

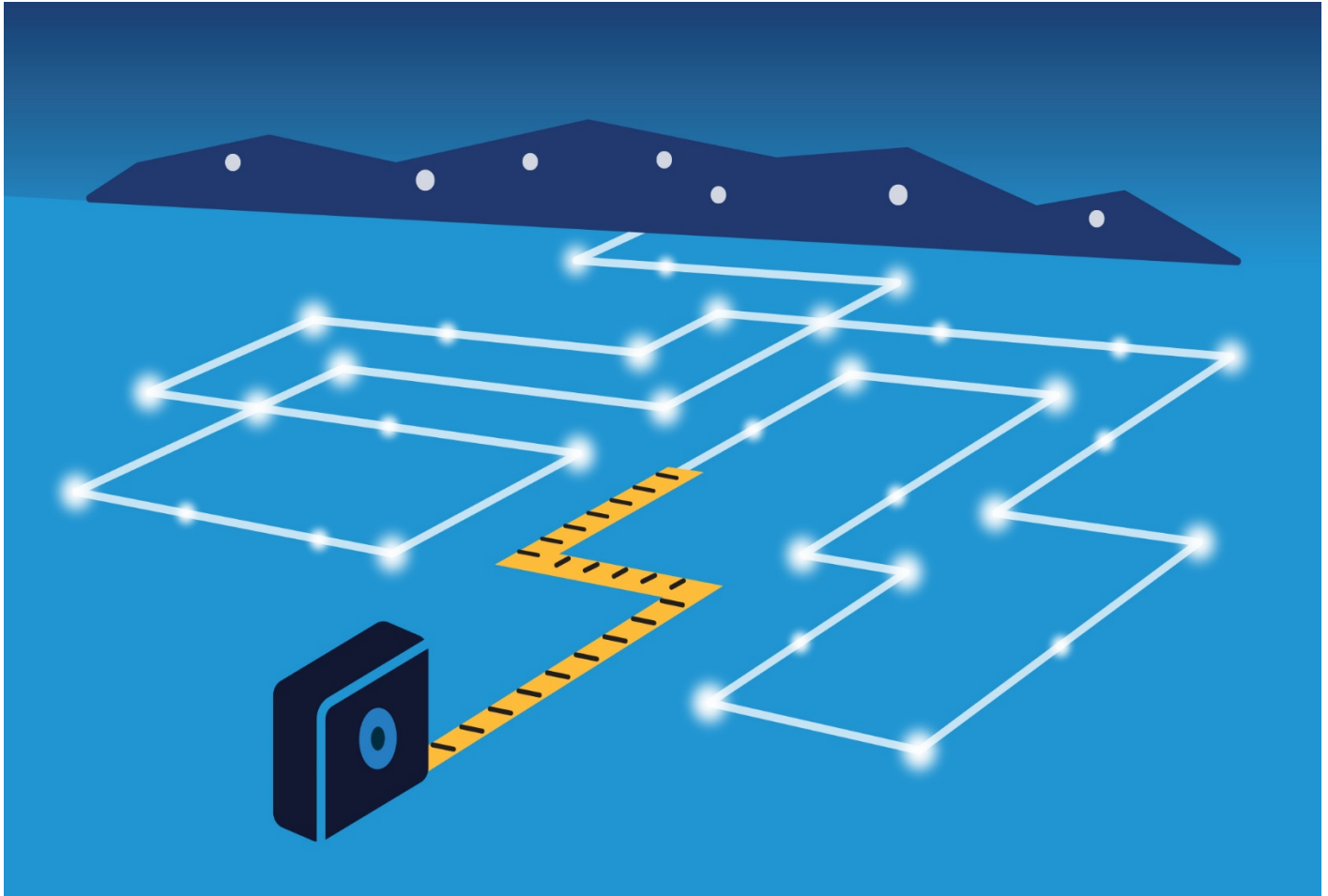


Opinion **Dynamics**

Boston | Headquarters

617 492 1400 tel
617 497 7944 fax
800 966 1254 toll free

1000 Winter St
Waltham, MA 02451



Impact and Process Evaluation of 2014 (PY7) Ameren Illinois Company Home Efficiency Income Qualified Program

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CADMUS

NAVIGANT





Contributors

Jeevika Galhotra
Project Manager, Opinion Dynamics

Mallorie Gattie-Garza
Energy Engineer, Opinion Dynamics

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1. Executive Summary

This report presents the results of Opinion Dynamics’ evaluation of the Program Year 7 (PY7) Ameren Illinois Company (AIC) Home Efficiency Income Qualified Program (Income Qualified Program). The program, a home energy diagnostic and whole-house retrofit program, began as a pilot in PY3 and is in its fourth year of implementation. The target market for the Income Qualified Program is existing homes heated by a fuel source (electricity or natural gas) provided by AIC and owned by customers with a household income between 150%-300% of federal poverty guidelines for household size. CLEAResult (formerly Conservation Services Group) implements the Income Qualified Program, reporting to Leidos who manages all of AIC’s commercial and residential programs.

The expected savings from this program is 0.5% of the overall PY7 portfolio of electric savings and 4.2% of PY7 portfolio therm savings (including both residential and commercial).¹ Per the Program Implementation Plan, CLEAResult estimated they would perform 735 home audits in PY7, with 439 homes receiving retrofits.

For PY7, the evaluation team conducted a process and impact evaluation of the Income Qualified Program.

Program Impacts

The Income Qualified Program reached 352 participants in PY7, providing net savings of 873 MWh, 0.52 MW and 210,250 therms. PY7 performance exceeded PY6 where the program achieved net savings of 617 MWh, 0.53 MW and 173,380 therms. Table 1 summarizes the net impacts for the Income Qualified program.

Table 1. PY7 Income Qualified Program Net Impacts

	Ex Ante Gross	Realization Rate	Ex Post Gross	NTGR	Ex Post Net
Energy Savings (kWh)					
Total MWh	880,882	99%	873,194	1.0	873,194
Demand Savings (kW)					
Total MW	565	92%	522	1.0	522
Therm Savings					
Total Therms	179,940	117%	210,250	1.0	210,250

The Income Qualified Program achieved gross PY7 realization rates of 99% for kWh, 92% for kW and 117% for therm. The variance in net realization rates is due to differences in input values for *ex ante* (calculated by the implementation team) and *ex post* (calculated by the evaluation team) savings algorithms for air sealing and insulation measures. Specifically, the evaluation team based values for cooling degree days (CDDs), heating degree days (HDDs), and full-load cooling hours on the location of each participating home while the program tracking system applied values for Springfield to all homes, regardless of location. *Ex Ante* and *Ex Post* savings estimates also differ with respect to baseline

¹ Note that the percentage of expected savings here and throughout the plan is calculated based on AIC Plan 3 Compliance Filing from Docket 13-0498, dated January 28, 2014.

assumptions for heating and cooling equipment and rim joist insulation. We provide a detailed explanation of all differences in the impact section of this report.

Process Results

The program underwent several changes in PY7 including Leidos joining the implementation team on the management side, with CLEAResult remaining the customer-facing implementer. The program also made several design changes to help facilitate participation. The program added a new channel for program participation: allowing trade allies to sell program work directly to customers. The program also expanded the group of potential program participants by lowering the qualifying financial threshold (from a household income of 200%-300% of federal poverty guidelines to 150%-300%).

Surveys revealed that trade allies are generally satisfied with the program and believe that it has had a positive impact on their business (notably, increases in revenue and customer satisfaction). The program has good recognition among trade allies and they feel very knowledgeable of program components – in part, due to the training they have received from CLEAResult. Allowing trade allies to market the program directly seems to have been a positive change. In addition, almost every trade ally reported using the program's On-Bill Financing (OBF) offering and reported that it makes selling work to customers much easier. Finally, trade allies reported that the Income Qualified Program has directly resulted in their adding/training more skilled employees (BPI certification) to their organization. Despite overall positive marks, trade allies did encounter some challenges with the program. They report that the program paperwork and general administration are tedious and require streamlining and that payment for services takes too long. These challenges lead some trade allies to complete qualifying jobs outside of the program.

Key Findings and Recommendations

Based on the process and impact evaluation findings, the following are some recommendations for the Income Qualified Program:

- **Streamline program paperwork and administration.** The trade ally survey revealed that filling out paperwork is not only time-consuming but also has prevented some contractors from running all of their qualified projects through the program (if the customer needs a quick project turnaround, for example). Reducing this administrative burden on trade allies would help make the program more attractive, and increase satisfaction with the program.
 - Part of this streamlining should include looking for opportunities to reduce the amount of time it takes to pay trade allies. The trade ally survey revealed that extended lead-times on payments can discourage and limit program participation.
- **Leverage trade allies for program marketing.** Historically, the Income Qualified Program has seen growth (in both PY5 and PY6) without making any major changes to marketing tactics or program implementation. Based on trade ally feedback, direct mailers and program material handouts are the most relevant marketing tactics. As such, it would be beneficial to work with trade allies to establish additional marketing materials for these marketing tactics.
- **Update program-tracking database to include a flag for projects using OBF.** Given that OBF is a key program component, it would be useful to track usage of OBF within the tracking database. This could allow future evaluation efforts to better understand the impact and extent to which OBF affects the Income Qualified Program.

- **Update program tracking savings assumptions to reflect the ex post values used in this evaluation.** Per our *ex post* savings calculations, the evaluation team identified several discrepancies in savings assumptions between the *ex ante* and *ex post* savings calculations. To increase the accuracy of tracked savings, we recommend that the Income Qualified Program adopt the *ex post* assumptions and savings calculations used by the evaluation team.
- **Update *ex ante* savings algorithms for rim joist, basement wall, and crawlspace insulation.** Through discussions with the implementer, we learned that supply vents are installed in below grade spaces, thus turning this space into a semi-conditioned area. However, *ex ante* and *ex post* calculations currently apply CDDs and HDDs for unconditioned space. We recommend modifying the algorithm to use unconditioned basement CDDs and HDDs for pre-existing conditions, and using conditioned basement CDDs and HDDs for post conditions.

2. Evaluation Approach

The PY7 evaluation of the Income Qualified Program involved both process and impact assessments. To support the process evaluation, we reviewed program materials and program-tracking data, interviewed implementation and AIC staff, and conducted surveys with participating trade allies. To evaluate gross impacts, the evaluation team conducted engineering analysis. Further, per the evaluation plan, we applied a net-to-gross ratio (NTGR) of 1.0 to evaluated gross savings to obtain PY7 net savings

2.1 Research Objectives

The evaluation team sought to answer the following research questions as part of the PY7 Income Qualified evaluation:

2.1.1 Process Questions

- Were program allies satisfied with program implementation?
- What challenges did program allies face as part of their participation in the program?
- What factors would help improve program ally satisfaction?
- Are there opportunities for program improvement?

2.1.2 Impact Questions

- What are the estimated program gross energy and demand savings?
- What are the estimated program net energy and demand savings?
- Did the program meet its energy and demand goals?

2.2 Evaluation Tasks

Table 2 summarizes the PY7 evaluation activities conducted for the Income Qualified Program.

Table 2. Summary of PY7 Evaluation Methods

Task	PY7 Process	PY7 Impact	Forward Looking	Details
Program Materials Review	✓			Reviewed program materials—including program design, implementation plans, marketing and outreach efforts, and program databases—to assess program implementation and provide recommendations for improvement, where applicable.
Interviews with Program Staff and Implementers	✓			Interviewed AIC and CLEAResult staff to understand the program’s design, implementation, and evaluation priorities.
Trade Ally Survey	✓		✓	Interviewed 11 participating trade allies to inform program processes and satisfaction.
Engineering Review		✓		Conducted an engineering analysis for all PY7 participants to estimate gross and net impacts.

The following activities informed the PY7 process evaluation of the Income Qualified Program.

2.2.1 Review of Program Materials and Data

The evaluation team reviewed program materials, including implementation plans, marketing and outreach activities, training materials, and the program-tracking database.

2.2.2 Program Staff Interviews

We conducted in-depth interviews with one member of the AIC program staff and two members of the CLEAResult implementation team. The purpose of these interviews was to gain insight into whether or not the program was implemented according to plan/design and determine if there had been any changes in the program's design and implementation from PY6. The team also inquired about data tracking and customer outreach related to the program.

2.2.3 Trade Ally Interviews

During previous program cycles, program staff noted trade ally dissatisfaction with the program, which resulted in reduced involvement with the program. As such, in PY7 we conducted interviews to understand program challenges and opportunities from the perspective of trade allies. Specific survey topics included: overall satisfaction with the program, experience with OBF, program training, and marketing.

Sample Design

The evaluation team attempted to contact all participating trade allies in the PY7 program cycle (i.e., census approach) and thus no sampling was required. We used a mixed mode approach in order to capture as many trade allies as possible, first reaching out through an online survey and then following up, as needed, with phone surveys.

Survey Disposition and Response Rate

We sent emails and/or called all 30 participating trade allies to obtain 11 completed interviews. Table 3 presents the final survey dispositions.

Table 3. Survey Dispositions

Disposition	Total
Completed Interviews (I)	11
Partials (P)	0
Eligible Non-Interviews	11
Refusals (R)	2
Respondent never available (NC)	9
Not Eligible (E)	1
Unknown Eligibility Non-Interview (U)	7
Total Participants in Sample	30

Table 4 provides the response and cooperation rates. Appendix D provides information on the methodology used to calculate response and cooperation rates.

Table 4. Survey Response and Cooperation Rates

AAPOR Rate	Percent
Response Rate #3	38%
Cooperation Rate #3	85%

2.2.4 Impact Analysis

The primary objective of the impact evaluation was to estimate the energy savings from installing measures. The evaluation team conducted the engineering analysis outlined below to assess PY7 program impacts.

Gross Impacts Analysis Approach

To determine gross impacts associated with the Income Qualified program, we applied savings algorithms from the Statewide Illinois Technical Reference Manual V3.0² (IL TRM V3.0) to the information in the program-tracking database. We outline the algorithms used to calculate all evaluated program savings in Appendix A, along with all input variables.

Net Impacts Analysis Approach

We applied a NTGR of 1.0 to gross savings to obtain PY7 Income Qualified Program net savings. In PY3, the evaluation team discussed and reached agreement on the calculation of net savings with AIC staff given our understanding of program design and targeted customers. We applied a NTGR of 1.0 because the program targets participants with household incomes between 150%-300% of the federal poverty level guidelines for household size. These participants are unlikely to have installed many of the measures offered through the program without assistance. As a result, *ex post* gross impacts and *ex post* net impacts are identical.

2.3 Sources and Mitigation of Error

Table 5 provides a summary of possible sources of error associated with the data collection conducted for the Income Qualified Program. We discuss each item in detail below.

Table 5. Potential Sources of Error

Research Task	Survey Error		Non-Survey Error
	Sampling	Non-Sampling	
Trade Ally Interviews	None, census attempt	<ul style="list-style-type: none"> ▪ Measurement error ▪ Non-response and self-selection bias ▪ Data processing error 	N/A
Gross Savings Calculations	N/A	N/A	Analytical error
Net Savings Calculations	N/A	N/A	Analytical error

The evaluation team took a number of steps to mitigate potential sources of error throughout the planning and implementation of the PY7 evaluation.

² Illinois Statewide Technical Reference Manual for Energy Efficiency V3.0. Effective June 1, 2014.

Survey Error

■ Sampling Error

- Given that the trade ally surveys were conducted at the census level, there are no sampling errors.

■ Non-Sampling Error

- **Measurement Error:** We addressed the validity and reliability of quantitative data through multiple strategies. First, we relied on the experience of the evaluation team to create questions that, at face value, appear to measure the idea or construct that they are intended to measure. We reviewed the questions to ensure that we did not ask double-barreled questions (i.e., questions that ask about two subjects, but with only one response) or loaded questions (i.e., questions that are slanted one way or the other). We also checked the overall logical flow of the questions so as not to confuse respondents, which would decrease reliability.

Key members of the evaluation team, as well as AIC staff, reviewed all survey instruments. To determine whether the questions were clear and unambiguous, we pre-tested each survey instrument, reviewed the pre-test survey data, and monitored the telephone interviews as they were being conducted. We also used the pre-tests to determine that the length of the survey was reasonable.

- **Non-Response Bias:** Since the response rate for the trade ally survey was approximately 38%, there is the potential for non-response bias. However, we attempted to mitigate possible bias by calling each potential respondent at least five times, or until we received a firm refusal, and by calling at different times of day, as appropriate.³
- **Data Processing Error:** The team addressed processing error through interviewer training and through quality checks of completed survey data. Opinion Dynamics interviewers went through rigorous training before interviews began. Interviewers received a general overview of the research goals and the intent of each survey instrument. Through survey monitoring, members of the evaluation team also provided guidance on proper coding of survey responses.

Non-Survey Error

- **Gross Impact Calculations:** We applied the IL TRM V3.0 calculations to the participant data in the tracking database to calculate gross impacts. To minimize analytical errors, all impact calculations were reviewed by a separate team member to verify their accuracy.

³ The evaluation team also checked available program data to see if there were any differences on observable variables. Unfortunately, due to data limitations, there were not many variables available to assess non-response error.

3. Detailed Evaluation Findings

3.1 Program Design and Implementation

The process analysis leverages data from three different data collection methods: a review of program materials, in-depth interviews with program and implementation staff, and surveys with participating trade allies.

3.1.1 Program Design Changes

In PY7, the Income Qualified Program underwent many changes, with one of them being Leidos assuming the role of prime implementer. Through PY6, Leidos was the prime implementer for AIC's commercial and industrial programs; in PY7, they became the prime implementer for both residential and commercial programs. As such, although CLEAResult is still implementing the Income Qualified Program, instead of reporting directly to AIC they now report to Leidos.

In their role as the prime, Leidos took steps to ensure that marketing materials and messages are uniform across the residential program portfolio. They also worked to improve data tracking and reporting for the program. To accomplish these goals, the following changes were made:

- Program names were changed to standardize marketing. The Warm Neighbors Cool Friends (WNCF) program, previously known as the ActOnEnergy Moderate Income program, became the Home Efficiency Income Qualified Program. The program now falls under the Home Efficiency Program umbrella along with the Home Efficiency Standard Program (previously the Home Performance with Energy Star Program).
- In PY7, Leidos reviewed all marketing materials to assure consistent messaging across AIC's portfolio of programs. As such, the Income Qualified Program marketing efforts, while similar to those in PY6, also included sales training for trade allies (i.e., how to market and sell the program), bill inserts, direct mail (regarding energy audits), marketing events (home shows, realtor group events, etc.), and Pandora and television advertisements
- Starting in PY7, customers can access the program through three channels: (1) submit an application for pre-approval of income for a free audit, (2) be directed to the program through a Home Efficiency Standard Program audit referral, or (3) apply to the program directly through a program ally.
 - In previous years, customers had two channels for program participation: (1) request an in-home audit from AIC, or (2) get directed to the program through a Standard Program audit referral. In PY7, the program added a new channel where trade allies gained the ability to sell the program directly to qualifying clients rather than waiting for AIC to provide them with customer leads. Trade allies underwent training in the middle of the program cycle to learn how to sell the program. The trade ally surveys revealed that more than half of the trade allies (7 of 11 trade allies interviewed) directly marketed the Income Qualified Program to their customers in PY7.
- The program lowered the qualifying threshold for the Income Qualified Program from 200%-300% to 150%-300% of the federal poverty guideline for household size, thus increasing the number of customers qualified to participate in the program.

- The program continued offering OBF in PY7. However, due to insufficient funds, the program petitioned to get additional budget for the OBF component in PY7. While the budget for OBF in PY7 was expanded to about \$10 million, the budget was available only during the last two months of the PY7 program cycle, thereby limiting OBF participation.
- Our trade ally interviews, however, showed a different picture where 10 of 11 trade allies reported having used OBF. Thus, there seems to be some confusion among the trade allies in regards to the OBF component of the program. They could be thinking about their experience with OBF in the PY8 program cycle rather than PY7.

3.2 Program Participation and Measure Installation

Participation

In PY7, the Income Qualified Program reached 352 participants. The participation experience varied somewhat across the 352 participants based on the services received. As shown in Table 6, the evaluation team grouped participants based on whether they received only an audit, only a retrofit, or both an audit and a retrofit.

Table 6. Overview of Participation by Household and Services Received in PY7

Participant Type	Number of Participants	% of Participants
Audit and Retrofit	183	52%
Retrofit Only	153	43%
Audit Only	16	5%
Total	352	100%

We also calculated a conversion rate by dividing the number of participants who received a retrofit following an audit (audit and retrofit) by the total number of participants who received an audit at all (whether or not they received a retrofit). However, participants who receive an audit in one year and receive the associated retrofit in the following year (or two) complicate this calculation. Thus, to take these participants into account, the conversion rate was calculated using cumulative results. For example, 48 participant received an audit in PY4, and then 36 received a retrofit in PY5 and three received a retrofit in PY6. As such, conversion rates for each program year can change from year to year. Comparing the conversion rates between PY4 through PY7, we can see that the conversion rate is increasing over time (see Table 7). Notably, these counts do not include Program-Ally driven leads/contacts that ultimately chose not to participate as these are not tracked and reported.

Table 7. PY4-PY7 Conversion Rates

Approach	Participant Type	PY4 Participants	PY5 Participants	PY6 Participants	PY7 Participants
CLEAResult-Driven	(a) Audit & Retrofit	198	195	239	183
	(b) Audit Only	48	27	23	16
Program Ally-Driven	(c) Retrofit Only	15	78	54	153
Total Participants = a + b + c		261	300	316	352
Total Audits = a + b		246	222	262	199
Conversion Rate = a/(a + b)		80%	88%	91%	92%

Measures Installed

The program offers a variety of measures to participants. Table 8 summarizes the number of households and the quantity of installed measures based on the team’s review of the program-tracking database.

Table 8. Overview of PY7 Income Qualified Participation by Measure Category

Measure Category	Measure	Unique Households ^a	Unit	Measure Quantity	Database Verification Rate
Lighting	CFL – Low (13–15 Watt)	59	Bulb	449	1.00
	CFL – Medium (18–20 Watt)	42	Bulb	232	1.00
	CFL – High (23-25 Watt)	57	Bulb	263	1.00
	Specialty CFL – 9W Candelabra	47	Bulb	278	1.00
	Specialty CFL – 14W Globe	40	Bulb	225	1.00
	Specialty CFL – 15W Reflector	12	Bulb	72	1.00
Domestic Hot Water (DHW)	Faucet Aerators	74	Aerator	129	1.00
	Showerheads	94	Showerhead	108	1.00
HVAC (Cooling)	Air Source Heat Pump Replacement	11	Heat pump	12	1.00
	Central AC Replacement	177	CAC	183	1.00
HVAC (Heating)	Furnace > 95 AFUE	269	Furnace	277	1.00
	Gas Boiler > 90 AFUE	3	Boiler	3	1.00
	Gas Boiler > 95 AFUE	4	Boiler	4	1.00
HVAC (Controls)	Programmable Thermostat	205	Thermostat	409	1.00
Motor	ECM – Brushless Motor	118	Motor	122	1.00
Envelope	Air Sealing	320	CFM	990,120	1.00
	Attic Insulation	288	Sqft	607,879	1.00
	Wall Insulation	148	Sqft	258,602	1.00
	Rim Joist Insulation	259	Linear Feet	64,029	1.00
	Crawl Space Insulation	137	Sqft		1.00
	Basement Wall Insulation	49	Linear Feet		1.00

^a A unique household represents one particular (unique) household regardless of the number and types of measures installed. As such, the sum of the number of unique households is greater than the number of participating households (N=352) because any given household could install more than one measure.

3.3 Trade Ally Interview Results

The evaluation team conducted interviews with participating trade allies in the Income Qualified Program. In addition to asking about overall satisfactions levels, the evaluation team asked for suggestions for overall program improvement as well as potential improvements to specific program components such as

OBF, training, technical assistance, and marketing. This section provides the results from the interviews⁴. The data collection instrument can be found in Appendix C.

The evaluation team conducted interviews with 11 participating trade allies. Of these 11 trade allies, six also participated in the Home Efficiency Standard program.

Trade Ally Firmographics

Most of the trade allies classified themselves as air sealing/insulation contractors or HVAC contractors, while a majority also classified themselves as energy audit contractors (see Table 9). On average, the 11 trade allies have 15 employees (minimum of 2 and maximum of 35) conducting about 264 jobs per year (minimum 20 and maximum of 500).

Table 9. Business Category (multiple response)

	Number of Respondents (n=11)
Contractor - Air Sealing/Insulation	7
Contractor - HVAC	7
Contractor - Energy Audits	5
Energy Consultant	2
Contractor - Other	1
Equipment Supplier	1

Satisfaction with the Program

In general, trade allies are very familiar with the program (score of 9.3 out of 10) and satisfied with the program (score of 7.5 out of 10). The majority of trade allies (9 of 11) noted that the program had a positive effect on their business; the remaining two could not speak to the impact of the program (responding with a “don’t know”). In addition, most of the trade allies (8 of 11) would recommend the Income Qualified Program to other trade allies.

When asked about specific program components, the trade allies rated the program high on interactions with CLEAResult and assistance with completing required paperwork. Notably, of all program components, trade allies were the least satisfied with the payment time from Ameren upon project completion (see Table 10).

Table 10. Satisfaction with the Program

On a scale of 0-10, how satisfied were you with the following.....(n=11)	Score of 0-3	Score of 4-7	Score of 8-10	Don't Know / Refused	Average Score
The Income Qualified Program overall	10%	30%	60%	0%	7.5
Program Components					
Interactions with implementer	0%	30%	70%	0%	8.4

⁴ Notably, these findings summarize what the Evaluation Team learned from the 11 trade allies interviewed. The findings are not generalized to all trade allies.

Assistance in completing required paperwork	10%	50%	40%	0%	7.0
On-Bill Financing	30%	20%	50%	0%	6.8
Payment time from AIC upon project completion	30%	50%	20%	0%	5.4

Trade allies are most knowledgeable of the program’s benefits to participants (see Table 11).

Table 11. Knowledge of Program Components

On a scale of 0-10, how knowledgeable are you with the following.....(n=11)	Score of 0-3	Score of 4-7	Score of 8-10	Don't Know/Refused	Average Score
Benefits to program participants	9%	9%	82%	0%	9.0
Where to find help or information about the program	9%	9%	82%	0%	8.5
The application process	9%	18%	73%	0%	8.2
Best strategies to market the program to customers	9%	36%	55%	0%	7.6
On-Bill Financing	9%	36%	55%	0%	7.1

Given the overall high satisfaction with the program, it follows that trade allies identified numerous benefits associated with their participation: specifically, increasing jobs/revenue and improving customer satisfaction (see Table 12).

Table 12. Identified Program Benefits (Multiple Response)

Program Benefits	Number of Respondents (n=11)
Increasing jobs/revenue	10
Improving customer satisfaction	10
Expanding customer base	9
Developing/building a relationship with AIC	9
Increasing sales of energy efficient equipment	9
Providing a program with high customer demand	8
Providing on-bill financing to customers	8
Receiving technical assistance through the program	7
Marketing through the program	6
Receiving training through the program	6

While trade allies are generally satisfied with the program and its benefits to their business, most (9 of 11) experienced some challenges with the program. The most frequently encountered challenge was the tedious paperwork and administration (see Table 13).

Table 13. Challenges to Participation (Multiple Response)

Challenges	Number of Respondents (n=9)
Paperwork/administration was tedious/too time-consuming	7
Delays in payment	5
Difficulty meeting program requirements	2

Challenges	Number of Respondents (n=9)
Marketing support was not adequate	2
Difficulty understanding program process	1
Lack of communication from the implementer	1
Many customers did not qualify for the program	1
Inadequate technical assistance	1
Other	3

Two trade allies could not think of any possible improvements to the program and one other had no opinion. However, those that provided suggestions to improve the program (8 of 11) talked about the need to streamline paperwork and administration processes. Some interview quotes are shown below:

1. Streamline the paperwork and administration process

- *"Get forms to flow better [and] be more consistent."*
- *"Paper work needs to be streamlined, also forms do not work and need to be updated"*
- *"Simplify the On Bill Financing. This is a great perk for our customers who otherwise wouldn't be able to participate, however, the process takes entirely too long."*

2. Increase scope of incentives or increase existing incentives to help increase customer participation.

- *"Either increase incentives on high cost required upgrades such as basement wall insulation or remove the all or nothing approach to homes. If basement walls are required and incentivized, then incentivize replacement windows"*

On-Bill Financing

Given that the OBF component was offering only during the last two months of the PY7 program cycle, there seems to be a disconnect between what the program is offering versus what the trade allies say they are doing. Notably, this could have been due to trade allies thinking about PY8 projects rather than PY7, however, the evaluation team could not verify this discrepancy because the tracking database does not have an OBF flag.

Based on the interviews, all eleven surveyed trade allies reported having knowledge of the program's OBF component. The majority of trade allies (10 of 11) completed a job that used OBF and, of these trade allies, most (9 of 10) noted that OBF helps sell jobs to customers. As would be expected, OBF's financial benefit is a major component of its attractiveness to trade allies and customers alike. Mitigating customers' cost burden for retrofits allows trade allies to sell more jobs and customers to install equipment they would not have otherwise installed. Trade allies provided the following insight:

1. On-Bill Financing helps mitigate customers' cost burden

- *"Customers have been able to improve the efficiency of their homes when they may not have had the means otherwise."*
- *"For people without means to pay, this is a God-send! Really a great thing!"*
- *"It has made any portion not covered by incentives easier to take for homeowners"*
- *"It has made it easier for the customers to come up with the money to pay for the project."*
- *"They can afford to proceed with projects."*

The 10 trade allies who used OBF noted that the application form was neither particularly easy nor difficult to fill out (ranking the form a 4.9, on average, on a 0 to 10 scale where 0 is "very difficult" and 10 is "very easy"). Although some of these trade allies (3 of 10) reported no challenges with the OBF application, our

survey revealed that nearly half feel the application takes too much time to fill out (see Table 14). To this point, one contractor in particular cited the need for “resubmission if dollar amounts change during the job”.

Table 14. On-Bill Financing Application Challenges (Multiple Response)

Challenges for OBF Application	Number of Respondents (n=10)
Takes too much time	4
Instructions are not clear	2
Too many details required	1
Other	1
Don't know	2
No challenges	3

Marketing

In previous years, customers had two channels for program participation: (1) request an in-home audit from AIC, or (2) get referred to the program through the Standard Program audit referral. In PY7, the program added a new channel for program participation: trade allies gained the ability to sell the program directly to qualifying customers. Given this, the trade ally survey revealed that more than half of all trade allies (7 of 11) directly marketed the Income Qualified Program to their customers. These trade allies used three main direct marketing tactics; direct mailers (including program brochures), hand out applications/program materials at bid, and radio advertisements.

The four trade allies that did not directly market the program cited several reasons: one was unaware of the program until late in the program cycle, another relies on other contractors for referrals, and another only spends marketing dollars on non-program specific efforts (the last trade ally simply restated that he did not market the program).

Trade allies unanimously agree that word of mouth is the most effective marketing tactic to increase customer participation and the one most relied upon to market the program (see Table 15). Thus, marketing the program directly is not overly onerous as most trade allies include it as a part of their existing marketing tactics.

Table 15. Effective Marketing Tactics (Multiple Response)

Marketing Tactics	Number of Respondents (n=11)
Word of mouth	11
Company brochures and printed information	7
Direct mail	5
My company website	3
TV or radio advertising	3
Events/workshops	2
Cross-selling	1

In line with these findings, all trade allies reported that customers found them by leveraging their past customer-contractor relationship(s) and the trade ally’s company marketing. Trade allies also indicate that the AIC website also played a role in driving customer interest (see Table 16).

Table 16. How Program Customers Find the Trade Allies (Multiple Response)

	Number of Respondents (n=11)
Past relationship with customer/existing customer	11
The company’s own marketing	10
AIC website	9
Referral from another contractor	4
AIC provided customer leads	4

Training and Technical Support

Overall trade allies were somewhat satisfied with the training provided through the program (score of 6.8 out of 10). They most often received training on BPI certification opportunities and marketing material development (see Table 17) and were most likely to receive it through industry or other group meetings (see Table 18).

Table 17. Training Received through the Program (Multiple Response)

Training Type	Number of Respondents (n=11)
BPI certification opportunities	6
To help develop marketing materials	5
On the application process	4
On marketing materials available	3
On eligible equipment	3
More professional certification opportunities in general	2
Best practices/Sales Training for On-Bill Financing	2
Don't know	1

Table 18. Mode of Receiving Training (Multiple Response)

Training Mode	Number of Respondents (n=11)
Industry or other group meetings	6
Workshop	3
Brochures and other handouts	3
One on one meeting	2
Through the Trade Ally Coordinators	2
Website	2

Trade allies were more satisfied with the technical assistance provided through the program (score of 8.5 out of 10). They most often received technical assistance for answering questions on eligible/qualified measures and support filling out forms (see Table 19).

Table 19. Technical Assistance Received through the Program (Multiple Response)

Technical Assistance Type	Number of Respondents (n=11)
Answered questions on eligible/qualified measures	9
Support filling out forms	5
Answered questions on application process	8
Sales leads	8
Accompany on sales calls	1
I did not receive any support	1

Jobs outside the Program

The evaluation team also asked trade allies about eligible jobs performed outside of the program (i.e., eligible jobs for which they did not seek an incentive). Of the 11 trade allies interviewed, five explicitly stated that all their qualified projects went through the program, two were unsure, and four indicated that they had indeed performed eligible projects outside of the program. For these four trade allies, on average, 12% of their jobs fell into this category (as low as 2% and as high as 30%).

Trade allies reported that time-consuming paperwork and administration is the chief driver for completion of projects outside of the program (3 of 4). One trade ally mentioned that it is actually easier for him to sell jobs outside of the program.

Finally, looking at the effect of the program on trade allies' business practices (both inside and outside of the program), the survey revealed that 8 of the 11 trade allies have made changes to their company as a direct result of their participation in the Income Qualified Program. These changes include adding/training more skilled employees (BPI certification) and devoting more business resources to Income Qualified Program related work. Specific comments are outlined below:

1. Adding skilled employees

- "I have more BPI certified employees"
- "We built our HEP division around this program"

2. Business Growth and Resource Development

- "We are now participating in the Income Qualified Program [and] will be looking to add to our staff due

to an increase of jobs with both programs”

- “More training on whole house weatherization”

3.4 Impact Assessment

The evaluation team applied savings algorithms from the IL TRM V3.0 using program-tracking database inputs and a NTGR of 1.0 to determine PY7 gross and net savings.

3.4.1 Ex Post Gross Impact Results

Overall, total ex post gross impacts for the PY7 Home Efficiency Income Qualified Program are 873 MWh, 0.52 MW, and 210,250 therm savings. The gross realization rates are 99% for electric savings, 92% for demand savings, and 117% for gas savings. Table 20 summarizes these results. Notably, the evaluation team applied a NTGR ratio of 1.0 to the evaluated gross savings, making the evaluated gross and net savings identical (additional details on the evaluated net savings are in Section 3.4.2 below).

Table 20. PY7 Income Qualified Program Gross Impacts

Program Component	Number of Participants	Ex Ante Gross ^a			Ex Post Gross		
		kWh	kW	Therms	kWh	kW	Therms
Income Qualified Program	352	880,882	565	179,940	873,194	522	210,250
Gross Realization Rate ^b					99%	92%	117%

^a Source of ex ante savings: PY7 program-tracking database.

^b Gross realization rate = PY7 gross ex post savings/PY7 ex ante gross savings.

Table 21 summarizes the gross impact results by measure.

Table 21. Income Qualified Impacts by Measure

Measure	Ex Ante Gross Impacts			Ex Post Gross Impacts			Gross Realization Rate ^a		
	kWh	kW	Therms	kWh	kW	Therms	kWh	kW	Therms
Air Sealing	372,435	315.6	63,300	404,062	328.2	61,906	1.08	1.04	0.98
Central AC Replacement	177,621	165.5	-	128,469	91.2	-	0.72	0.55	n/a
Air Source Heat Pump Replacement	89,807	9.8	-	74,799	9.2	-	0.83	0.93	n/a
ECM - Brushless Motor	57,218	-	-	64,260	7.0	0	1.12	n/a	n/a
Attic Insulation	44,494	27.3	18,786	48,395	29.8	16,960	1.09	1.09	0.90
Wall Insulation	27,661	21.4	12,818	38,397	30.1	15,994	1.39	1.40	1.25
Crawl Space Insulation	21,072	11.6	15,556	21,209	12.1	16,167	1.01	1.05	1.04
Programmable Thermostats - Electric Heating	12,976	-	-	16,774	-	-	1.29	n/a	n/a
Specialty CFL - 9W Candelabra	12,827	1.4	-	11,755	1.1	-	0.92	0.80	n/a
Specialty CFL - 14W Globe	12,625	1.3	-	9,004	1.3	-	0.71	1.00	n/a
CFL - Low (13-15 Watt)	12,428	1.4	-	12,991	1.4	-	1.05	1.00	n/a
CFL - High (23-25 Watt)	11,893	1.3	-	12,429	1.3	-	1.05	1.00	n/a
CFL - Medium (18-20 Watt)	7,064	0.8	-	7,384	0.8	-	1.05	1.00	n/a
Rim Joist Insulation	6,403	3.9	3,214	8,109	4.5	4,829	1.27	1.17	1.50
Basement Wall Insulation	6,116	2.8	3,968	6,367	2.8	4,409	1.04	1.00	1.11

Measure	Ex Ante Gross Impacts			Ex Post Gross Impacts			Gross Realization Rate ^a		
	kWh	kW	Therms	kWh	kW	Therms	kWh	kW	Therms
Showerhead - Electric	3,610	0.3	-	3,605	0.3	-	1.00	1.00	n/a
Specialty CFL – 15W Reflector	2,916	0.3	-	3,468	0.4	-	1.19	1.26	n/a
Faucet Aerator - Electric	1,716	0.7	-	1,716	0.7	-	1.00	1.00	n/a
Gas Furnace	-	-	50,061	-	-	74,388	n/a	n/a	1.49
Programmable Thermostats - Gas Heating	-	-	7,827	-	-	10,304	n/a	n/a	1.32
Gas Boiler	-	-	3,068	-	-	3,949	n/a	n/a	1.29
Showerhead - Gas	-	-	1,038	-	-	1,038	n/a	n/a	1.00
Faucet Aerator - Gas	-	-	306	-	-	306	n/a	n/a	1.00
Total	880,882	565.4	179,940	873,194	522.2	210,250	0.99	0.92	1.17

Note: Numbers may not total due to rounding.

^a Gross Realization Rate = ex post gross value / ex ante gross value.

Differences in *ex post* and *ex ante* gross savings stem from differences in input values for the savings algorithms for each measure. Through our discussions with the implementer, we identified the sources of these differences. Table 22 summarizes these findings.

Table 22. Reasons for Realization Rates per Measure

Measure	kWh RR	kW RR	Therms RR	CDD, HDD, FLH	Pre & Post R-Value	Waste Heat Factors	HVAC Efficiency	Other (Specified)
Air Sealing	1.08	1.04	0.98	X			X	- Latent multiplier
Central AC Replacement	0.72	0.55	N/A	X				- Cooling efficiency
Air Source Heat Pump Replacement	0.83	0.93	N/A	X				- Capacity
ECM - Brushless Motor	1.12	N/A	N/A					- Installation of new HVAC equipment
Attic Insulation	1.09	1.09	0.90	X	X		X	
Wall Insulation	1.39	1.40	1.25	X	X		X	
Rim Joist Insulation	1.27	1.17	1.50	X	X		X	- Framing factor
Crawl Space Insulation	1.01	1.05	1.04	X	X		X	
Basement Wall Insulation	1.04	1.00	1.11	X	X		X	- Basement wall height
Programmable Thermostat	1.29	N/A	1.32					- Electric heating consumption - Gas heating consumption - Heating consumption adjustment factor
Standard CFLs	1.05	1.00	N/A			X		
Specialty CFLs	0.85	0.93	N/A			X		- Hours of Use - Misapplied ex ante per-unit demand savings
Gas Furnace	N/A	N/A	1.49					- Gas furnace load - ER weighted ex ante per unit value

Measure	kWh RR	kW RR	Therms RR	CDD, HDD, FLH	Pre & Post R-Value	Waste Heat Factors	HVAC Efficiency	Other (Specified)
Gas Boiler	N/A	N/A	1.29					- Gas boiler load - ER weighted ex ante per unit value
Faucet Aerator	1.00	1.00	1.00					
Showerhead	1.00	1.00	1.00					

The inputs for air sealing, insulation, and HVAC measures have the largest impact on program level realization rates. Because air sealing measures account for 42%, insulation measures account for 12%, and HVAC measures account for 38% of the total kWh program savings, any differences within these measures affect the program savings significantly. We describe the key differences in the *ex ante* and *ex post* savings calculations in detail below (additional details can be found in Appendix B). Note that while certain inputs may increase savings, others decrease savings. The combination of all inputs brings about the overall realization rate for a specific measure.

■ **Air Sealing Issues:**

- **CDD, HDD, and Full Load Hours (FLH):** *Ex ante* savings applies the CDD, HDD, and FLH input values for Springfield to all projects regardless of location to estimate *ex ante* savings, while the evaluation team used input values appropriate for the location of each participating home. Table 23 summarizes the *ex post* saving increase or decrease from the *ex ante* values due to locational differences.

Table 23. Change in Ex Post per unit Savings due to Differences in CDD, HDD, and FLH

Measure	% Difference in Ex Post kWh/per Unit		
	CDD	HDD	FLH
Central Air Conditioner	N/A	N/A	7% Increase
Air Source Heat Pump	N/A	N/A	12% Decrease
Air Sealing	5% Increase	1% Decrease	N/A
Attic Insulation	7% Increase	6% Decrease	N/A
Wall Insulation	4% Increase	3% Decrease	N/A
Rim Joist Insulation	1% Increase	7% Decrease	N/A
Basement Wall Insulation	3% Decrease	5% Decrease	N/A
Crawlspace Insulation	1% Increase	9% Decrease	N/A

- **Latent Multiplier for Air Sealing:** The latent multiplier accounts for latent cooling demand for air sealing measures and is dependent on project location. The *ex ante* savings calculations applied the latent multiplier for Springfield to all projects regardless of their project location. The *ex post* calculations applied the latent multiplier for each project’s actual location. As a result, the *ex post* per-unit savings for air sealing measures increased by an average of 4%.
- **HVAC Efficiency:** *Ex ante* air sealing savings uses weighted averages for cooling (10.9 SEER) and heating (1.77 COP) efficiencies. In past program years, the program database provided the actual existing efficiencies for HVAC equipment. However, the PY7 database did not include this information. As a result, *ex post* savings applied the efficiencies from the IL TRM V3.0 (with equipment age pre 2006) of 10 SEER for cooling and 1.7 COP for heat pumps. Table 24

summarizes the *ex post* increases over *ex ante* values due to the difference in HVAC efficiencies.

Table 24. Change in Ex Post per unit Savings due to Differences in HVAC Efficiencies

Measure	% Difference in Ex Post kWh/per Unit
Air Sealing	8% Increase
Attic Insulation	6% Increase
Wall Insulation	7% Increase
Rim Joist Insulation	6% Increase
Basement Wall Insulation	6% Increase
Crawlspace Insulation	6% Increase

■ **Central AC Replacement Issues:**

- **CDD, HDD, FLH:** See Table 23 above for specifics
- **Cooling Efficiency:** Early retirement (ER) central air conditioner *ex ante* efficiency is based on the average SEER (8.6 SEER) from the PY4 evaluation. The database did not provide actual efficiencies of existing equipment, and therefore *ex post* savings used the SEER value (10 SEER) from the IL TRM V3.0. The *ex post* per unit savings for the installation of central air conditioners is 32% smaller than *ex ante* savings due to the differences in efficiency assumptions.

■ **Air Source Heat Pump Replacement Issues:**

- **CDD, HDD, FLH:** See Table 23 above for specifics.
- **Cooling and Heating Capacity:** *Ex ante* savings applies heating and cooling capacities (BTUh) based on the average value of 36,000 BTUh from the PY4 evaluation. The IL TRM V3.0 specifies to use the actual capacity for each project for air source heat pumps. However, the IL TRM V3.0 provides a default capacity (if actual is unknown) of 33,600 BTUh for central air conditioning. *Ex post* savings used the default IL TRM V3.0 capacity for central air conditioners when calculating savings estimates for air source heat pumps. The *ex post* per unit savings for the installation of air source heat pumps decreased by 7% due to the changes in capacity assumptions.

■ **ECM – Brushless Motor Issues:**

- **Installation of New HVAC Equipment:** *Ex ante* savings for EC Motors includes heating and shoulder savings only. *Ex ante* savings exclude cooling savings with the assumption that all participants replaced their existing cooling equipment with a more efficient model exceeding minimum efficiency standards. The evaluation team agrees that fan motor savings help HVAC equipment achieve higher efficiencies. We also agree the ECM motor savings are included in the savings for the newly installed HVAC equipment and including ECM cooling savings would double count savings. However, *ex post* savings do not assume that all participants replaced existing cooling equipment with more efficient models. Of the 126 ECM motors receiving rebates in PY7, 100 are in newly replaced equipment. Therefore, the *ex post* analysis included cooling savings for 26 of the new motors, and heating and shoulder savings for all 126 motors. The inclusion of cooling savings for those who did not install new cooling equipment resulted in an increase in *ex post* savings of 12%.

■ **Attic, Wall, Rim Joist, Crawl Space, and Basement Wall Insulation Issues:**

- **CDD, HDD, FLH:** See Table 23 above for specifics
- **HVAC Efficiency:** See Table 24 above for specifics
- **Pre and Post R-Value:** *Ex ante* applied the same pre-existing and post-retrofit R-values for all participants to estimate *ex ante* savings despite the availability of actual pre-existing and post-retrofit R-values in the database. The evaluation team, however, used the actual pre and post R-values from the database to calculate *ex post* savings per participant. Table 25 summarizes the *ex post* increases over *ex ante* values due to the differences in pre and post R-values.

Table 25. Change in Ex Post per unit Savings due to Differences in R-values

Measure	% Difference in Ex Post kWh/per Unit	
	Pre R-value	Post R-value
Attic Insulation	12% Increase	14% Decrease
Wall Insulation	0%	2% Decrease
Rim Joist Insulation	7% Decrease	1% Decrease
Basement Wall Insulation	0% (Above Grade) 5% Decrease (Below Grade)	2% Increase
Crawlspace Insulation	0% (Above Grade) 2% Increase (Below Grade)	1% Increase

- **Framing Factor (Rim Joist Insulation):** *Ex ante* calculations underestimate rim joist insulation savings by including a framing factor of 0.25, which assumes that insulation installed is in either the studs or cavity. *Ex post* savings apply a framing factor of 0.05, because rim joist insulation is typically installed above any frame. The implementer agreed a framing factor of 0.05 is more appropriate.⁵ As a result, the per unit *ex post* savings for rim joist insulation is increased by 20%. While this increase may seem high, rim joist insulation accounts for less than 1% of the program’s total reported energy savings and therefore play a small role in the overall program realization rate.
- **Basement Wall Height:** *Ex ante* savings assumes a basement wall height of 4 feet (3 feet below grade). This is because code requires insulation in the top four feet of the basement wall. However, the implementer confirmed that his team installs basement wall insulation for the entire wall. *Ex post* savings assumed a basement wall height of 7 feet (6 feet below grade) where the implementer agrees is a more appropriate value. The basement wall height and the amount of basement wall below grade affects the below grade R-value. As seen in Table 25 above, this assumption decreases the *ex post* per unit savings for below grade R-values by 5%.

⁵ The reason for this is that the framing factor for rim joists should average the framing factor for joists that run from the front of the home to the back, and joists that run from the left side of the home to the right side of the home. Framing for joists that run parallel to the front of the home to the back is 1.75” for every 16, resulting in a framing factor of 0.10. However, joists that run perpendicular to the front of the home to the back are continuous (uninterrupted) and have a framing factor of 0. Therefore, the average framing factor is 0.05.

3.4.2 Ex Post Net Impacts Results

The evaluation team applied a NTGR ratio of 1.0 to the evaluated gross savings. In PY3, the evaluation team discussed and reached agreement with AIC staff on this value given the program design and targeted customers. In particular, the group agreed that this value was reasonable given that the program targets participants with household incomes between 150%-300% of the federal poverty level guidelines for household size. As such, program participants are unlikely to have installed many of the measures offered through the program without assistance. *Ex post* gross impacts and *ex post* net impacts are, therefore, identical. Table 26 below displays the overall net impacts for the Income Qualified Program in PY7.

Table 26. PY7 Income Qualified Program Net Impacts

Program Component	Number of Participants	Ex Ante Net ^a			Ex Post Net		
		kWh	kW	Therms	kWh	kW	Therms
Income Qualified Program	352	880,882	565	179,940	873,194	522	210,250
Net Realization Rate ^b					99%	92%	117%

^a Source of ex ante savings: PY7 program-tracking database.

^b The net realization rate is calculated as the PY7 net ex post savings divided by the PY7 ex ante net savings.

4. Conclusions and Recommendations

The results from our impact analysis show net realization rates of 99% for kWh, 92% for kW and 117% for therm savings. Based on our analysis of the program database and our discussions with the implementer, the evaluation team identified differences in input values between the *ex ante* and *ex post* savings calculations for air sealing, insulation, and HVAC equipment as the main factors driving the differences in net realization rates.

As part of our process evaluation, we found that the program underwent many changes to help improve the transparency, efficiency, QA/QC methodology, data management, and marketing for the Income Qualified Program. The main change being Leidos assuming the role of program prime implementer, with CLEAResult, remaining the customer-facing implementer. The program introduced several changes to help facilitate participation, such as introducing a new channel for customer participation (allowing trade allies to sell program work directly to customers and providing training to the trade allies to market the program) and expanding the financial threshold for qualification (150%-300% of the federal poverty rate).

In addition, interviews with program trade allies revealed that trade allies are generally satisfied with the program and believe that the program has had a positive impact on their business (notably, increases in revenue and customer satisfaction). Allowing trade allies to market the program directly seems to be a positive change with trade allies reporting that direct mailers and handing out program materials during bid as most effective in directly promoting the program. In addition, almost every trade ally reported using the program's OBF offering and that it makes selling work to customers much easier. Despite overall positive marks, trade allies did encounter some program-related challenges. They report that the program paperwork and general administration are tedious and require streamlining and that payment for services takes too long. These challenges lead some trade allies to complete qualifying jobs outside of the program.

Based on these findings, the following are some recommendations:

- **Streamline program paperwork and administration.** The trade ally survey revealed that filling out paperwork is not only time-consuming but also has prevented some contractors from running all of their qualified projects through the program (if the customer needs a quick project turnaround, for example). Reducing this administrative burden on trade allies would help make the program more attractive and increase satisfaction with the program.
 - Part of this streamlining should include looking for opportunities to reduce the amount of time it takes to pay trade allies. The trade ally survey revealed that extended lead-times on payments can discourage and limit program participation.
- **Leverage trade allies for program marketing.** Historically, the Income Qualified Program has seen growth (in both PY5 and PY6) without making any major changes to marketing tactics or program implementation. Based on trade ally feedback, direct mailers and program material handouts are the most relevant marketing tactics. As such, it would be beneficial to work with trade allies to establish additional marketing materials for these marketing tactics.
- **Update program-tracking database to include a flag for projects using OBF.** Given that OBF is a key program component, it would be useful to track usage of OBF within the tracking database. This could allow future evaluation efforts to better understand the impact and extent to which OBF affects the Income Qualified Program.
- **Update program tracking savings assumptions to reflect the ex post values used in this evaluation.** Per our *ex post* savings calculations, the evaluation team identified several discrepancies in savings

assumptions between the *ex ante* and *ex post* savings calculations. To increase the accuracy of tracked savings (and improve realization rates), we recommend that the Income Qualified Program adopt the *ex post* assumptions and savings calculations used by the evaluation team.

- **Update *ex ante* savings algorithms for rim joist, basement wall, and crawlspace insulation.** Through discussions with the implementer, we learned that supply vents are installed in below grade spaces, thus turning this space into a semi-conditioned area. However, *ex ante* and *ex post* calculations currently apply CDDs and HDDs for unconditioned space. We recommend modifying the algorithm to use unconditioned basement CDDs and HDDs for pre-existing conditions, and using conditioned basement CDDs and HDDs for post conditions.

A. APPENDIX – ENGINEERING ANALYSIS ALGORITHMS

In PY7, the impact evaluation efforts estimated gross impact savings for the Income Qualified Program by applying savings algorithms from the Illinois Statewide Technical Reference Manual (TRM) V3.0 (2014)⁶ to the information in the program-tracking database.

We present the algorithms used to calculate all evaluation program savings below, along with all input variables.

A.1 COMPACT FLUORESCENT LIGHTING (CFLs) ALGORITHMS

The evaluation team determined ex post lighting savings using the algorithms below.

Equation 1. Standard and Specialty CFL Algorithms

$$\text{Energy Savings: } \Delta kWh = ((\text{WattsBase} - \text{WattsEE}) / 1,000) * \text{ISR} * \text{HOURS} * \text{WHF}_e$$

$$\text{Demand Savings: } \Delta kW = ((\text{WattsBase} - \text{WattsEE}) / 1,000) * \text{ISR} * \text{WHF}_d * \text{CF}$$

Where:

WattsBase = Wattage of existing equipment

Table 27 Baseline Wattages for Lighting Measures

Measure	EISA Adjusted ^a	Baseline Wattage	Resource
CFL - Low 13 to 15 Watt	Yes	43	IL TRM V3.0
CFL - Medium 18 to 20 Watt	Yes	53	IL TRM V3.0
CFL - High 23 to 25 Watt	Yes	72	IL TRM V3.0
Specialty CFL – 9W Candelabra	No	40	IL TRM V3.0
Specialty CFL – 14W Globe	No	60	IL TRM V3.0
Specialty CFL – 15W Reflector	No	65	IL TRM V3.0

^a The EISA schedule requires baseline adjustments to measures with incandescent baseline wattages of 100W (as of June 2012), 75W (as of June 2013), and 60W (as of June 2014).

WattsEE = Wattage of installed equipment (actual wattage used)

⁶ Illinois Statewide Technical Reference Manual for Energy Efficiency V3.0. Effective June 1, 2014.

ISR = In-service rate or the percentage of units rebated that get installed

Table 28. Installation Rates for Lighting Measures

Measure	ISR	Source
CFL - Low 13 to 15 Watt	97.0%	PY6 Survey Results
CFL - Medium 18 to 20 Watt	97.0%	
CFL - High 23 to 25 Watt	97.0%	
Specialty CFL – 9W Candelabra	96.9%	IL TRM V3.0
Specialty CFL – 14W Globe	96.9%	
Specialty CFL – 15W Reflector	96.9%	

HOURS = Annual operating hours (See Table 29)

Table 29. Annual Hours of Use for Lighting Measures

Measure	Hours
Standard CFL (Spiral)	938
Specialty CFL (Globe)	847
Specialty CFL (Candelabra)	1,328
Specialty CFL (Interior Reflector)	938

WHF_e = Waste heat factor for energy (accounts for cooling savings from efficient lighting) = 1.06

WHF_d = Waste heat factor for demand (accounts for cooling savings from efficient lighting) = 1.11

CF = Summer Peak Coincidence Factor

Table 30. Coincidence Factors for Lighting Measures

Measure	CF
Standard CFL (Spiral)	0.095
Specialty CFL (Globe)	0.116
Specialty CFL (Candelabra)	0.122
Specialty CFL (Interior Reflector)	0.095

A.2 LIGHTING MEASURES HEATING PENALTY

The evaluation team determined heating penalties for different heating fuel types using the algorithms below. Based on the agreement between the ICC and AIC, we do not include heating penalties in the ex post energy savings, but will include this in the data for the PY7 cost-effectiveness analysis.

Equation 2. Heating Penalty Algorithms

Electric Heating Penalty: $\Delta kWh = -(((WattsBase - WattsEE) / 1,000) * ISR * HOURS * HF) / \eta_{Heat}$

Gas Heating Penalty: $\Delta therms = -(((WattsBase - WattsEE) / 1,000) * ISR * Hours * HF * 0.03412) / \eta_{Heat}$

Where:

- WattsBase = Wattage of existing equipment (See Table 27)
- WattsEE = Wattage of installed equipment
- ISR = In-service rate or the percentage of units rebated that get installed (See Table 28)
- Hours = Annual operating hours (See Table 29)
- HF = Heating Factor = 0.49
- η_{Heat} = Efficiency of Heating equipment (we used the COP for heat pumps for those manufactured before 2006)

Table 31. η_{Heat} for Lighting Heating Penalties

Measure	η_{Heat}	Units
Heat Pump (Before 2006)	2.0	COP
Electric Resistance	1.0	COP
Gas Heating	0.7	AFUE

Table 32 summarizes the heating penalties for the six lighting measures offered through the program by heating equipment type.

Table 32. Heating Fuel Penalties for CFL Lighting

Heating Equipment	Measure	ΔkWh	$\Delta therms$
Heat Pump (htg only)	CFL - Low 13 TO 15 Watt	-6.69	n/a
	CFL - Medium 18 to 20 Watt	-7.36	n/a
	CFL - High 23 to 25 Watt	-10.92	n/a
	Specialty CFL - 9W candelabra	-9.77	n/a
	Specialty CFL - 14W globe	-9.25	n/a
	Specialty CFL - 15W reflector	-11.13	n/a
Electric Resistance	CFL - Low 13 TO 15 Watt	-13.37	n/a
	CFL - Medium 18 to 20 Watt	-14.71	n/a
	CFL - High 23 to 25 Watt	-21.85	n/a
	Specialty CFL - 9W candelabra	-19.55	n/a
	Specialty CFL - 14W globe	-18.50	n/a
	Specialty CFL - 15W reflector	-22.27	n/a
Gas Heating	CFL - Low 13 TO 15 Watt	n/a	-0.65
	CFL - Medium 18 to 20 Watt	n/a	-0.72
	CFL - High 23 to 25 Watt	n/a	-1.06
	Specialty CFL - 9W candelabra	n/a	-0.95
	Specialty CFL - 14W globe	n/a	-0.90
	Specialty CFL - 15W reflector	n/a	-1.09

A.3 WATER HEATING CONSERVATION MEASURE ALGORITHMS

The evaluation team determined ex post water heating conservation measure savings using the algorithms below.

Equation 3. Low-flow Showerhead Algorithms

$$\text{Energy Savings: } \Delta kWh = \%ElectricDHW * ((GPM_base * L_base - GPM_low * L_low) * Household * SPCD * 365.25 / SPH) * EPG_electric * ISR$$

$$\text{Demand Savings: } \Delta kW = \Delta kWh / \text{Hours} * CF$$

$$\text{Therm Savings: } \Delta Therms = \%FossilDHW * ((GPM_base * L_base - GPM_low * L_low) * Household * SPCD * 365.25 / SPH) * EPG_gas * ISR$$

Equation 4. Low-flow Faucet Aerator Algorithms

$$\text{Energy Savings: } \Delta kWh = \%ElectricDHW * ((GPM_base * L_base - GPM_low * L_low) * Household * 365.25 * DF / FPH) * EPG_electric * ISR$$

$$\text{Demand Savings: } \Delta kW = \Delta kWh / \text{Hours} * CF$$

$$\text{Therm Savings: } \Delta Therms = \%FossilDHW * ((GPM_base * L_base - GPM_low * L_low) * Household * 365.25 * DF / FPH) * EPG_gas * ISR$$

Where:

%ElectricDHW = 100% if electric water heater, 0% if gas water heater

%GasDHW = 100% if gas water heater, 0% if electric water heater

GPM_base = Flow rate of the baseline showerhead or faucet aerator (See Table 33)

GPM_low = As-used flow rate of the low-flow showerhead or faucet aerator (See Table 33)

Table 33. GPM for Water Heating Measures

Measure	GPM_base	GPM_low
Faucet aerator	1.39	0.94
Showerhead	2.67	1.75

L_base = Average baseline length faucet use per capita for all faucets in minutes

Table 34. L_base for Water Heating Measures

Measure	Minutes
Faucet aerator	9.0
Showerhead	7.8

L_low = Average retrofit length faucet use per capita for all faucets in minutes (same as L_base)

Household = Average number of people in household = 2.56

SPCD = Showers per capita per day = 0.60

SPH = Showerheads per household for single family homes = 1.79

- DF = Drain factor = 0.795 (unknown location)
- FPH = Faucets per household for single family homes = 3.83 (unknown location)
- EPG_electric = Energy per gallon of hot water supplied by electric (See Table 35)
- EPG_gas = Energy per gallon of hot water supplied by gas (See Table 35)

Table 35. EPG for Water Heating Measures

Measure	EPG_electric	EPG_gas
Faucet Aerator	0.09190	0.00394
Showerhead	0.11700	0.00501

- ISR = In-Service Rate⁷

Table 36. ISR for Water Heating Measures

Measure	ISR
Faucet Aerator	95%
Showerhead	98%

- Hours = Annual electric DHW recovery hours

Table 37. Hours for Water Heating Measures

Measure	Hours
Faucet Aerator ^a	52
Showerhead	302

^a Hours of use for single family with unknown location

- CF = Coincidence Factor for electric load reduction

Table 38. CF for Water Heating Measures

Measure	CF
Faucet Aerator	0.0220
Showerhead	0.0278

A.4 PROGRAMMABLE THERMOSTAT ALGORITHMS

The evaluation team calculated the ex post programmable thermostat savings using the algorithms below.

Equation 5. Programmable Thermostat Algorithms

$$\Delta kWh_{heating} (electric\ heat) = \%ElectricHeat * Elec_Heating_Consumption * Heating_Reduction * HF * Eff_ISR$$

$$Gas\ Savings\ (gas\ heat): \Delta Therms = \%FossilHeat * Gas_Heating_Consumption * Heating_Reduction * HF * Eff_ISR$$

⁷ ISR calculated for the Income Qualified program in PY6 was used for PY7 participants.

$$\Delta kWh_{heating} \text{ (gas heat furnace fan run time reduction)} = \Delta Therms * F_e * 29.3$$

Where:

%ElectricHeat = 100% if electric space heating fuel, 0% if gas space heating fuel

%FossilHeat = 100% if gas space heating fuel, 0% if electric space heating fuel

Elec_Heating_Consumption = Estimated annual household heating consumption for electrically heated homes (applied per participant based on project location)

Table 39. Electric Heating Consumption by Climate Zone

Climate Zone	kWh	
	Electric Resistance	Heat Pump
1 (Rockford)	21,741	12,789
2 (Chicago)	20,771	12,218
3 (Springfield)	17,789	10,464
4 (Belleville)	13,722	8,072
5 (Marion)	13,966	8,215

Gas_Heating_Consumption = Estimated annual household heating consumption for gas heated homes (applied per participant based on project location)

Table 40. Gas Heating Consumption by Climate Zone

Climate Zone	Therms
1 (Rockford)	1,052
2 (Chicago)	1,005
3 (Springfield)	861
4 (Belleville)	664
5 (Marion)	676

Heating_Reduction = Reduction in heating energy consumption due to installing programmable thermostat = 6.2%

HF = Household factor to adjust heating consumption for single family homes = 100%

Eff_ISR = Percentage of thermostats installed and effectively programmed = 100% (Direct Install)

F_e = Furnace fan energy consumption as a percentage of annual fuel consumption = 3.14%

A.5 GAS BOILER

The evaluation team calculated ex post gas boiler savings using the algorithms below.

Equation 6. Gas Boiler Algorithms

$$\text{(Time of Sale) Gas Savings: } \Delta Therms = Gas_Boiler_Load * ((1/AFUE_{base}) - (1/AFUE_{eff}))$$

(Early Replacement) Gas Savings: $\Delta Therms = Gas_Boiler_Load * ((1/AFUE_{exist}) - (1/AFUE_{eff}))$

Where:

Gas_Boiler_Load = Estimated annual household load for gas boiler for single family homes (applied per participant based on project location)

Table 41. Gas Boiler Load by Climate Zone

Climate Zone	Therms
1 (Rockford)	1,275
2 (Chicago)	1,218
3 (Springfield)	1,043
4 (Belleville)	805
5 (Marion)	819

AFUE_{base} = Annual Fuel Utilization Efficiency (AFUE) for the baseline boiler for time of sale installation = 82% AFUE⁸

AFUE_{exist} = Annual Fuel Utilization Efficiency (AFUE) of the existing boiler for early replacement installation = Actual if available. If unknown use 61.6% AFUE

AFUE_{eff} = Annual Fuel Utilization Efficiency (AFUE) for the newly installed boiler.

Table 42. Gas Boiler Efficiency for Newly Installed Boiler

Measure Type	Efficiency (AFUE)
AFUE 90%	92.5%
AFUE 95%	95.0%

A.6 GAS FURNACE ALGORITHMS

The evaluation team calculated the ex post gas furnace savings using the algorithms below.

Equation 7. Gas Furnace Algorithms

(Time of Sale) Gas Savings: $\Delta Therms = Gas_Furnace_Htg_Load * ((1/AFUE_{base}) - (1/AFUE_{eff}))$

(Early Replacement) Gas Savings: $\Delta Therms = Gas_Furnace_Htg_Load * ((1/AFUE_{exist}) - (1/AFUE_{eff}))$

Where:

Gas_Furnace_Htg_Load = Estimated annual household heating load for gas furnace for single family homes (applied per participant based on project location)

⁸ Illinois TRM V3.0 specifies a baseline boiler efficiency of 82% AFUE for program year beginning June 2013 and beyond.

Table 43. Gas Furnace Load by Climate Zone

Climate Zone	Therms
1 (Rockford)	873
2 (Chicago)	834
3 (Springfield)	714
4 (Belleville)	551
5 (Marion)	561

- AFUE_{base} = Annual Fuel Utilization Efficiency (AFUE) for the baseline furnace for a time of sale installation = 80% AFUE
- AFUE_{exist} = Annual Fuel Utilization Efficiency (AFUE) of the existing furnace for early replacement installation = Actual if available. If unknown use 64.4% AFUE
- AFUE_{eff} = Annual Fuel Utilization Efficiency (AFUE) for the newly installed furnace = 95% AFUE

A.7 AIR SOURCE HEAT PUMP ALGORITHMS

The evaluation team calculated ex post savings for the installation of air source heat pumps using the algorithms below.

Equation 8. Air Source Heat Pump Algorithms

Energy Savings: $\Delta kWh = \Delta kWh_{cooling} + \Delta kWh_{heating}$

(Time of Sale) $\Delta kWh_{cooling} = ((FLH_{cooling} * Capacity_{cooling} * ((1/SEER_{base}) - (1/SEER_{eff}))) / 1,000$

(Early Replacement) $\Delta kWh_{cooling} = ((FLH_{cooling} * Capacity_{cooling} * ((1/SEER_{exist}) - (1/SEER_{eff}))) / 1,000$

(Time of Sale) $\Delta kWh_{heating} \text{ (electric heat)} = ((FLH_{heating} * Capacity_{heating} * ((1/HSPF_{base}) - (1/HSPF_{eff}))) / 1,000$

(Early Replacement) $\Delta kWh_{heating} \text{ (electric heat)} = ((FLH_{heating} * Capacity_{heating} * ((1/HSPF_{exist}) - (1/HSPF_{eff}))) / 1,000$

(Time of Sale) Demand Savings: $\Delta kW = (Capacity_{cooling} * ((1/EER_{base}) - (1/EER_{eff}))) / 1,000 * CF$

(Early Replacement) Demand Savings: $\Delta kW = (Capacity_{cooling} * ((1/EER_{exist}) - (1/EER_{eff}))) / 1,000 * CF$

Where:

FLH_{cooling} = Full load hours for air conditioning (applied per participant based on project location)

Table 44. Full Load Cooling Hours by Climate Zone

Climate Zone	FLH _{cooling}
1 (Rockford)	512
2 (Chicago)	570
3 (Springfield)	730

Climate Zone	FLH_cooling
4 (Belleville)	1,035
5 (Marion)	903

Capacity_Cooling= Cooling capacity of air source heat pump in units of Btuh. Used 33,600 BTUH as specified in the IL TRM V3.0 for Central Air Conditioners when the capacity is unknown.

SEER_{base} = Seasonal Energy Efficiency Ratio (SEER) of the baseline air source heat pump or air conditioner for a time of sale installation = 13 SEER

SEER_{exist} = Seasonal Energy Efficiency Ratio (SEER) of the existing air source heat pump or existing air conditioner for early replacement installation = IL TRM V3.0 specifies 9.12 SEER for ASHP or 8.60 SEER for Central A/C

SEER_{eff} = Seasonal Energy Efficiency Ratio (SEER) for the newly installed air source heat pump = 14.5 SEER (based on program-tracking database measure label)

FLH_heating = Full load hours for heating (applied per participant based on project location)

Table 45. Full Load Heating Hours by Climate Zone

Climate Zone	FLH_heating
1 (Rockford)	1,969
2 (Chicago)	1,840
3 (Springfield)	1,754
4 (Belleville)	1,266
5 (Marion)	1,288

Capacity_Heating = Heating capacity of air source heat pump in units of Btuh (same as Capacity_Cooling)

HSPF_{base} = Heating System Performance Factor (HSPF) for the baseline air source heat pump for time of sale installation = 7.7 HSPF

HSPF_{exist} = Heating System Performance Factor (HSPF) for the baseline air source heat pump or electric resistance heating for early replacement installation. IL TRM V3.0 specifies 5.44 HSPF for replacing an existing ASHP or 3.41 HSPF for replacing electric resistance heat

HSPF_{eff} = Heating System Performance Factor (HSPF) for the newly installed air source heat pump. Used average from PY6 database = 8.6 HSPF (n=7)

EER_{base} = Energy Efficiency Ratio (EER) for the baseline air source heat pump or air conditioner for time of sale installation = 11.2 EER

EER_{exist} = Energy Efficiency Ratio (EER) for the existing air source heat pump or air conditioner for early replacement installation. Calculated using $EER = -0.02 * SEER^2 + 1.12 * SEER$; 8.55 EER for replacing an existing ASHP or 8.15 EER for replacing a central air conditioner

EER_{eff} = Energy Efficiency Ratio (EER) for the newly installed air source heat pump.
 Calculated using $EER = (-0.02 * SEER^2) + (1.12 * SEER) = 12.04 \text{ EER}$

CF = Coincidence Factor = 0.72

A.8 CENTRAL AIR CONDITIONER ALGORITHMS

The evaluation team calculated ex post savings for the installation of central air conditioners using the algorithms below.

Equation 9. Central Air Conditioner Algorithms

$$\text{(Time of Sale) } \Delta kWh_{\text{cooling}} = ((FLH_{\text{cooling}} * Capacity_{\text{Cooling}} * ((1/SEER_{\text{base}}) - (1/SEER_{\text{eff}})))/1,000$$

$$\text{(Early Replacement) } \Delta kWh_{\text{cooling}} = ((FLH_{\text{cooling}} * Capacity_{\text{Cooling}} * ((1/SEER_{\text{exist}}) - (1/SEER_{\text{eff}})))/1,000$$

$$\text{(Time of Sale) Demand Savings: } \Delta kW = (Capacity_{\text{cooling}} * ((1/EER_{\text{base}}) - (1/EER_{\text{eff}}))/1,000) * CF$$

$$\text{(Early Replacement Demand Savings: } \Delta kW = (Capacity_{\text{cooling}} * ((1/EER_{\text{exist}}) - (1/EER_{\text{eff}}))/1,000) * CF$$

Where:

FLH_{cooling} = Full load hours for air conditioning (applied per participant based on project location)

Table 46. Full Load Cooling Hours by Climate Zone

Climate Zone	FLH _{cooling}
1 (Rockford)	512
2 (Chicago)	570
3 (Springfield)	730
4 (Belleville)	1,035
5 (Marion)	903

Capacity_{Cooling}= Cooling capacity of air conditoiner in units of Btuh = 33,600 BTUh per IL TRM V3.0

SEER_{base} = Seasonal Energy Efficiency Ratio (SEER) for the baseline air conditioner for a time of sale installation = 13 SEER

SEER_{exist} = Seasonal Energy Efficiency Ratio of the existing air conditioner for early replacement installation = 10 SEER

SEER_{eff} = Seasonal Energy Efficiency Ratio (SEER) for the newly installed air conditioner = 14.5 SEER (based on program-tracking database measure label)

EER_{base} = Energy Efficiency Ratio (SEER) for the baseline air conditioner for a time of sale installation = 11.2 EER

- EER_{exist}** = Energy Efficiency Ratio of the existing air conditioner for early replacement installation = 9.2 EER
- EER_{eff}** = Energy Efficiency Ratio (SEER) for the newly installed air conditioner = 12.04 EER
- CF** = Coincidence Factor = 0.68

A.9 FURNACE BLOWER MOTOR

The evaluation team calculated the ex post savings for the installation of ECM brushless furnace blower motors using the algorithms below.

Equation 10. ECM Brushless Motor Algorithms

$$\Delta kWh = \Delta kWh_{cooling} + \Delta kWh_{heating} + \Delta kWh_{shoulder}$$

$$\Delta kWh_{cooling} \text{ (with CAC)} = 263 \text{ kWh (deemed value)}$$

$$\Delta kWh_{cooling} \text{ (without CAC)} = 175 \text{ kWh (deemed value)}$$

$$\Delta kWh_{heating} = 418 \text{ kWh (deemed value)}$$

$$\Delta kWh_{shoulder} = 51 \text{ kWh (deemed value)}$$

$$\Delta kW = \Delta kWh_{cooling} / FLH_{Cig} * CF$$

$$\Delta therms = - \Delta kWh_{heating} * 0.03412$$

Where:

- FLH_{cooling}** = Full load hours for air conditioning (applied per participant based on project location)

Table 47. Full Load Cooling Hours by Climate Zone

Climate Zone	FLH _{cooling}
1 (Rockford)	512
2 (Chicago)	570
3 (Springfield)	730
4 (Belleville)	1,035
5 (Marion)	903

- CF** = Coincidence Factor = 0.68

A.10 AIR SEALING ALGORITHMS

The evaluation determined ex post air sealing savings using the algorithms below.

Equation 11. Air Sealing Algorithms

$$\text{Energy Savings: } \Delta kWh = \Delta kWh_{cooling} + \Delta kWh_{heating}$$

$$\Delta kWh_{cooling} = [(((CFM50_{existing} - CFM50_{new}) / N_{cool}) * 60 * 24 * CDD * DUA * 0.018) / (1000 * \eta_{Cool})] * LM$$

$$\Delta kWh_{heating} \text{ (electric heat)} = (((CFM50_{existing} - CFM50_{new})/N_{heat}) * 60 * 24 * HDD * 0.018) / (\eta_{Heat} * 3,412)$$

$$\text{Demand Savings: } \Delta kW = (\Delta kWh_{cooling} / FLH_{cooling}) * CF$$

$$\text{Gas Savings (gas heat): } \Delta Therms = (((CFM50_{existing} - CFM50_{new})/N_{heat}) * 60 * 24 * HDD * 0.018) / (\eta_{Heat} * 100,000)$$

$$\Delta kWh_{heating} \text{ (gas heat furnace fan run time reduction)} = \Delta Therms * F_e * 29.3$$

Where:

CFM_existing = Infiltration at 50 Pascals as measured by blower door before air sealing

CFM_new = Infiltration at 50 Pascals as measured by blower door after air sealing

N_Cool = Conversion factor from leakage at 50 Pascal to leakage at natural conditions = 18.5⁹

CDD = Cooling Degree Days (applied per participant based on location)

Table 48. Cooling Degree Days by Climate Zone

Climate Zone	CDD 65
1 (Rockford)	820
2 (Chicago)	842
3 (Springfield)	1,108
4 (Belleville)	1,570
5 (Marion)	1,370

DUA = Discretionary Use Adjustment = 0.75

ηCool = Seasonal Energy Efficiency Ratio (SEER) of cooling system (actual cooling efficiency and age of existing equipment unknown; used age of existing equipment pre 2006)

Table 49. ηCool for Air Sealing Measures

Cooling Equipment Age	SEER
Before 2006	10
After 2006	13

LM = Latent Multiplier to account for latent cooling demand (applied per participant based on project location)

Table 50. Latent Multiplier by Climate Zone

Climate Zone	Latent Multiplier
1 (Rockford)	8.5

⁹ Assumed CZ2 Normal Exposure.

2 (Chicago)	6.2
3 (Springfield)	6.6
4 (Belleville)	5.8
5 (Marion)	6.6

N_{heat} = Conversion factor from leakage at 50 Pascal to leakage at natural conditions = 15.75¹⁰

HDD = Heating Degree Days (applied per participant based on project location)

Table 51. Heating Degree Days by Climate Zone

Climate Zone	HDD 65
1 (Rockford)	6,569
2 (Chicago)	6,339
3 (Springfield)	5,497
4 (Belleville)	4,379
5 (Marion)	4,476

η_{Heat} = Efficiency of heating system (based on heating equipment type per participant) (actual heating efficiency and age of existing equipment unknown; used age of existing equipment pre 2006)

Table 52. η_{Heat} for Air Sealing Measures

Existing Heating Equipment	η _{Heat} (pre 2006)		η _{Heat} (post 2006)	
	COP	AFUE	COP	AFUE
Gas Furnace	n/a	0.7	n/a	0.7
Electric Resistance	1.00	n/a	1.00	n/a
Air Source Heat Pump (ASHP)	1.70	n/a	1.92	n/a

FLH_{cooling} = Full Load Hours of air conditioning (applied per participant based on project location)

Table 53. FLH cooling by Climate Zone

Climate Zone	FLH _{cooling}
1 (Rockford)	512
2 (Chicago)	570
3 (Springfield)	730
4 (Belleville)	1,035
5 (Marion)	903

CF = Coincidence Factor (varies by cooling equipment type)

¹⁰ Applied average of 1, 1.5, 2 and 3 story homes for homes with normal exposure in CZ2.

Table 54. Air Sealing Coincidence Factors

Cooling Equipment	CF
Central Air Conditioner	0.68
Heat Pump	0.72

F_e = Furnace fan energy consumption as a percentage of annual fuel consumption = 3.14%

A. 11 ATTIC AND WALL INSULATION ALGORITHMS

The evaluation team determined ex post attic and wall insulation savings using the algorithms below.

Equation 12. Attic Insulation Algorithms

Energy Savings: $\Delta kWh = \Delta kWh_{cooling} + \Delta kWh_{heating}$

$$\Delta kWh_{cooling} = (((1/R_{old} - 1/R_{new}) * A_{attic} * (1-Framing_factor_{attic})) * 24 * CDD * DUA) / (1,000 * \eta_{Cool})$$

$$\Delta kWh_{heating} \text{ (electric heat)} = (((1/R_{old} - 1/R_{new}) * A_{attic} * (1-Framing_factor_{attic}) * ADJ_{attic}) * 24 * HDD) / (\eta_{Heat} * 3,412)$$

Demand Savings: $\Delta kW = (\Delta kWh_{cooling} / FLH_{cooling}) * CF$

$$\text{Gas Savings (gas heat): } \Delta Therms = (((1/R_{old} - 1/R_{new}) * A_{attic} * (1-Framing_factor_{attic}) * ADJ_{attic}) * 24 * HDD) / (\eta_{Heat} * 100,067 \text{ Btu/therm})$$

$$\Delta kWh_{heating} \text{ (gas heat furnace fan run time reduction)} = \Delta Therms * F_e * 29.3$$

Equation 13. Wall Insulation Algorithms

Energy Savings: $\Delta kWh = \Delta kWh_{cooling} + \Delta kWh_{heating}$

$$\Delta kWh_{cooling} = (((1/R_{old} - 1/R_{new}) * A_{wall} * (1-Framing_factor_{wall})) * 24 * CDD * DUA) / (1,000 * \eta_{Cool})$$

$$\Delta kWh_{heating} \text{ (electric heat)} = (((1/R_{old} - 1/R_{new}) * A_{wall} * (1-Framing_factor_{wall}) * ADJ_{wall}) * 24 * HDD) / (\eta_{Heat} * 3,412)$$

Demand Savings: $\Delta kW = (\Delta kWh_{cooling} / FLH_{cooling}) * CF$

$$\text{Gas Savings (gas heat): } \Delta Therms = (((1/R_{old} - 1/R_{new}) * A_{wall} * (1-Framing_factor_{wall}) * ADJ_{wall}) * 24 * HDD) / (\eta_{Heat} * 100,067 \text{ Btu/therm})$$

$$\Delta kWh_{heating} \text{ (gas heat furnace fan run time reduction)} = \Delta Therms * F_e * 29.3$$

Where:

- R_{new} = Total attic or wall assembly R-value after the installation of additional insulation (see Equation 14 for assembly R-value algorithms)
- R_{old} = R-value of existing attic or wall assembly and any existing insulation with a minimum of R-5 (see Equation 14 for assembly R-value algorithms)
- A_{wall} = Total area of insulated wall (ft²)

A_{attic} = Total area of insulated attic (ft²)

$Framing_factor$ = Adjustment to account for area of framing (Framing Factor included in the assembly R-value algorithms; see Equation 14)

Table 55. Framing Factors for Attic and Wall Areas

Measure	Framing Factor
Attic Insulation	0.07
Wall Insulation	0.25

ADJ_{attic} = Adjustment for attic insulation to account for prescriptive engineering algorithms over claiming savings = 74%

ADJ_{wall} = Adjustment for wall insulation to account for prescriptive engineering algorithms over claiming savings = 63%

CDD = Cooling Degree Days (applied per participant based on project location)

Table 56. Cooling Degree Days by Climate Zone

Climate Zone	CDD
1 (Rockford)	820
2 (Chicago)	842
3 (Springfield)	1,108
4 (Belleville)	1,570
5 (Marion)	1,370

DUA = Discretionary Use Adjustment = 0.75

η_{Cool} = Seasonal Energy Efficiency Ratio (SEER) of cooling system (actual cooling efficiency and age of existing equipment unknown; used age of existing equipment pre 2006)

Table 57. η_{Cool} for Attic and Wall Insulation Measures

Cooling Equipment Age	SEER
Before 2006	10
After 2006	13

HDD = Heating Degree Days (applied per participant based on project location)

Table 58. Heating Degree Days by Climate Zone

Climate Zone	HDD
1 (Rockford)	5,352
2 (Chicago)	5,113
3 (Springfield)	4,379
4 (Belleville)	3,378
5 (Marion)	3,438

η_{Heat} = Efficiency of heating system (based on heating equipment type per participant) (actual heating efficiency and age of existing equipment unknown; used age of existing equipment pre 2006)

Table 59. η_{Heat} for Attic and Wall Insulation Measures

Existing Heating Equipment	η_{Heat} (pre 2006)		η_{Heat} (post 2006)	
	COP	AFUE	COP	AFUE
Gas Furnace	n/a	0.7	n/a	0.7
Electric Resistance	1.00	n/a	1.00	n/a
Air Source Heat Pump (ASHP)	1.70	n/a	1.92	n/a

FLH_cooling = Full Load Hours of air conditioning (applied per participant based on project location)

Table 60. FLH_cooling by Climate Zone

Climate Zone	FLH_cooling
1 (Rockford)	512
2 (Chicago)	570
3 (Springfield)	730
4 (Belleville)	1,035
5 (Marion)	903

CF = Coincidence Factor

Table 61. Attic and Wall Insulation Coincidence Factors

Cooling Equipment	CF
Central Air Conditioner	0.68
Heat Pump	0.72

F_e = Furnace fan energy consumption as a percentage of annual fuel consumption = 3.14%

Because the R-values in these algorithms are stated to be assembly R-values, our engineering calculations deviated somewhat from the TRM as follows:

- We determined the assembly R-value using the ASHRAE Isothermal Planes method (page 27.3, ASHRAE Fundamentals, 2013).
- This method includes the IL TRM V3.0 framing factor within the calculations as shown below.
- Equation 14 was not applied to calculate assembly R-values for pre-existing attic or wall insulation for those with R-values less than 5. These cases were assigned an assembly R-value of 5 for both attic and wall insulation.

The following algorithms used to calculate the assembly R-values for attic insulation and wall insulation include:

Equation 14. Attic and Wall Assembly R-value Algorithms

$$\text{Attic Assembly R-value} = ((1/R\text{-value}_{\text{database}}) * (1 - \text{Framing_Factor}_{\text{attic}}) + 1/R\text{-value}_{\text{WoodStud2x6}} * \text{Framing_Factor}_{\text{attic}}) + (R\text{-value}_{\text{indoor air film}} + R\text{-value}_{\text{plywood}} + R\text{-value}_{\text{gypsum}} + R\text{-value}_{\text{indoor air film}})$$

$$\text{Wall Assembly R-value} = ((1/R\text{-value}_{\text{database}}) * (1 - \text{Framing_Factor}_{\text{wall}}) + 1/R\text{-value}_{\text{WoodStud2x4}} * \text{Framing_Factor}_{\text{wall}}) + (R\text{-value}_{\text{outdoor air film}} + R\text{-value}_{\text{rigid foam}} + R\text{-value}_{\text{claytile}} + R\text{-value}_{\text{gypsum}} + R\text{-value}_{\text{indoor air film}})$$

Where:

R-value_{database} = Pre or post insulation R-value found in the database (for R-values that are greater than 5)

Framing_factor_{attic} = Adjustment to account for area of framing = 0.07

Framing_factor_{wall} = Adjustment to account for area of framing = 0.25

Figure 1. Engineering Factors Used within Attic Insulation Calculations

No Insulation				With Insulation			
N	Element	R	R	N	Element	R	R
1	indoor air film, still air		0.68	1	indoor air film, still air		0.68
2	air ^a	0.86	0.92	2	mineral fiber batt insulation	19	16.45
3	Joist (nominal 5.5") - southern pine	5.78		3	Joist (nominal 5.5") - southern pine	5.78	
4	plywood, 5/8", douglas fir		0.85	4	plywood, 5/8", douglas fir		0.85
5	gypsum wallboard, 0.5 inch		0.45	5	gypsum wallboard, 0.5 inch		0.45
6	indoor air film, still air		0.68	6	indoor air film, still air		0.68
	R value		3.6		R value		19.1
	U value		0.28		U value		0.05
	% of assembly	0.925	0.07		% of assembly	0.925	0.07
	U of assembly	0.28			U of assembly	0.05	
	R of assembly	3.58			R of assembly	19.11	

^ahorizontal position, up heat flow, 50 degree mean with 30 degree difference, emissivity of 0.82 for building materials, 5.5" air space

Figure 2. Engineering Factors Used within Wall Insulation Calculations

No Insulation				With Insulation			
N	Element	R	R	N	Element	R	R
1	Outdoor Air film, 15 mph wind		0.17	1	Outdoor Air film, 15 mph wind		0.17
2	clay tile, 1 cell deep, 4", no insulation		1.11	2	clay tile, 1 cell deep, 4", no insulation		1.11
3	rigid foam insulating sheathing		4	3	rigid foam insulating sheathing		4
4	air ^a	1.25	1.52	4	mineral fiber batt insulation	13	8.71
5	Wood stud (nominal 2 x 4)	4.38		5	Wood stud (nominal 2 x 4)	4.38	
6	gypsum wallboard, 0.5 inch		0.45	6	gypsum wallboard, 0.5 inch		0.45
7	indoor air film, still air		0.68	7	indoor air film, still air		0.68
	R value		7.9		R value		15.1
	% of assembly	0.75	0.25		% of assembly	0.75	0.25
	R of assembly	7.94			R of assembly	15.13	

^avertical position, horizontal heat flow, 50 degree mean with 30 degree difference, emissivity of 0.82 for building materials

After speaking with the implementer and learning more about typical attic and wall assemblies in the Illinois territory for homes built in pre 1970s, we feel it is appropriate to update these values as part of the PYS evaluation.

A.12 RIM JOIST INSULATION AND BASEMENT WALL INSULATION ALGORITHMS

The evaluation team calculated the ex post basement wall insulation and rim joist insulation savings using the algorithms below. The TRM does not have algorithms specifically for rim joist; therefore, we applied the basement sidewall insulation algorithms to determine rim joist savings.

Equation 15. Rim Joist Insulation Algorithms

Energy Savings: $\Delta kWh = \Delta kWh_{cooling} + \Delta kWh_{heating}$

$$\Delta kWh_{cooling} = (((1/R_{old_AG_{RimJoist}} - (1/(R_{new} + R_{old_AG_{RimJoist}}))) * L_{rimjoist} * H_{rimjoist} * (1-Framing_factor)) * 24 * CDD * DUA) / (1,000 * \eta_{Cool})$$

$$\Delta kWh_{heating} \text{ (electric heat)} = (((1/R_{old_AG_{RimJoist}} - (1/(R_{new} + R_{old_AG_{RimJoist}}))) * L_{rimjoist} * H_{rimjoist} * (1-Framing_factor)) * 24 * HDD) / (3412 * \eta_{Heat}) * ADJ$$

$$\text{Demand Savings: } \Delta kW = (\Delta kWh_{cooling} / FLH_{cooling}) * CF$$

$$\text{Gas Savings (gas heat): } \Delta Therms = (((1/R_{old_AG_{RimJoist}} - (1/(R_{new} + R_{old_AG_{RimJoist}}))) * L_{rimjoist} * H_{rimjoist} * (1-Framing_factor)) * 24 * HDD) / (100,067 * \eta_{Heat}) * ADJ$$

$$\Delta kWh_{heating} \text{ (gas heat furnace fan run time reduction)} = \Delta Therms * F_e * 29.3$$

$$R_{old_AG_{RimJoist}} = R\text{-value}_{Joist} + R\text{-value}_{outdoor\ air\ film} + R\text{-value}_{wallboard} + R\text{-value}_{indoor\ air\ film}$$

Equation 16. Basement Sidewall Insulation Algorithms

Energy Savings: $\Delta kWh = \Delta kWh_{cooling} + \Delta kWh_{heating}$

$$\Delta kWh_{cooling} = (((1/R_{old_AG_{basement}} - (1/(R_{new} + R_{old_AG_{basement}}))) * L_{basement_wall\ total} * H_{basement_wall_AG} * (1-Framing_factor)) * 24 * CDD * DUA) / (1,000 * \eta_{Cool})$$

$$\Delta kWh_{heating} \text{ (electric heat)} = [(((1/R_{old_AG_{basement}} - (1/(R_{new} + R_{old_AG_{basement}}))) * L_{basement_wall_total} * H_{basement_wall_AG} * (1-Framing_factor)) + ((1/R_{old_BG} - (1/(R_{new} + R_{old_BG}))) * L_{basement_wall_total} * (H_{basement_wall_total} - H_{basement_wall_AG}) * (1-Framing_Factor))) * 24 * HDD] / (3,412 * \eta_{Heat}) * ADJ$$

$$\text{Demand Savings: } \Delta kW = (\Delta kWh_{cooling} / FLH_{cooling}) * CF$$

$$\text{Gas Savings (gas heat): } \Delta Therms = [(((1/R_{old_AG_{basement}} - (1/(R_{new} + R_{old_AG_{basement}}))) * L_{basement_wall_total} * H_{basement_wall_AG} * (1-Framing_factor)) + ((1/R_{old_BG} - (1/(R_{new} + R_{old_BG}))) * L_{basement_wall_total} * (H_{basement_wall_total} - H_{basement_wall_AG}) * (1-Framing_Factor))) * 24 * HDD] / (100,067 * \eta_{Heat}) * ADJ$$

$$\Delta kWh_{heating} \text{ (gas heat furnace fan run time reduction)} = \Delta Therms * F_e * 29.3$$

Where:

$R_{old_AG_{RimJoist}}$ = R-value of existing foundation wall assembly above grade = R-3.18 (using algorithm above and R-values in Table 62).

Table 62. Rim Joist Above-Grade R-value

Variable	R-value ^a
$R\text{-value}_{Joist} (1.5")$	1.88

R-value _{outdoor air film}	0.17
R-value _{wallboard}	0.45
R-value _{indoor air film}	0.68
Total R-value	3.18

R_{old_AG}_{basement} = R-value of existing foundation wall assembly above grade = R-1.0

R_{old_BG} = R-value of existing foundation wall assembly below grade (including thermal resistance of Earth) = 9.46 (for 6' below grade basement wall)

R_{new} = R-value of added insulation (spray foam, rigid foam, cavity); Used actual R-value from database

L_{rimjoist} = Total linear feet of installed insulation (ft)

L_{basement_wall_total} = Length of basement wall for the insulated perimeter (ft)

H_{rimjoist} = Height of floor joist in which insulation is installed = 0.85 ft (average of 2x10 and 2x12 framing)

H_{basement_wall_AG} = Height of above grade insulated basement wall (ft) = 1.0 ft

H_{basement_wall_total} = Total height of basement wall = 7.0 ft

Framing_factor = Adjustment to account for area of framing (varies by measure)

Table 63. Framing Factor for Rim Joist and Basement Wall Insulation

Measure	Framing Factor
Rim Joist	0.05 ^a
Basement Wall	0.00

^a Average framing factor for joists from front to back (1.75" for every 16" = FF 0.10) and joists from side to side (continuous FF = 0)

ADJ = Adjustment to account for prescriptive engineering algorithms over claiming savings (used non low income since this program targets moderate income participants)

Table 64. Adjustment for Rim Joist and Basement Wall Insulation

Market	ADJ
Low Income	70%
Non Low Income	88%

CDD = Cooling Degree Days (assumed unconditioned basement) (applied per participant based on project location)

Table 65. Cooling Degree Days by Climate Zone

Climate Zone	CDD 65
	Unconditioned Basement
1 (Rockford)	263

2 (Chicago)	281
3 (Springfield)	436
4 (Belleville)	538
5 (Marion)	570

DUA = Discretionary Use Adjustment = 0.75

η_{Cool} = Seasonal Energy Efficiency Ratio (SEER) of cooling system (actual cooling efficiency and age of existing equipment unknown; used age of existing equipment pre 2006)

Table 66. η_{Cool} for Rim Joist and Basement Wall Insulation Measures

Cooling Equipment Age	SEER
Before 2006	10
After 2006	13

HDD = Heating Degree Days (assumed unconditioned basement) (applied per participant based on project location)

Table 67. Heating Degree Days by Climate Zone for Unconditioned Basement

Climate Zone	HDD
1 (Rockford)	3,322
2 (Chicago)	3,079
3 (Springfield)	2,550
4 (Belleville)	1,789
5 (Marion)	1,796

ηHeat = Efficiency of heating system (based on heating equipment type per participant) (actual heating efficiency and age of existing equipment unknown; used age of existing equipment pre 2006)

Table 68. ηHeat for Rim Joist and Basement Wall Insulation Measures

Existing Heating Equipment	ηHeat (pre 2006)		ηHeat (post 2006)	
	COP	AFUE	COP	AFUE
Gas Furnace	n/a	0.7	n/a	0.7
Electric Resistance	1.00	n/a	1.00	n/a
Air Source Heat Pump (ASHP)	1.70	n/a	1.92	n/a

FLH_cooling = Full Load Hours of air conditioning (applied per participant based on project location)

Table 69. FLH_cooling by Climate Zone

Climate Zone	FLH_cooling
1 (Rockford)	512
2 (Chicago)	570
3 (Springfield)	730
4 (Belleville)	1,035
5 (Marion)	903

CF = Coincidence Factor

Table 70. Rim Joist and Basement Wall Insulation Coincidence Factors

Cooling Equipment	CF
Central Air Conditioner	0.68
Heat Pump	0.72

F_e = Furnace fan energy consumption as a percentage of annual fuel consumption = 3.14%

A.13 CRAWLSPACE INSULATION ALGORITHMS

The evaluation team calculated the ex post crawlspace insulation savings using the algorithms below.

Equation 17. Crawlspace Insulation Algorithms

Energy Savings: $\Delta kWh = \Delta kWh_{cooling} + \Delta kWh_{heating}$

$$\Delta kWh_{cooling} = \left(\left(\frac{1}{R_{old_AG}} - \frac{1}{(R_{added} + R_{old_AG})} \right) * LF * H_{AG} * (1 - Framing_factor) \right) * 24 * CDD * DUA / (1,000 * \eta_{Cool})$$

$$\Delta kWh_{heating} \text{ (electric heat)} = \left[\left(\left(\frac{1}{R_{old_AG}} - \frac{1}{(R_{added} + R_{old_AG})} \right) * LF * H_{AG} * (1 - Framing_factor) \right) + \left(\frac{1}{R_{old_BG}} - \frac{1}{(R_{added} + R_{old_BG})} \right) * LF * H_{BG} * (1 - Framing_Factor) \right] * 24 * HDD / (3,412 * \eta_{Heat}) * ADJ$$

Demand Savings: $\Delta kW = (\Delta kWh_{cooling} / FLH_{cooling}) * CF$

$$\text{Gas Savings (gas heat): } \Delta Therms = \left[\left(\left(\frac{1}{R_{old_AG}} - \frac{1}{(R_{added} + R_{old_AG})} \right) * LF * H_{AG} * (1 - Framing_factor) \right) + \left(\frac{1}{R_{old_BG}} - \frac{1}{(R_{added} + R_{old_BG})} \right) * LF * H_{BG} * (1 - Framing_Factor) \right] * 24 * HDD / (100,067 * \eta_{Heat}) * ADJ$$

$$\Delta kWh_{heating} \text{ (gas heat furnace fan run time reduction)} = \Delta Therms * F_e * 29.3$$

Where:

- R_old_AG = Above grade existing R-value of crawlspace = 1.0
- R_old_BG = Below grade existing R-value of crawlspace insulation (assume 2.0' below grade) = 5.41
- R_added = R-value of additional insulation (actual value from database)
- ADJ = Adjustment to account for prescriptive engineering algorithms over claiming savings (used non low income since this program targets moderate income participants)

Table 71. Adjustment for Crawlspace Insulation

Market	ADJ
Low Income	70%
Non Low Income	88%

- LF = Total linear feet of installed insulation (ft²) (from database)
- H_AG = Height of crawlspace wall above grade = 1.0 foot
- H_BG = Height of crawlspace wall below grade = 2.0 feet
- Framing_factor = Adjustment to account for area of framing = 0.0 (spray foam)
- CDD = Cooling Degree Days (assumed unconditioned (vented) crawlspace) (applied per participant based on project location)

Table 72. Cooling Degree Days by Climate Zone for Unconditioned (Vented) Crawlspace

Climate Zone	CDD
1 (Rockford)	263
2 (Chicago)	281
3 (Springfield)	436

Climate Zone	CDD
4 (Belleville)	538
5 (Marion)	570

DUA = Discretionary Use Adjustment = 0.75

η_{Cool} Seasonal Energy Efficiency Ratio (SEER) of cooling system (actual cooling efficiency and age of existing equipment unknown; used age of existing equipment pre 2006)

Table 73. η_{Cool} for Crawlspace Insulation Measures

Cooling Equipment Age	SEER
Before 2006	10
After 2006	13

HDD = Heating Degree Days (assumed unconditioned (vented) crawlspace) (applied per participant based on project location).

Table 74. Heating Degree Days by Climate Zone for Unconditioned (Vented) Crawlspace

Climate Zone	HDD
1 (Rockford)	3,322
2 (Chicago)	3,079
3 (Springfield)	2,550
4 (Belleville)	1,789
5 (Marion)	1,796

η_{Heat} = Efficiency of heating system (based on heating equipment type per participant) (actual heating efficiency and age of existing equipment unknown; used age of existing equipment pre 2006)

Table 75. η_{Heat} for Crawlspace Insulation Measures

Existing Heating Equipment	η_{Heat} (pre 2006)		η_{Heat} (post 2006)	
	COP	AFUE	COP	AFUE
Gas Furnace	n/a	0.7	n/a	0.7
Electric Resistance	1.00	n/a	1.00	n/a
Air Source Heat Pump (ASHP)	1.70	n/a	1.92	n/a

FLH_cooling = Full Load Hours of air conditioning (applied per participant based on project location)

Table 76. FLH_cooling by Climate Zone

Climate Zone	FLH_cooling
1 (Rockford)	512
2 (Chicago)	570
3 (Springfield)	730
4 (Belleville)	1,035
5 (Marion)	903

CF = Coincidence Factor

Table 77. Crawlspace Insulation Coincidence Factors

Cooling Equipment	CF
Central Air Conditioner	0.68
Heat Pump	0.72

F_e = Furnace fan energy consumption as a percentage of annual fuel consumption = 3.14%

B. APPENDIX – DIFFERENCES IN INPUT VALUES FOR EX POST AND EX ANTE GROSS SAVINGS

Differences in ex post and ex ante gross savings stem from differences in input values for the savings algorithms for each measure. Through our discussions with the implementer, we identified the sources of these differences. Note that while the inputs for air sealing, insulation, and HVAC measures have the largest impact on program level realization rates, other measure inputs have some differences as well. The other measure input differences are detailed below.

■ Programmable Thermostat Issues:

- **Electric Heating Consumption:** Ex ante savings applied the electric heating consumption from the IL TRM V3.0 for Springfield to all projects regardless of location. The evaluation team assigned electric heating consumption from the IL TRM V3.0 for the location of each participating home. The ex post per unit electric savings for programmable thermostats increased by 1% due to the locational differences in electric heating consumption.
- **Gas Heating Consumption:** Ex ante savings applied the gas heating consumption from the IL TRM V3.0 for Springfield to all projects regardless of location. The evaluation team assigned gas heating consumption from the IL TRM V3.0 for the location of each participating home. The ex post per unit therm savings for programmable thermostats decreased by 3% due to the locational differences in gas heating consumption.
- **Heating Consumption Adjustment Factor:** Ex ante savings changed the heating consumption for programmable thermostats to account for higher efficiencies, which led to lower saving than if they has applied the IL TRM V3.0 consumption values.¹¹ Applying this change to gas heating consumption reduces the ex ante per unit therm value by 26% and reduces the ex ante per unit kWh value by 16%, leading to ex post realization rates that are higher than 1.0.

■ Standard CFLs and Specialty CFLs Issues:

- **Waste Heat Factors:** The ex ante energy savings included the waste heat factor heating penalty for all standard and specialty CFLs, which results in less ex ante savings. However, consistent with past evaluations, and per agreements between ICC staff and AIC regarding the treatment of waste heat factors, we did not include waste heat factor heating penalties for lighting in the calculation of ex post savings. Therefore, ex post savings were higher.
- **Hours of Use (Specialty CFLs only):** Ex ante savings applied hours of use (1,240 hrs/yr) for specialty globe CFLs based on the hours of use provided in an older version of the IL TRM.¹² Ex post savings applied the hours of use (847 hrs/yr) from a more recent publication of the same version of the IL TRM. As a result, ex ante per-unit savings for specialty globe CFLs overestimate

¹¹ The TRM efficiency values are 7.7 HSPF for heat pumps and 0.70 AFUE for gas furnaces. The ex ante efficiency values are 8.5 HSPF for heat pumps and 0.95 AFUE for furnaces.

¹² The ex ante hours of use (1,240 hours per year) for specialty globe CFLs is from the IL TRM dated January 3, 2014. Ex post hours of use (847 hours per year) is from the IL TRM dated February 24, 2014.

savings by 29%. Specialty globe CFLs account for 1.4% of the program's total reported energy savings and therefore play a small role in the overall program realization rate.

- **Misapplied Ex Ante Per Unit Demand Savings (Specialty CFLs only):** Ex ante savings misapplied the demand per unit value for the 9W candelabra and 15W reflector specialty CFLs. Ex ante savings inadvertently applied the demand value for the 15W reflector CFLs to the 9W candelabra CFLs resulting in a 20% reduction in demand savings. Additionally, ex ante savings applied the demand value for the 9W candelabra CFLs to the 15W reflector CFLs resulting in increased demand savings of 26%. Specialty globe CFLs account for 1.4% of the program's total reported energy savings and therefore play a small role in the overall program realization rate.

- **Gas Furnace Issues:**

- **Gas Furnace Load:** Ex ante savings applied the gas furnace load from the IL TRM V3.0 for Springfield to all projects regardless of location. The evaluation team assigned gas furnace loads from the IL TRM V3.0 for the location of each participating home. The ex post per unit savings for new furnaces decreased by 2% due to the differences in gas furnace load assumptions.
- **Weighted Ex Ante per Unit Value (Early Replacement (ER) Furnaces):** Ex ante savings applied to ER furnaces is a weighted savings value for ER and time of sale (TOS) furnaces, even though the database measure name indicates that the furnace is either ER or TOS. The ex post savings applies the appropriate per-unit savings based on whether the unit is ER or TOS.¹³ The weighted value applied to ER furnaces in the program database is 42% less than the originally calculated ex ante savings for the same furnace.

- **Gas Boiler Issues:**

- **Gas Boiler Load:** Ex ante savings applied the gas boiler load from the IL TRM V3.0 for Springfield to all projects regardless of location. The evaluation team assigned gas boiler loads from the IL TRM V3.0 for the location of each participating home. The ex post per unit savings for new boilers decreased by 0.3% due to the differences in gas boiler load assumptions.
- **Weighted Ex Ante per Unit Value (ER Boiler):** Ex ante savings applied to ER boilers is a weighted savings value for ER and time of sale boilers even though the database measure name indicates that the boiler is either ER or TOS. There were no TOS boilers installed in PY7. The ex post savings applies the appropriate per-unit ER savings.¹⁴ The weighted average value applied to ER boilers in the program database is about 50% less than the originally calculated ex ante savings for the same boiler.

¹³ The per unit for ER furnaces is 357 therms and the per unit for TOS furnaces is 141 therms. The ex ante estimates apply a weighted per unit ex ante savings to ER furnaces of 206 therms.

¹⁴ The per unit for 90% AFUE ER boilers is 566 therms and the per unit for TOS boilers is 144 therms. The ex ante estimates apply a weighted per unit ex ante savings to all 90% ER boilers of 279 therms and a value of 557 therms to 95% AFUE ER boilers.

C. APPENDIX – DATA COLLECTION INSTRUMENT

Screening

- SC1.** Our records indicate that your company participated in...
 [IF IQ=1, READ IN...
 “the Home Efficiency Income Qualified Program, previously the Moderate Income program.”]
 [IF SP=1 & IQ=1, READ IN...
 “both the Home Efficiency Standard Program, previously the Home Performance with Energy Star program and the Home Efficiency Income Qualified Program, previously the Moderate Income Program.”]
 Is that correct?
 1. (Yes)
 2. (No) [THANK AND TERMINATE]
 98. (Don’t Know) [SKIP TO SC3]
 99. (Refused) [THANK AND TERMINATE]

- SC2.** Are you knowledgeable about your company's involvement in this program?
 1. Yes [SKIP TO SC4]
 2. No
 98. Don’t know [THANK AND TERMINATE]

- SC3.** Is there someone more knowledgeable in your company to whom we could send this survey? If so, could you please provide us with their Name and email address or phone number.
 1. Yes [OPEN END, RECORD DETAILS and then thank and terminate]
 2. No [THANK AND TERMINATE]

- SC4.** How familiar are you with the...?

Not at all familiar						Very familiar				
0	1	2	3	4	5	6	7	8	9	10
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

- A. Income Qualified Program

[IF IQ=1 & SC4b = 0 OR SP=1 & IQ=1 & SC4a=0 & SC4b=0, THANK AND TERMINATE]

Benefits and Barriers

[ASK QUESTION BATTERY IF IQ=1 & SC4b>0]

The next few question focus on specifics about the Income Qualified Program.

- IQ1.** How knowledgeable do you feel about each of the following aspects of the Income Qualified Program? [ROTATE]

	Not at all Knowledgeable						Very knowledgeable				
	0	1	2	3	4	5	6	7	8	9	10
A. The application process	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
B. Benefits to program participants	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
C. Best strategies to market the program to customers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
D. Where to find help or information about the program	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
E. On-Bill Financing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

IQ2. Which, if any, of the following benefits has your company experienced through its participation in the Income Qualified Program? Please mark all that apply. [MULTIPLE RESPONSE]

	ROTATE	Yes	No	Don't Know
1	Helped increase jobs/revenue	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2	Helped expand customer base	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3	Customers had been asking about the program	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4	Developing/building a relationship with Ameren Illinois	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5	Increased sales of energy efficient equipment	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6	Helped improve customer satisfaction	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7	Marketing provided through the program	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8	Training provided through the program	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9	Technical assistance provided through the program	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10	On-bill financing provided through the program	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
00	Other, specify_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

IQ3. Did you encounter any challenges while participating in the program?

- 1. Yes
- 2. No
- 98. Don't know

[ASK IF IQ3=1]

IQ4. What challenges did you face? Please mark all that apply. [MULTIPLE RESPONSE]

- 1. Lack of customer demand
- 2. Many customers did not qualify for the program
- 3. Paperwork/administration was tedious/too time-consuming
- 4. Difficulty understanding program process
- 5. Challenges marketing the program
- 6. Difficulty meeting program requirements
- 7. Marketing support was not adequate
- 8. Training provided was not adequate
- 9. Technical assistance was not adequate

- 10. Delays in payment
- 11. Lack of communication from CSG (CLEAResult)
- 12. Lack of communication from Ameren Illinois
- 00. Other, specify _____
- 98. Don't Know

IQ5. In your opinion, what could Ameren Illinois change to help improve the Income Qualified program?
[OPEN END]

- 00. Other, specify _____
- 96. Nothing/No Changes
- 98. Don't Know

IQ6. Would you recommend the Income Qualified program to another contractor?

- 1. Yes
- 2. No

Jobs outside the Program

OP1. In the last year, have you completed a job that would have been eligible for the [IF IQ=1 "Income Qualified Program", IF SP=1 & IQ=1 "Standard or Income Qualified programs"], but you chose not to go through the program?

- 1. Yes
- 2. No
- 98. Don't Know

[ASK IF OP1=1]

OP2. With approximately what percentage of jobs did this happen? [NUMERIC OPEN END]

- 00. Specify, _____
- 98. Don't Know

[ASK IF OP1=1]

OP3. Why did you choose to complete the jobs outside of the program? Please mark all that apply.
[MULTIPLE RESPONSE]

- 1. Paperwork/administration was tedious/too time-consuming
- 2. Easier to sell the jobs without the program
- 3. Customers did not qualify for the program
- 4. Delay in payment
- 5. Lack of communication from CSG (CLEAResult)
- 6. Lack of communication from Ameren Illinois
- 00. Other, specify _____
- 98. Don't Know

OP4. Are there any changes in your company that have occurred as a direct result of your participation in the [IF IQ=1 "Income Qualified Program", IF SP=1 & IQ=1 "Standard or Income Qualified programs"]?

- 1. Yes
- 2. No
- 98. Don't know

[ASK IF OP4=1]

OP5. Could you tell us about these changes? [OPEN END]

- 00. Specify___
- 98. Don't Know

On-Bill Financing

OBF2. Did you know that the Income Qualified Program offers On-Bill Financing for customers?

- 1. Yes
- 2. No

[ASK IF OBF2=1]

OBF3. Have you completed a job that used On-Bill Financing?

- 1. Yes
- 2. No
- 98. Don't know

[ASK IF OBF3 = 2]

OBF4. Why haven't you used On-Bill Financing? Please mark all that apply. [MULTIPLE RESPONSE]

- 1. The application is difficult, too many details required
- 2. The application takes too long to fill out
- 3. The application instructions are not clear
- 4. Customers did not qualify for it
- 5. Customers did not want it
- 6. Do not quite understand how on-bill financing works
- 00. Other, specify: _____
- 98. Don't know

[ASK IF OBF3 = 1]

OBF5. Has On-Bill Financing made it easier to sell jobs to customers?

- 1. Yes
- 2. No
- 98. Don't know

[ASK IF OBF5 = 1]

OBF6. How has it made it easier? [OPEN END]

[ASK IF OBF3=1]

OBF7. How easy or difficult is it to fill out an On-Bill Financing application?

Very Difficult										Very Easy
0	1	2	3	4	5	6	7	8	9	10
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

[ASK IF OBF7<7]

OBF8. What challenges, if any, have you experienced with the application? Please mark all that apply.

[MULTIPLE RESPONSE]

- 1. Too many details required
- 2. Takes too much time
- 3. Difficult to contact Ameren Illinois if I have questions
- 4. Instructions are not clear

- 00. Other, specify: _____
- 98. Don't know

Training and Support

- T1. What training did Ameren Illinois provide to you and/or your company? Trainings can cover topics like on-bill financing application process, eligible equipment etc. Please mark all that apply. [MULTIPLE CHOICE]**
- 1. On the application process
 - 2. On marketing materials available
 - 3. On eligible equipment
 - 4. To help develop marketing materials
 - 5. Sales training for On-Bill Financing
 - 6. Best practices for On-Bill Financing sales
 - 7. BPI certification opportunities
 - 8. More professional certification opportunities in general
 - 9. I opted out of receiving training [SKIP TO T5]
 - 10. I did not receive any training [SKIP TO T5]
 - 00. Other, specify: _____
 - 98. Don't know

[ASK IF ANY T1 (1-00) = "YES"]

- T2. How did Ameren Illinois train you and/or your company? Please mark all that apply. [MULTIPLE CHOICE]**
- 1. One on one meeting
 - 2. Industry or other group meetings
 - 3. Workshop
 - 4. Brochures and other handouts
 - 5. Website
 - 6. Through the Trade Ally Coordinators
 - 00. Other, specify: _____
 - 98. Don't know

T3. How would you rate your satisfaction with the overall training you received?

Very Dissatisfied									Very Satisfied	
0	1	2	3	4	5	6	7	8	9	10
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

[ASK IF T3 <7]

- T4. How can they improve their training? [OPEN END]**
- 00. Specify: _____
 - 96. Nothing/no changes
 - 98. Don't know
- T5. What technical support did Ameren Illinois provide to you and/or your company? Please mark all that apply. [MULTIPLE CHOICE]**
- 1. Sales leads
 - 2. Support filling out forms
 - 3. Accompany on sales calls

- 4. Answered questions on eligible/qualified measures
- 5. Answered questions on application process
- 6. I opted out of receiving any support [SKIP TO M1]
- 7. I did not receive any support [SKIP TO M1]
- 00. Other, specify: _____
- 98. Don't know

[ASK IF ANY T5 (1-00) = "YES"]

T6. How would you rate your satisfaction with the overall technical support that you received?

Very Dissatisfied										Very Satisfied
0	1	2	3	4	5	6	7	8	9	10
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

[ASK IF T6 <7]

- T7. How can they improve their technical support? [OPEN END]
 - 00. Specify: _____
 - 96. Nothing/no changes
 - 98. Don't know

Marketing

- M1. How do your program customers find out about you? Please mark all that apply. [MULTIPLE CHOICE]
 - 1. Ameren Illinois provides me with customer leads
 - 2. Ameren Illinois' website
 - 3. Our company's own marketing
 - 4. Referral from another contractor
 - 5. Past relationship with customer/existing customer
 - 00. Other, specify _____
 - 98. Don't know

- M2. Do you do any marketing or outreach specifically for the [IF IQ=1 "Income Qualified Program", IF SP=1 & IQ=1 "Standard or Income Qualified programs"]?
 - 1. Yes
 - 2. No
 - 98. Don't know

[ASK IF M2=2]

M3. Why not? [OPEN END]

[ASK IF M2=1]

M4. What marketing or outreach do you do? [OPEN END]

- M6. Which marketing tactics are most effective in encouraging customer participation? Please mark all that apply. [MULTIPLE RESPONSE]
 - 1. Company brochures and printed information
 - 2. My company website
 - 3. Ameren Illinois' website
 - 4. Events/workshops

- 5. TV or Radio Advertisements
- 6. Word of mouth
- 7. Direct mail
- 8. Cross-selling
- 9. Cold-calling
- 10. Emailing customers
- 00. Other, specify: _____
- 98. Don't know

M7. Do you think the level of marketing and promotion that Ameren Illinois conducts is appropriate?

- 1. Yes
- 2. No
- 98. Don't know

M8. Is there anything that Ameren Illinois could do to help you be more effective in promoting the program to your customers? [OPEN END]

- 00. Specify _____
- 96. None – current materials are enough
- 98. Don't know

Satisfaction

SA1. How satisfied are you with the following: [ROTATE]

- A. Your interactions with CSG (CLEAResult)
- B. Assistance in completing required paperwork
- C. On-Bill Financing
- D. Payment time from Ameren Illinois upon project completion
- F. The Income Qualified program overall [ANCHOR LAST]

Very Dissatisfied					Very Satisfied					
0	1	2	3	4	5	6	7	8	9	10
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

SA2. Did the [IF IQ=1 “Income Qualified Program”, IF SP=1 & IQ=1 “Standard or Income Qualified programs”] have a positive, negative, or no effect at all on your business since you started participating?

- 1. Positive
- 2. No affect at all
- 3. Negative
- 98. Don't know

SA6. Do you have any suggestions on ways to improve the [IF IQ=1 “Income Qualified Program”, IF SP=1 & IQ=1 “Standard or Income Qualified programs”]? [OPEN END]

- 00. Specify: _____
- 96. No suggestions
- 98. Don't Know

Firmographics

We just have some last few questions about the size and type of your company.

- F1. Please select the business categories below that describe your company. [MULTIPLE RESPONSE]**
- 1. Contractor - Air Sealing**
 - 2. Contractor - HVAC**
 - 3. Contractor - Energy Audits**
 - 4. Contractor – Other**
 - 5. Energy Consultant**
 - 6. Manufacturer’s Rep**
 - 7. Equipment Supplier**
 - 8. Engineer [ANCHOR AS LAST BEFORE OTHER SPECIFY]**
 - 00. Other. specify____ [ANCHOR LAST]**
- F3. Approximately, how many employees does your company have? [OPEN END]**
- F4. Approximately, how many jobs does your company complete in a year? [OPEN END]**

D. APPENDIX – SURVEY RESPONSE RATE METHODOLOGY

The survey response rate is the number of completed interviews divided by the total number of potentially eligible respondents. We calculated the response rate (Response Rate 3 (RR3)) using the standards and formulas set forth by the American Association for Public Opinion Research (AAPOR).¹⁵ The formulas used to calculate RR3 are presented below. The definitions of the letters used in the formulas are displayed in the Survey Disposition table. The response rate for this survey was 38%.

$$RR3 = \frac{I}{(I + R + P + NC) + (E * U)}$$

We also calculated a cooperation rate, which is the number of completed interviews divided by the total number of eligible trade allies actually contacted. In essence, the cooperation rate gives the percentage of participants who completed an interview out of all of the participants with whom we actually spoke. The cooperation rate for this survey was 85%. We used AAPOR Cooperation Rate 3 (COOP3), calculated as:

$$COOP3 = \frac{I}{(I + P) + R}$$

¹⁵ *Standard Definitions: Final Dispositions of Case Codes and Outcome Rates for Surveys*, AAPOR, 2011. http://www.aapor.org/AM/Template.cfm?Section=Standard_Definitions2&Template=/CM/ContentDisplay.cfm&ContentID=3156

E. APPENDIX – COST-EFFECTIVENESS INPUTS

Table 78 presents total gross impacts for AIC cost-effectiveness calculations. These values differ from those included in the main report due to the inclusion of heating penalties for lighting measures and the reduction in waste heat for EC motors. This approach was taken based on discussions with AIC and past agreements between AIC and ICC staff that heating penalties would not be included in savings calculations for goal attainment. Overall, total gross program savings reduced by 0.2% for kWh and 1.4% for therms after the application of waste heat factors.

Table 78. PY7 Income Qualified Gross Impacts (Including Heating Penalties)

	kWh	kW	Therms
Gross Savings	873,194	522	210,250
Lighting Heating Penalty	- 1,520	0	- 1,171
ECM Furnace Fan Heating Penalty	0	0	- 1,740
Total Gross Savings with Heating Penalty	871,674	522	207,338

Lighting Heating Penalty

The inclusion of waste heat factors for lighting is based on the concept that heating loads are increased to supplement the reduction in heat that was once provided by the existing lamp type. We applied the heating penalty to 1,519 lamps based on the specific heating fuel type and installed lamp type. The heating fuel type is known for 89% (1,356 lamps) of the installed lighting measures. For the remaining 163 lamps with unknown space heating fuel types, we applied waste heat factors based on the percentage of installed lighting measures where heating fuel types are known. Therefore, four lamps (2.6%) were applied waste heat factors for electric resistance heating, 10 lamps (6.1%) were applied waste heat factors for heat pumps, and 149 lamps (91.3%) were applied waste heat factors for gas heating. Table 79 summarizes the percentages for lighting measures with known heating fuel types.

Table 79. PY7 Income Qualified Known Heating Fuel Type for Lighting Measures

Heating Fuel	Heating Equipment	% of Heating Fuel Type Known
Electric	Electric Resistance	2.6%
Electric	Heat Pump	6.1%
Gas	Furnace/Boiler	91.3%

The total heating penalty for lighting measures is 1,520 kWh and 1,171 therms.

EC Motor Heating Penalty

High efficiency EC motors operate at cooler temperatures than traditional furnace blower motors. The amount of heat released decreases due to cooler operating conditions. Heating equipment must make up for this loss of heat during the heating season resulting in an increase in HVAC heating loads (negative therm savings). We applied the heating penalty to all 122 EC motors incented within the program for a total heating penalty of 1,740 therms.

The evaluation team will provide AIC with measure specific gross impacts that include waste heat factors as part of the provision of inputs for cost effectiveness calculations.

For more information, please contact:

**Hannah Arnold
Senior Project Manager**

**510 444 5050 tel
510 444 5222 fax
harnold@opiniondynamics.com**

**1999 Harrison Street, Suite 1420
Oakland, CA 94612**



Boston | Headquarters

617 492 1400 tel
617 497 7944 fax
800 966 1254 toll free

1000 Winter St
Waltham, MA 02451

San Francisco Bay

510 444 5050 tel
510 444 5222 fax

1999 Harrison St
Suite 1420
Oakland, CA 94612

Madison, WI

608 819 8828 tel
608 819 8825 fax

2979 Triverton Pike
Suite 102
Fitchburg, WI 53711

Orem, UT

510 444 5050 tel
510 444 5222 fax

206 North Orem Blvd
Orem, UT 84057