Impact and Process Evaluation of the 2012 (PY5) Ameren Illinois Company Residential Multifamily Program

Draft

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1. EXECUTIVE SUMMARY

This report presents results from the evaluation of the fifth program year (PY5) (June 2012 and ended in May 2013) of the Ameren Illinois Company's (AIC) Multifamily Program. AIC offers the Multifamily Program to owners and managers of residential properties with three or more units in its service territory. The program consists of three different components:

- The In-Unit Direct Install Component, which offers free compact fluorescent light bulbs (CFLs), faucet aerators, low-flow showerheads, programmable thermostats, and water heater setbacks for in-unit installation. The program implementer has staff who install the measures offered through this component.
- The Common Area Lighting Component, which provides rebates for lighting fixture upgrades, CFLs to replace incandescent bulbs, and no-cost occupancy sensors and LED exit signs. Property managers can install rebated measures in this component using their own staff or an independent contractor, and must then apply for rebates.
- The Major Measures Component, which offers incentives for air sealing, attic and wall insulation, and programmable thermostats. Participating contractors perform the bulk of the marketing and all of the installations for this component. This component also offers training for participating contractors.

Conservation Services Group (CSG) implements the Multifamily Program, which launched in November 2008. The expected annual savings from this program were 2% of the overall portfolio of electric savings and 7% of portfolio therm savings (including both residential and commercial).

To support the evaluation, we conducted in-depth interviews with program staff and contractors. In addition, we applied 2012 Illinois Statewide Technical Reference Manual (2012 TRM)[1] savings calculations to the database to obtain gross impacts, conducted a property manager survey to collect net-to-gross ratio (NTGR) information for the Major Measures and Common Area Lighting Components, and conducted site visits to verify measure installation for the In-Unit Direct Install Component.

1.1 IMPACT RESULTS

The evaluation team applied savings algorithms from the 2012 TRM, and applied measure-level NTGRs to the program-tracking database to determine PY5 net savings. The PY5 Multifamily Program achieved net realization rates of 0.89 for electric savings, 0.79 for demand savings, and 0.55 for gas savings.

Table 1. Multifamily Net Impacts by Program Component

Component	*Ex Ante* Net Impacts			*Ex Post* Net Impacts			Net Realization Rate		
	MWh	MW	Therms	MWh	MW	Therms	MWh	MW	Therms
In-Unit Direct Install	8,387.85	0.70	87,951	7,949	0.79	79,466	0.95	1.13	0.90

[1] State of Illinois Energy Efficiency Technical Reference Manual, Final as of September 14, 2012.

Component	*Ex Ante* Net Impacts			*Ex Post* Net Impacts			Net Realization Rate		
	MWh	MW	Therms	MWh	MW	Therms	MWh	MW	Therms
Common Area Lighting	400.86	0.08	--	448	0.06	--	1.12	0.75	n/a
Major Measures	6,832.98	3.05	120,148	5,535	2.18	34,388	0.81	0.71	0.29
Total	15,621.69	3.83	222,456	13,932	3.03	113,854	0.89	0.79	0.55

1.2 PROCESS RESULTS

Although the program was performing strongly in PY5, partway through the year AIC made a portfolio-level decision to shift funds for gas measures from the Multifamily Program to the Home Energy Performance (HEP) Program, which had run out of funds. This fund-shifting limited the total number of measures that AIC was able to install through the Multifamily Program in PY5. However, participants and contractors are satisfied with the program overall. In particular, contractors report that the program is having a positive effect on their business, and that the trainings offered by the program are useful.

The program staff also made several changes to the program design in PY5. First, the program hired staff to perform direct installs of faucet aerators, showerheads, and CFL bulbs. Previously, the program would rely on the multifamily buildings' maintenance staff to install these measures, and would then follow-up with a quality assurance check. The motivation behind this change was to increase participation in the program and ensure that a greater percentage of distributed measures ended up installed in tenant units. The results of our evaluation suggest that this was a beneficial change, as the number of measures installed in the In-unit component increased by 88% over PY4, and our on-site efforts showed that installation rates ranged from 97% to 99%. The program also decided to offer exit signs and occupancy sensors as direct install measures, as opposed to offering a rebate on them.

Managing the flow of work, especially in the Major Measures Component, continued to be a challenge for the program in PY5. Program staff indicated that some contractors do such a high volume of work that it can be difficult to monitor program spending. Contractors also felt that they could not accurately gauge when program funds would run out, and were therefore somewhat hesitant to recruit new participants. The shifting of funds to the HEP Program likely exacerbated this issue.

1.3 RECOMMENDATIONS

Key recommendations for the program include the following:

- **Make contractors aware of projected program funding.** The gas side of the program ran out of funds before the end of the year and stopped accepting participants. Contractors are reluctant to promote the program to their customers when they are unsure whether program funds will be available at the time their project is completed. Communicating expected availability of incentives may help alleviate contractors' concerns and allow them to manage customer expectations.

- **Involve contractors who participate in the Major Measures Component in the marketing of the other two components.** Contractors conduct a lot of marketing and networking to recruit participants into the Major Measures Component, and could be a resource for the program if they have marketing materials and information on the other two components as well. If the program plans to use the leads they generate in the Major Measures Component to recruit for other components, AIC should make the contractors aware of that to avoid confusion.

- **To improve the evaluability of the program, track property manager contact information instead of or along with tenant contact information in the tracking database.** The evaluation team found in several cases, especially in the Major Measures Component, that participation and participant contact information were tracked at the tenant level. Ensuring that property manager contact information is tracked in the database would allow for a more accurate understanding of participation counts, as well as cross-participation among program components. It would also facilitate contacting decision makers (i.e., property managers) for data collection efforts.

2. INTRODUCTION

This report presents results from the evaluation of the AIC Residential Multifamily Program. The Multifamily Program launched in November 2008, and is implemented by CSG. This evaluation reviews the program's performance in Program Year 5 (PY5), which began in June 2012 and ended in May 2013.

AIC offers the Multifamily Program to owners or managers of residential properties with three or more units in its service territory. The program consists of three different components:

- The In-Unit Direct Install Component, which offers free compact fluorescent light bulbs (CFLs), faucet aerators, low-flow showerheads, programmable thermostats, and water heater setbacks for in-unit installation. The program implementer has staff who install the measures offered through this component.
- The Common Area Lighting Component, which provides rebates for lighting fixture upgrades, CFLs to replace incandescent bulbs, and no-cost occupancy sensors and LED exit signs. Property managers can install rebated measures in this component using their own staff or an independent contractor, and must then apply for rebates.
- The Major Measures Component, which offers incentives for air sealing, attic and wall insulation, and programmable thermostats. Participating contractors perform the bulk of the marketing and all of the installations for this component. This component also offers training for participating contractors.

To support the evaluation, we conducted in-depth interviews with program staff and contractors; applied 2012 TRM savings calculations to the database to obtain gross impacts; conducted a property manager survey to collect net-to-gross ratio (NTGR) information for the Major Measures and Common Area Lighting Components; and conducted site visits to verify measure installation for the In-Unit Direct Install Component.

3. EVALUATION METHODS

3.1 DATA SOURCES AND ANALYTICAL METHODS

The PY5 assessment of the Multifamily Program included both process and impact analyses. Table 2 below summarizes the activities performed by the evaluation team in support of the PY5 evaluation.

Table 2. Summary of Evaluation Methods

Task	PY5 Impact	PY5 Process	Forward Looking	Details
Program Staff In-Depth Interviews		√		Telephone interviews with AIC and CSG program managers (n=2)
Database Review and Analysis	√			Review database for errors and quality. Obtain verified participation values.
Property Manager Survey	√	√	√	Telephone interviews with property managers who participated in the Common Area Lighting or Major Measures Components (n=25)
Contractor Interviews		√		Telephone interviews with participating contractors (n=3)
Onsite Verification			√	On-site visits to verify installation of In-Unit Direct Install Component measures (n=106 units, 6 properties)
Obtain Gross and Net Impacts	√			Apply savings values based on the Illinois TRM and NTGRs from the PY5 property manager survey to Major Measures Component measures, a deemed NTGR of 0.8 to Common Area Lighting Component measures, and a deemed NTGR of 1.00 to In-Unit Direct Install Component measures

3.1.1 PROCESS ANALYSIS

In PY5, process evaluation efforts focused on understanding any changes made to the program, and collecting data on participant and contractor satisfaction and recommendations for improvement.

Program Staff In-Depth Interviews

The evaluation team reviewed program materials and performed in-depth interviews with both AIC and CSG program managers in June 2013 (n=2). Topics included program goals and objectives, marketing and outreach, trade allies, and program design changes in PY5. Discussions also included upcoming program changes in PY6.

Contractor Interviews

The evaluation team conducted interviews with three of the eight contractors who had participated in the Multifamily Program's Major Measures Component in PY5. The three contractors we spoke to

represented more than 90% of all buildings that participated in the Major Measures Component. The interviews collected information on the program processes and trade ally customer engagement, and explored additional ways for the program to work with trade allies.

Property Manager Survey

The evaluation team conducted a survey with 25 property managers who participated in either the Major Measures Component or the Common Area Lighting Component in PY5. The goal of this survey was to verify measure installation and estimate NTGR, as well as to collect information about satisfaction and identify potential areas of improvement for the program.

3.1.2 Impact Analysis

In PY5, the impact evaluation efforts focused on updating the program's NTGR for the Major Measures and Common Area Lighting Components, verifying installation rates and applying savings algorithms.

Gross Impacts

The evaluation team reviewed the program's tracking database for errors and data quality to determine gross impacts. To calculate gross impacts, we applied savings algorithms from the 2012 Illinois Statewide Technical Reference Manual (2012 TRM)[2] to the information in the program-tracking database. The algorithms used to calculated all evaluated program saving are outlined in B, along with all input variables.

Based on our understanding of the agreement between the ICC and AIC to not count heating penalties in impacts toward goals, interactive effects were not included in *ex post* savings calculations. We provide impacts, including heating penalties, in Appendix C for use in cost-effectiveness calculations.

Installation Rate Factor

The installation rate obtained from PY5 data collection and subsequent analysis is for future planning purposes only. A full description of the installation rate methodology is included in Appendix A.

Net Impacts

We define gross impacts as the change in energy (or demand) consumption that results directly from program-related actions taken by program participants, in this case property managers, regardless of why those actions were taken. We define net impacts as the impacts (i.e., changes in consumption) that can be attributed to the program. Net impacts may be lower than total program gross impacts due to energy savings that would have occurred in the absence of the program (free riders). Conversely, the net impacts may be higher than total program gross impacts due to energy impacts that occurred because of the program, but were not incented by the program (spillover).

[2] State of Illinois Energy Efficiency Technical Reference Manual, Final as of September 14, 2012.

Attribution comprises these two concepts—free ridership (FR) and spillover (SO)—and is indicated as an NTGR. The NTGR is calculated as (1-FR + SO).

Free riders are program participants who would have implemented the program's energy-efficient measure(s) even without the program. These estimates are based on a series of questions in the telephone survey that explored the influence of the program in making the energy-efficient improvements, as well as likely actions had the program not been available.

Data Sources for Net-to-Gross Ratios

For In-Unit Direct Install Component measures, we used the PY3 NTGR of 1.00, which was determined through primary research conducted in PY2. For the Major Measures Component, we calculated PY5 NTGRs using self-report data from the property manager survey. In the case of programmable thermostats, we ultimately did not have sufficient data to calculate an NTGR, and used a deemed value of 1.00. The PY5 NTGR was applied retrospectively because this program component's attribution had never been assessed through primary research. The Major Measures Component PY5 NTGR achieved 10% precision at 90% confidence.

Although we conducted research to develop a NTGR for the Common Area Lighting Component in PY5, this value will be applied prospectively. As a result, for PY5 net impacts the team applied a Common Area Lighting Component NTGR of 0.80 based on primary research conducted in PY3. We present the NTGR that resulted from this year's primary research in Appendix B.

Table 3. Net-to-Gross Ratio Sources

Component	Measure	NTGR	Source
In-Unit Direct Install	CFL (15, 20, 23 Watt)	1.00	PY3 Evaluation
In-Unit Direct Install	Faucet Aerator	1.00	PY3 Evaluation
In-Unit Direct Install	Showerhead	1.00	PY3 Evaluation
In-Unit Direct Install	Water Temp Setback	1.00	PY3 Evaluation
Common Area Lighting	CFL (14, 20, 23 Watt)	0.80	PY3 Evaluation
Common Area Lighting	Modular CFL (<=18 watts, pin-based electronic ballast fixture)	0.80	PY3 Evaluation
Common Area Lighting	Modular CFL Exterior	0.80	PY3 Evaluation
Common Area Lighting	LED Exit Sign	0.80	PY3 Evaluation
Common Area Lighting	Occupancy Sensors	0.80	PY3 Evaluation
In-Unit Direct Install & Major Measures	Programmable Thermostat	1.00	PY3 Evaluation
Major Measures	Insulation	0.89	PY5 Participant Survey
Major Measures	Air Sealing	0.94	PY5 Participant Survey

Free Ridership Battery for Rebated Measures

For each rebated measure included in the survey, we developed a free ridership factor that consists of three scores, as described below. Rebated measures include insulation and air sealing.

- **Overall program influence**. This score reflects the degree of influence the program had on the property manager's decision to install the specified measures. The score is based on two survey questions. The first question asked respondents whether they heard about the program before or after they had measures installed in their building. Hearing about the program after installing measures means the customer is a free rider. The second question asked respondents to rate the likelihood (on a 0-10 scale) that they would have installed the measures at all in the absence of the program. A greater likelihood value means a higher level of free ridership.
- **Influence of program timing**. This score is developed based on two questions: 1) Would the work have been done at the same time without the program? 2) If the work would have been done later, how much later? Later implementation in the absence of the program results in a lower level of free ridership.
- **Influence of program components**. This score is developed based on three factors that might have influenced property managers' decision to install energy efficiency measures. The factors are: 1) availability of the rebate; 2) recommendation from the contractor; and 3) information from AIC. Greater influence of program components results in a lower level of free ridership. Customers who received direct install measures are not asked about the influence of program components.

Each score can take on a value of 0 to 1, where a higher score means a higher level of free ridership. The overall free ridership factor for a project is the average of the three scores. The NTGR is 1-FR for each project, and therefore ranges from 0 (100% free ridership) to 1 (no free ridership). To get further clarity, the NTGR is weighted by the energy savings (of the survey respondents) to get the final NTGR.

In PY5, we did not find any spillover among Multifamily Program participants.

3.2 Sampling and Survey Completes

The evaluation team conducted a quantitative telephone survey with participating property managers. These interviews focused both on satisfaction and NTG. In addition, we conducted onsite visits at participating properties to develop installation rates for the in-unit component of the program.

3.2.1 Telephone Surveys

Property Manager Survey

The evaluation team conducted a survey with 25 property managers who participated in either the Major Measures Component or the Common Area Lighting Component in PY5. According to the program database, in PY5, the program reached 68 unique properties in the Common Area Lighting

Component and 475 unique properties in the Major Measures Component.[3] However, upon closer review, the evaluation team discovered that many of the properties in the Major Measures Component were tracked at the tenant level, which resulted in a much higher participant count than expected. Upon request, CSG provided a secondary contact list that included contact information for property managers. After merging the tracking database with a list of property management contacts provided by the implementation team, we were able to determine that 64 unique property managers participated in the Major Measures Component in PY5.

Many property management companies managed multiple properties, and some property owners had multiple properties participate in the program. As such, we did not base our sample on the number of unique sites, but rather on the 119 property managers that represented all projects across the participating properties in the Major Measures and Common Area Lighting Components. Given the relatively small number of potential respondents, we used a census sampling approach.

The number of respondents by program component is shown in Table 4 below. The goal of this survey was to verify measure installation and estimate NTGR, as well as to collect information about satisfaction and identify potential areas of improvement for the program.

Table 4. Participant Survey Respondents by Component

Component	Number of Respondents	Number of Participants PY5
Common Area Lighting	11	68
Major Measures	14	64
Total	**25**	**119**

Note: Thirteen (13) properties participated in both the Common Area Lighting and Major Measures Components.

The survey respondents account for almost 29% of Common Area Lighting Component electric savings, 40% of Major Measures Component electric savings, and 25% of Major Measures Component gas savings. The specific representations of savings by measure are included in Table 5.

Table 5. Savings Represented in Participant Survey

Measure	Population Savings		Savings Represented in Participant Survey		% of Population Savings Represented in Survey	
	(kwh)	(therms)	(kwh)	(therms)	(kwh)	(therms)
Common Area Lighting						
Occupancy sensors	2,746	-	785	-	29%	-
LED exit signs	58,555	-	13,485	-	23%	-
CFL (interior) total	328,844	-	47,654	-	14%	-

[3] Unique properties were determined by the variable "siteid".

Measure	Population Savings		Savings Represented in Participant Survey		% of Population Savings Represented in Survey	
Mod CFL (exterior)	10,962	-	-	-	0%	-
Total	**401,107**	**-**	**61,924**	**-**	**29%**	**-**
Major Measures						
Insulation	1,448,391	29,638	575,132	7,353	40%	25%
Air sealing	5,439,344	87,374	2,606,959	17,682	48%	20%
Thermostats	77,138	15,412	-	1,641	0%	11%
Total	6,964,873	132,424	6,964,873	132,424	**40%**	**25%**

Survey Dispositions and Response Rate

We completed 25 interviews with participants in the Multifamily Program. We conducted the survey from August 28 through September 11, 2013. Table 6 shows the final survey dispositions.

Table 6. Property Manager Survey Dispositions

Disposition	N
Completed Interviews (I)	25
Partial Interviews (P)	0
Eligible Non-Interviews	57
Refusals (R)	27
Mid-Interview Terminate (R)	6
Respondent Never Available (NC)	24
Not Eligible (e)	32
Fax/Data Line	2
Non-Working/Disconnect	12
Wrong Number	16
No Eligible Respondent	2
Unknown Eligibility Non-Interview (U)	5
No Answer	3
Always Busy	1
Call Blocking	1
Total Participants in Sample	**119**

The survey response rate is the number of completed interviews divided by the total number of potentially eligible respondents in the sample. We calculated the response rate using the standards

and formulas set forth by AAPOR.[4] As we were unable to reach all potential respondents by phone, we were unable to determine the eligibility of all sample units through the survey process, and chose to use AAPOR Response Rate 3 (RR3). RR3 includes an estimate of eligibility for these unknown sample units. Below, we present the formulas used to calculate RR3. Table 6 above displays the definitions of the letters used in the formulas.

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

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

We also calculated a cooperation rate, which is the number of completed interviews divided by the total number of eligible sample units actually contacted. In essence, the cooperation rate provides the percentage of participants who completed an interview out of all the participants with whom we actually spoke. We used AAPOR Cooperation Rate 3 (COOP3), for which we show the formula below. Table 6 above displays the definitions of the letters used in the formulas.

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

Table 7 below lists both the response rate and cooperation rate we derived using the formulas described above. Although the response rate for this survey is very high relative to other similar survey efforts, this figure does not include the high number of ineligible respondents in the population (32 respondents). Generally, we found the high rate of ineligible respondents to be a result of tenant contact information in the tracking database, as opposed to property manager contact information.

Table 7. Property Manager Survey Response and Cooperation Rate

Property Manager Survey	Percentage
Response Rate	29%
Cooperation Rate	43%

The tracked characteristics of non-respondents, number of units and energy savings, do not differ significantly from those of the respondents, which indicates that there is not likely to be a significant non-response bias in our results.

3.2.2 Onsite Verification

The evaluation team conducted site visits at properties that participated in the In-Unit Direct Install Component of the AIC Multifamily Program in PY5. The goal of these site visits was to gather data necessary for the development of an installation rate factor for in-unit measures.

The team worked with property managers at each property to inform them of the study; gained their approval to conduct the on-site work; notified the tenants in advance of entry; scheduled the

[4] *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.

day/time for on-site verification; and identified an on-site contact to help us enter tenant units. We compensated property managers with a $50 incentive for their assistance with this study.

Based on experience conducting site visits for other multifamily programs, the evaluation team knew that it would be challenging to get property managers to participate in the study. As a result, we made a census attempt, calling all 149 properties in the sample frame and visiting as many sites as possible within that group. Ultimately, we were able to recruit six properties for the study. At each site, we randomly selected between four and 29 units for verification, depending on the property size and property manager/unit accessibility.

Table 8 shows the total number of sites and units in the population, and the total number we were able to visit and verify.

Table 8. Multifamily Program Site Visit Sample Design

Multifamily Program	PY5 Population	Completed Visits
Properties	149	6
Tenant Units	9,963	106

4. RESULTS AND FINDINGS

4.1 PROCESS FINDINGS

The evaluation team reviewed program materials and performed in-depth interviews with both AIC and CSG program managers in June and July of 2012. Topics included program goals and objectives, marketing and outreach, participating trade allies, program design changes, and how recommendations from previous evaluations were addressed. Upcoming program changes in PY5 were also discussed.

Program Changes

A major change for the program in PY5 was that CSG hired staff to perform direct installs of faucet aerators, showerheads, and CFL bulbs. Previously, the program would rely on the multifamily buildings' maintenance staff to install these measures, and would then follow-up with a quality assurance check. While the original reason for this change was to increase participation in the program, the change had other benefits as well. By using program staff to install certain measures, the program is able to have greater control over its inventory of those measures. In theory, a greater number of the measures distributed should end up installed in the participating buildings. The results of our on-site verification efforts for In-Unit Direct Install Component measures support this theory—the installation rate for direct installed measures ranges from 97% to 99%.

Program staff also decided in PY5 to give exit signs and occupancy sensors to property managers to install themselves, as opposed to offering a rebate for those measures. Again, the motivation behind this change was to increase participation by eliminating the need for the participating property manager to purchase the equipment and fill out a rebate form. This also ensured that the exit sign and occupancy sensors would fall within program requirements, which was not always the case when property managers had to purchase equipment themselves.

Training

The program had two training classes in PY5 for the Major Measures Component. These classes provided an overall building science training, with an emphasis on testing air sealing and the proper installation of insulation.

Challenges

According to program staff, one of the greatest challenges they face is managing the volume of work. Some contractors move projects through the Major Measures Component so quickly that it can be difficult to monitor program spending and ensure that the program does not run over budget.

4.1.1 MARKETING AND OUTREACH

Program marketing and outreach in PY5 was similar to PY4. Most outreach consisted of calls by account managers to property owners or managers, and walk-through audits or site visits to discuss program offerings and identify potential audit recommendations.

In an effort to encourage participation, program staff developed a sample box that contained all of the direct install measures offered through the program. The sample boxes were distributed at trade

shows and directly to potential participants through property visits. Program staff also increased their efforts to work with relevant industry groups in PY5, by marketing the program at local meetings.

One trade ally performed considerable outreach to multifamily properties and performed the majority of Major Measures Component projects. This trade ally also completed the majority of Major Measures Component projects in PY4.

4.1.2 Contractor Interview Findings

The evaluation team interviewed three of the eight contractors who participated in the Major Measures Component in PY5. We asked contractors about their experience with the program, and for recommendations for program improvement.

The contractors all reported that the Multifamily Program is having a significant effect on their business. Two of the three contractors reported that they have increased the size of their staff as a direct result of the Multifamily Program. One contractor explained that the incentives are "90% of the sale of the measures." Furthermore, all contractors reported that the property managers they work with are very satisfied with the program.

The contractors all reported having positive experiences with program staff. They found them to be very helpful in completing applications, and thought that the application review process was very thorough.

The main source of contractor dissatisfaction was that the program ran out of funds before the end of the program year. All of the contractors had already scheduled work before learning that the program had run out of funds. The ways that the contractors handled this situation varied. Two contractors canceled the work that they had scheduled. The third didn't want to risk creating dissatisfied customers, so they went ahead with the work as planned but paid the incentives out of their own pockets. One contractor also expressed frustration that he had invested time into learning about the program but then was only able to complete a very small number of projects before the funding ran out.

Despite the issue of the program closing early in the program year, contractors are generally satisfied with the program. When asked to rate their satisfaction with the program on a scale from 0 to 10, where 0 is very dissatisfied and 10 is very satisfied, the contractors rated the program a 7.0 on average. When asked to rate the ease of participating in the program on a scale from 0 to 10, where 0 is very difficult and 10 is very easy, the contractors rated it a 9.3 on average.

Overall, contractors felt that the amount of information required by the applications was substantial and slowed their ability to get projects completed. However, they also acknowledged that most of that information was probably essential, and didn't offer many suggestions for how to improve the process. The one exception is the tracking down of account numbers. One contractor who did a large volume of work indicated that it was difficult to get the correct account numbers for the high number of properties they worked on.

All of the contractors we interviewed had attended and/or sent their employees to attend the training sessions offered by the program. They reported that the training was very helpful to their businesses and alleviated some of the burden involved in training employees.

The contractors offered a few suggestions on areas of training that they would find useful, which included combustible safety testing and specialized blower door training. The contractors also

requested training on topics that are specific to multifamily properties. They explained that while other good training exists, such as the training offered by BPI, it usually focuses on single-family style housing. If the training offered by the Multifamily Program highlighted topics that pertain to multifamily buildings in particular, they would be filling a "training gap" that exists in the market.

One contractor requested that the program communicate to him ahead of time if they plan to use the lead he generated for the Major Measures Component to market the other components of the program. He experienced some confusion among his customers when program staff contacted them about other program components, while they were still in communication with him about the Major Measures Component. If he had known ahead of time, he could have prepared his customers for that, and mentioned that he was even willing to help with marketing the other components.

4.1.3 Participant Survey Findings

The participant survey was fielded to 25 property managers who participated in the Common Area Lighting Component or the Major Measures Component.

Participants were generally satisfied with the program and AIC Global. On a scale from 0 to 10, where 0 is very dissatisfied and 10 is very satisfied, participants gave the program overall a mean satisfaction score of 7.9. They also gave AIC a mean satisfaction score of 7.9. Participants also indicated their satisfaction with several aspects of the Common Area Lighting Component. All satisfaction scores are presented in Table 9.

Table 9. Participant Satisfaction

Multifamily Program Participant	Dissatisfied (0-3)	Neutral (4-6)	Satisfied (7-10)	Mean
Time it took to receive Common Area Lighting measures (n=10)	10%	0%	90%	8.6
The Common Area Lighting Application (n=9)	11%	0%	89%	8.2
Common Area Measures (n=10)	10%	0%	90%	8.1
Program Overall (n=25)	8%	8%	84%	7.9
AIC (n=25)	8%	8%	84%	7.9

The greatest motivator for property managers to participate in this program was to save money (reported by 72% of respondents), while 20% indicated that they participated to attract new tenants or help out existing tenants, 16% participated to save energy, and 12% participated for the cash incentive or the tax write-off.

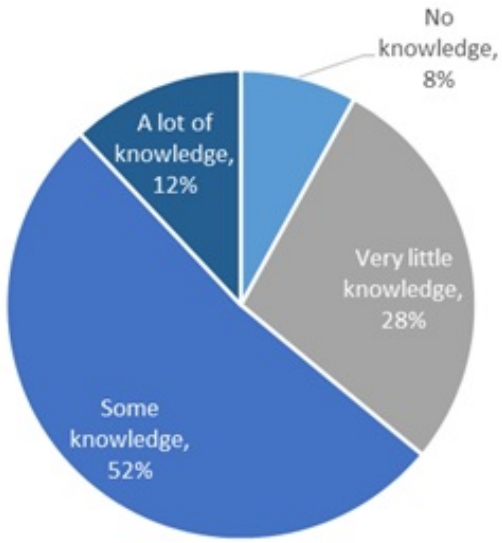
Just over half of the participants (52%) reported that they learned about the program through a phone call from program staff. Other ways that participants learned about the program include through word of mouth (16%), reading about it in a brochure or flyer (12%), or through email/the Internet (12%). Email was the most common way that participants would like to be informed of energy efficiency programs (reported by 52% of respondents), followed by ads in print media (20%), bill inserts (20%), and phone calls (20%).

When asked how they would typically look for information about ways to save energy, the majority of participants (76%) said they would look on the Internet, including AIC's website. One-fifth of participants (20%) mentioned that they would contact AIC in another way, such as by phone.

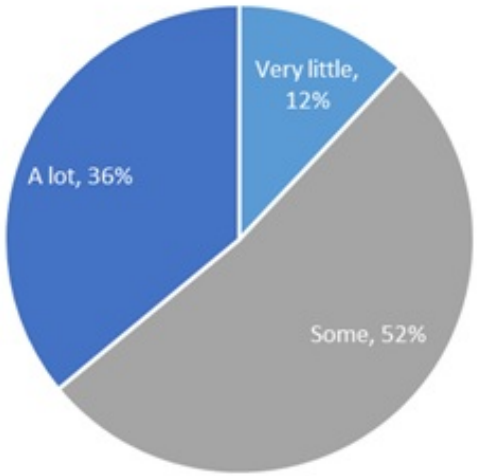
When asked how the program could be improved, 20% of respondents said that they had an issue with the programmable thermostats; some had problems getting them to work properly, and some never received them even though they had been told they would be getting them. Two respondents said that they would have liked the installation team to be more professional.

More than half of the participants report that prior to participating the program, they had "some knowledge of energy efficiency," while 12% report that they knew a lot, and 28% said they had very little knowledge. Participants reported some knowledge gain from participating in the program, with over one-half (52%) saying that they learned "some," and over a third (36%) saying they learned "a lot."

Figure 1. Participant Knowledge of Energy Efficiency before Participating and Reported Knowledge Gain (n=25)



Before you participated in the program, how much knowledge did you have of energy efficiency?



How much did you learn about energy efficiency from the program?

4.2 IMPACT RESULTS

Participation in the program ramped-up in PY5. The total number of measures installed through the program increased 41% to 87% from PY4 to PY5, depending on the component. The In-Unit Direct Install Component had the greatest increase in measures installed, with an 88% increase over the previous year. However, the Common Area Lighting and Major Measures Components also saw significant increases, at 74% and 41%, respectively.

Table 10. Number of Measures Installed in PY4 and PY5

Program Component	Count of Measures (PY4)	Count of Measures (PY5)	Count of Measures (Percent Change)
In-Unit Direct Install Component	60,208	113,107	+88%
Common Area Lighting Component	1,300	2,268	+74%
Major Measures Component	1,398	1,975	+41%

The following sections provide gross and net impacts for the Multifamily Program in PY5.

4.2.1 Gross Impacts

The evaluation team applied deemed savings values to the verified number of measures to determine verified gross savings values. As shown in Table 11, in PY5 the program had gross savings of 14,322 MWh, 3.14 MW, and 122,365 therms.

Table 11. Gross Impacts by Component

Component	*Ex Ante* Gross Impacts			*Ex Post* Gross Impacts[a]			Gross Realization Rate		
	MWh	MW	Therms	MWh	MW	Therms	MWh	MW	Therms
In-Unit Direct Install Component	8,388	0.70	87,043	7,949	0.79	79,466	0.95	1.13	0.91
Common Area Lighting Component	401	0.08	0	560	0.07	0	1.40	0.88	n/a
Major Measures Component	6,965	2.12	118,067	5,813	2.29	42,899	0.83	1.08	0.36
Total	**15,754**	**2.90**	**205,110**	**14,322**	**3.15**	**122,365**	**0.91**	**1.09**	**0.60**

[a] *Ex post* gross impacts are based on the application of deemed fixed savings values to verified participation numbers.

Note: Gross Realization Rate = *ex post* gross value / *ex ante* gross value

Table 12 below shows the per-unit savings values used to calculate program-level savings. Per-unit values were calculated using the algorithms presented in the 2012 TRM. Where indicated, savings were calculated individually for each participant, as opposed to on a per-unit basis.

Table 12. Multifamily Program PY5 *Ex Post* Per-Unit Savings Values

Component	Measure	Per-Unit kWh Savings	Per-Unit kW Savings	Per-Unit Therm Savings
In-Unit Direct Install	15-Watt CFL	42.54	0.0044	0
In-Unit Direct Install	20-Watt CFL	51.99	0.0054	0
In-Unit Direct Install	23-Watt CFL	72.79	0.0076	0
Common Area	14-Watt CFL	275.82	0.0358	0

Component	Measure	Per-Unit kWh Savings	Per-Unit kW Savings	Per-Unit Therm Savings
Lighting				
Common Area Lighting	20-Watt CFL	329.79	0.0428	0
Common Area Lighting	23-Watt CFL	461.71	0.0599	0
Common Area Lighting	Modular CFL (≤18 watts, pin-based electronic ballast fixture)	calculated	calculated	calculated
Common Area Lighting	Modular CFL Exterior	calculated	calculated	calculated
Common Area Lighting	LED Exit Sign (DI)	82.05	0.0096	0
Common Area Lighting	LED Exit Sign (rebated)	calculated	calculated	calculated
Common Area Lighting	Occupancy Sensors	1,144.13	0.3297	0
In-Unit Direct Install	Faucet Aerator (gas DWH)	0	0	5.34
In-Unit Direct Install	Faucet Aerator (electric DWH)	106.11	0.0144	0
In-Unit Direct Install	Showerhead (gas DWH)	0	0	15.01
In-Unit Direct Install	Showerhead (electric DWH)	302.58	0.0238	0
In-Unit Direct Install	Water Temp Setback (gas DWH)	0	0	6.40
In-Unit Direct Install	Water Temp Setback (electric DWH)	86.40	0.0099	0
In-Unit Direct Install & Major Measures	Programmable Thermostat	calculated	calculated	calculated
Major Measures	Insulation	calculated	calculated	calculated
Major Measures	Air Sealing	calculated	calculated	calculated

The gross realization rate was .91 for electric savings, 1.08 for demand savings, and 0.60 for therm savings. *Ex post* savings are calculated using inputs and algorithms from the 2012 TRM. CSG provided the evaluation team with documentation of the inputs and algorithms that were used to calculate *ex ante* savings. When possible, we provide explanations for the differences between *ex ante* and *ex post* savings below in Table 13. In some cases, there were discrepancies between the tracked savings and the savings in the input and algorithm documentation provided by the implementation team, which account for additional discrepancy between the *ex ante* and *ex post* savings.

Based on our understanding of the agreement between the ICC and AIC to not count heating penalties in impacts toward goals, interactive effects were not included in *ex post* savings calculations. The interactive effects that could be applied to the Multifamily Program measures are heating penalties for lighting measures, and a penalty for the additional use of a dishwasher internal

water heater for the water heater setback. We will provide impacts, including heating penalties, in C for use in cost-effectiveness calculations.

Table 13. Multifamily Program PY5 *Ex Ante* and *Ex Post* Gross Savings by Measure

Component	Measure	Count	*Ex Ante* Gross Savings			*Ex Post* Gross Savings			Gross Realization Rates		
			kWh	kW	Therms	kWh	kW	Therms	kWh	kW	Therm
Common Area Lighting	20-Watt CFL	241	29,075	9.87	0	79,479	10.31	0	2.73	1.04	n/a
In-Unit Direct Install	Faucet Aerator	21,371	845,140	114.7	14,198	1,690,365	230	29,054	2.00	2.00	2.05
Common Area Lighting	23-Watt CFL	361	53,240	13.12	0	106,066	14	0	1.99	1.05	n/a
Common Area Lighting	14-Watt CFL	1,222	215,119	42.24	0	337,057	44	0	1.57	1.03	n/a
In-Unit Direct Install	23-Watt CFL	935	43,309	4.49	0	43,308	5	0	1.00	1.01	n/a
Major Measures	Air Sealing	914	5,439,344	1,435	87,374	5,429,891	2,246	34,745	1.00	1.56	0.40
In-Unit Direct Install	Water Temp Setback	19	0	0	122	0	0.00	121.6	n/a	n/a	1.00
Common Area Lighting	LED Exit Sign (rebated)	4	984	0.12	0	984.59712	0.12	0	1.00	0.96	n/a
In-Unit Direct Install	15-Watt CFL	72,872	3,168,475	327.92	0	3,099,796	323	0	0.98	0.99	n/a
In-Unit Direct Install	20-Watt CFL	5,455	288,788	30	0	283,607	30	0	0.98	0.99	n/a
Common Area Lighting	Occupancy Sensors	14	2,746	0.73	0	2,458	0.97	0	0.90	1.33	n/a
In-Unit Direct Install	Showerhead	11,343	3,517,954	226.92	59,274	2,561,978	201	43,169	0.73	0.89	0.73
Common Area Lighting	Modular CFL Exterior	96	10,962	0	0	7,282	0.02	0	0.66	n/a	n/a
Major Measures	Programmable Thermostat	133	77,138.23	0	1,054.8	49,073	0.00	690	0.64	n/a	0.65
In-Unit Direct	Programmable	1,112	524,187	0	13,449	270,409	0.00	7,121	0.52	n/a	0.53

Component	Measure	Count	*Ex Ante* Gross Savings			*Ex Post* Gross Savings			Gross Realization Rates		
Install	Thermostat										
Common Area Lighting	LED Exit Sign (DI)	222	57,571	9.43	0	18,215	2.14	0	0.32	0.23	n/a
Common Area Lighting	Modular CFL	108	31,410	4.06	0	8,340	0.02	0	0.27	0.01	n/a
Major Measures	Insulation	928	1,448,391	683	29,638	334,104	39.46	7,464	0.23	0.06	0.25
Total		**117,350**	**15,753,833**	**2,902**	**205,110**	**14,322,413**	**3,144**	**122,365**	**0.91**	**1.08**	**0.60**

Note: Gross Realization Rate = *ex post* gross value / *ex ante* gross value

Ex post savings are different than *ex ante* for several reasons:

- **Programmable Thermostats:** *Ex ante* programmable thermostat savings are based on Climate Zone 3 (Springfield), whereas *ex post* programmable thermostat savings use participant ZIP codes to determine the climate zone where each participating property is located.
- **Common Area Lighting 20W CFL Bulbs:** *Ex ante* 20W savings are based on a 19W bulb, whereas the measure is labeled in the tracking database as a 20W bulb, so the evaluation team used 20W in the *ex post* calculations.
- **CFL Modular Lighting:** The interior CFL Modular Lighting was installed on porches according to the tracked location field in the database, therefore we calculated the *ex post* impacts for this measure using the exterior modular CFL calculations. Furthermore, the *ex ante* calculations used a base wattage of 80W, whereas the 2012 TRM indicated an assumed base wattage of 60W. The *ex ante* calculations used an installed wattage of 18W, but the assumed value as indicated by the 2012 TRM is 13W.
- **LED Exit Sign:** The installed and base wattage varied, along with the hours of use per year. The *ex post* calculations used 35W as the base wattage and 2W as the installed wattage. The *ex post* calculations were different for direct install exit signs than for rebated exit signs, as more information was tracked in the database for the rebated exit signs. For rebated exit signs, the *ex post* used a base wattage of 30W and an installed wattage of 3W (as indicated in the database). For direct installed exit signs, the base wattage (11W) and the installed wattage (2W) are determined by the assumptions in the 2012 TRM.
- **Occupancy Sensor:** *Ex ante* values assume 0.18 kW controlled wattage and a 41% energy savings factor, while *ex post* values assume .07 kW controlled wattage and a 30% energy saving factor, as stated in the 2012 TRM.
- **Air Sealing:** There were significant differences between the *ex ante* and *ex post* savings for air sealing, which be attributed to the following. The *ex ante* values used for Cooling Degree Days, Heating Degree Days, full load hours, and latent multiplier are based on Climate Zone 3 (Springfield) only, whereas the corresponding values used in the *ex post* calculations use participant ZIP code to determine the climate zone where each participating property is located. The *ex ante* baseline efficiency rating for heating and cooling is a weighted average assuming 90% pre-2006 units and 10% post-2006 units, while the *ex post* baseline efficiency rating is a weighted average assuming 50% pre-2006 units and 50% post-2006 units. The conversion factor value is based on a 1.5-story building height in *ex ante* calculations, and on an average of all building heights provided in the 2012 TRM in *ex post* calculations.
- **Insulation:** The *ex ante* values used for Cooling Degree Days, Heating Degree Days, full load hours, and latent multiplier are based on Climate Zone 3 (Springfield) only, whereas the corresponding values used in the *ex post* calculations use participant ZIP code to determine the climate zone where each participating property is located. The *ex ante* baseline efficiency rating for heating and cooling is a weighted average assuming 90% pre-2006 units and 10% post-2006 units, while the *ex post* baseline efficiency rating is a weighted average assuming 50% pre-2006 units and 50% post-2006 units.
- **Faucet Aerators:** Although the faucet aerators have gross realization rates greater than 2.00 for electric, demand, and gas savings, the evaluation team did not receive documentation of *ex ante* calculations for water heating measures, and therefore we are unable to explain the reason for this discrepancy.

4.2.2 Net Impacts

In PY5, the program achieved net impacts of 13,932 MWh and 113,854 therms resulting in a net realization rate of 0.89 for electric savings, 0.79 for demand savings and 0.55 for gas savings.

Table 14. Multifamily Program Net Impacts by Program Component

Component	*Ex Ante* Net Impacts			*Ex Post* Net Impacts			Net Realization Rate		
	MWh	MW	Therms	MWh	MW	Therms	MWh	MW	Therms
In-Unit Direct Install	8,387.85	.70	87,951	7,949	0.79	79,466	0.95	1.13	0.90
Common Area Lighting	400.86	.08	0	448	0.06	0	1.12	0.75	n/a
Major Measures	6,832.98	3.05	120,148	5,535	2.18	34,388	0.81	0.71	0.29
Total	**15,621.69**	**3.83**	**222,456**	**13,932**	**3.03**	**113,854**	**0.89**	**0.79**	**0.55**

Note: Realization Rate = *ex post* net value / *ex ante* net value

As shown in Table 15, the program a had final overall NTGR of 0.97 for electric savings and 0.93 for demand savings. The In-Unit Direct Install Component and the Common Area Lighting NTGRs were developed based on primary research in PY3. However, the evaluation team calculated the Major Measures NTGR of 0.95 for electric savings and 0.80 gas savings using primary data from the PY5 Property Manager Survey and applied those NTGRs retrospectively.

Table 15. Multifamily Program Net Impacts by Program Component

Component	*Ex Post* Gross Impacts			*Ex Post* NTGR		*Ex Post* Net Impacts		
	MWh	MW	Therms	Elec.	Gas	MWh	MW	Therms
In-Unit Direct Install	7,949	0.79	79,466	1.00	1.00	7,949	0.79	79,466
Common Area Lighting	560	0.07	0	0.80	n/a	448	0.06	0
Major Measures	5,813	2.29	42,899	0.95	0.80	5,535	2.18	34,388
Total	**14,322**	**3.14**	**122,365**	**0.97**	**0.93**	**13,933**	**3.06**	**113,854**

Note: Realization Rate = *ex post* net value / *ex ante* net value

Next, we present detailed net impacts by program component.

For the In-Unit Direct Install Component, the evaluation team calculated net impacts of 7,949,463 kWh and 787.81 kW, resulting in a realization rate of 0.95 for electric savings and 1.12 for demand savings.

Table 16. Multifamily Program In-Unit Component Net Electric Impacts

Measure	*Ex Ante* Gross		*Ex Post* Gross		*Ex Ante* NTGR	*Ex Post* NTGR	*Ex Ante* Net		*Ex Post* Net		Net Realization Rate	
	kWh	kW	kWh	kW			kWh	kW	kWh	kW	kWh	kW
Faucet Aerator	845,140	114.7	1,690,365	229.56	1.00	1.00	845,140	114.7	1,690,365	229.56	2.00	2.00
Showerhead	3,517,954	226.92	2,561,978	201.19	1.00	1.00	3,517,954	226.92	2,561,978	201.19	0.73	1
15W CFL	3,168,475	327.92	3,099,796	323	1.00	1.00	3,168,475	327.92	3,099,796	323.00	0.98	1
20W CFL	288,788	30	283,607	29.55	1.00	1.00	288,788	30	283,607	29.55	0.98	1
23W CFL	43,309	4.49	43,308	4.51	1.00	1.00	43,309	4.49	43,308	4.51	1.00	1
Water Temp Setback	0	0	0	0	1.00	1.00	0	0	0	0.00	n/a	n/a
Programmable Thermostat	524,187.35	0	270,409	0	1.00	1.00	524,187	0	270,409	0.00	0.52	n/a
Total	**8,387,853**	**704.03**	**7,949,463**	**787.81**	**1.00**	**1.00**	**8,387,853**	**704**	**7,949,463**	**787.81**	**0.95**	**1.12**

Note: Realization Rate = *ex post* net value / *ex ante* net value.

The In-Unit Direct Install Component also achieved a realization rate of 0.90 for gas measures, resulting in net therm savings of 79,466.

Table 17. Multifamily Program In-Unit Component Net Gas Impacts

Measure	*Ex Ante* Gross Therms	*Ex Post* Gross Therms	*Ex Ante* NTGR	*Ex Post* NTGR	*Ex Ante* Net Therms	*Ex Post* Net Therms	Net Realization Rate
Faucet Aerator	14,198	29,054	1.00	1.00	14,198	29,054	2.05
Showerhead	59,274	43,169	1.00	1.00	59,274	43,169	0.73
15W CFL	0	0	1.00	1.00	0	0	n/a
20W CFL	0	0	1.00	1.00	0	0	n/a

Measure	*Ex Ante* Gross Therms	*Ex Post* Gross Therms	*Ex Ante* NTGR	*Ex Post* NTGR	*Ex Ante* Net Therms	*Ex Post* Net Therms	Net Realization Rate
23W CFL	0	0	1.00	1.00	0	0	n/a
Water Temp Setback	122	122	1.00	1.00	122	122	1.00
Programmable Thermostat	13,449	7,121	1.00	1.00	14,357	7,121	0.50
Total	**87,043**	**79,466**	**1.00**	**1.00**	**87,951**	**79,466**	**0.90**

Note: Realization Rate = *ex post* net value / *ex ante* net value.

For the Common Area Lighting Component, the evaluation team calculated a realization rate of 1.12 for electric savings, with net kWh savings of 447,906. We found that a different *ex ante* NTGR was used for exterior Modular CFLs in the tracking database (0.98) than the planning value NTGR (1.00).

Table 18. Common Area Lighting Component Net Electric Impacts

Measure	*Ex Ante* Gross		*Ex Post* Gross		*Ex Ante* NTGR	*Ex Post* NTGR	*Ex Ante* Net		*Ex Post* Net		Net Realization Rate	
	kWh	kW	kWh	kW			kWh	kW	kWh	kW	kWh	kW
14W CFL	215,119	42.24	337,057	43.71	1.00	0.80	215,119	42.24	269,646	34.97	1.25	0.83
20W CFL	29,075	9.87	79,479	10.31	1.00	0.80	29,075	9.87	63,583	8.25	2.19	0.84
23W CFL	53,240	13.12	106,066	13.76	1.00	0.80	53,240	13.11	84,853	11.01	1.59	0.84
Modular CFL (<=18 watts, pin based electronic ballast fixture)	31,410	4.06	8,340	0.02	1.00	0.80	31,410	4.06	6,672	0.02	0.21	0.00
Modular CFL Exterior	10,962	0.00	7,282	0.02	0.98	0.80	10,715	0.00	5,826	0.02	0.54	n/a
LED Exit Sign (DI)	57,571	9.43	18,215	2.14	1.00	0.80	57,571	9.43	14,572	1.71	0.25	0.18
LED Exit Sign (rebated)	984	0.12	985	0.12	1.00	0.80	984	0.12	788	0.10	0.80	0.80
Occupancy Sensors	2,746	0.73	2,458	0.97	1.00	0.80	2,746	0.73	1,966	0.78	0.72	1.06
Total	**401,107**	**79.57**	**559,882**	**71.05**	**1.00**	**0.80**	**400,860**	**79.56**	**447,906**	**56.84**	**1.12**	**0.71**

Note: Realization Rate = *ex post* net value / *ex ante* net value.

For the Major Measures Component, the evaluation team calculated a realization rate of 0.81, with net kWh savings of 5,534,826 kWh.

Table 19. Major Measures Component Net Electric Impacts

Measure	*Ex Ante* Gross		*Ex Post* Gross		*Ex Ante* NTGR	*Ex Post* NTGR	*Ex Ante* Net		*Ex Post* Net		Net Realization Rate	
	kWh	kW	kWh	kW			kWh	kW	kWh	kW	kWh	kW
Programmable Thermostat	77,138	0.00	49,073	0.00	1.00	1.00	77,138	0	49,073	0.00	0.64	n/a
Insulation	1,448,391	683.27	334,104	39.46	0.93	0.88	1,343,081	904.91	293,445	34.66	0.22	0.04
Air Sealing	5,439,344	1,435.42	5,429,891	2,245.66	1.00	0.96	5,412,764	2,139.85	5,192,308	2,147.40	0.96	1.00
Total	**6,964,873**	**2118.69**	**5,813,068**	**2285.12**	**0.98**	**0.95**	**6,832,983**	**3,045**	**5,534,826**	**2,175.74**	**0.81**	**0.71**

Note: Realization Rate = *ex post* net value / *ex ante* net value.

The Major Measures Component attained net gas savings of 34,388 therms and a net realization rate of 0.29. Table 20 below shows impacts by measure.

Table 20. Major Measures Component Net Gas Impacts

Measure	*Ex Ante* Gross Therms	*Ex Post* Gross Therms	*Ex Ante* NTGR	*Ex Post* NTGR	*Ex Ante* Net Therms	*Ex Post* Net Therms	Net Realization Rate
Programmable Thermostat	1,055	690	1.00	1.00	1,055	690	0.65
Insulation	29,638	7,464	0.97	0.75	28,660	5,598	0.20
Air Sealing	87,374	34,745	1.04	0.81	90,433	28,143	0.31
Total	**118,067**	**42,899**	**1.02**	**0.80**	**120,148**	**34,388**	**0.29**

Note: Realization Rate = *ex post* net value / *ex ante* net value.

4.3 INPUTS FOR FUTURE PROGRAM PLANNING

In PY5, the evaluation team gathered data to update the installation rate for the In-Unit Direct Install measures. This value will be applied by AIC in future program years. In addition, the team conducted a telephone survey with participating property managers to develop a NTGR for the Major Measures Component, which had not been researched previously.

4.3.1 INSTALLATION RATE

In PY5, the evaluation team developed installation rates for the In-Unit Direct Install measures through onsite visits and for Common Area Lighting Component measures though a property manager telephone survey. Appendix A contains the results and a detailed methodology.

Table 21 provides the installation rate for the In-Unit Component, which is 0.98 at the program component level.

Table 21. Multifamily Program In-Unit Component Installation Rate

Measure	Installed	Verified	Installed Savings	Verified Savings	Installation Rate
CFL	1,020	1,001	39,364	38,620	0.98 ± 0.02
Aerator	171	169	19,683	19,453	0.99 ± 0.05
Showerhead	98	95	34,314	33,263	0.97 ± 0.03
Programmable Thermostat	4	4	2,411	2,411	1.00 ± 0.05
Total	**1,293**	**1,269**	**95,772**	**93,747**	**0.98 ± 0.03**

Table 25 shows the installation rate for the Common Area Lighting Component of the Multifamily Program. Overall, we found that the component had an installation rate of 0.95.

Table 22. Multifamily Program Common Area Lighting Component Installation Rate

Measure	Installed	Verified	Installed Savings	Verified Savings	Installation Rate
CFL	283	271	47,319	45,158	0.95 ± 0.02
Occupancy Sensor	3	1	246	82	0.33 ± 0.45
LED Exit Sign	15	15	2,634	2,634	1.00 ± 0.00
Total	**301**	**287**	**50,199**	**47,874**	**0.95 ± 0.02**

4.3.2 UPDATED NTGRS FOR PY7

Additionally, we conducted research with property managers to develop a NTGR for the Common Area Lighting Component. As discussed in greater detail in Appendix B, the overall NTGR for the Common Area Lighting Component is 0.56 ± 0.25. Given the low precision of this estimate, we present these results for informational and planning purposes, and recommend conducting additional research in this area in future program years.

Table 23. Common Area Lighting Component NTGR

Measure	NTGR
14-Watt CFL	0.56
20-Watt CFL	0.56
23-Watt CFL	0.56
Modular CFL	0.56
Modular CFL Exterior	0.56
LED Exit Sign (DI)	0.53
LED Exit Sign (rebated)	0.53
Occupancy Sensors	1.00
Common Area Lighting Overall (n=11)	0.56 ± .25

A. APPENDIX: PROGRAM INSTALLATION RATES

Methodology

The evaluation team verified the installation and operation of individual program measures based on responses to the property manager survey and site visits. In the property manager survey, we asked participants to verify that they received the quantity of measures tracked in the database. Since the Multifamily Program incents a variety of different lighting measures, we grouped these measures into a single lighting measure category and asked about those measures together. During site visits, a representative from the evaluation team visited a sample of tenant units that received measures to verify the quantities indicated in the tracking database.

To calculate the installation rate, the team divided the savings associated with verified measures by the savings associated with the number reported in the program-tracking data. After creating the program-level installation rate, we estimated the sampling error associated with this factor. The first step in this process is calculating variance using Cochran's[5] estimation of the variance from a sample.

Equation 1. Equation for Variance from a Sample

$$Variance = \frac{(1-f)}{n\bar{X}^2}\left({s_y}^2 + \hat{R}^2{s_x}^2 - 2\hat{R}s_{yx}\right)$$

Where:

1-*f* = Fraction of the population sampled

n = Number of respondents in the sample

$\bar{X}^2$ = Mean audited savings of the population

s_y^2 = Variance of the verified savings across the sample

s_x^2 = Variance of the audited savings across the sample

$\hat{R}$= Realization Rate (verified savings/audited savings)

s_{xy} = Covariance of the verified and audited savings

We applied a weight to the installation rate for each participant based on the savings associated with the measures. The weight was equal to the savings associated with a particular participant and measure divided by the total savings in the sample associated with that measure. The team applied these weights prior to calculating the variance. In most instances, weighting did not substantially change the overall installation rate.

[5] Cochran, William G. *Sampling Techniques. Third Edition.* John Wiley & Sons. 1977. Equation 6.12.

After we determine the variance in the sample, we calculate the standard error, confidence interval, and relative precision for this factor. We calculated a 90% confidence interval, the value typically used for sampling error in energy efficiency program evaluation.

Equation 2. Equation for Calculating IRAF Precision

$$standard\ error = \sqrt{variance}$$

$$90\%\ Confidence\ Interval = 1.645 * standard\ error$$

$$\boldsymbol{Relative\ Precision = \frac{Confidence\ Interval}{\widehat{R}}}$$

Installation Rate

The follow sections outline the PY5 installation rates. These installation rates are for future planning purposes only, and the team did not apply them to determine PY5 *ex post* savings.

In-Unit Direct Install Component

Table 24 shows the installation rate for the In-Unit Direct Install Component of the Multifamily Program. Overall, we found that the component had an installation rate of 98%.

Table 24. Multifamily Program In-Unit Component Installation Rate

Measure	Installed	Verified	Installed Savings	Verified Savings	Installation Rate
CFL	1,020	1,001	39,364	38,620	0.98 ± 0.02
Aerator	171	169	19,683	19,453	0.99 ± 0.05
Showerhead	98	95	34,314	33,263	0.97 ± 0.03
Programmable Thermostat	4	4	2,411	2,411	1.00 ± 0.05
Total	**1,293**	**1,269**	**95,772**	**93,747**	**0.98 ± 0.03**

Common Area Lighting Component

Table 25 shows the installation rate for the Common Area Lighting Component of the Multifamily Program. Overall, we found that the component had an installation rate of 95%.

Table 25. Multifamily Program Common Area Lighting Component Installation Rate

Measure	Installed	Verified	Installed Savings	Verified Savings	Installation Rate
CFL	283	271	47,319	45,158	0.95 ± 0.02
Occupancy Sensor	3	1	246	82	0.33 ± 0.45
LED Exit Sign	15	15	2,634	2,634	1.00 ± 0.00
Total	**301**	**287**	**50,199**	**47,874**	**0.95 ± 0.02**

Major Measures Component

It is unlikely that a property manager would be able to verify details of air sealing and insulation installation, such as change the air leakage or R-value. Therefore, the verification process for the Major Measures Component consisted of asking if the property manager received the measures associated with their property in the tracking database. All of the responding property managers that participated in the Major Measures Component (n=14) confirmed that they received the measures associated with their property in the tracking database, resulting in an installation rate of 1.0.

B. APPENDIX: COMMON AREA LIGHTING NTGR RESULTS

In PY5, the evaluation team collected self-report information on NTGR for the Common Area Lighting Component. However, because this component's existing NTGR of 0.80 is based on primary research that took place in PY3, we did not retroactively apply the NTGR that we calculated from this year's data. Furthermore, given the relatively low number of respondents and the variation in their responses, the PY5 NTGR has low precision. Although the PY5 NTGR, at 0.56, is lower than the PY3 NTGR, the error bounds are large enough on the PY5 value that the difference between the two is not significant. However, we present the findings of the PY5 Common Area Lighting Component NTGR analysis here for informational and future planning purposes only.[6]

Methodology

Gross impacts are defined as the change in energy (or demand) consumption that results directly from program-related actions taken by program participants—in this case property managers—regardless of why those actions were taken. Net impacts are defined as the impacts (i.e., changes in consumption) that can be attributed to the program. Net impacts may be lower than total program gross impacts due to energy savings that would have occurred in the absence of the program (free riders). Conversely, the net impacts may be higher than total program gross impacts due to energy impacts that occurred because of the program, but were not incented by the program (spillover).

Attribution comprises these two concepts—free ridership (FR) and spillover (SO)—and is indicated as an NTGR. The NTGR is calculated as (1-FR + SO).

Free riders are program participants who would have implemented the program's energy-efficient measure(s) even without the program. These estimates are based on a series of questions in the telephone survey that explored the influence of the program in making the energy-efficient improvements, as well as likely actions had the program not been available.

Free Ridership Battery for Common Area Lighting Component Measures

For each direct install measure included in the survey, we developed a free ridership factor that consists of two scores, as described below.

- Overall program influence. This score reflects the degree of influence the program had on the property manager's decision to install the specified measures. This score is based a question that asked respondents to rate the likelihood (on a 0-10 scale) that they would have installed the measure(s) at all in the absence of the program. A greater likelihood value means a higher level of free ridership.
- Influence of program timing. This score is developed based on two questions: 1) Would the work have been done at the same time without the program? 2) If the work would have been done later, how much later? Later implementation in the absence of the program results in a lower level of free ridership.

[6] We present the methodology and results of the PY5 Major Measures Component NTGR analysis in the body of this report.

Each score can take on a value of 0 to 1, where a higher score means a higher level of free ridership. The overall free ridership factor for a project is the average of the three scores. The NTGR is 1-FR for each project, and therefore ranges from 0 (100% free ridership) to 1 (no free ridership). The NTGR is weighted by the energy savings (of the survey respondents) to get the final NTGR.

Spillover

Spillover energy and demand savings are based on responses from participants who indicated installing energy-efficient measures outside of the program, but were heavily influenced by the program. The spillover energy and demand savings are added back to the program savings after adjusting for free ridership to determine the overall NTGR for the program. In PY5, we did not find any spillover among Multifamily Program participants.

Net-to-Gross Ratio Findings

Based on PY5 research, the overall NTGR for the Common Area Lighting Component is 0.56 ± 0.25, as seen below in Table 26. Many respondents indicated that they were very likely to have purchased CFLs or LED exit signs if they had not received them from the program, which is the main cause for the low NTGR. Given the low precision of this estimate, we present these results for informational and planning purposes, and recommend conducting additional research in this area in PY6.

Table 26. Common Area Lighting Component NTGR

Measure	NTGR
14-Watt CFL	0.56
20-Watt CFL	0.56
23-Watt CFL	0.56
Modular CFL	0.56
Modular CFL Exterior	0.56
LED Exit Sign (DI)	0.53
LED Exit Sign (rebated)	0.53
Occupancy Sensors	1.00
Common Area Lighting Overall (n=11)	0.56 ± .25

Spillover

Participant spillover refers to energy efficiency installations that were influenced by the program, but did not receive an incentive. An example of participant spillover is a customer, who installed incented equipment in one property and, as a result of the positive experience, installs additional equipment at other properties, but does not request an incentive or perform additional efficiency-related actions in the same facility because of the program. We found no spillover among participants.

C. APPENDIX: COST-EFFECTIVENESS INPUTS

Table 27 presents net impacts for AIC cost-effectiveness calculations. These values differ from those included in the main report due to the inclusion of heating penalties. This approach was taken based on discussions with AIC, and past agreement between AIC and ICC staff that heating penalties would not be included in savings calculations for goal attainment.

Table 27. PY5 Multifamily Net Impacts (Including Heating Penalties)

Component	Electric Savings (MWh)	Demand Savings (MW)	Gas Savings (Therms)
In-Unit Direct Install	7,949	0.79	770
Common Area Lighting	448	0.06	-9,954
Major Measures	5,535	2.18	34,388
Total	**13,932**	**3.06**	**25,204**

D. APPENDIX: IMPACT ALGORITHMS

Lighting Algorithms

The evaluation team used the algorithms below, from the 2012 TRM, to determine *ex ante* lighting savings.

Equation 3. Interior Hardwired CFL Algorithms

Energy Savings: $\Delta kWh = ((WattsBase - WattsEE) / 1000) * ISR * HOURS * WHF_e$

Demand Savings: $\Delta kW = ((WattsBase - WattsEE) / 1000) * ISR * WHFd * CF$

Heating Penalty (not included in *ex post* savings): $\Delta Therms = - (((WattsBase - WattsEE) / 1000) * ISR * Hours * HF * 0.03412) / \eta Heat$

Equation 4. LED Exit Sign Algorithms

Energy Savings: $\Delta kWh = ((WattsBase - WattsEE) / 1000) * HOURS * WHF_e$

Demand Savings: $\Delta kW = ((WattsBase - WattsEE) / 1\ 000) * WHFd * CF$

Heating Penalty (not included in *ex post* savings): $\Delta Therms = - (((WattsBase - WattsEE) / 1000) * Hours * HF * 0.03412) / \eta Heat$

Equation 5. Exterior Hardwired CFL Algorithms

Energy Savings: $\Delta kWh = ((WattsBase - WattsEE) / 1000) * ISR * HOURS$

Demand Savings: $\Delta kW = ((WattsBase - WattsEE) / 1000) * ISR * CF$

Equation 6. Occupancy Sensor Algorithms

Energy Savings: $\Delta kWh = KWControlled * Hours * ESF * WHFe$

Demand Savings: $\Delta kW = KWcontrolled * WHFd * (CFbaseline - CFos)$

Where:

WattsBase = Wattage of existing equipment

WattsEE = Wattage of installed equipment

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

Table 28. In-Service Rate for Common Area Lighting Measures

Measure	ISR
Direct Install Weighted Average First Year	96.9%

HOURS = Annual operating hours

Table 29. Annual Operating Hours for Lighting Measures

Measure	HOURS
LED Exit Sign – Multifamily	8,766
Exterior Hardwired CFLs	1,643
Interior Hardwired CFLs	5,950
CFLs (In-Unit Direct Install)	938
CFLs (Common Area Lighting)	5,950

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

Table 30. Waste Heat Factor for Energy for Lighting Measures

Measure	WHF_e
LED Exit Sign – Multifamily	1.04
Interior Hardwired CFLs	1.04
CFLs	1.04
Occupancy Sensors	1.34

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

Table 31. Waste Heat Factor for Demand for Lighting Measures

Measure	WHF_d
LED Exit Sign – Multifamily	1.07
Interior Hardwired CFLs	1.07
CFLs	1.07
Occupancy Sensors	1.57

CF = Summer Peak Coincidence Factor

Table 32. Coincidence Factor for Lighting Measures

Measure	CF
LED Exit Sign – Multifamily	1
Interior Hardwired CFLs	.4
CFLs (In-Unit Direct Install)	.095
CFLs (Common Area Lighting)	.75

kWcontrolled = Total lighting load connected to the control in kilowatts[7]

= 0.35

[7] Assumed wall-mounted occupancy sensor.

CFbaseline = Baseline Summer Peak Coincidence Factor for the lighting system without occupancy sensors installed

= .75

CFos = Retrofit Summer Peak Coincidence Factor for the lighting system with occupancy sensors installed

= .15

ESF = Energy Savings Factor[8]

=.41

HF = Heating Factor

Table 33. Heating Factor for Lighting Measures

Measure	HF
Interior or Unknown Location	.49
Exterior or Unheated Location	0

ηHeat = Efficiency in COP of Heating equipment

Table 34. Efficiency of Heating Equipment for Lighting Measures[9]

Measure	ηHeat
Interior or Unknown Location	.7
Exterior or Unheated Location	0

Water Heating Measure Algorithms

The evaluation team used the algorithms below, from the 2012 TRM, to determine *ex ante* water heating measure savings.

Equation 7. Showerhead Algorithms

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

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

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

[8] Assumed wall-mounted occupancy sensor.

[9] Assumed values since actual unknown.

Equation 8. Faucet Aerator Algorithms

Energy Savings: *ΔkWh = %ElectricDHW * ((GPM_base * L_base - GPM_low * L_low) * Household * 365.25 *DF / FPH) * EPG_electric * ISR*

Demand Savings: *ΔkW = ΔkWh/ Hours * CF*

Therm Savings: *ΔTherms = %FossilDHW * ((GPM_base * L_base - GPM_low * L_low) * Household * 365.25 *DF / FPH) * EPG_gas * ISR*

Equation 9. Water Temp Setback Algorithms

Energy Savings: *ΔkWh = deemed value (86.4 if electric water heater)*

Demand Savings: *ΔkW = deemed value (.0099 if electric water heater)*

Therm Savings: *ΔTherms = deemed value (6.4 if gas water heater)*

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/faucet aerator

GPM_low = As-used flow rate of the low-flow showerhead/faucet aerator

Table 35. GPM for Water Heating Measures

Measure	GPM_base	GPM_low
Faucet aerator	1.2	0.94
Showerhead	2.67	2.0

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

Table 36. L_base for Water Heating Measures

Measure	Minutes
Faucet aerator	9.85
Showerhead	8.2

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 = 2.1

SPCD = Showers Per Capita Per Day = 0.75

SPH = Showerheads Per Household = 1.3

DF = Drain Factor = .795 (unknown location)

FPH = Faucets Per Household = 1.25 (unknown location)

EPG_electric = Energy per gallon of hot water supplied by electric

EPG_gas = Energy per gallon of hot water supplied by gas

Table 37. EPG for Water Heating Measures

Measure	EPG_electric	EPG_gas
Faucet Aerator	0.0894	0.0045
Showerhead	0.127	0.0063

ISR = In-Service Rate = 0.98 for direct install

Hours = Annual electric DHW recovery hours

Table 38. Hours for Water Heating Measures

Measure	Hours
Faucet Aerator	162
Showerhead	354

CF = Coincidence Factor for electric load reduction

Table 39. CF for Water Heating Measures

Measure	CF
Faucet Aerator	0.022
Showerhead	0.0278

Programmable Thermostat Algorithms

The evaluation team used the algorithms below, from the 2012 TRM, to determine *ex ante* programmable thermostat savings.

Equation 10. Programmable Thermostat Algorithms

Energy Savings: $\Delta kWh = \%ElectricHeat * Elec_Heating_Consumption * Heating_Reduction * HF * Eff_ISR + (\Delta Therms * Fe * 29.3)$

Demand Savings: *none - no cooling savings*

Therm Savings: $\Delta Therms = \%FossilHeat * Gas_Heating_Consumption * Heating_Reduction * HF * Eff_ISR$

Where:

%ElectricHeat = 100% if electric heat, 0% if gas heat

%GasHeat = 100% if gas heat, 0% if electric heat

Elec_Heating_Consumption = Estimate of annual household heating consumption

Table 40. Elec_Heating_Consumption for Programmable Thermostats

Climate Zone	Electric Resistance Elec_Heating_Consumption (kWh)	Electric Heat Pump Elec_Heating_Consumption (kWh)
1 (Rockford)	26,038	13,019
2 (Chicago)	24,875	12,438
3 (Springfield)	21,304	10,652
4 (Belleville)	16,434	8,217
5 (Marion)	16,726	8,363

Gas_Heating Consumption = Estimate of annual household heating consumption

Table 41. Gas_Heating_Consumption for Programmable Thermostats

Climate Zone	Gas_Heating_Consumption (therms)
1 (Rockford)	889
2 (Chicago)	849
3 (Springfield)	727
4 (Belleville)	561
5 (Marion)	571

Heating_Reduction = Assumed percentage reduction in heating energy consumption due to programmable thermostat

=.062

HF = Household Factor, to adjust heating consumption for non-single-family households

= 0.65

Eff_ISR = Effective In-Service Rate = 1.00 for Direct Install

Fe = Furnace Fan energy consumption as a percentage of annual fuel consumption

= .0314

Insulation Algorithms

The evaluation team used the algorithms below, from the 2012 TRM, to determine *ex ante* insulation savings.

Equation 11. Insulation Algorithms

Energy Savings: $\Delta kWh = \Delta kWh_cooling + \Delta kWh_heating$

$$\Delta kWh_cooling = [((1/R_old - 1/R_wall) * A_wall * (1\text{-}Framing_factor) + (1/R_old - 1/R_attic) * A_attic * (1\text{-}Framing_factor/2)) * 24 * CDD * DUA] / (1000 * \eta Cool)$$

$$\Delta kWh_heating = [(1/R_old - 1/R_wall) * A_wall * (1\text{-}Framing_factor) + (1/R_old - 1/R_attic) * A_attic * (1\text{-}Framing_factor/2)) * 24 * HDD] / (\eta Heat * 3412)$$

Demand Savings: $\Delta kW = (\Delta kWh_cooling / FLH_cooling) * CF$

Gas Savings (if gas heat): $\Delta Therms = (((1/R_old - 1/R_wall) * A_wall * (1\text{-}Framing_factor) + (1/R_old - 1/R_attic) * A_attic * (1\text{-}Framing_factor/2)) * 24 * HDD) / (\eta Heat * 100{,}067\ Btu/therm)$

Where:

R_wall = R-value of new wall assembly

R_attic = R-value of new attic assembly

R_old = R-value value of existing assemble and any existing insulation (minimum of R-5)

A_wall = Total area of insulated wall (ft^2)

A_attic = R-value of new attic assembly

Framing_factor = Adjustment to account for area of framing = 0.15

CDD = Cooling Degree Days

Table 42. 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

ηCool = Seasonal Energy Efficiency Ratio of cooling system (assumed 13)

HDD = Heating Degree Days

Table 43. 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

ηHeat = Efficiency of heating system

Table 44. Assumed ηHeat by Heat Type

Heat Type	Assumed ηHeat
Heat Pump	1.92
Electric Resistance	1
Gas	0.7

FLH_cooling = Full Load Hours of air conditioning

Table 45. FLH_cooling by Climate Zone

Climate Zone	FLH_cooling
1 (Rockford)	467
2 (Chicago)	506
3 (Springfield)	663
4 (Belleville)	940
5 (Marion)	820

CF = Coincidence Factor = 0.915

Air Sealing Algorithms

The evaluation team used the algorithms below, from the 2012 TRM, to determine *ex ante* air sealing savings.

Equation 12. Air Sealing Algorithms

Energy Savings: $\Delta kWh = \Delta kWh_cooling + \Delta kWh_heating$

$$\Delta kWh_cooling = [(((CFM50_existing - CFM50_new)/N_cool) * 60 * 24 * CDD * DUA * 0.018) / (1000 * \eta Cool)] * LM$$

$$\Delta kWh_heating = (((CFM50_existing - CFM50_new)/N_heat) * 60 * 24 * HDD * 0.018) / (\eta Heat * 3{,}412)$$

Demand Savings: $\Delta kW = (\Delta kWh_cooling / FLH_cooling) * CF$

Gas Savings (if gas heat): $\Delta Therms = (((CFM50_existing - CFM50_new)/N_heat) * 60 * 24 * HDD * 0.018) / (\eta Heat * 100{,}000)$

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

= 18.5[10]

CDD = Cooling Degree Days

Table 46. 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

ηCool = Seasonal Energy Efficiency Ratio of cooling system = 13

LM = Latent Multiplier to account for latent cooling demand

Table 47. Latent Multiplier by Climate Zone

Climate Zone	Latent Multiplier
1 (Rockford)	8.5
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

=15.75[11]

HDD = Heating Degree Days

Table 48. 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

[10] Assumed Zone 2 Normal Exposure.

[11] Assumed Zone 2 Normal Exposure, average of all given building heights.

Climate Zone	HDD
5 (Marion)	3,438

ηHeat = Efficiency of heating system

Table 49. Assumed ηHeat by Heat Type

Heat Type	Assumed ηHeat
Heat Pump	1.92
Electric Resistance	1
Gas	0.7

FLH_cooling = Full Load Hours of air conditioning

Table 50. FLH_cooling by Climate Zone

Climate Zone	FLH_cooling
1 (Rockford)	467
2 (Chicago)	506
3 (Springfield)	663
4 (Belleville)	940
5 (Marion)	820

CF = Coincidence Factor = 0.915

E. APPENDIX: DATA COLLECTION INSTRUMENTS

AIC PY5 MF Part Survey FINAL 2013-0