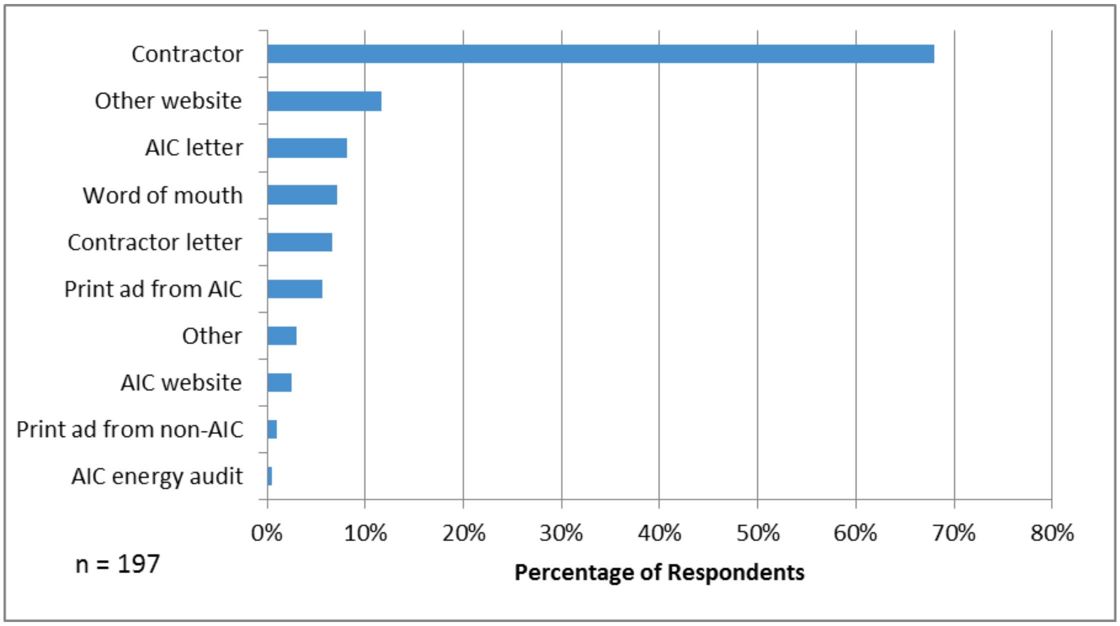
[12] AIC qualifies ER rebates and checks that equipment is functioning at the time of replacement. AIC's verification process includes checking portal, age, model, customer information, and all fields required, then an account manager cross-references to Kelly Blue Book guide to make sure that it qualifies for ER. AIC requires 48 hours to confirm that the measure meets criteria. Some are approved and others are flagged for field check. AIC performs field checks on a random sample: furnaces 20-25%, CAC 10-15%.

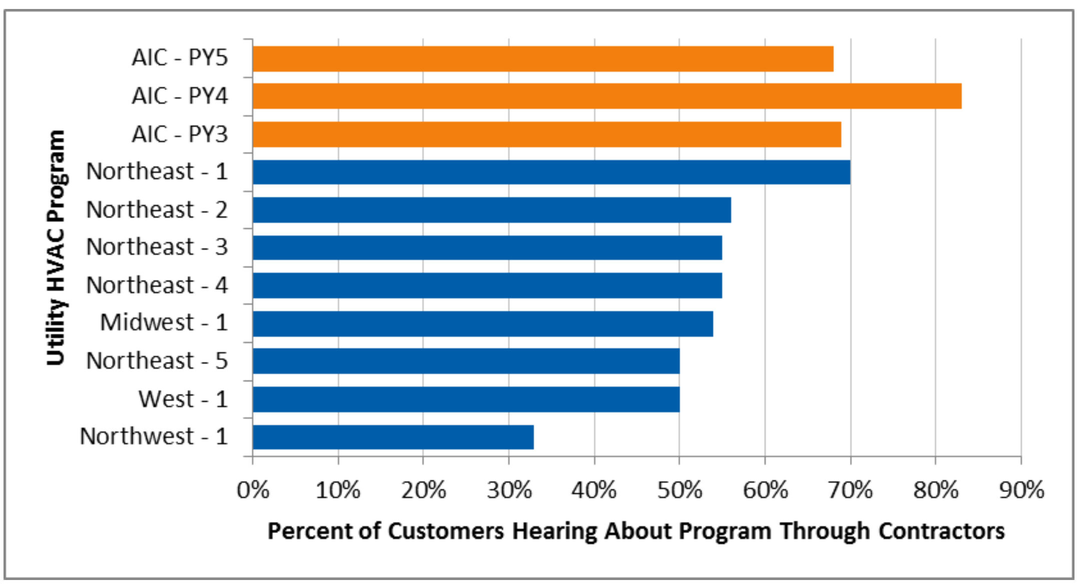
[13] Impact and Process Evaluation of Ameren Illinois Company's Residential HVAC Program (PY4) Final Report. January 2013.

Figure 7. QA1. How Customers Learned of the Program



Other utility HVAC programs evaluated by Cadmus reporting initial awareness through contractors ranged from 33% to 70%.[14] Compared to these other programs, AIC's customers more likely learned of the program through their contractor. This likely resulted from customers only being allowed to participate through a contractor, while in other utility programs, customers could submit rebates directly. See Figure 8 for details.

Figure 8. Utility-Wide Comparison of Customer Awareness through Contractors*

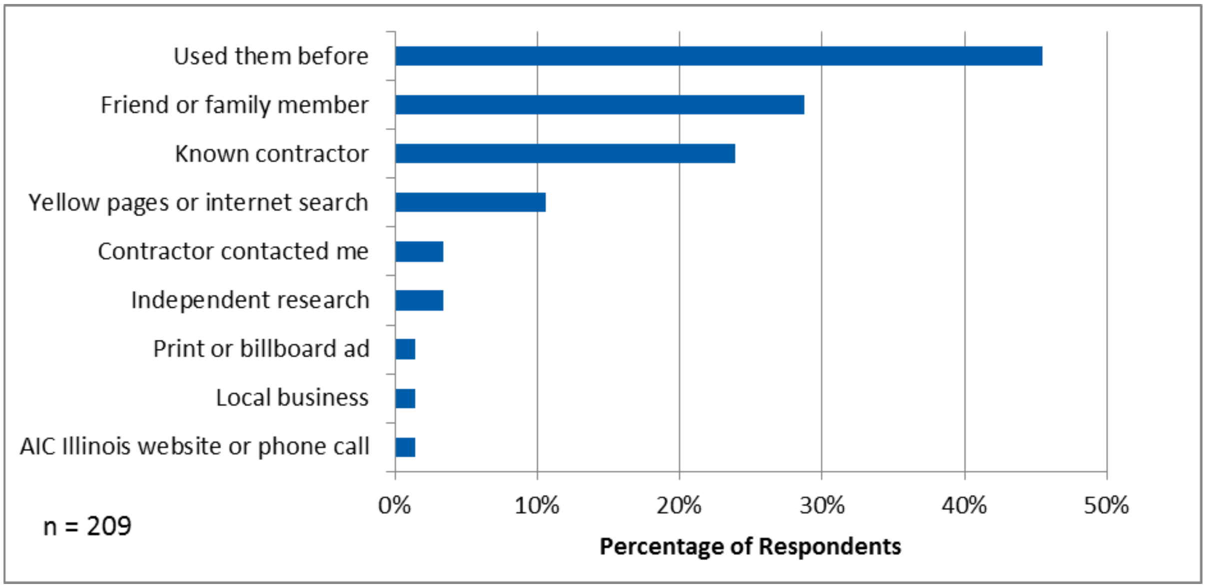


* Unpublished studies evaluated by Cadmus.

[14] These results are based on responses to customer surveys.

Generally, customers already knew of these contractors (69%), had worked with them before (69%), or had them recommended (33%), as shown in Figure 9. Other top entry pathways included AIC sources (17%), other websites (12%), and word of mouth (7%).

Figure 9. QB1. How Customers Found Contractors



Program staff reported that by the end of PY5, the program registered a total of 873 trade allies (up from 811 in PY4), with 517 considered active (meaning they submitted an application during the last 12 months), an increase from 400 in PY4. In PY5, CSG reported signing up 109 new allies, just 1% shy of its goal of adding 20% more new contractors to the program in CY2012.[15]

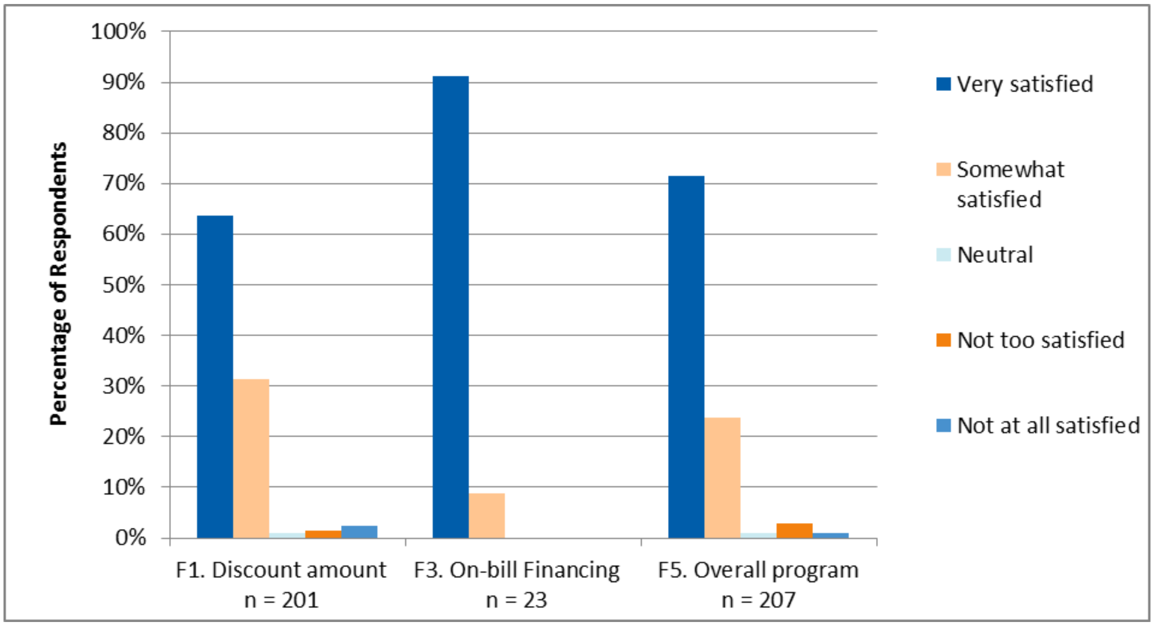
AIC also extended the inactivity period from six to twelve months to account for some smaller contractors in rural areas not installing many furnaces in AIC territory. Contractors continued to play a critical role in program participation, since most installations came through direct contractor sales.

As shown in Figure 10 and Figure 11 below, surveyed customers expressed strong satisfaction with the program and its contractors, with 95% either very satisfied (71%) or satisfied (24%). We averaged HVAC overall program satisfaction across nine programs throughout the country, providing a benchmark of 93%.

In PY5, CSG and AIC program staff expressed strong satisfaction with the increase in trade ally engagement, characterizing communications and relations as greatly improved. CSG, however, continues to seek increased engagement of NAR contractors.

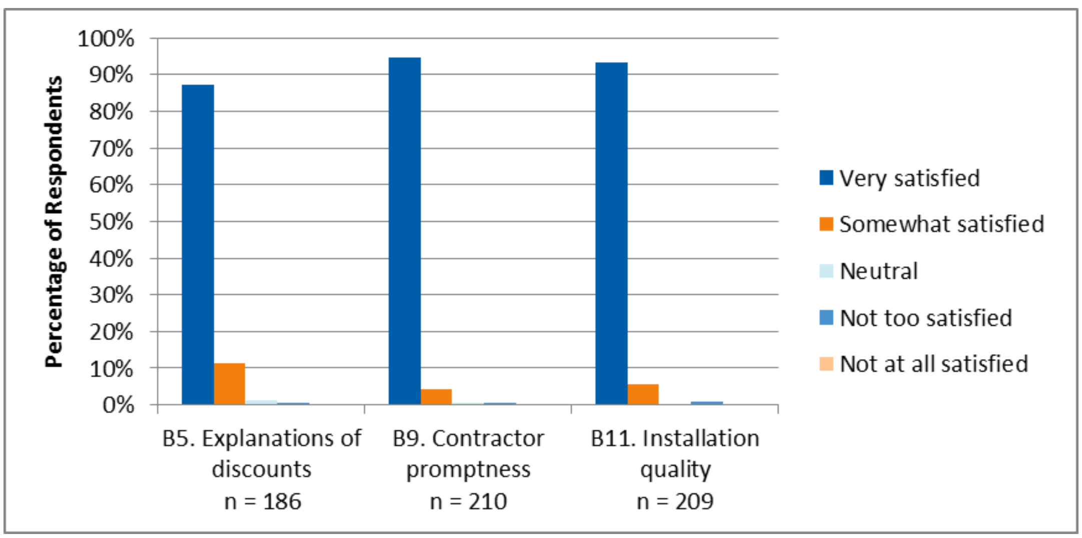
[15] CSG tracks contractor involvement by calendar year.

Figure 10. QF1,3,5: Customer Satisfaction with HVAC Program



Customers in PY5 expressed equal satisfaction with their contractors as in PY4; the percentage of customers responding "very satisfied" for the three categories shown is almost identical to PY4 results.

Figure 11. QB5,9,11: Customer Satisfaction with Contractor



4.1.3 Design and Implementation Effectiveness

The evaluation team utilized the results from interviews, database analysis, customer surveys, and contractor surveys to assess design and implementation effectiveness.

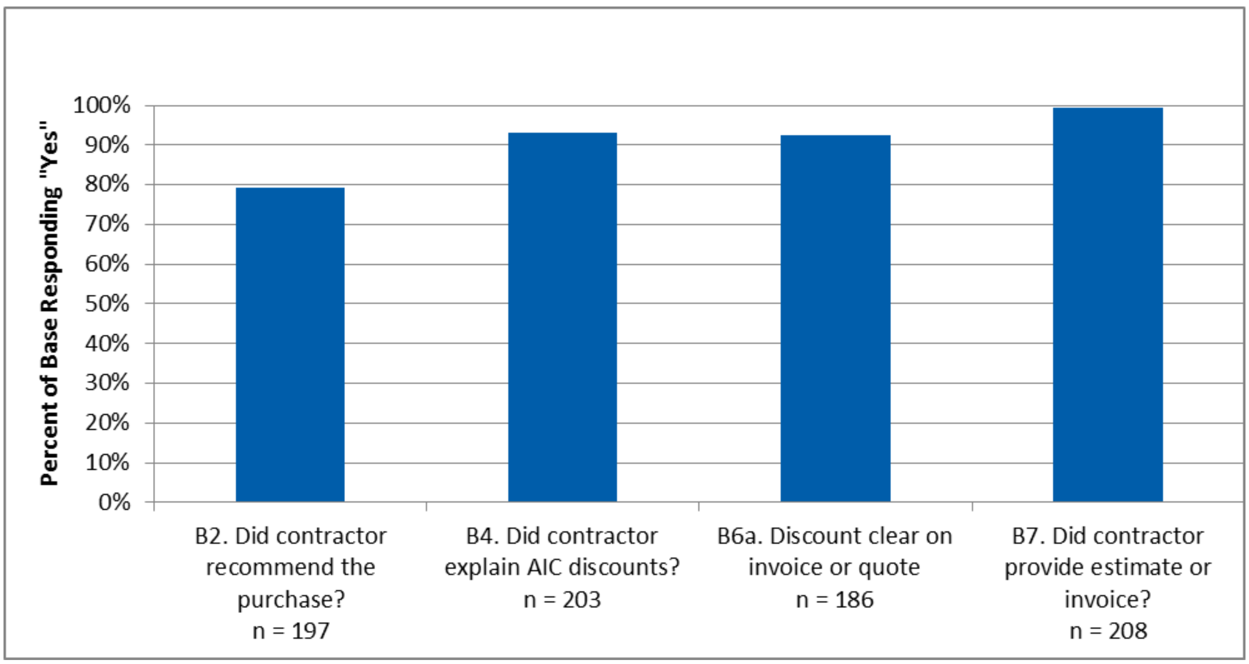
The AIC HVAC Program's design assumed customers choose higher-efficiency equipment when they receive better information about efficiency and when knowledgeable contractors present the case for such equipment. Further, AIC hoped to motivate customers to increasingly choose ER by offering a significantly higher rebate for older equipment that still worked. As the program relied heavily on contractors to offer and make the case for higher-efficiency equipment, AIC supported contractors by offering training and providing marketing materials. Survey questions sought to evaluate these aspects of program design and implementation.

Program Design

In concept, the HVAC Program design has not changed: contractors drive participation and incentives attract customers. In PY5, AIC introduced new tiers of existing equipment and launched new ER incentives for gas equipment and the ECM motor. CSG launched the ECMs and the 97% furnace in August and ERs for gas equipment in November.

Survey results indicated that contractors highly influenced customers' purchasing decisions, as shown in Figure 7 above and Figure 12 below. However, equipment condition, as shown later in Figure 13, served as the most important factor in customers' decisions to replace the equipment, with 45% replacing equipment due to failure and 25% replacing because units were close to failure.

Figure 12. Contractor Interaction with Customer



In PY3, the HVAC Program did not include ER rebates. The program introduced ER rebates in PY4 for electric equipment and in PY5 for gas equipment (see Table 4 above). Monthly ER rebate trends in PY5 indicated customers consistently took advantage of the CAC rebate, at a ratio of 70:30 for ER versus RB. ASHP ratios varied a bit more over the year, but averaged about 60:40 ER to RB.

Surveyed NAR contractors offered several recommendations for additional equipment that AIC could add to the mix, including:

- Hot water heaters and tankless hot water heaters (13 references)
- Mini-split systems (three references)
- Adding high-efficiency motors to existing units (one reference)
- Programmable thermostats (one reference)

These suggestions highlight an opportunity for AIC to educate contractors about incentives available through other programs.

Program Implementation

The evaluation team asked program staff about program design, goal setting, and management, and examined survey results for success indicators (including customer satisfaction scores and customer and NAR contractor recommendations to improve the program). High customer satisfaction ratings, the addition of more than 100 new contractors, and a significant increase in the number of incentives distributed in the last few months of PY5 compared to PY4 suggest that, overall, the program has been implemented well.

AIC and CSG HVAC Program managers have established a good working relationship, and feel they have sufficient resources to manage the program. They reported that they continue to use the same implementation process as in PY4. According to CSG, rebates typically are processed within two to three weeks of receipt; CSG makes payments to contractors twice per month. CSG has increased the percentage of incentive forms correctly filled out by assigning an administration person to directly assist contractors with this task.

CSG also increased the saturation of ECMs—initially only 30% and now about 60%, according to CSG. They did so by identifying contractors who could have added ECMs or could have received a rebate for furnaces installed with ECM, and then training them individually about the ECM opportunities.

CSG and AIC managers feel CSG has improved contractor communications and relationships through aggressive outreach, identification, and responsiveness to contractor issues. (The following Contractor Management and Role section discusses this in greater detail). Five in-person rollout meetings were held at the beginning of the year for contractors in Champaign, Decatur, Effingham, Marion, and Peoria, followed by an online webinar. The November 2012 gas rebate rollout was accompanied by another set of meetings, introducing the new ER offerings for furnaces and boilers.

Rollouts included multiple contractor e-blasts and breakfast and lunch meetings. An effort to tape the webinar (and offer it online to all contractors) proved unsuccessful. A program manual (documenting procedures, contacts, roles, responsibilities, theory, or strategies) does not exist. CSG employs a QA/QC process for data entry and ER installations. No on-site or telephone verification process exists for other equipment installations. However, all equipment paperwork is cross-checked to compare invoice model numbers and equipment numbers with AHRI certificates.

Program Management

Program managers monitor progress closely, consider evaluation recommendations, and annually make adjustments to increase participation. Each year, AIC program staff review program progress across the whole portfolio to set new targets and consider design changes. AIC relies on CSG to propose incentive levels and measures to include in the HVAC Program. CSG balances previous accomplishments, expected future participation, and funding availability across all the residential programs, and sets goals to maximize energy savings across the whole portfolio.

CSG actively looks for opportunities to improve participation and to consider evaluation feedback. Thinking that contractor inactivity might result from small sales volumes or locations at the outskirts of AIC territory, AIC made adjustments to keep contractors registered, rather than dropping them after six months of inactivity. Following evaluation recommendations, AIC increased incentives and introduced equipment at higher-efficiency levels.

In some cases, AIC/CSG did not implement evaluators' recommendations. For example, evaluators suggested increasing the rebate for the GSHP and providing a direct incentive to the contractor. These suggestions were considered but not implemented because AIC had an insufficient budget to support the increased incentive and because program funds were expected to be used to compensate customers rather than contractors.

The evaluation team's review of the HVAC Program-tracking database found it comprehensive and largely accurate, containing much of the information necessary to perform an evaluation. However, there were several issues: some columns exhibited limited data entry (see the database review in Section 4.2.1), residential program data have yet to be compiled into one dataset, and a data dictionary does not exist. CSG respondents explained that a previous administrative staffer made some database entry errors, which, for the most part, have been identified and resolved. AIC uses negative values to correct entries that should not have been made, and these entries were removed from the database prior to preparing summary statistics for this report.

Regarding program operations, AIC currently is working toward a computer-based interactive PDF incentive application process for the HVAC Program, and expects to have this ready for PY6. The online process has been introduced for some of AIC's other residential programs. AIC also tasked CSG with developing an integrated database structure to include data across all residential programs, per evaluators' recommendations.

Contractor Management and Role

Because the program is promoted by contractors, contractor communication remains an important aspect of implementation effectiveness. Two CSG account managers work directly with contractors in the north and south AIC regions. CSG tracks contractor activity using a database that includes the company name, contractor name, date of first signing, type of measures installed, and participation in training or rollout meetings. This database also identifies which contractors have signed an additional page in their agreements to confirm they understand and will abide by the rules for use of co-marketing with AIC.

In PY5, CSG made a concerted effort to conduct greater contractor outreach and to better explain program processes. CSG's north and south account managers maintain active contact with contractors, answer questions, and follow-up with contractors experiencing difficulty with program requirements or missing opportunities to submit applications for the ER equipment. Recently, CSG added an administrative employee to help contractors correctly complete program forms. This addition reduced the number of incorrectly filled-out forms from 30% to less than 3% of the latest batch of 150 applications.

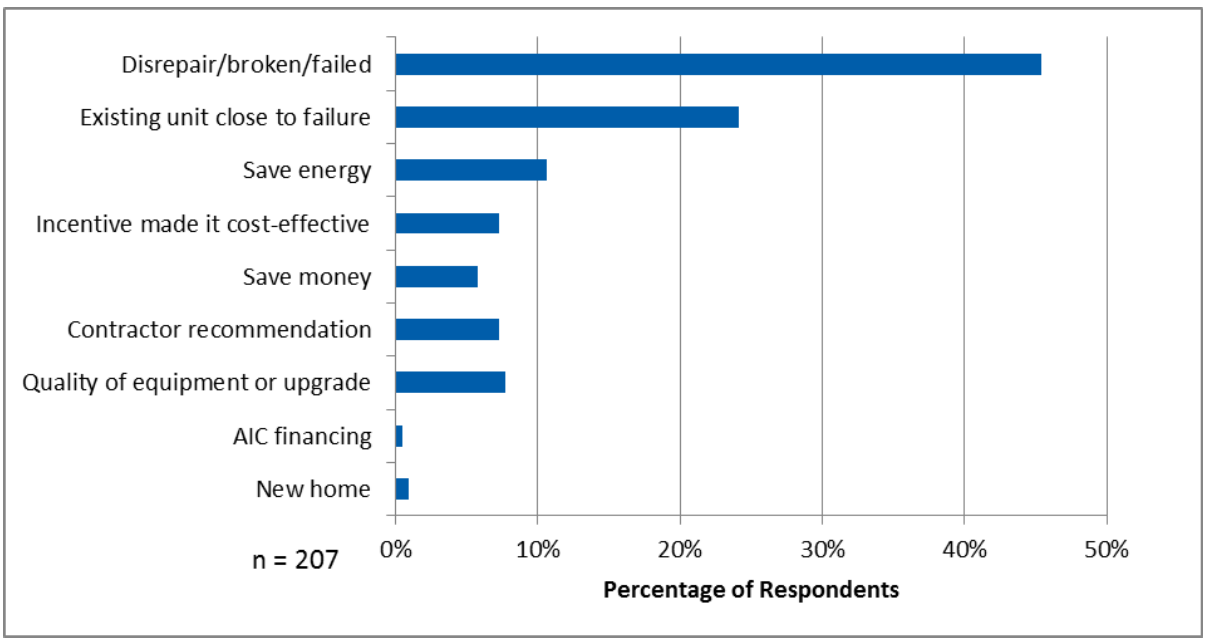
CSG and AIC program managers are pleased with the intensification of contractor outreach efforts in PY5, feel their relationship with the active allies has greatly improved, and, as a result, generated higher program interest and participation. CSG does not survey contractors, but rather solicits feedback from a key group of active allies (about 12 in the north and 12 in the south). CSG previously convened a roundtable of key contractors that met once a month, but it moved away from this model and now uses a more informal approach to obtain feedback.

CSG and AIC program managers believe their companies have sufficient resources to manage the program, and program staff report few customer or contractor complaints. AIC experienced some management challenges during the last few months of PY5 because one of its two residential program managers retired. AIC has addressed the problem by identifying a new program manager to assist the incumbent. The AIC program manager expressed strong satisfaction with CSG's work, communications, and reporting.

CSG provides AIC with a monthly report and an informal weekly summary of program progress. The monthly report, prepared for all programs, summarizes progress against goals, discusses recent trends, and provides an update on the number of active versus inactive contractors as well as new contractors recruited into the program. The weekly report presents a PY5 monthly quantitative compilation for each HVAC measure, by units reimbursed and as a percentage of the total. It also provides monthly averages of equipment installed; BTUh, AFUE, and incentive costs for gas measures; and summaries of electric measures by ER and RB.

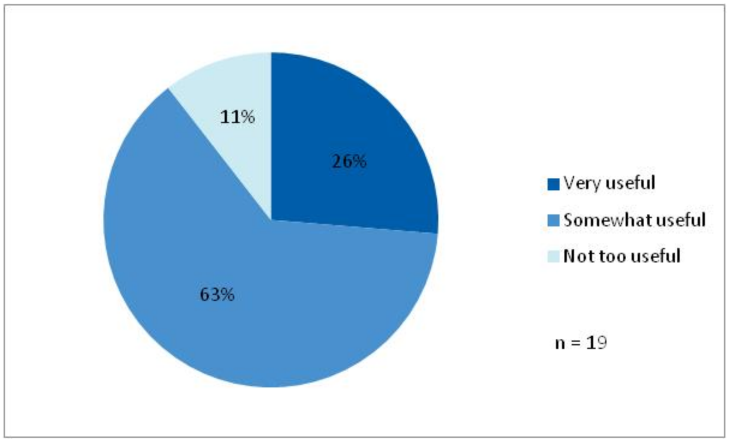
Contractors continue to inform customers and influence them in their choices. Customers reported that more than 90% of contractors explained the AIC discounts and presented the discount clearly on the invoice. Most customers (79%) reported that their contractor recommended their equipment purchase (as shown in Figure 12 above). Customers reported they primarily purchased the measure due to previous measure failures or conditions close to failure (as shown in Figure 13 below). The majority (94% of 154) of survey respondents reported their contractors' recommendations as very influential (58%) or somewhat influential (36%).

Figure 13. QA4: Customer Reasons for Equipment Purchase



While NAR contractors had not participated within the last year, they had registered with the program and had access to training and marketing materials. Survey results indicated that these contractors did not know of these resources or chose not to take full advantage of their access to these resources. Of 64 responding contractors, 19 (30%) said they received training from AIC/CSG, and 22 (35%) said they received marketing materials. Of those receiving training, 63% reported the training as somewhat useful, and 26% reported it as very useful, as shown in Figure 14 below.

Figure 14. QA12. How useful was the training provided by AIC, in terms of helping you sell more energy-efficient equipment?



Nineteen (30%) NAR contractors reported receiving training. Of these, 17 provided views on why they thought the program useful, and eight offered suggestions for improving training. Most of these NAR contractors thought the training helped them understand the program better due to the quality of instruction and information. Table 15 and Table 16 below provide summaries of categorized, verbatim responses.

Table 15. NAR Contractor Verbatim Response on Training Benefits

Q A13a. Regarding the training, what was particularly good about it?	
Answer Category	Verbatim Response
Equipment testing (12%)	• *Probably examples and basic information that could be used in the field.* • *Procedures on testing equipment.*
Helped understand program better (53%)	• *Table to ask questions. Having the once-a-year meeting locally helped me understand their part in it.* • *Easy to understand.* • *It was a good general overview of the program.* • *Making us understand what was available.* • *The fact that they were well versed.* • *They were actually very helpful at answering questions.* • *We got to know the program.*
Learned how to deal with paperwork (12%)	• *It showed you how to fill out the paperwork.* • *Just simply ease in filling out the paperwork. Learning how to apply for incentives that I was not aware of.*

Learned how to market /explain to homeowner (18%)	• *It was useful in marketing the incentive to customers to make it worthwhile to make the purchase.*
	• *Just learning the marketing. How to market the equipment and yourself.* • *They have a lot of knowledge and information and it helps us explain it to the homeowner a lot better. It helps fill out the paperwork a lot better too.*

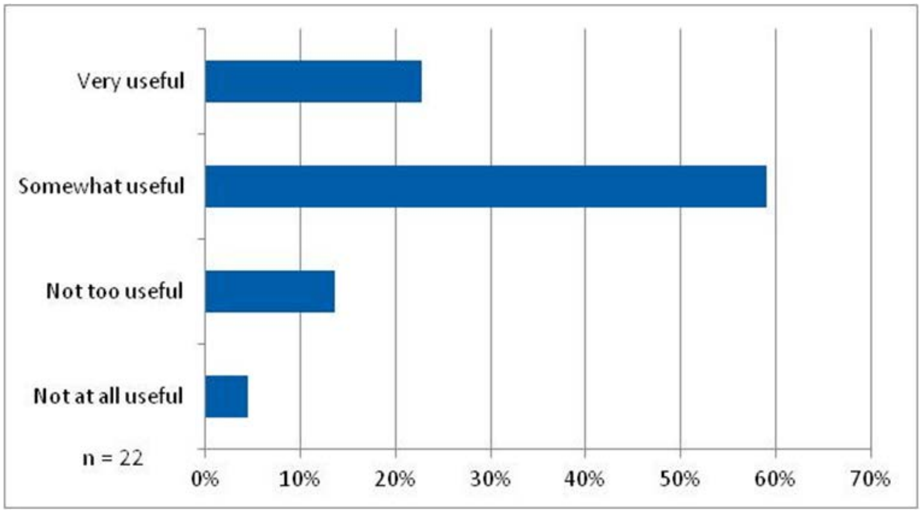
Comparing the responses from Table 15 and Table 16, some contradictions appeared among responding NAR contractors. Some found the material simple and easy to use, while others found it cumbersome. Some indicated receiving a good deal of useful material, while others wanted more material and more in-depth explanations. Overall, positive comments (18) outnumbered recommendations for improvements (8) from this group.

Table 16. NAR Contractor Verbatim Response on How Training Could Be Improved

Q A13b. What could be improved (Regarding training?)	
Answer Category	Verbatim Response
Provide more information (31%)	• *A little bit more in-depth.* • *Further details on the incentives and more notification on the changes of the program throughout the year.* • *Probably go through how you do the application process better.* • *More hands-on experience.*
Better support from representative (23%)	• *Getting back to us so that we can initiate the program again.* • *I like my representative. But I wish he could take care of my needs.* • *Whenever your sales people that call you call to get service, if they had the ability to send someone right away that would be better for us.*
Less paperwork (8%)	• *Make the application simpler. Cumbersome with how much paper I have to print out. Make it easier.*
Nothing (38%)	• *I don't think there was anything.* • *It was adequate.* • *Not sure. That's all you do. Anything else is up to us.* • *Nothing.* • *You offer very good programs.*

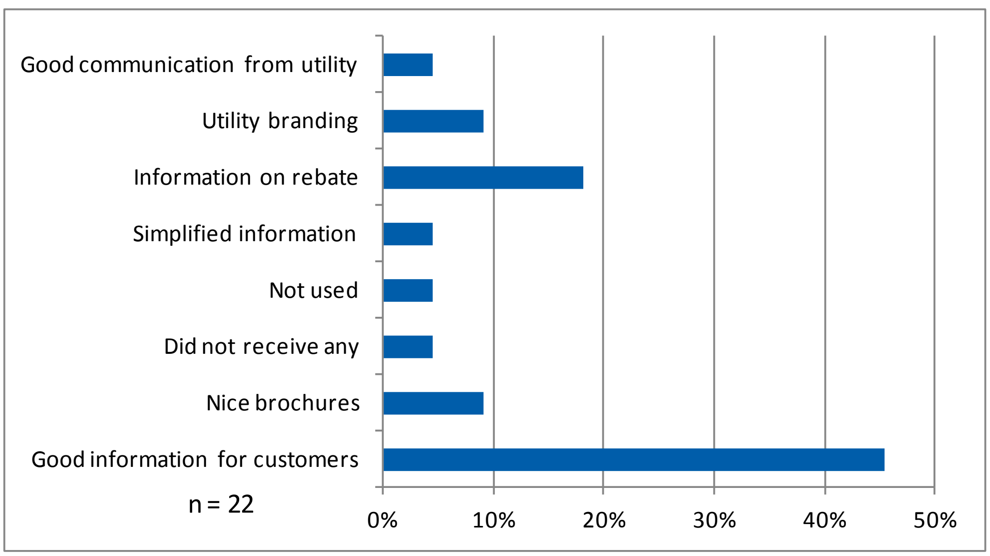
Twenty-two (35%) NAR contractors reported receiving marketing materials. Of those receiving marketing materials, 59% found the materials somewhat useful, and 23% found them very useful, as shown in Figure 15 below.

Figure 15. QA14. How useful were the marketing materials provided by AIC, in terms of helping you sell more high-energy efficiency equipment?



All but two NAR contractors reported why they found the materials useful (one each said they did not receive any materials or did not use them). Figure 16 summarizes these responses into categories. Contractors did not provide comments when asked how these materials could be improved.

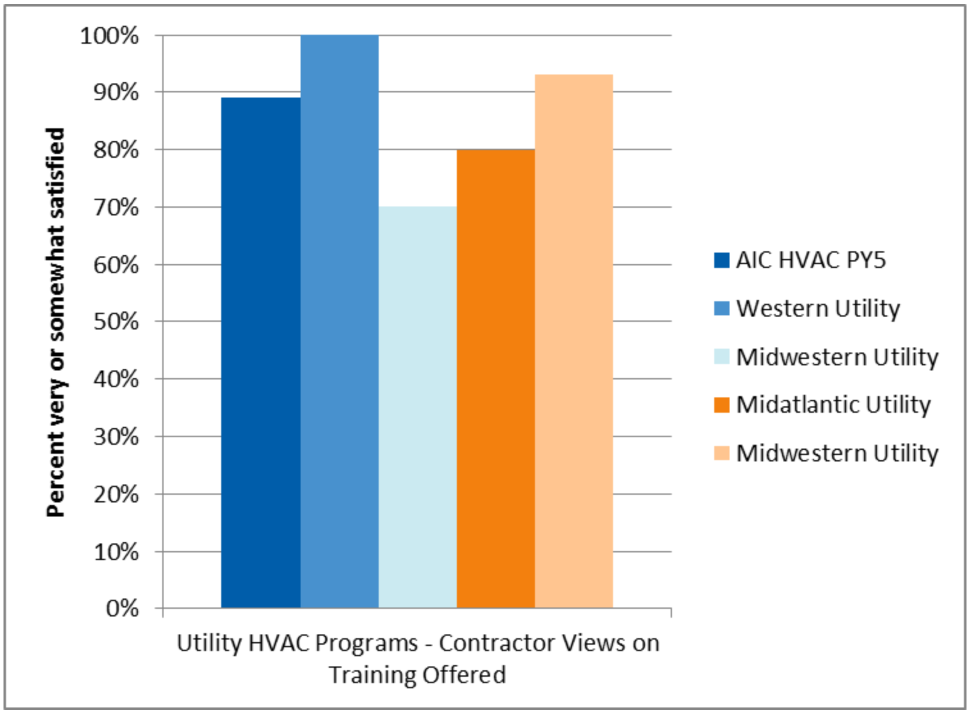
Figure 16. NAR Contractor Views on Marketing Materials



We compared these results with other utilities across the country, combining "very useful" and "somewhat useful." AIC's NAR contractors' views on training and marketing materials fell within the same range as other utilities where contractors were asked to rate their satisfaction with training and marketing materials (as shown in Figure 17 and Figure 18 below). In most cases, contractors from these other utilities reported being "very satisfied" more than "somewhat satisfied," in contrast to the results found for PY5 NAR contractors. The potential bias of

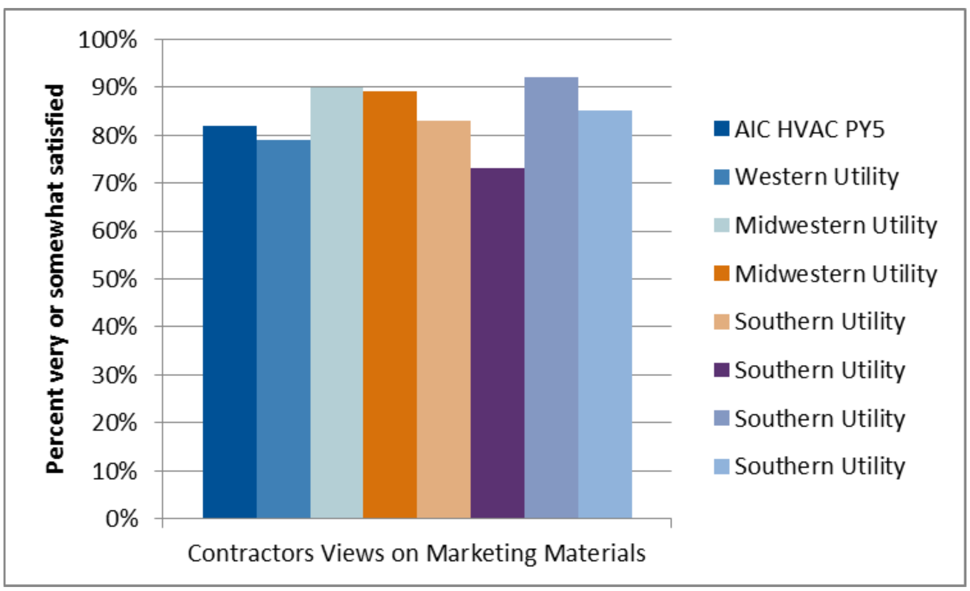
nonparticipating contractors should be considered, given that the other utilities' surveyed contractors were actively participating in their programs.

Figure 17. Utility Contractor Survey Responses to HVAC Program Training Satisfaction*



***Combining "Very Satisfied" and "Somewhat Satisfied" responses.**

Figure 18. Utility Contractor Survey Responses to HVAC Program Marketing Materials Satisfaction



Program staff reported that, unlike home performance contractors, HVAC contractors did not seem interested in marketing materials offered (such as door hangers, lawn signs, brochures, and fliers), and rarely asked to be resupplied. Contractors seemed to prefer assistance with websites and co-branding.[16] However, CSG reported that by the end of PY5, contractors appeared to show greater interest in marketing assistance and collateral. As discussed in the “Barriers” section, however, NAR contractors suggested that better communications and utility support would encourage greater program activity (see Table 18 and Figure 21 below).

4.1.4 Quality of Marketing Materials

The HVAC Program’s marketing efforts use direct marketing aimed toward customers and partnerships with contractors that receive resources and guidelines for sharing program information with customers. Marketing materials directed at customers consist of print ads, bill inserts, oversized postcards, the HVAC incentive content on AIC’s ActOnEnergy webpage, and the www.ActOnEnergy.com/contractor webpage.

Customer-facing materials reference the latter webpage and direct customers to find contractors participating in the program. The program communicates to Program Allies via webinars, e-blasts, and the Program Ally webpage on www.ActOnEnergy.com, and conducts one-on-one outreach and support efforts through two dedicated account managers.

Overall, AIC utilizes best practices across the majority of the marketing materials made available for the evaluation team’s review. The team reviewed these materials against the six best practice elements presented in the marketing materials methodology section (section 3.1.1). We provide findings and recommendations below and in Table 17, a summary scoring table.

Direct Marketing Materials

Overall, the evaluation team found the marketing materials supplied—and aimed directly at customers—well-constructed and following industry and marketing best practices. These include:

- Sufficient program details contained in all materials
- Appropriate messaging and tone for the residential customer target audience
- Consistent branding, use of logos, and “look and feel” across the suite of materials
- Clear, prominent, and consistent calls-to-action across all materials, driving customers to www.ActOnEnergy.com/contractor and providing easy next steps for accessing program and participation information

The formatting of the materials did offer opportunities for possible improvements. For example, on its second page, the winter bill insert shows a header containing a long line of text, with each word capitalized; this minor style error detracts from the insert’s readability. Formatting inconsistency also occurs in the print advertisement, which uses different font sizes that could potentially detract from the overall visual appeal of the piece.

[16] As contractors did not properly follow co-branding guidelines, AIC requires that contractors sign an additional “co-branding” agreement, which provides guidelines and suggestions for use of the AIC brand.

The program webpage (http://www.actonenergy.com/for-my-home/explore-incentives/heating-and-air-conditioning-rebates) appears strong, cleanly and explicitly providing program details and participation directions. While the page contains a great deal of information, it presents it in a digestible format, as page components can be expanded to provide more detail on specific program aspects (and closed for less detail). This allows readers to control the presentation of the information they seek.

While the program webpage provides most program details, customer-facing marketing collateral largely drives customers to the www.ActOnEnergy.com/contractor webpage. This page allows customers to find Program Ally contractors that offer program incentives. Customers can search for contractors by name, city, or ZIP code. The webpage uses a simple, easy-to-use format, which effectively directs customers to the next program participation steps.

Program Ally Communications and Webpage

Program Ally communications deliver clear and concise program information to contractors, provide quick access to program resources, and enable contractors to assist customers. The e-blasts served a variety of purposes, such as inviting Program Allies to a webinar or informing them of program changes and updates. All communications delivered key pieces of information clearly and effectively, while using a casual and straightforward tone appropriate for this type of communication.

Branding remained consistent in all e-blasts. The Program Ally resource area on the website includes downloadable Program Ally co-branding guidelines. The text formatting, however, could be improved. Several e-blasts (e.g., New Incentives, Boiler Incentives) used numerous, differing font sizes, colors, and formatting of copy, which could detract from the e-blast's readability and visual appeal.

The Program Ally webpage (www.ActOnEnergy.com/for-contractors/become-a-residential-program-ally/hvac-new-heating-cooling-equipment) presents clear and comprehensible information. It can be easily navigated, and it provides readers with an overview of the program as well as information on how to become a Program Ally.

Table 17. Marketing Materials Best Practices Scoring Matrix

Direct Marketing Materials	Program details and benefits are clear and comprehensive	Messaging is compelling and appropriate for the target audience	Branding and "look and feel" are consistent with that of other program materials	Communications are professional (e.g., easy to read, properly formatted, free of errors)	There is a clear call-to-action	There are easy next steps for program participation
Print Ad	4	4	4	3	4	4
Bill Insert (Winter)	4	4	4	3	4	4
Bill Insert (Early Retirement)	4	4	3	4	4	4
Oversized Postcard (Winter)	4	4	4	4	4	4
Oversized Postcard (Summer)	4	4	4	4	4	4
Program Webpage[1]	4	4	4	4	4	4
Customer Webpage[2]	3	4	4	4	4	4
Program Ally Communication Materials						
E-blast (HVAC Webinar)	4	4	4	4	4	4
E-blast (Search Engine)	4	4	4	4	4	4
E-blast (New Incentive)	4	4	4	3	N/A	4
E-blast (Boiler Incentives)	4	4	4	2	N/A	4
Program Ally Webpage	4	4	4	4	N/A	4

Key: 1= Not at all, 2=Somewhat, 3=Mostly, 4=With Certainty

Notes:

1./ http://www.actonenergy.com/for-my-home/explore-incentives/heating-and-air-conditioning-rebates

2./ www.actonenergy.com/contractor

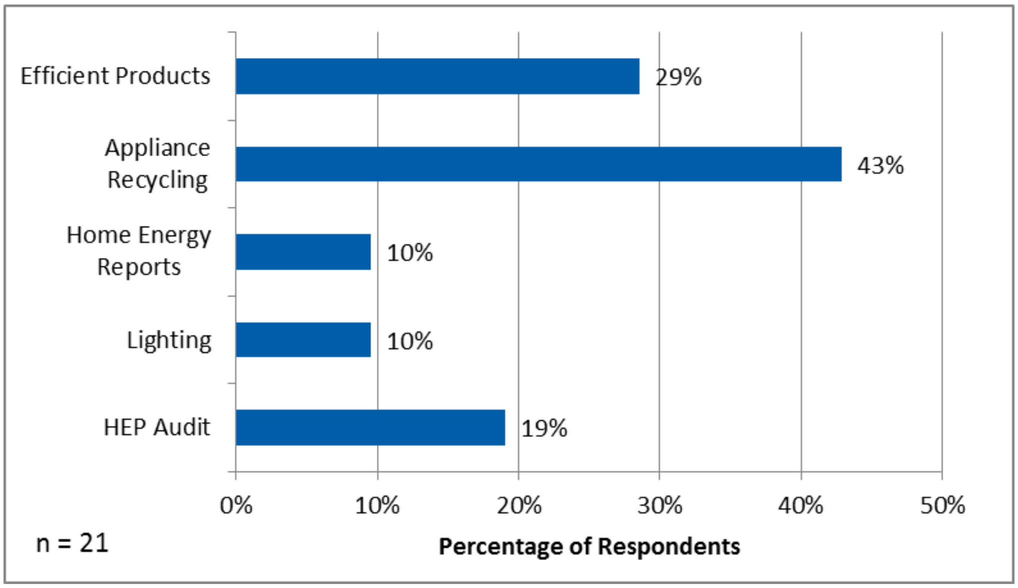
3./ http://www.actonenergy.com/for-contractors/become-a-residential-program-ally/hvac-new-heating-cooling-equipment

4.1.5 AIC Cross-Program Influences

The evaluation team investigated questions addressing cross-program influences by directly asking customers if they participated in other programs before or after participating in the HVAC Program, and if their HVAC participation would influence their decisions to participate in other AIC programs.

Twenty-three (11% of the 210 customer respondents) participating in the residential HVAC Program also participated in other AIC programs, with the majority of the 21 who could remember program names participating in ARP (9 or 43%) or Efficient Products (6 or 29%). Figure 19 presents all programs in which customers reported participating.[17]

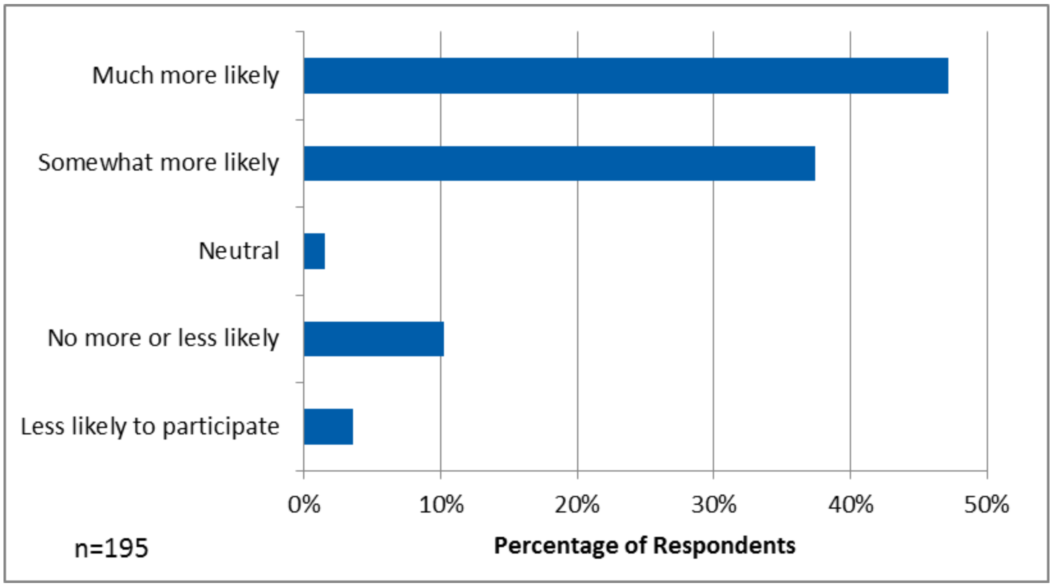
Figure 19. QF8: Other Programs in which HVAC Customers Participated



Most (75%) of these 21 customers said they participated in these other programs before participating in the HVAC Program (this represented a small subset of the total surveyed population of 210). We asked all customers in the survey sample if their experience with the HVAC Program would likely influence their participation in other AIC programs; the majority (84%) said it would, as shown in Figure 20 below. This indicates opportunity for additional marketing between most or all AIC programs.

[17] Note that we are including participants who participated in more than one program. We use the number of respondents (21) as the denominator, even if the total number of responses per respondent may be more than one. In this graph the total number of responses is 23.

Figure 20. QF11: Likely Influence on Participation in Other AIC Programs



4.1.6 Participation Barriers

Because contractors serve as the key mechanism for participant entry into the program, and NAR contractors were not active over the last year, the evaluation team focused on the NAR survey results to identify participation barriers. We also obtained insights from the AIC and CSG program managers.

A significant proportion (22%) of NAR contractors said there was nothing AIC could do to make them more active in the program, often citing their own low sales of related equipment as the reason (as shown in Table 18).

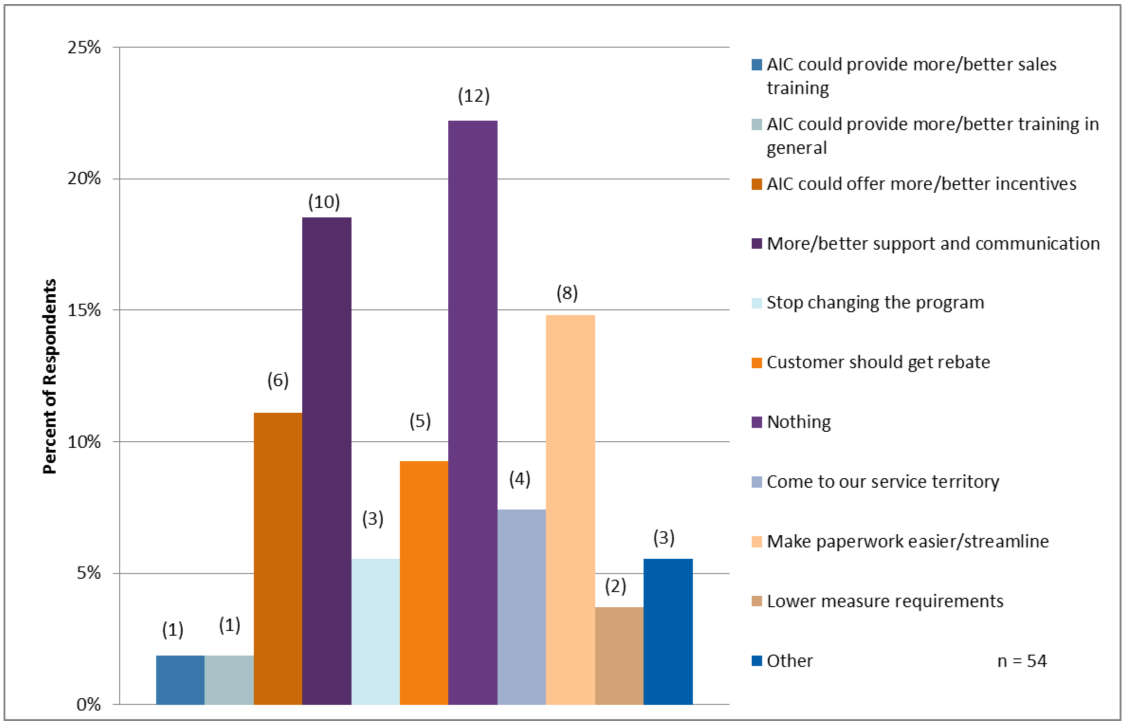
Table 18. Contractor Suggestions to Increase Their Activity

Q C3: What would Ameren Illinois Company need to change about the program for you to market the higher-efficiency models, offer the customer a discount, and submit invoices for incentives?	
Answer Category	Verbatim Response
AIC could offer more/better incentives (11%)	"Bigger rebates."
	"Either to lower the SEER requirement or raise the rebate."
	"It has more to do with the ENERGY STAR program than the AIC program. They are making it too hard for the customer to make things cost-effective."
Come to our service territory (7%)	"If AIC could come to Wabash County that would be wonderful. But that company is out of our county."
	"It's probably just a matter of location."
	"Nothing, we just don't do a lot of business in their territory."
	"Nothing, it's just geography."
Customer should get rebate (9%)	"I'd like to have them put the incentive responsibility on the customer."
	"Reimburse the customer not the contractor."
	"Send the discount to customer not contractor."
	"Simplify the program where the rebate goes directly to the customer."
	"Simplify rebates."
Lower measure requirements (4%)	"The SEER rating needs to be a 14."

Q C3: What would Ameren Illinois Company need to change about the program for you to market the higher-efficiency models, offer the customer a discount, and submit invoices for incentives?	
Answer Category	Verbatim Response
	"The specs are too high. 13 SEER is more realistic. If it's just a SEER rating, it costs money. The features also need more features than just the SEER. It's more than just efficiency of energy."
Make paperwork easier/streamline (15%)	"Less hassle. More streamline."
	"Make it simpler."
	"Make the paperwork a little easier to do."
	"Make the program friendlier to small contractors."
	"One technicality will knock you out of the deal."
	"Speed the process up a bit."
	"Speed up payback time to about 2 weeks."
	"Streamlined system where we can easily use the information and not absorb a lot of our time and follow-up."
More or better support and communication (19%)	"A rep for us."
	"Ask me to join the program again."
	"Communication."
	"Contractor more aware."
	"Get more information out to contractors."
	"Informing us sales people and installers about the updates. We were relying on TV ads instead of AIC contacting us."
	"Need more information on the requirements."
	"Need proper documentation as far as applications and paperwork."
	"Send us contractors pamphlets."
	"Lack of self-education on my part."
Stop changing the program (6%)	"Get a solid game plan together and stick to it. Stop switching things around."
	"Quit changing on and off. When we sign up leave us alone. Realize things go up and down."
	"Quit changing the program, especially on the electric end."
Nothing (22%)	"I'm really not sure since we don't sell the equipment on a regular basis. We might do one or two on a yearly basis."
	"It is probably nothing that AIC needs to do. I am just a small contractor."
	"It's a good program the way it is. They just need to keep offering the rebates."
	"Nothing on their part. It's the fact that I sell so many different things regarding home repair."
	"Nothing."
	"Nothing. I am shutting my business down."
	"Nothing. I have just been sick."
	"Nothing. We offer it on everything that is eligible."
	"Nothing."
Other (6%)	"All time."
	"Offering it to commercial."
	"Reimburse us for the paperwork end of it. If the contractor got a benefit out of it."

Of the 42 NAR contractors who offered suggestions about how AIC could encourage greater activity, most (43%) suggested that AIC provide better support and communication (24%) or streamline the rebate process (19%). Other contractors suggested that the program should not change so often. Table 18 above presents the detailed responses that we categorized to create the graphic in Figure 21 below.

Figure 21. What NAR Contractors Want Changed to Become More Active



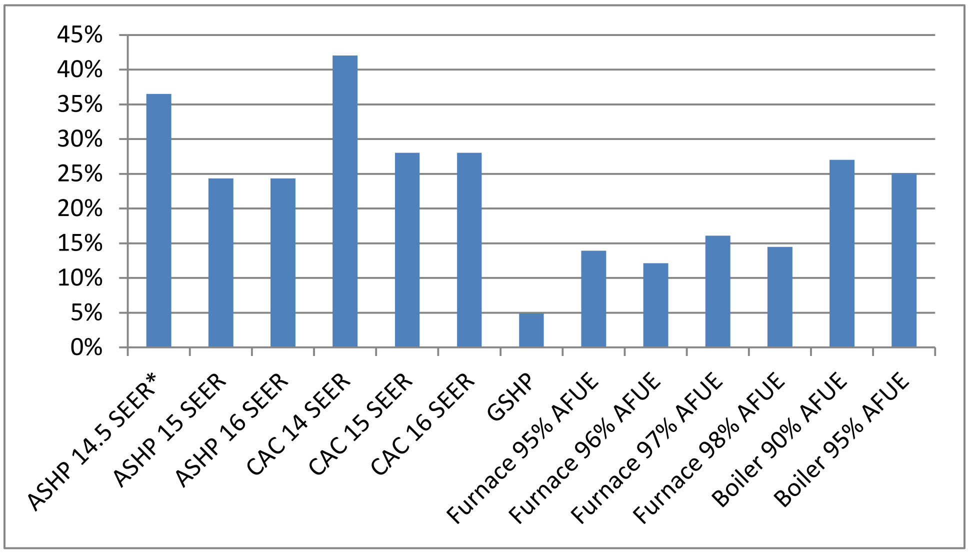
Because most participating customers are "very satisfied" or "satisfied" with the incentive amount, that does not appear to present a key participation barrier. The eight (4%) customers who responded as "not too satisfied" or "not at all satisfied" to survey questions expressed displeasure with the incentive/discount amount, not receiving the discount, or not being informed adequately about the program. Since discounts should be provided immediately by the contractor, customers still waiting for their discounts may be confusing the HVAC Program with another AIC program, or may not realize they received a discount upfront.

Table 19. Verbatim Responses from Customers Less Than Satisfied

QF2. Why less than satisfied with the amount of the discount?	QF6. Why were you less than satisfied with the HVAC Program overall?
Because of the cost of the product.	*$150 is like a tear in a bucket considering what I paid to get the unit in here.*
Because we did not know.	*Because I did not know there was a program.*
For the HVAC it was $8,700 and all I got was $300 off. I never received anything about an AIC energy program.	*Because I didn't know about it.*
I don't think it was that big of a deal.	*I didn't think it was that big of a deal.*
If everybody purchased a unit like I did, it would reduce operating cost in peak periods for AIC. It gives them some squeeze room for energy-efficient equipment. I can't see how the rising cost goes up every year.	*I have not received a discount.*
It was a $10,000 bill so taking off $300 was not a big deal.	*It wasn't that much of a break.*
It was expensive but getting a great savings on the utility bill.	*It's been three-and-a-half months and I have not received the rebate.*
We didn't know about the incentive program.	*Offer more items.*
Well it's about the thermostat. Well I sent that rebate form in and they sent it back, because the invoice did not have the price of the thermostat on it. So the contractor sent that in and they then sent it back. It was a fiasco. ***[Seems to be related to another program]***	*I have not seen anything and was told I was going to get a discount.*

The higher-efficiency SEER units consistently maintain a low percentage of overall measures installed, probably due to the significantly higher prices for this equipment. Figure 22 below presents the ratio of PY5 RB incentives to incremental costs described in the TRM for equipment incented through the AIC program.

Figure 22. Percent Incremental Cost (RB) Covered by AIC PY5 Incentive



* The TRM only reports 14 and 15 SEER costs, so we averaged them to estimate SEER 14.5 SEER ASHP.

Higher SEER units[18] are incented at about 26% of the incremental cost for RB, compared to 39% for lower SEER units (as shown in Table 20). Customers may see the lower SEER units as a better bargain than the higher SEER units.

Table 20. Average Incremental Cost Coverage by Efficiency Level

Measure Level (CAC and ASHP Average)	PY5 AIC Incentive (% of Incremental Cost)
	PY5 (RB)
Average 14.5 SEER*	39%
Average 15 SEER	26%
Average 16 SEER	26%

* The TRM only reports 14 and 15 SEER costs, so we averaged them to estimate SEER 14.5 SEER ASHP.

Apart from initial costs, CSG expects that the program's biggest barriers will continue to be low activity among NAR contractors, and the 80% of active contractors currently bringing in 20% of the incentives. CSG also indicated that some larger, very successful contractors have not joined the program, as they do not believe they need the additional business; they already operate extremely successful companies due to superior customer service.

4.1.7 Market Effects

The program may be having an effect on NAR contractor practices. We asked NAR contractors, even though they were not active in the past year, whether the program influenced their customer

[18] Combined ASHP and CACs.

recommendations. Thirty percent (30%) of those selling CACs and ASHPs, and 27% of those selling furnaces and boilers said yes. Prior to the program, NAR contractors recommended SEER 14.5 or higher CACs and ASHPs about 66% of the time, while after the program it increased to approximately 78% of the time (see Figure 23). For gas furnaces and boilers, the average increased from 76% to 82% (see Figure 24).

Figure 23. CAC/ASHP: Percent of Time NAR Contractors Recommended High-Efficiency Equipment

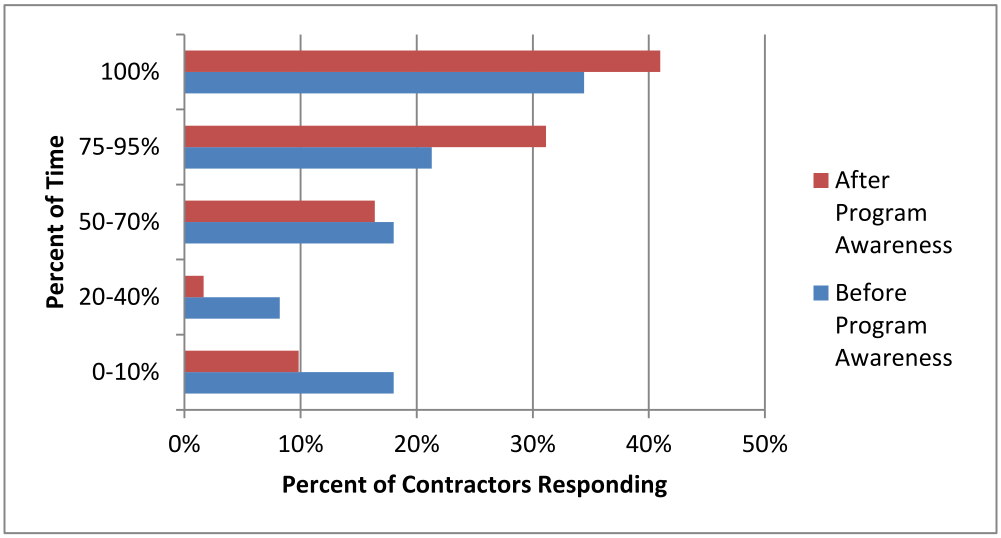
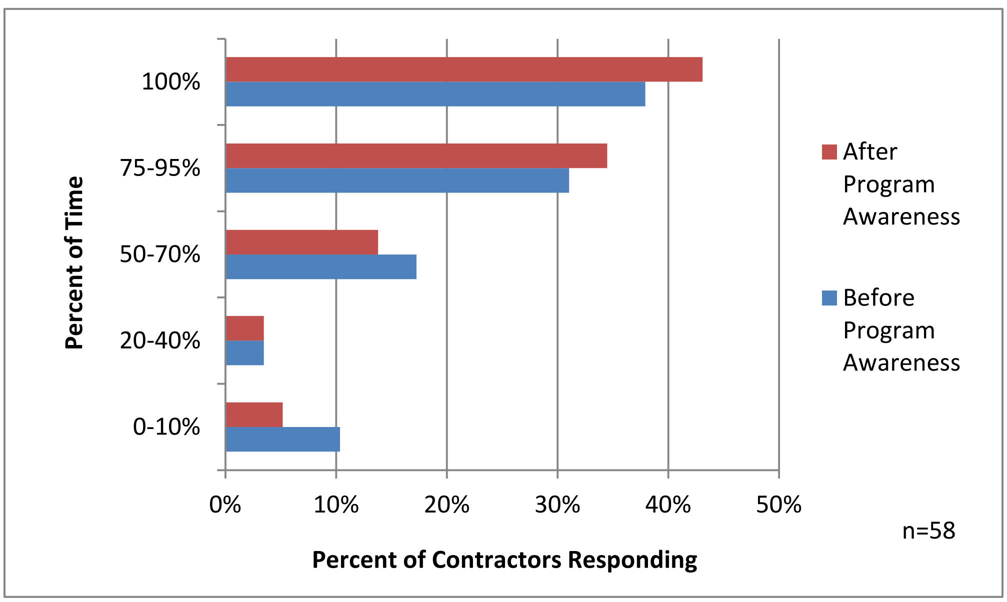


Figure 24. CAC/ASHP: Percent of Time NAR Contractors Recommended High-Efficiency Equipment



Alternatively, program managers fear that the minimum 14.5 SEER efficiency levels for PY4 (up from 14 in PY3) negatively impacted the market, in that they heard some contractors dropped back to minimum efficiency SEER 13 levels and did not seek incentives because the cost premium between SEER 13 and 14.5 was too much.

AIC does provide program information to distributors, who are not direct program participants, in hopes that these distributors stock and promote higher-efficiency products to contractors to pass on to end-use customers. Program managers want to continue to find ways to educate HVAC contractors about energy efficiency, noting that some are small family businesses and may not have formal education about energy-efficient systems.

CSG respondents thought strong progress had been achieved using the current group of active contractors, and they planned to focus more on outreach and education of distributors going forward. Distributors may be able to contact contractors who are not yet in the program, on the outskirts of AIC's territory, and registered but not active in the program.

4.1.8 Quality Installation

AIC does not require test data or installation protocols for new equipment installations, which makes it easier for more contractors to participate in the program. In researching other regions, the evaluation team has found that contractors who participate in quality installation (QI) programs indicate that rigorous requirements often discourage participation. To properly assess all QI elements would require testing refrigerant charges, airflows, load calculations with ACCA Manual J calculations, and system sizing/matching with ACCA Manual S.

The evaluation team reviewed the CAC and ASHP metered data to qualitatively assess the QI of metered systems. If an HVAC system has certain types of quality installation issues, even a general review of meter data can identify potential problems. Though we did not review all QI elements, we concluded through the meter data that, in general, systems are achieving the savings as intended.

Airflow

The evaluation team metered supply and return wet bulb and dry bulb temperatures. By reviewing these temperature differentials, we could assess whether the airflow appeared reasonable. For example, in cooling mode, if temperature measurements indicate a higher-than-expected temperature differential, the coil may be too cold and/or the airflow rate too low. Often, incorrect airflow does not indicate poor installation quality, but rather duct system limitations. Contractors sometimes have limited choices when selecting equipment and setting airflow rates for that equipment. QI ACCA standards cannot be followed when the existing duct system limits airflow. We have found that contractors installing high-efficiency systems with ECM fans tend to set airflows at reasonable levels.

Sizing

To assess the proper sizing of systems, the evaluation team reviewed meter data to examine the coincidence factor during peak times, a key indicator of oversizing. If, upon setting indoor temperatures to cooling mode, a system runs for more than 75% of the time during peak outdoor temperatures, we consider the system properly sized. If a system frequently cycles on and off during the hottest times of summer, the system probably is oversized. Although a few HVAC systems (two CACs and three HPs out of 48) appeared oversized, the majority of systems appeared reasonably sized.[19]

Refrigerant Charge

Refrigerant charge provides another QI component. The evaluation team did not test sub-cooling values of the HVAC systems metered, a measurement necessary to assess whether a system with a thermal expansion valve (TxV) metering device has been properly charged. We have found that assessing refrigerant charges in similar evaluations generally does not provide conclusive results, even when utilizing a much more rigorous evaluation methodology. Although a system might not be charged to the correct sub-cooling value, the impacts (efficiency degradation) of incorrect charges prove negligible or difficult to assess. New high-efficiency systems, which include an ECM fan and TxV, generally operate reasonably well, even if the refrigerant charge has been improperly set (within a certain range of installation error). Compared to fixed-orifice metering devices found on older systems, thermal expansion valves better accommodate incorrect refrigerant charges.

4.2 Impact Results

4.2.1 Participant Verification / Installation Rate

As the evaluation team expected, the telephone survey and document verification indicated that systems were installed as expected and efficiency and system sizes were accurately reported. Telephone and document verification resulted in a 100% measure verification rate.

4.2.2 Database Analysis Applying TRM Formulae

The evaluation team analyzed data from the tracking database (census) to calculate *ex post* annual per-unit gross savings. The following summary provides reasons for *ex post* annual per-unit savings differing from the *ex ante* savings reported in the tracking database:

- The reported savings used one savings value for each measure type, regardless of the unit size, efficiency, or weather zone. The team estimated savings for every measure using unit-specific information and reported geographic locations.
- If the database contained erroneous values (~1% of electric measures), the evaluation team looked up the AHRI number to determine the correct unit size and efficiency.
- Differences occur between the efficiency used to estimate *ex ante* savings and the actual average efficiency of units installed. *Ex ante* savings use conservative inputs to estimate a deemed savings value for each measure category (e.g., the 97 AFUE furnace measure uses 97 AFUE but the actual efficiency of equipment installed is higher). The highest-efficiency measures, such as SEER 16+ and ground source heat pumps, exhibit the greatest disparity between the measure efficiency minimum requirements and the actual nameplate efficiency. For example, the GSHP measure requires an EER of 18.5 and a COP of 3.7, with

[19] An undersized system actually would use less energy throughout the season than a properly sized system, so undersizing does not present an issue when assessing energy impacts from QI programs. An undersized system would, however, be a concern for homeowner comfort.

these values used to calculate reported savings. Actual nameplate average efficiency averaged an EER of 21.4 and a COP of 4.2, and results in realization rates greater than 1.

- To estimate savings, the evaluation team used the ER baseline system efficiency reported by contractors and tracked in the database. When these data proved unavailable, we used the average of the reported values.
- The study adjusted gas furnaces installed with ECMs by the electric heating savings converted to equivalent heat (in therms) not supplied by the waste heat of a standard motor.
- The study assumed an ER furnace efficiency of 0.625 AFUE from the average of reported values and an ER baseline boiler efficiency of 0.6 AFUE, described in an earlier section on Calculating Gas Furnace and Boiler Savings.

Table 21 shows the electrical energy saved in kWh, as reported and estimated by the evaluation team. The thorough review and use of values in the tracking database indicated conservative reported savings. Energy savings of all electric measures achieved a total gross realization rate of 108%.

Table 21. Measure-Level kWh Savings and Realization Rate

Measure Type	Count of Reported Measures	Total *Ex Ante* Reported kWh	Total *Ex Post* Reported kWh	Realization Rate
ASHP 14.5-14.9 SEER	35	24,821	33,035	133%
ASHP 15.0-15.9 SEER	61	63,522	70,501	111%
ASHP 16+ SEER	123	141,555	240,179	170%
ASHP ER 14.5-14.9 SEER - Replaces ASHP	38	150,629	107,439	71%
ASHP ER 14.5-14.9 SEER - Replaces Resistance	8	95,571	82,216	86%
ASHP ER 14.5-15.9 SEER	26	103,062	83,494	81%
ASHP ER 15.0-15.9 SEER - Replaces ASHP	79	339,392	248,992	73%
ASHP ER 15.0-15.9 SEER - Replaces Resistance	28	343,799	291,533	85%
ASHP ER 16+ SEER	30	132,168	110,537	84%
ASHP ER 16+ SEER - Replaces ASHP	84	370,070	321,831	87%
ASHP ER 16+ SEER - Replaces Resistance	30	371,642	356,336	96%
Central AC 14.5-14.9 SEER	398	77,682	101,812	131%

Measure Type	Count of Reported Measures	Total *Ex Ante* Reported kWh	Total *Ex Post* Reported kWh	Realization Rate
Central AC 15.0-15.9 SEER	191	48,050	60,237	125%
Central AC 16+ SEER	548	193,866	231,819	120%
Central AC ER 14.5-14.9 SEER	1,163	1,349,673	1,534,845	114%
Central AC ER 15.0-15.9 SEER	413	502,576	616,977	123%
Central AC ER 16+ SEER	1,153	1,520,911	1,714,407	113%
ECM - Brushless Motor - with Furnace	1,943	1,398,960	1,627,797	116%
GSHP 18.5 EER 3.7 COP	228	872,700	1,271,449	146%

Table 22 shows the electricity demand saved in kW, as reported and estimated by the evaluation team. The thorough review and use of values in the tracking database indicated conservative reported savings. Energy savings of all electric measures achieved a total gross realization rate of 108%.

Table 22. Measure-Level kW Savings and Realization Rate

Measure Type	Count of Reported Measures	Total *Ex Ante* Reported kW	Total *Ex Post* Reported kW	Realization Rate
ASHP 14.5-14.9 SEER	35	7	7	96%
ASHP 15.0-15.9 SEER	61	16	15	92%
ASHP 16+ SEER	123	46	57	124%
ASHP ER 14.5-14.9 SEER - Replaces ASHP	38	45	46	101%
ASHP ER 14.5-14.9 SEER - Replaces Resistance	8	10	10	107%
ASHP ER 14.5-15.9 SEER	26	31	37	120%
ASHP ER 15.0-15.9 SEER - Replaces ASHP	79	99	103	104%
ASHP ER 15.0-15.9 SEER - Replaces Resistance	28	35	38	108%
ASHP ER 16+ SEER	30	41	50	122%
ASHP ER 16+ SEER - Replaces ASHP	84	114	129	114%
ASHP ER 16+ SEER - Replaces Resistance	30	41	45	111%
Central AC 14.5-14.9 SEER	398	78	90	116%
Central AC 15.0-15.9 SEER	191	48	50	104%
Central AC 16+ SEER	548	191	198	104%
Central AC ER 14.5-14.9 SEER	1,163	1,415	1,407	99%
Central AC ER 15.0-15.9 SEER	413	525	529	101%
Central AC ER 16+ SEER	1,153	1,602	1,515	95%
ECM - Brushless Motor - with Furnace	1,943	611	857	140%
GSHP 18.5 EER 3.7 COP	228	136	394	290%
Grand Total	**6,579**	**5,089**	**5,849**	**115%**

Table 23 shows gas unit therm savings reported and estimated by the evaluation team. Verified gas furnace savings were less than reported savings, while gas boiler verified savings were higher than reported savings.

Table 23. Measure-Level Therm Savings and Realization Rate

Measure Type	Count of Reported Measures	Total *Ex Ante* Reported Therms	Total *Ex Post* Reported Therms	Realization Rate
92_AFUE	81	9,113	8,840	97%
95_AFUE	4,730	644,131	632,993	98%
95_AFUE_ER_PY5	568	190,405	199,473	105%
97_AFUE_ER_PY5	58	20,312	20,661	102%
97_AFUE_PY5	432	65,301	60,935	93%
BOIL_90	8	1,159	1,478	128%
BOIL_90_ER_PY5	10	5,066	5,919	117%
BOIL_95_ER_PY5	17	9,480	10,369	109%
BOIL_95_PY5	26	5,352	4,949	92%

The TRM estimates savings for ER CAC measures using dual baselines. The TRM assumes the replaced CAC would have a remaining useful life of six years. Savings are estimated for six years using the efficiency of the equipment replaced as the baseline. The TRM assumes that the remaining useful life of the equipment (12 years) should be a different baseline. Federal minimum efficiency is used to estimate efficiency for the next 12 years.

The team calculated average savings using the dual baseline approach.

Table 24 shows the average efficiency by measure, calculated from the PY5 database. The "Average of *Ex Post* Annual Savings" shows the average savings value of all PY5-reported measures, using the efficiency of the existing equipment as a baseline. The "Average of TRM Dual Baseline *Ex Post* Savings" equals the average value of all measures using both baselines (existing equipment and federal standard equipment), weighted by six and 12 years, respectively. We include this information as it will be used for cost effectiveness calculations.

Table 24. TRM Dual Baseline Calculation for Early Replacement Measures

Measure Type	Average of *Ex Post* Annual Savings (kWh)	Average of TRM Dual Baseline *Ex Post* Annual Savings (kWh)	Average of *Ex Post* Annual Peak Demand Reduction (kW)	Average of TRM Dual Baseline *Ex Post* Annual Savings (kW)
ASHP ER 14.5-14.9 SEER - Replaces ASHP	2,827	1,536	1.203	0.517
ASHP ER 14.5-14.9 SEER - Replaces Resistance	10,277	4,025	1.270	0.546
ASHP ER 14.5-15.9 SEER	3,211	1,940	1.427	0.654
ASHP ER 15.0-15.9 SEER - Replaces ASHP	3,152	1,838	1.307	0.602
ASHP ER 15.0-15.9 SEER - Replaces Resistance	10,412	4,192	1.348	0.602
ASHP ER 16+ SEER	3,786	2,471	1.687	0.868
ASHP ER 16+ SEER - Replaces ASHP	3,831	2,476	1.539	0.817
ASHP ER 16+ SEER - Replaces Resistance	11,878	5,093	1.501	0.776
Central AC ER 14.5-14.9 SEER	1,324	841	1.301	0.609
Central AC ER 15.0-15.9 SEER	1,500	965	1.388	0.667
Central AC ER 16+ SEER	1,490	1,006	1.400	0.727

4.2.3 Net Impacts

As specified by the NTGR framework provided in the ICC Order for Docket 10-0568, net savings estimates use NTGRs of 0.59 for electric measures (ASHPs, CACs, ECMs, and GSHPs), 1.02 for gas furnaces, and 1.01 for gas boilers.[20] These values draw upon results from the PY3 evaluation. Table 25 shows the program's net impacts.

[20] PY3 NTGR estimates for all measures include spillover.

Table 25. Net Impacts for All Measures

Measure	NTGR	*Ex Ante* Net Savings			*Ex Post*[a] Net Savings		
		kW	MWh	Therms	kW	MWh	Therms
CAC/ASHP	0.59	2,548	3,439	N/A	2,693	3,661	N/A
ECM Fans	0.59	623	1,427	N/A	525	960	N/A
GSHP	0.59	80	515	N/A	232	750	N/A
Gas Furnace	1.02	N/A	N/A	947,849	N/A	N/A	941,722
Gas Boiler	1.01	N/A	N/A	21,278	N/A	N/A	22,943
	Total	3,252	5,381[b]	969,127	3,451	5,372[b]	964,664
				Net Realization Rate	*1.06*	*1.00*	*1.00*

[a] *Ex post* results were based on a review of the program-tracking database and participant invoices.
[b] Totals may be different than the sum of each measure due to rounding differences.

4.3 Inputs for Future Program Planning

NTGR

As part of the PY5 evaluation, the evaluation team performed primary research to develop an updated NTGR for the AIC Residential Heating and Cooling Program. We last provided an NTGR estimate based on customer and contractor surveys in PY3, but not in PY4. AIC requested an early NTGR estimate for planning purposes, to be delivered in advance of the final evaluation report. We present the detailed methodology and findings for this research in Appendix C.

Table 26 and Table 27 show the free ridership, spillover, and NTGR estimates by measure type and overall for the electric and gas measure types, respectively.

Table 26. Electric HVAC NTGR Results by Measure

Measure	FR	Spillover	NTGR
<SEER 16 CAC/HP (RB)	57%*	26%	69%
SEER 16+ CAC/HP (RB)	50%*	26%	76%
<SEER 16 CAC/HP (ER)	69%*	26%	57%
SEER 16+ CAC/HP (ER)	44%*	26%	82%
Brushless Motors	56%*	26%	70%
Program Total	**52%***	**26%**	**74%**

* Estimate is weighted by total program measure-level kWh savings.

Table 27. Gas HVAC NTGR Results by Measure

Measure	FR	Spillover	NTGR
95% Furnace or Boiler	50%	13%	63%
97% Furnace	62%	13%	51%
Program Total	**51%***	**13%**	**62%**

* Estimate is weighted by total program measure-level therm savings.

4.3.1 Dual Replacement Summary

As part of the PY5 evaluation, the evaluation team performed primary research to investigate standard market practices—as perceived by NAR contractors—occurring among contractors and customers regarding the simultaneous replacement of heating and cooling equipment. Questions we asked regarding this topic sought to inform stakeholder discussions related to the Illinois TRM regarding possible free ridership occurring when a second piece of equipment has been purchased under AIC's Residential Heating and Cooling Program.

Results indicated that customers would likely replace heating and cooling equipment at the same time, without any incentive, from 42% to 62% of the time. We assume this range reflects the baseline or standard market practice for dual replacement. This can also be considered free ridership for a program aimed at incentivizing dual replacements. We asked contractors to estimate the potential influence of two rebates levels on this baseline activity. Contractors indicated that a $500 incentive would increase the likelihood of dual replacement by about 5%, and a $1,000 incentive would increase the likelihood of dual replacement by about 12%. Appendix D presents a complete discussion of methodology used and results produced.

4.3.2 Metering Analysis Summary

Metering Overview

The evaluation team began its metering effort in May 2012, leaving meters in place through the end of the cooling season. We successfully installed meters on 24 CACs and 24 ASHPs. Many customers who had CACs installed in PY4 received incentives for both installations of a high-efficiency air conditioner and a high-efficiency gas furnace. Of the 24 homes with CACs randomly sampled, 16 also received a gas furnace installation. All 16 gas furnaces were also metered. The gas furnace meters were installed during the initial site visits in May. The team aimed to install furnace meters on a total of 48 gas furnaces, and the remaining 32 gas furnace meters were installed between late October and early November. At the same time, the 24 CAC meters were removed. The ASHP meters were left in place to record winter energy consumption.

Results Summary

We compared savings estimates calculated from metering data to savings estimated calculated using TRM algorithms. These results, along with the realization rate and metering results' relative precision, are presented in Table 28. With the exception of the demand savings per ton of cooling, TRM savings estimates fall within the sampling error of the metered data results. The team recommends adjusting the TRM demand savings algorithms by a factor of 1.37. We present the complete methodology and results in Appendix B.

Table 28. Metering Results Summary

Metering Results	Metered Savings Estimate	TRM Calculated Savings Estimate	Realization Rate (Metered/TRM)	Relative Precision at 90% Confidence
CAC and HP Cooling Savings	343 kWh	362 kWh	0.95	13.0%

Metering Results	Metered Savings Estimate	TRM Calculated Savings Estimate	Realization Rate (Metered/TRM)	Relative Precision at 90% Confidence
Per-Ton Demand Savings	0.078 kW/ton	0.057 kW/ton	1.37	13.2%
Coincidence Factor*	43.2%	46.6%	0.93	13.0%
Heat Pump Heating Savings	708 kWh	866 kWh	0.82	35.3%
Gas Furnace Therm Load*	592 Therms	676 Therms	0.88	12.4%
Gas Furnace Therm Savings	116 Therms	124 Therms	0.94	11.7%

*Included for comparison purposes only.

Appendix A. Data Collection Instruments

AIC PY5 Residential New Heating & Air Conditioning Equipment Program *Participant Survey*

HVAC Appendix A1.pdf

AIC PY5 Residential New Heating & Air Conditioning Equipment Program Non-Active Registered (NAR) Contractor *Survey*

HVAC Appendix A2.pdf

Appendix B. Metering Study Results

Metering Overview

The evaluation team began its metering effort in May 2012, leaving meters in place through the end of the cooling season. We successfully installed meters on 24 CACs and 24 ASHPs. Many customers who had CACs installed in PY4 received incentives for both installations of a high-efficiency air conditioner and a high-efficiency gas furnace. Of the 24 homes with CACs randomly sampled, 16 also received a gas furnace installation. All 16 gas furnaces were also metered. The gas furnace meters were installed during the initial site visits in May. The team aimed to install furnace meters on a total of 48 gas furnaces, and the remaining 32 gas furnace meters were installed between late October and early November. At the same time, the 24 CAC meters were removed. The ASHP meters were left in place to record winter energy consumption.

Some of the installations (a total of 19) used cellular loggers, which upload data each day. The data were checked throughout the year for accuracy, completeness, and sensor errors. If a regular logger was used, in late October the team returned to the participant site to download data from the logger, change logger batteries, check sensors, and re-launch the loggers.

The team also interviewed homeowners before and after the metering period to gather information about the site's operational characteristics. Homeowners were asked when they first began using the HVAC system in the season and other characteristics of their use, such as whether they went on vacation and, if so, for how long.

Methodology

We estimated the amount of CAC, ASHP, and gas furnace heating and/or cooling provided to the home by metering gas and electricity consumption in addition to specific characteristics of the system. We assumed that homes use the same amount of heating or cooling regardless of the system efficiency, and therefore we can estimate savings by multiplying energy used by the difference in efficiency between the old and new systems.

Electric Savings

To meet International Performance Measurement and Verification Protocol (IPMVP) Option A requirements, we metered the following to determine electric savings:

- Energy consumption (kWh) in two-minute intervals, outside air temperature and humidity, evaporator blower amperage, supply air temperature and humidity, return air temperature and humidity, and space temperature (using U-10 or equivalent)
- For air source ASHPs, the evaluation team metered the above parameters in addition to the power drawn by electric resistance back-up heaters

For each metered interval we used detailed manufacturers' engineering data to calculate the rated efficiency of the unit at the coinciding outdoor temperature, and the efficiency of a baseline code model (nominal SEER[21] 13). For each metering interval we calculated the energy impacts for interval 'i' and temperature 'T' as follows:

$$\text{Equation A: Consumption Savings}_i = Metered\ Energy\ Use_i \times \frac{EER_{High}(T)}{EER_{Replaced}(T)} - Metered\ Energy\ Use_i$$

For each metered system, we derived EER (or COP)[22] values from the manufacturer's CAC and ASHP performance data. Figure 25 is an example of a Carrier performance data sheet for an ASHP in heating mode. This table provides heating capacity and system power estimates at various outdoor temperatures. According to Figure 25, as outdoor temperature (outdoor coil entering air temperature) declines from 37°F to 27°F, the heating capacity that the ASHP provides decreases by about 15%.[23] Conversely, the heat load on a typical home in Illinois increases by about 15% when the outdoor temperature drops by 10°F. Ultimately an ASHP is unable to provide sufficient capacity to heat the home, and therefore additional heating capacity from another source is needed. Typical backup heat sources are electric resistance (ER) heat or fuel-based heating sources. A properly controlled ASHP will use minimal backup, thus maximizing energy savings.

Figure 25. Example Capacity and Power Values versus Temperature for ASHP

INDOOR AIR		OUTDOOR COIL ENTERING AIR TEMPERATURES °F (°C)														
		−3 (−19.4)			7 (−13.9)			17 (−8.3)			27 (−2.8)			37 (2.8)		
EDB °F (°C)	CFM	Capacity MBtuh		Total Sys. KW†	Capacity MBtuh		Total Sys. KW†	Capacity MBtuh		Total Sys. KW†	Capacity MBtuh		Total Sys. KW†	Capacity MBtuh		Total Sys. KW†
		Total	Integ*		Total	Integ*		Total	Integ*		Total	Integ*		Total	Integ*	
25HCC518A30 Outdoor Section With FX4DNF019 Indoor Section																
65 (18.3)	525	5.13	4.72	1.02	7.34	6.75	1.07	9.76	8.90	1.12	12.54	11.13	1.18	15.15	13.78	1.24
	600	5.22	4.80	1.02	7.46	6.85	1.07	9.91	9.03	1.11	12.68	11.27	1.17	15.35	13.97	1.22
	675	5.30	4.87	1.02	7.55	6.94	1.07	10.04	9.15	1.11	12.80	11.37	1.16	15.51	14.12	1.20
70 (21.1)	525	4.84	4.45	1.07	7.04	6.47	1.12	9.43	8.60	1.18	12.28	10.90	1.24	14.86	13.52	1.31
	600	4.92	4.53	1.07	7.15	6.57	1.12	9.58	8.74	1.17	12.44	11.04	1.23	15.05	13.70	1.28
	675	4.99	4.59	1.07	7.25	6.66	1.12	9.71	8.85	1.16	12.56	11.16	1.21	15.21	13.84	1.26
75 (23.9)	525	4.50	4.14	1.11	6.70	6.16	1.17	9.09	8.29	1.23	11.98	10.64	1.30	14.56	13.25	1.37
	600	4.59	4.22	1.12	6.82	6.27	1.17	9.24	8.42	1.22	12.15	10.79	1.29	14.75	13.43	1.34
	675	4.66	4.29	1.12	6.92	6.36	1.17	9.36	8.54	1.22	12.29	10.91	1.27	14.91	13.57	1.33

The energy savings algorithm for cooling savings for CACs or ASHPs used in the TRM is:

Equation 7.

$$kWh\ saved = EFLH \times \frac{BTU}{hr} \times \frac{\frac{1}{SEER_{base}} - \frac{1}{SEER_{efficient}}}{1{,}000\ W/kW}$$

The limitation of the equation is that the EFLH[24] is not well known, and that many literature values over-predict consumption and savings[25]. Simply inserting run time from metering does not fully account for variations in efficiency. Instead we calculated savings directly from metering, as

[21] Seasonal Energy Efficiency Ratio.

[22] EER is the standard term for cooling capacity over system power, while coefficient of performance (COP) is the standard term for heating capacity over system power.

[23] Percentages are estimates provided for purposes of an example.

[24] Equivalent Full-Load Hours.

[25] Ameren Missouri evaluation found that the 2002 DOE EFLH used in the TRM to predict energy consumption was 25% higher than meter data results.

described above in Equation A. We compared the savings calculated from meter data to the savings calculated from the TRM for each piece of equipment metered.

Gas Savings

To meet IPMVP Option A requirements, we performed the following evaluation activities for gas savings:

- Spot combustion metering on the 48 furnaces, noting excess oxygen, flue temperature, and efficiency
- Metering of the supply and return air temperatures, flue gas temperature, and gas valve position
- Metering of the space temperature, using U-10 or equivalent

The purpose of this effort was to verify the annual fuel utilization efficiency (AFUE) of the installed high-efficiency gas furnace or boiler. AFUE is defined as:

Equation 8.

$$AFUE = \frac{BTU\ Provided\ in\ the\ Season}{BTU\ Input\ in\ the\ Season}$$

A high AFUE rating greatly depends on the amount of condensing achieved by the furnace or boiler. We compared the rated AFUE to the actual AFUE, and determined savings by comparing a spot thermal efficiency measurement to expected thermal efficiency. We noted the flue gas temperature to estimate efficiency throughout the entire heating season, then developed an actual AFUE to compare to the baseline condition.

Weather Normalization

We developed weather-normalization factors for heating and cooling savings by multiplying the ratio of degree days observed during the metering period to degree days of the 30-year normal. Typically a base of 65°F is used, but the TRM specifies HDD base 60 and CDD base 65, so we calculated HDD and CDD using these base temperatures.

Summer Metering Method: CACs and ASHPs

To evaluate key parameters, the evaluation team used Option A of the IPMVP manual: "Partially Measured Retrofit Isolation/Stipulated Measurement." Using this option as a guide, the team measured the following:

- The condenser energy consumption (kWh per metered interval)
- The outdoor temperature and relative humidity in the vicinity of the condenser (using solar shielded sensors)
- The indoor temperature and humidity of the supply and return air
- The fan current (amps)

- The indoor temperature and humidity near the thermostat to examine set points

We performed spot power measurements of the fan to determine fan power from metered amps.[26]

To verify the accuracy of the loggers, we performed spot power measurements for all of the logging input parameters. Table 29 lists the instrumentation used to measure the HVAC units' energy consumption, the indoor and outdoor temperatures, and the relative humidity.

Table 29. Metering Equipment Specifications

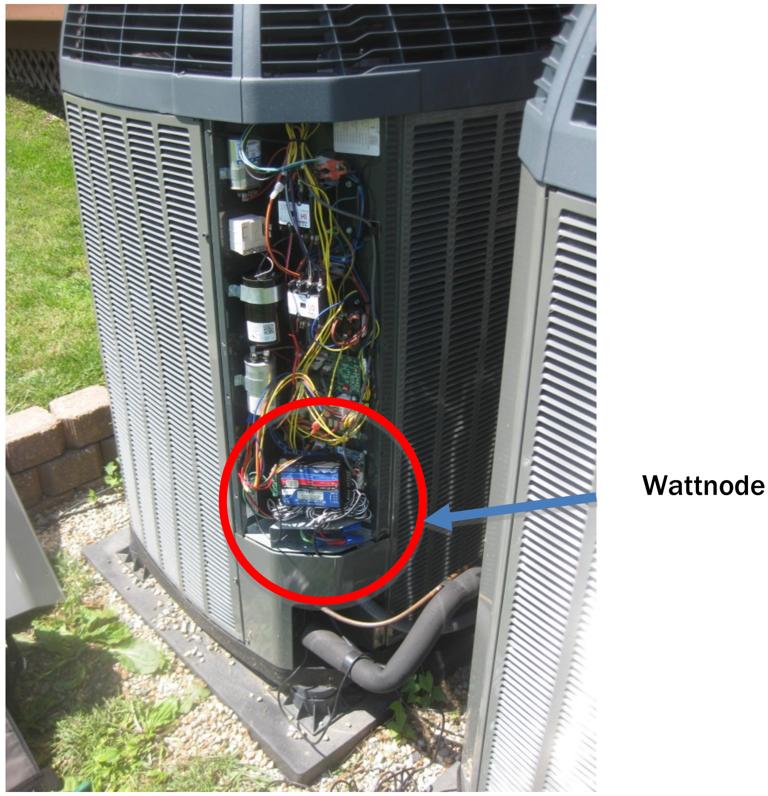
Function/ Data Point	Equipment Brand/ Model	Qty Req'd	Rated Full Scale Accuracy		Accuracy of Expected Measurement		Planned Metering Duration (months)	Planned Metering Interval (min)
Energy/Time	Wattnode/WNB-3Y-240-P	1	± 0.05%		± 0.45%		6	2
Temperature RH%	Hobo Microstation or U30 with S-TMB-M002 Sensor	1	±0.36°F	±3.5% RH	±0.3°F	±3.0% RH	6	2
Amps	ACT-075-050	3	± 0.75%		0.05% (variable by measured current)		6	2
Indoor Temperature	Hobo Temp/ RH data logger	1	±0.36°F	±3.5% RH	±0.3°F	±3.0 RH	6	5

Source: Cadmus engineering data and manufacturer specifications from Onset Corporation and Continental Controls Corporation.

Below are figures illustrating the metering configurations.

[26] With metered fan current and known power factor and voltage (assumed constant), power is calculated using the equation: *Watts = Spot Measured Volts x Metered Amps x Spot Measured Power Factor.*

Figure 26. Wattnode Installed in Condenser Electrical Compartment



*Unit is open in photograph to show metering details.

Figure 26 shows the energy/demand logger installed in the electrical compartment of an ASHP condenser. Figure 27 below shows a solar-shielded temp/RH sensor mounted to the condenser.

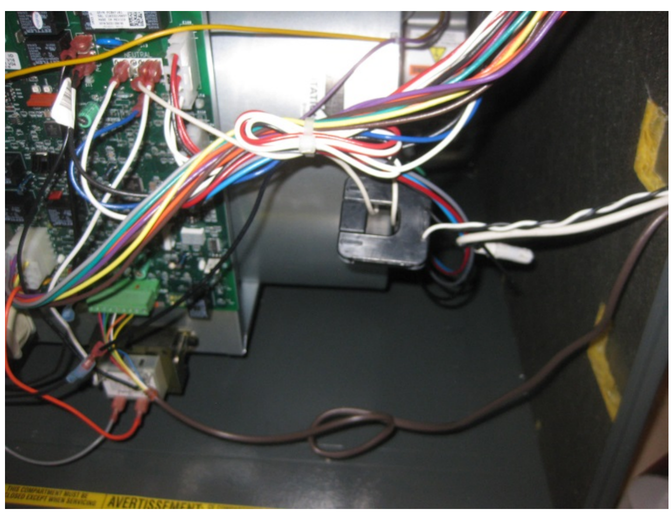
Figure 27. Solar-Shielded Temp/RH Sensor

When a cellular logger was used, a data cable was run along the refrigerant lines into the home, and the logger was typically placed on the furnace. Figure 28 below shows a cellular logger (white box) placed on a furnace and AC cooling coil.

Figure 28. Cellular Logger for Furnace and AC Meter Installation

We metered the fan current with a 20-amp CT[27] (pictured in Figure 29). In most cases we metered the load-carrying wire connecting directly to the furnace. In a few cases this was not possible, and we metered the entire electrical power of the furnace. We assumed that the standby power of the control board was negligible in these cases (and had no bearing on savings analysis).

Figure 29. Fan Current Metering

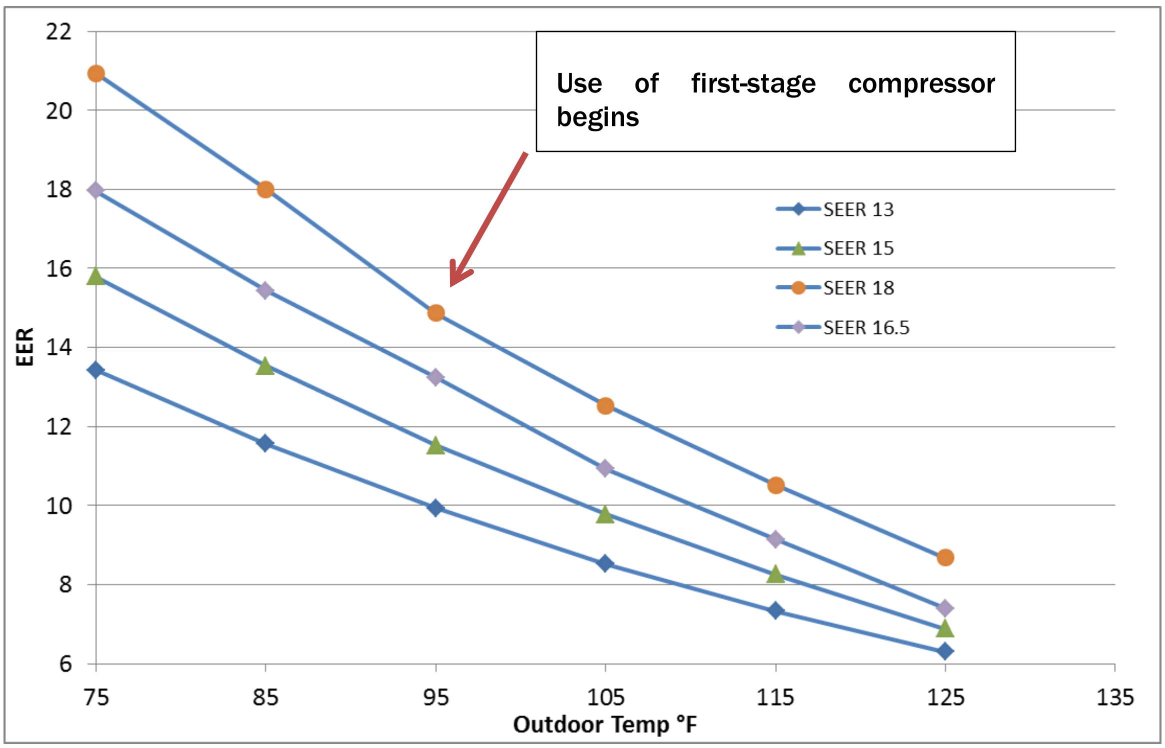


27 Current transformer.

Summer Meter Data Summary

We use full-load hours and SEER values to roughly estimate energy use and consumption. We based SEER values on tests conducted at four discrete ambient conditions. Very high SEER systems typically have multi-stage compressors, and the efficiency difference between the high SEER system and a baseline efficiency system is proportionally much higher at cooler outdoor conditions than at peak conditions. As Figure 30 below shows, EER curves "pinch" together as the outdoor ambient temperature increases. This effect is dramatically increased if a system has a multi-stage compressor. At 85°F and 75°F, the 18 SEER curve in Figure 30 increases, not following the same polynomial trend as other single-stage units.

Figure 30. Example EER Performance Curves



Detailed investigation of energy consumption at variable outdoor conditions is important because savings vary from region to region. For example, a high-efficiency two-stage 21 SEER system that only operates at 95 degrees or hotter will never operate in a single stage where it is very efficient. Its effective SEER might only be 12. The effective SEER of a federal minimum efficiency 13 SEER system at 95 degrees would be roughly 11, and the savings would be minimal. If these same two systems operated at 75 degrees or less, the savings would greatly increase because the effective SEER of the high-efficiency system would be ~25 SEER and the 13 SEER system would be ~16 SEER. AHRI[28] SEER ratings are based on climate zone IV weather data.

With an average of 15.6 SEER (based on the AHRI nameplate rating), the ASHPs and CACs metered are similar to the efficiency of all systems in the PY4 database, which averaged 15.3 SEER. The TRM algorithm was reconstructed to estimate energy consumption for the systems metered. The TRM estimates 1,834 kWh, 6% more than the metered energy consumption. Energy savings

[28] Air-Conditioning, Heating, and Refrigeration Institute.

calculated from meter data averaged 343 kWh, while the TRM calculates 362 kWh for the sites metered—a difference of 5%. Thus, according to our analysis, the AHRI SEER ratings of CACs and ASHPs and published cooling EFLH in the TRM generate savings estimates that agree with savings estimated through detailed analysis of meter data. The metered energy consumption and savings are shown in Table 30 below. With a coefficient of variation (CV) of 0.52, energy use per ton of heating/cooling capacity is variable, reflecting differences in sizing procedures, efficiency, external weather conditions, and occupant behavior. Table 30 compares metered energy use and savings per unit to TRM algorithm estimates.

Table 30. Per-Unit Metered Cooling Energy Consumption and Savings (kWh)

Consumption and Savings	CV*	Average	Relative Precision	90% Confidence (High)	90% Confidence (Low)	TRM
Metered Energy Consumption	0.52	1,724	12.6%	1,942	1,506	1,834**
kWh Savings from Meter Data	0.53	343	13.0%	388	299	362

* CV based on kWh per ton.
** Calculated using TRM algorithm with EFLH, tons, and SEER.

Peak Demand Savings

According to the Illinois Statewide TRM:

Summer peak coincidence factors can be found within each measure characterization. The source is provided and is based upon evaluation results, analysis of load shape data (e.g., the Itron eShapes data provided by Ameren), or through a calculation using stated assumptions.

Because Illinois is a summer peaking state, only the summer peak period is defined for the purpose of this TRM. The coincident summer peak period is defined as 1 p.m. to 5 p.m. Central Prevailing Time on non-holiday weekdays, June through August.

We estimated demand savings by analyzing ASHPs and CAC meter data during the peak period. We calculated temperature-dependent savings according to the method described in the previous section, using manufacturer information to calculate efficiency as a function of temperature for the system metered and a 13 SEER baseline system.

Table 31. Per-Ton Demand Savings and Coincidence Factor for CACs and ASHPs

Demand Savings & Coincident Factor	Average	Relative Precision	90% Confidence (High)	90% Confidence (Low)	TRM	Realization Rate
Demand Savings (kW Per Ton)	0.078	13.2%	0.088	0.068	0.057	1.37
PJM Coincidence Factor	43.2%	13.0%	48.9%	37.5%	46.6%	0.93
CAC Ameren System Peak Coincidence Factor	68.4%	13.2%	81.6%	51.3%	91.5%	0.75
ASHP Ameren System Peak Coincidence Factor	72%	9.6%	81.6%	62.5%	91.5%	0.78

Table 31 provides demand and coincidence factor results and the TRM demand savings estimate for the CACs and ASHPs metered. The data show that the coincidence factor[29] provided in the TRM matches the meter data reasonably well. The meter data indicated that the coincidence factor of all systems was 43.2%. The TRM estimates 46.6% for the same period of interest. This estimate is within the 90% confidence interval for the meter data results. However, we estimated metered demand savings as higher than the TRM-based demand savings estimate. Even though the coincidence factor is similar, we expected this result because the TRM algorithm uses EER at peak conditions, while the meter data analysis uses EER at actual conditions. The disparity between the EER of a high-efficiency HVAC system and the EER of a federal minimum EER at peak conditions is less than at cooler conditions (explained above, refer to Figure 30). The result is larger savings than the TRM algorithm calculates, because the average temperature during the peak demand period was less than 95°F.

Winter Metering Method: ASHPs

We also metered ASHPs in the winter to capture winter heating energy consumption. If the ASHP had backup electrical resistance (ER) heat, we metered the heating circuit(s) with one or two additional 50-amp CTs. We performed spot-measurements of voltage to collect a voltage estimate for the metered period. The power and energy consumption can be directly calculated from volts and amps because there is no power factor component to purely resistive loads. We assumed electrical resistance heating was used in a similar manner for both replaced and new units. Consequently, ER backup heat use did not directly affect calculated energy savings. By definition, ER is less efficient than ASHP operations for most temperatures, with a 1.0 COP. Where ER is not carefully controlled, its use to provide backup heat can result in a low HSPF30 and high consumption at a site, regardless of the site's ASHP nominal efficiency. The ER use was metered to provide insights about the control of use of inefficient backup heat—an indication of the quality of installation.

[29] Average on/off run time percentage during peak period.
[30] Heating Seasonal Performance Factor.

Winter Metering Results: ASHPs

Table 32 compares ASHP metered energy consumption savings to that estimated using TRM algorithms, along with the coefficient of variance (CV), confidence intervals, and relative precision.

Table 32. Per-Unit ASHP Meter Data Summary – Heating Only

Meter Data	CV	Average kWh from Meter Data	Relative Precision	90% Confidence (high)	90% Confidence (low)	TRM
ASHP Condenser and Fan for Systems with ER	0.45	3,777	17%	4,420 kWh	3,314 kWh	N/A
ER kWh Consumption	2.43[c]	2,180	126%	9,160 kWh	0 kWh	N/A
Total kWh for ASHPs with ER[b]	1.15	5,957	59%	9,472 kWh	2,442 kWh	7,250[a]
ASHP Condenser and Fan for Systems with Alternate Backup (No ER)	0.86[d]	4,898	63.5%	8,007 kWh	1,790 kWh	N/A
kWh Savings from Meter Data	0.89	708 kWh	35.3%	957 kWh	458 kWh	866 kWh

[a] Calculated using TRM algorithm with heating EFLH, tons, and HSPF. The third row provides like comparison of ASHP pump TRM energy consumption to metered energy consumption.
[b] ER kWh average based on 14 systems with ER. Other ASHPs with gas backup heat are not included in this average.
[c] Very high CV and poor precision because this is a small sample (13 total) and one system had significant ER use (18,745 kWh).
[d] One system is driving very high CV and poor relative precision. This system ran almost continuously the entire winter.

Energy consumption of the ASHP without backup varied significantly, from 856 kWh to 13,417 kWh. The resulting CV for savings was higher than anticipated: 0.89 with a relative precision of 35.3% at the 90% confidence level due to variations in backup heating usage and fuel type. With the exception of one system, ASHPs with gas backup heat ran less than the ASHPs with backup electric resistance heat.[31] We calculated savings without considering backup heat because we assume backup fuel use from the baseline system would be the same.

Winter Metering Results: Gas Furnaces

We metered 48 gas furnaces using the supply air temperature sensor and fan current sensor to determine when the furnace was operating in first and second stage. We used nameplate BTUh data to determine efficiency and BTUh output in each stage. If the furnace was multi-stage or had a modulating gas valve, we first investigated the data to estimate the approximate temperature

[31] Contractors usually set dual-fuel systems to operate cost-effectively. As temperature decreases, the heat pump becomes less efficient while gas furnace efficiency is unaffected. As the price of natural gas decreases, contractors are more likely to control the system to switch to the gas furnace at warmer outdoor temperatures. The gas furnace and heat pump cannot run at the same time.

differential (between supply and return air) at its minimum and maximum rated BTUh output. We assumed a linear relationship exists between maximum and minimum BTUh values, and estimated BTUh output when the furnace is modulating in between the max and min. We used both fan current and supply air temperature to estimate BTUh output at any given time.

The gas furnace metering included a stainless steel temperature sensor installed directly into the PVC flue pipe. This sensor (pictured in Figure 31) was used to confirm whether the furnace was always condensing or if there were times when the flue gas temperature exceeded the condensing temperature—an indication that the furnace was not operating at its nameplate efficiency. Review of these data indicates that there is no reason to believe that any of the high-efficiency condensing furnaces installed through the program did not operate at their nameplate rated efficiency.

Figure 31. Temperature Sensor in Flue Gas Pipe

Winter Metering Results: Gas Furnaces

The TRM provides a table for heating load of a home, which is the household heating need, not household gas consumption. The source for this estimate, which is used to calculate savings, is "*Nicor R29 Res Rebate Evaluation Report 092611_REV FINAL to Nicor.*" The heating load is independent of efficiency and independent of furnace heating capacity, so we compared the metered value to the TRM value. Table 33 shows the average metered heating load was 592 therms. This is estimated using the nameplate output (BTUh) and runtime in first or second stage (or determining output when the furnace is modulating between max and min, as described above).

While the heating output metered was 592 therms, the TRM estimates a heating output of 676 therms for the homes metered, a difference of 12%. With a minimum of 105 therm heating load and a maximum of 1,413 therms, there is a large difference in furnace therm consumption. The home requiring the least amount of heat load had a furnace installed in conjunction with an ASHP. The home with the largest heat load had a furnace that ran nearly constantly. Even without normalizing for furnace size and location of the metering participant, the data achieved 12.4% relative precision at 90% confidence.

Table 33. Metered Heating Load of Homes

Heating Load	CV	Average	Relative Precision	90% Confidence (High)	90% Confidence (Low)	TRM Average Therm Use of Metered Sites
Metered Heating Load (therms)	0.46	592	12.4%	665	518	676

Table 34 shows the calculated savings. The metered savings difference from TRM-calculated savings is 5% to 7% less than the therm use estimated by the TRM.[32]

Table 34. Metered and TRM-Calculated Therm Savings of Gas Furnaces

Savings	CV	Average	Relative Precision	90% Confidence (High)	90% Confidence (Low)	TRM Savings
Metered Heating Savings (Therms)	0.43	116	11.7%	129	102	124

The TRM includes an interactive effect for furnaces installed with ECM fans. We applied the adjustment specified in the TRM for systems installed with an ECM fan. Metered sites do not require adjustment because the total heating capacity provided by the furnace is metered.

ECM Data Review

When we began the metering study in PY4, AIC had not yet initiated the ECM measure as part of its HVAC Program, therefore we did not sample to achieve statistically significant results. Regardless, we analyzed ECMs metering data we collected through our CAC, ASHP, and furnace sites. We reviewed ECM and standard fan motor use to determine whether data showed differences in energy consumption. We found no discernible differences that we are not able to interpret—largely because the operational characteristics varied so much across the metered sites. We recorded the fan energy consumption of ECM and standard fan motors for the following systems:

- 42 gas furnaces (18 with ECM)
- 22 CACs (13 with ECM)

[32] The team calculated savings for stage one and stage two, which can have two different efficiencies.

- 21 ASHPs (16 with ECM)

We only obtained partial-year information on most units because:

- Furnaces were only metered during the winter
- CACs were only metered during the summer
- Savings greatly depend on the amount of fan runtime in heating, cooling, and circulation mode, and usage patterns vary greatly from home to home

Overall, the study metered 42 furnace fans successfully. Of those, 18 furnaces had an ECM fan. Eleven of the ECM fans operated in "Auto" mode, meaning the fan motor operated only when there was a call for heat. Seven furnaces operated either continuously or sporadically. Stratification of the sample to reflect these differences results in a sample size that is too small to accurately estimate savings.

Additional Considerations—ASHP Controls

The evaluation team was surprised to find that ASHPs were controlled and operated very efficiently. Thirteen ASHPs had backup electric resistance strip heat. Backup heat accounted for 18% of the total energy consumption of these systems. Our informal conversations with customers with backup electric resistance heat showed homeowners were well-aware of the high cost of the "Emergency Heat," and several noted that they had worked with their contractors to get the setpoint at the "most efficient" control temperature.

Summary of Results

Table 35 below shows the savings metered and TRM-calculated savings. The TRM values are estimated using the nameplate data from the equipment metered at each site.

Table 35. Meter Data and TRM Summary

Savings	Metered Savings Estimate	TRM-Calculated Savings Estimate	Realization Rate (Metered/TRM)	Relative Precision at 90% Confidence
CAC and ASHP Cooling Savings	343 kWh	362 kWh	0.95	13.0%
Per-Ton Demand Savings	0.078 kW/ton	0.057 kW/ton	1.37	13.2%
Coincidence Factor*	43.2%	46.6%	0.93	13.0%
ASHP Heating Savings	708 kWh	866 kWh	0.82	35.3%
Gas Furnace Therm Load*	592 Therms	676 Therms	0.88	12.4%
Gas Furnace Therm Savings	116 Therms	124 Therms	0.94	11.7%

*Included for comparison purposes only.

We calculated TRM savings at each metered site using equipment nameplate information and site location (weather zone) with the standard TRM algorithms. Table 35 compares the metering results to savings estimated using TRM algorithms. The TRM savings estimates fall within the uncertainty of the metered results, with the exception of demand savings. The team recommends adjusting the TRM algorithm for demand savings by the realization rate of 1.37.

Appendix C. NTGR Results

HVAC Report
Appendix C.pdf

Appendix D. Dual Replacement Analysis

HVAC Report
Appendix D.pdf