



Opinion **Dynamics**

Boston | Headquarters

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

1000 Winter St
Waltham, MA 02451



Evaluation of the 2014 (PY7) Illinois Power Agency Residential Multifamily Program

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CADMUS

NAVIGANT



Contributors

Rick G. Winch
Vice President, Opinion Dynamics

Hannah Arnold
Managing Director, Opinion Dynamics

Ute Zischka
Project Analyst, Opinion Dynamics

Mallorie Gattie
Senior Energy Engineer, Opinion Dynamics

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1. Executive Summary

This report presents results from the Illinois Power Agency (IPA) Multifamily Major Measures Program, which was implemented from June 2014 to May 2015 (also referred to as program year seven [PY7]) by implementation contractor CLEAResult (formerly Conservation Services Group [CSG]). During PY7, multifamily program offerings in Ameren Illinois Company (AIC) service territory were split between the IPA Multifamily Program and another multifamily program implemented by AIC. While there was no change in program offerings from the customer perspective, the AIC Multifamily Program focused largely on implementing in-unit and common area direct installation projects while the IPA Multifamily Program completed the majority of major measure projects.¹

Measures offered through the IPA program include LED exit signs, occupancy sensors, modular CFLs, and T8 lights for common areas, as well as major measures including air sealing and insulation, which the program provides at no costs to the property. Program delivery differs somewhat by project type. In general, the program implementer conducts outreach and provides common area lighting measures, whereas for major measures, program allies are responsible for generating leads and bringing customers into the program.

The PY7 IPA Multifamily Program offering functions much the same as the traditional AIC Multifamily Program has during prior program years.

Below we present the key findings from the PY7 IPA Multifamily Program evaluation.

Program Impacts

Table 1 summarizes the net electricity and demand savings from the PY7 IPA Multifamily Program, which are 15,437 MWh and 3.93 MW. The evaluation team verified all program measures through a database review process, and applied the same net-to-gross ratios (NTGR) as the implementation team. As such, differences between ex ante and ex post gross savings calculations are due to variances in savings for air sealing and insulation, which account for 73% and 27% of program savings respectively.

¹ The evaluation team provides results from the evaluation of the AIC Multifamily Program in a separate report.

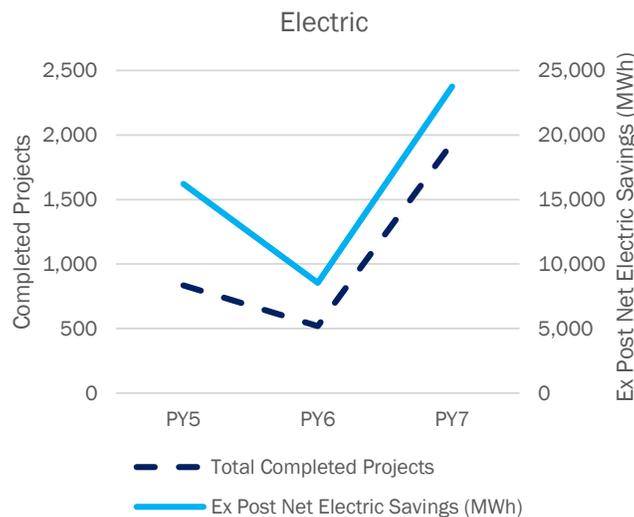
Table 1. PY7 IPA Net Multifamily Program Impacts

	Ex Ante Gross	Gross Realization Rate	Ex Post Gross	NTGR	Ex Post Net
Energy Savings (MWh)					
Total MWh	13,398	1.15	15,437	1.00	15,437
Demand Savings (MW)					
Total MW	2.14	1.84	3.93	1.00	3.93

Program Participation

Program staff achieved the PY7 IPA Multifamily Program savings presented above through implementation of 943 projects with 120 property managers/owners. When considered in conjunction with activity in the AIC Multifamily Program, a dramatic increase in savings for this sector is evident.

Figure 1. AIC and IPA Multifamily Program Activity from PY5 – PY7



Note: The IPA Multifamily began in PY7.

Key Findings and Recommendations

While program design changed somewhat given the movement of most major measures projects to the IPA Multifamily Program, the AIC Multifamily Program generally operated smoothly and effectively in PY7. As noted in detail below, research with participating customers and program allies points to high levels of satisfaction, while discussions with non-participants and a review of secondary data provide insight on how the program can identify decision-makers and target properties going forward.

The following are the key findings and recommendations from the PY7 evaluation.

- **Key Finding #1:** Participating property managers are highly satisfied with the program and those with additional properties are likely to participate in the future. Contractors also appear to be happy with the program, noting that communications between program staff and trade allies have improved over time.

- **Recommendation:** The ownership and management of multifamily properties appears to be highly concentrated, meaning a relatively small percentage of property management firms oversee a high percentage of all multifamily buildings. As a result, it is imperative to ensure that current participants have positive program experiences. A consistent commitment to QA/QC and a timely resolution of outstanding issues/problems should continue to be used to ensure current participants continue to participate in the future.
- **Key Finding #2:** The vast majority of participating property managers are aware of all three program components (i.e., in-unit direct install, common area direct install, major measures), suggesting that all parties involved in the Multifamily Program are doing a good job making sure participating property managers are aware of ALL program possibilities. About one-half of nonparticipating property managers are aware of the program.
 - **Recommendation:** Continue to emphasize that all parties involved in the multifamily program promote all three program components. Awareness of the various program components, among participating property managers, appears to be high. Therefore, the future goal is to maintain present awareness levels by continuing to focus on cross-component marketing.
 - **Recommendation:** Additional outreach, across multiple communication channels, may be needed to increase awareness among nonparticipating property managers. Industry events and associations, including associated publications, may be a good way of reaching these individuals. Outreach should also include contractors and equipment manufacturers as both groups are common sources of information for nonparticipating property managers. Communications should emphasize the program's ability to help property managers reduce operating costs.
- **Key Finding #3:** Building owners plays a critical role in approving building and efficiency upgrades and are particularly motivated to reduce building operating costs.
 - **Recommendation:** It is important to develop strategies to engage building owners, as the central decision maker, in conversations about potential energy efficiency projects. Associated with this, property managers should be provided with information that will support them in pitching energy efficiency upgrades to building owners.

2. Evaluation Approach

The PY7 evaluation of the IPA Multifamily Program involved both process and impact assessments. To support the process evaluation, we conducted a review of program materials and program-tracking data, interviews with program implementation staff, and interviews with program allies and participants. We also conducted a survey with non-participating property managers/owners and analyzed secondary data to characterize the multifamily market in AIC service territory. To evaluate gross impacts, the evaluation team reviewed the PY7 program tracking data and applied the Illinois Statewide Technical Reference Manual for Energy Efficiency Version 2.0 (IL-TRM 2.0). To calculate net impacts, the team applied NTGRs submitted by the program implementer as part of their IPA bid.

In general, the team coordinated evaluation activities across both the AIC and IPA Multifamily programs.

2.1 Research Objectives

The evaluation team sought to answer the following research questions as part of the PY7 IPA Multifamily evaluation:

2.1.1 Impact Questions

1. What are the estimated gross energy and demand impacts from this program?
2. What are the estimated net energy and demand impacts from this program?

2.1.2 Process Questions

1. Program Participation
 - a. How many projects were completed? By how many different customers? What types of projects?
 - b. Does customer participation meet expectations? If not, how different is it and why?
 - c. How many customers participate in more than one component?
2. Program Design and Implementation
 - a. Has the program changed compared to PY6? If so, how, why, and was this an advantageous change?
 - b. What implementation challenges have occurred in PY7, and how has the program overcome them?
3. Opportunities for Program Improvement
 - a. What changes could the program make to improve the customer experience and generate greater energy savings?
4. Market Characterization
 - a. What is the size of the multifamily market in AIC service territory?
 - b. What are the characteristics of multifamily buildings in AIC service territory?

- c. How do property managers and owners make decisions about building improvements?

2.2 Evaluation Tasks

Table 2 summarizes the evaluation activities that we conducted for the PY7 evaluation of the IPA Multifamily Program.

Table 2. Summary of PY7 Multifamily Program Evaluation Activities

Activity	PY7 Process	PY7 Impact	Forward Looking	Details
Program Staff Interviews	✓			Conducted interviews with AIC and CSG program managers to understand changes in program design and implementation.
Review Program-Tracking Data and Materials	✓	✓		Reviewed the PY7 database, relevant administrative program reports, as well as marketing and outreach materials to document program design and changes.
Program Ally Interviews	✓			Conducted interviews with program allies to collect information about their role in program marketing and implementation, and to gain their perspectives on potential barriers to participation.
Participating Property Manager/ Owner Survey	✓		✓	Conducted telephone surveys with participating property managers/owners to collect process-related information, and help characterize the multifamily market in AIC service territory.
Non-participating Property Manager/ Owner Survey	✓		✓	Conducted telephone surveys with property managers/owners to help characterize the multifamily market in AIC service territory and identify barriers to participation in the Multifamily program.
Secondary Data Review and Analysis			✓	Reviewed AIC Residential Customer data and publicly available Census data to assess the size and characteristics of the multifamily market in the AIC service territory.
Impact Analysis		✓		Conducted an engineering analysis of all measures installed during PY7.

We summarize each of these activities in detail below.

2.2.1 Program Staff Interviews

In May 2015, the evaluation team conducted two in-depth interviews with AIC and CSG program managers. The interviews provided the evaluation team with insights about changes, during PY7, in 1) program design and implementation, 2) data tracking, and 3) customer outreach.

2.2.2 Review of Program Materials and Data

In addition to program staff interviews, the evaluation team reviewed program materials including program flyers, the Multifamily Program Implementation Plan, and Monthly Administrative Meeting Reports. The team also reviewed the program-tracking database to examine the type of data that is tracked and to obtain data for both the process and impact analysis.

2.2.3 Program Ally Interviews

The evaluation team conducted in-depth interviews with participating program allies. The interviews collected information about the role of program allies in marketing and implementation, and their perspectives on barriers to program participation. Opinion Dynamics used the data from the interviews to inform the process evaluation.

Overall, we spoke with four of nine program allies who installed shell measures such as insulation or air sealing through the program. Three of the program allies with whom we spoke completed projects within both the 8-103/8-104 and IPA programs. Further, the four companies we spoke to represent the majority (91%) of all projects completed during PY7.

2.2.4 Participating Property Manager/Owner Survey

The evaluation team conducted quantitative telephone interviews with 70 property managers/owners who participated in the AIC and IPA Multifamily programs during PY7. These interviews explored the company and building characteristics of program participants, as well as the decision-making process related to energy efficiency upgrades among other topics. The participant population for this survey included property managers/owners who received direct installation (in-unit or common area) and major measures through the program. As a result, the survey findings are presented in this report as well as the AIC Multifamily Program report.

Sample Design

Given the size of the participant population, the evaluation team did not conduct sampling for this survey effort. Instead, we conducted a census attempt and called all of the participants in the program (both the AIC and IPA components). In total, the evaluation team identified 248 unique contacts and completed 70 interviews. We fielded the survey from August 18 to September 16, 2015.

Table 3 shows the population of property managers/owners and number of completed surveys.

Table 3. Overview of Completed Participating Property Manager/Owner Surveys

Component	PY7 Participating Property Manager/Owner Population	Completed Surveys
AIC Only	128	29
IPA Only	59	16
Both	61	25
Unique Property Managers	248	70

As noted above, we attempted to reach a census of property managers; therefore, there is no sampling error associated with the survey results. However, we identify and comment on other sources of potential error in Section 2.3.

Survey Disposition and Response Rate

Table 4 presents the final survey dispositions for the participating property manager/owner survey. Note that the total records in the sample differ from the 248 unique property manager/owners listed above given the initial presence of both tenants and property managers/owners in the program-tracking data. While the implementer corrected this issue, it led to a greater amount sample being loaded.

Table 4. Participating Property Manager/Owner Survey Dispositions

Disposition	N
Completed Interviews (I)	70
Partial	2
Eligible Non-Interviews	169
<i>Refusal</i>	53
<i>Mid-Interview Terminate (R)</i>	3
<i>Respondent Never Available (NC)</i>	57
<i>Answering Device</i>	55
<i>Language Problem (NC)</i>	1
Not Eligible (e)	60
<i>Fax/Data Line</i>	4
<i>Non-Working</i>	35
<i>No eligible respondent</i>	3
<i>Wrong number</i>	18
Unknown Eligibility Non-Interview (U)	374
<i>Not attempted or worked</i>	349
<i>Call blocking</i>	1
<i>Always busy</i>	3
<i>No Answer</i>	21
Total Records in Sample	675

Table 5 provides the response and cooperation rates. Note that ineligible respondents in the original sample (i.e., tenants) are not included in the calculation of the response or cooperation rates. Appendix C describes the methodology to calculate response rates in more detail.

Table 5. Participating Property Manager/Owner Survey Response and Cooperation Rates

AAPOR Rate	Percentage
Response Rate	27%
Cooperation Rate	55%

2.2.5 Non-Participating Property Manager/Owner Survey

The evaluation team also conducted quantitative telephone interviews with property managers/owners who had not participated in the Multifamily Program. The interviews explored company and building characteristics, property-managers' and owners' decision-making process related to energy efficiency upgrades, as well as barriers to participation in the Multifamily Program. In general, the team designed the survey to inform the market characterization effort.

Sample Design

The evaluation team did not conduct sampling for the non-participating property manager/owner survey. Similar to the participant survey, we conducted a census attempt by calling all contacts within our population frame. However, the evaluation team faced significant challenges in determining the size of the non-participant population, as well as accessing data on members of this population. As a result, the team ultimately used the only viable data source available, an existing list from AIC containing property managers and building owners in the multifamily sector. AIC developed this list based on information about customers utilizing account management processes with their tenants, as well as those who opted-in to the utility's property manager portal.

It is important to note that before determining that the AIC list represented the only viable sample source, the evaluation team explored a number of other data sources. However, none provided the contacts or property information needed for completing the non-participating property manager survey. The data sources that the team assessed include:

- **AIC Customer Data:** We could not use AIC's customer database because it did not contain a flag for multifamily properties. In addition, the database generally contains information at the tenant level and not the owner/operator level.
- **Hoovers (a D&B Company):** We explored purchasing data from Hoovers to support the survey effort. Within Hoovers, the team can filter by property management SIC or NAICS codes, as well as industry codes to try to hone in on the appropriate group of respondents. However, once the team filtered down to the appropriate categories, we found only a handful of potential records that did not appear to be appropriate.
- **Illinois Property Management Associations:** The evaluation team conducted an extensive Internet search to try to identify property management associations with information about this population.² However, associations do not provide both contact information and addresses of multifamily properties.

Based on the AIC list, the evaluation team identified 413 unique contacts defined by phone number, and completed 20 interviews from August 26 to September 11, 2015. The evaluation team took a number of steps to prepare data from the AIC list for fielding the non-participating property manager survey. First, we collapsed the 5,229 records to 883 unique phone numbers. If one phone number appeared more than once (for example with different properties), we randomly selected the site we would ask about during the survey. We then

² For example, we reviewed information from the Illinois Rental Property Owners Association, the Association of Condominium, Townhouse and Homeowners Associations, the Apartment Building Owners and Managers Association, and the National Multifamily Housing Council.

removed records with duplicate contact information and phone numbers of Multifamily Program participants. This yielded an approximate population of 860 property managers or owners who had not previously participated in the Multifamily Program. To establish the sample frame, we further removed records with no or invalid property addresses as the survey included site-specific questions.

Table 6 provides a summary of the survey population, the sample frame, and completed surveys.

Table 6. Summary of Completed Non-Participating Property Manager/Owner Surveys

Target Population	Population (Approximated)	Sample Frame	Completed Surveys
Non-Participating Property Manager/Owners	860	413	20

Note that because we lack information about the true non-participating property manager population, it is difficult to determine if the sample frame is representative of the all property managers or owners in AIC service territory who have not previously participated in the Multifamily Program. Therefore, we use information from the non-participating property manager survey cautiously and primarily to enhance the information provided by participating property managers. We also identify and comment on sources of potential error in Section 2.3.

Survey Disposition and Response Rate

Table 7 presents the final survey dispositions for the non-participating property manager/owner survey.

Table 7. Non-Participating Property Manager/Owner Survey Dispositions

Disposition	N
Completed Interviews (I)	20
Partial	3
Eligible Non-Interviews	222
<i>Refusal</i>	120
<i>Mid-Interview Terminate (R)</i>	0
<i>Respondent Never Available (NC)</i>	71
<i>Answering Device</i>	31
<i>Language Problem (NC)</i>	0
Not Eligible (e)	139
<i>Fax/Data Line</i>	0
<i>Non-Working</i>	38
<i>Duplicate Number</i>	0
<i>Wrong number</i>	52
<i>No eligible respondent available</i>	47
<i>Other organization</i>	2
Unknown Eligibility Non-Interview (U)	29
<i>Always busy</i>	1
<i>No Answer</i>	28
Total Non-Participants in Sample	413

Table 8 provides the response and cooperation rates. Appendix C describes the methodology to calculate response rates in more detail.

Table 8. Non-Participating Property Manager/Owner Survey Response and Cooperation Rates

AAPOR Rate	Percentage
Response Rate	8%
Cooperation Rate	14%

2.2.6 Secondary Data Review and Analysis

The evaluation team identified and analyzed secondary data to support the market characterization. The principal source of secondary information is the 2009-2013 American Community Survey (Census data), though we also draw on AIC customer data. The Census data provides information on the number of units in multifamily structures, the year those units were built, as well as important socio-demographic data on building occupants. Through a series of analysis steps, AIC customer data was used to estimate the number of multifamily buildings within AIC’s service territory as well as their size (number of units) and location. A full discussion of the analysis applied to both Census data and AIC customer data can be found in the Appendix B (Market Characterization).

2.2.7 Impact Analysis

The evaluation included both gross and net impact analyses as described below.

Gross Impact Analysis Approach

To estimate PY7 ex post gross savings for the Multifamily Program, we conducted an engineering review of the program-tracking database and applied values from the IL-TRM V2.0. We present the algorithms used to calculate all evaluated program savings in Appendix C, along with all input variables.

Net Impact Analysis Approach

The evaluation team calculated PY7 net impacts by applying a NTGR of 1.0 for all program measures. The implementation team submitted these values as part of their IPA bid, and therefore the team used them to calculate net impacts.

2.3 Sources and Mitigation of Error

Table 9 provides a summary of possible sources of error associated with the research activities conducted for this evaluation. We discuss each item in detail below.

Table 9. Potential Sources of Error

Research Task	Survey Error		Non-Survey Error
	Sampling	Non-Sampling	
Participating Property Manager/Owner Survey	<ul style="list-style-type: none"> No sampling error since it was an 	<ul style="list-style-type: none"> Measurement error Non-response and self-selection bias Data processing error 	<ul style="list-style-type: none"> N/A

Research Task	Survey Error		Non-Survey Error
	Sampling	Non-Sampling	
	attempted census	<ul style="list-style-type: none"> External validity 	
Non-participating Property Manager/Owner Survey	<ul style="list-style-type: none"> No sampling error since it was an attempted census 	<ul style="list-style-type: none"> Sample frame error Measurement error Non-response and self-selection bias Data processing error External validity 	<ul style="list-style-type: none"> N/A
Secondary Data Review	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> Data processing error
Impact Analysis	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> N/A 	<ul style="list-style-type: none"> Data processing error

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

Survey Error

- **Non-Sampling Error:**

- **Measurement Error:** We addressed both the validity and reliability of quantitative data through multiple strategies. First, we relied upon 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 and ICC Staff had the opportunity to review all survey instruments. In addition, to determine if the wording of the questions was clear and unambiguous, we pre-tested each survey instrument, monitored both the participating and non-participating property manager interviews as they were being conducted, and reviewed the pre-test survey data. We also used the pre-tests to assess whether the length of the survey was reasonable and reduced survey length as needed.

- **Non-Response Bias:** Given the response rate of 13% for the participating property manager/owner survey and 8% for the non-participating property manager/owner survey, there is the potential for non-response bias. However, we attempted to mitigate possible bias by calling each potential respondent at least eight times at different times of the day (unless a refusal was received or the phone number was deemed ineligible). In addition, we reviewed population-level data for the property managers/owners where available to determine whether those we spoke with were significantly different from those who did not respond to the survey.

Based on this assessment, we found that the share of property managers/owners who received shell measures was identical between survey respondents and the participant population (both 50%). However, participants who completed in-unit or common area direct install projects were under-represented in the survey. Only 13% of survey respondents completed common area projects compared to 29% in the participant population, and 37% of the survey respondents received direct install measures for rental units, compared to 58% in the population. In

determining whether to weight survey responses due to this misalignment between survey respondents and the population, the team reviewed prior survey results that included testing for significant differences across participants in different program components. Given that few differences have been found between these groups, a decision was made to present unweighted results.

For the non-participant survey, while there is the potential for non-response bias, the team had no population-level data to review to determine its extent. However, we did speak with a high share of respondents who own smaller properties, which suggests that larger firms may not have responded to our interview request, likely due to gatekeeper refusals.

- **Data Processing Error:** The team addressed processing error through interviewer training, as well as quality checks of completed survey data. First, Opinion Dynamics interviewers went through a rigorous training before they began interviewing. 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. In addition, we carry-out continuous, random monitoring of all telephone interviews and validation of at least 10% of every interviewer's work.
- **External Validity:** Given that we attempted a census of participating property managers/owners, we did not need to worry about having a sample that was representative of customers who participated in the program. However, for the non-participating property manager survey, external validity of findings (the ability to generalize any findings to the population of interest) may be an issue due to the absence of population-level data on multifamily properties within AIC service territory. As noted above, this means that we use this data with caution.
- **Sample Frame Error:** This type of error occurs when the sample frame is not a perfect representation of the population, which may be the case for the non-participating property manager/owner survey due to the difficulty in forming the sample frame (i.e., the population of all non-participating property managers). This reduces our ability to generalize any findings to the target population of interest. As a result, we note within the methodology section that the results from this survey are largely used in conjunction with the participant survey, as well as to verify trends seen in the secondary data analysis.
- **Data Processing Error:**
 - **Gross Impact Calculations:** We applied the TRM calculations to the participant data in the tracking database to calculate gross impacts. To minimize data processing error, the evaluation team had all calculations reviewed by a separate team member to verify accurate calculations.
 - **Net Impact Calculations:** We applied the prospective deemed NTGR to estimate the program's net impacts. To minimize data processing error, the evaluation team had all calculations reviewed by a separate team member to verify accurate calculations.

3. Detailed Evaluation Findings

3.1 Program Description

The IPA Multifamily Program offers incentives and services that promote energy savings and lower operating costs in market rate multifamily properties. In PY7, delivery of Multifamily Program offerings was split between AIC's energy efficiency portfolio (referred to as 8-103/8-104 or AIC) and the Illinois Power Agency (IPA). The IPA program largely focused on the delivery of major measures such as air sealing and insulation, but also provided lighting measures for common areas of multifamily buildings.

Delivery of the Multifamily Program focuses on establishing relationships with property managers and owners eligible to participate. For major measures, program allies are responsible for generating leads and bringing customers into the program, whereas the program implementer, CLEAResult, conducts outreach and recruitment of participants for the direct-install of common area measures. Both conduct outreach via phone, in-person visits and industry events.

In terms of program implementation, program allies and implementation team staff also have differing roles. Here again, program allies are dedicated to the major measures projects, which involves identifying upgrade opportunities, performing the work and completing program paperwork. Program QA/QC staff inspects 10% of reservations made for shell measure upgrades. On the common area side of the program, CLEAResult account managers perform audits to identify potential for common area lighting upgrades. The program then provides lighting measures to property staff responsible for the installation.

3.2 Program Design and Implementation

According to program staff, implementation of the IPA Multifamily Program went smoothly and generally according to plan in PY7. However, the program staff did make minor implementation changes to address various issues that arose over the course of the program year.

3.2.1 Program Design Changes

The implementer made a few adjustments to program delivery in PY7 related to common area lighting and shell measures. First, the program began to cover the full cost of select common area lighting measures - occupancy sensors, exit signs, T-8 lamps or T-12 lamps - which had previously been rebated. Second, the program implementer brought a QA/QC inspector on board in October 2014 to improve oversight of major measures projects.³ The program aims to inspect at least 10% of project reservations, but program staff noted that the inspection rate is currently close to 25%.

The third programmatic change made by the implementer allowed for the ongoing tracking of budget allocations to shell measure projects. In particular, the program continued implementation of a reservation system started at the end of PY6 when the major measures program component reopened for two months. This system allows program staff to better monitor budget expenditures and associated program ally activities.

³ Previously, account managers performed this work.

3.3 Program Participation and Experience

3.3.1 PY7 Participation

Over the course of PY7, the program completed 943 projects (based on unique project ID) through the IPA program. As shown in Table 10, the majority of these projects included building shell upgrades. As indicated by the low percentage of projects and savings, program staff noted that finding opportunities for common area upgrades remains challenging.

Table 10. PY7 IPA Multifamily Program Participation and Projected Savings by Component

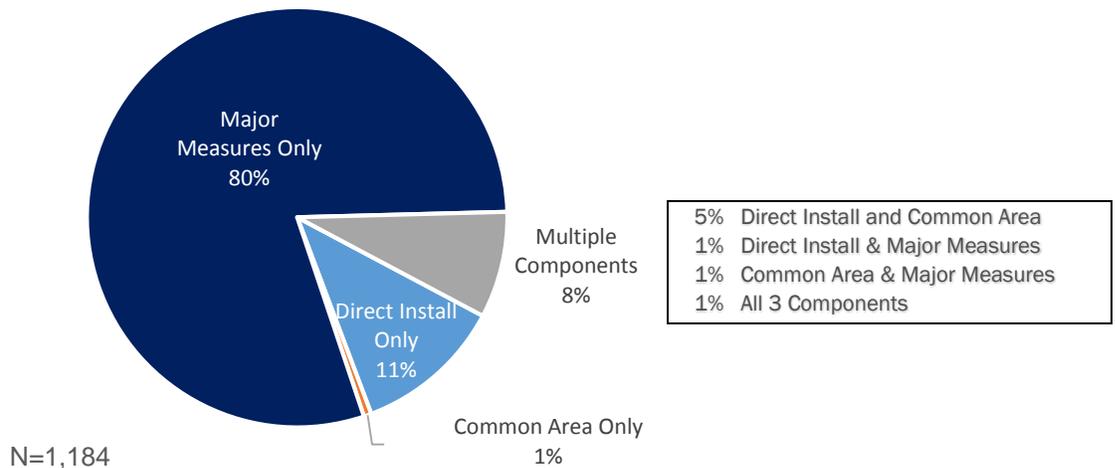
Component	Projects		Ex Ante Gross Electric Savings			
	#	%	kWh	%	kW	%
Common Area Lighting	47	5.0%	57,269	0.4%	8	0.4%
Major Measures	896	95.0%	13,340,778	99.6%	2,129	99.6%
Total ^a	943		13,398,047		2,137	

^a Totals may not sum due to rounding.

Note: The number of projects are based on unique Project ID.

To fully assess uptake of different project types, the team also looked at participation across both the AIC and IPA programs. Across both of these programs, program staff completed 1,940 projects in 1,184 multifamily buildings.⁴ As shown in Figure 2, the majority of these buildings (80%) only performed shell measure upgrades, the majority of which came through the IPA program. Further, only a few buildings participated in more than one component although program allies indicated they generally make property managers aware of other program offerings when appropriate.

Figure 2. Multifamily Building Upgrades Across AIC and IPA Programs



⁴ Defined by unique street address

3.3.2 Trends in Participation

Figure 3 plots the number of projects completed through the Multifamily Programs (AIC and IPA), as well as the ex post net savings from PY5 to PY7. As shown, the number of projects completed through the program has doubled over the past three years from 835 projects in PY5 to 1,940 projects in PY7. Electric savings also increased significantly from 15,754 MWh to 22,851 MWh (45% increase) due to the addition of the IPA program offering, which is electric only.

Figure 3. Multifamily Program Participation and Savings PY5-PY7 (AIC and IPA Programs)

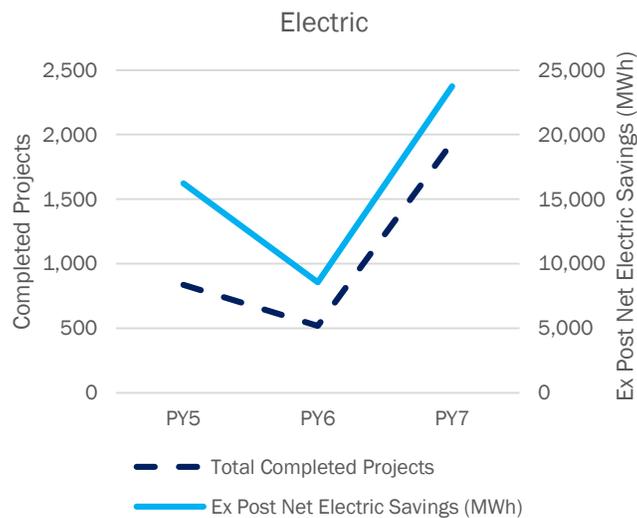
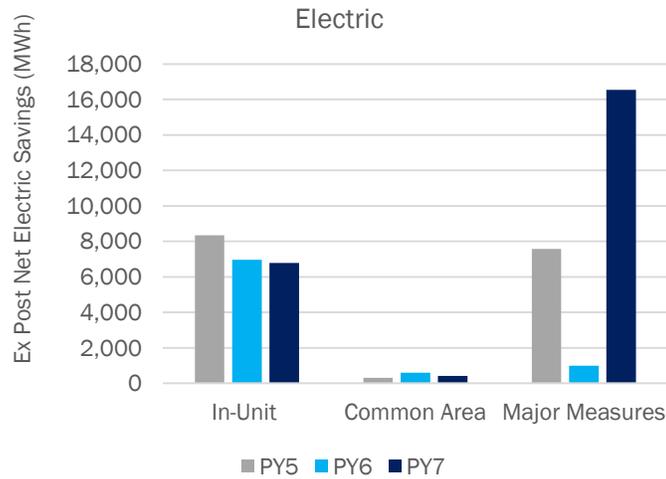


Figure 4 shows savings achieved by project type across both programs and indicates that the removal of shell or major measures in PY6 drove the decline in savings that year. It also shows that in part through use of the IPA program as a delivery mechanism for shell or major measures, program sponsors are achieving greater savings through that component than in any of the prior program years.

Figure 4. Savings by Project Type from PY5-PY7 (AIC and IPA Programs)



3.3.3 Participant Satisfaction and Program Engagement

Overall, the evaluation team found that participants are highly satisfied with the program, and will likely participate again with other properties. Similarly, participants report very few issues associated with participation, and those mentioned largely relate to their work with program contractors. Note that we present survey results for all Multifamily Program participants (IPA and AIC) given the small number of IPA only participants (Table 3).

Customer Entry into the Program

Consistent with the program’s outreach strategy and findings from the PY6 program evaluation, Table 11 shows that participating property managers most commonly learned about the program through implementer staff (29%) or AIC representatives (19%). Likewise, these results show that very few participants learn about the program from information sources outside of those prioritized by program staff.

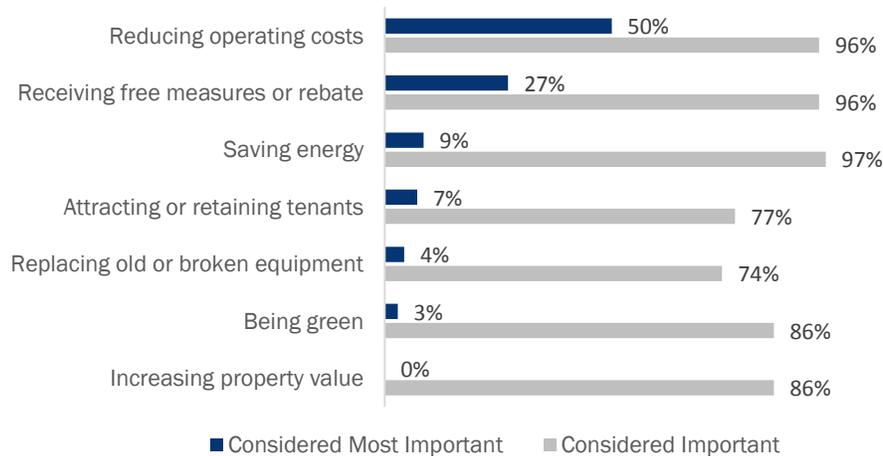
Table 11. How Participants Heard About the Program (Multiple Response)

Ways to learn about the program	Percent (n=70)
Multifamily Program staff (phone call or visit)	29%
AIC	19%
Word-of-mouth / colleague	14%
Mailing/Brochure/Flyer	10%
Contractor	10%
Associations	7%
Participated before	4%
Website	4%
Email	3%
Don't know	4%

Detailed Evaluation Findings

To understand what drives customers to participate in the Multifamily Program, the evaluation team also asked participating property managers/owners whether a number of specific factors were important in motivating them and followed up with a question about what factor was most important. As shown in Figure 5, although property managers/owners generally consider all of the factors we asked about as important, half of the participating property managers/owners reported that reducing operating costs was the most important in motivating them to participate.

Figure 5. Factors Important in Motivating Participation



n=70

Property Manager Satisfaction and Recommendations for Improvement

The evaluation team also explored property managers' and owners' satisfaction with the program, and asked about challenges in the participation process and suggestions for program improvement. As shown in Table 12, program satisfaction remains high across almost all of the aspects reviewed.

Table 12. Property Manager Satisfaction with the Program

Satisfaction with ...	Mean Score
Program overall (n=70)	9.4
Quality of the Direct Install and Common Area Work (n=34)	9.3
Performance of the equipment (n=69)	9.2
AIC overall (n=70)	9.1
Quality of Insulation Work (n=35)	8.6

Note: Scale from 0 to 10, where 0 is "Very dissatisfied" and 10 is "Very satisfied."

Further, very few property managers/owners (eight of 70) experienced challenges during their participation in the program. Among those who did report issues with their participation, five out of eight noted problems with their contractors who performed shell measure upgrades. The challenges identified include:

- Issues with the contractor's work, including audit errors, equipment failure, and the contractor leaving behind an uncleaned work site (3)

Detailed Evaluation Findings

- Communication issues with the contractor (2)
- Longer project timeline than anticipated (2)
- No follow-up regarding common area upgrades after direct install upgrades in rental units (1)

While these comments are rare, responses to a question about how the Multifamily Program could be improved elicited responses related to the issues identified here. In particular, as shown in Table 13, respondents voiced a desire for greater contractor options and improved communications. However, it is clear that the majority of participants (60%) do not have suggestions for program improvement suggesting that implementation is generally meeting the needs of customers.

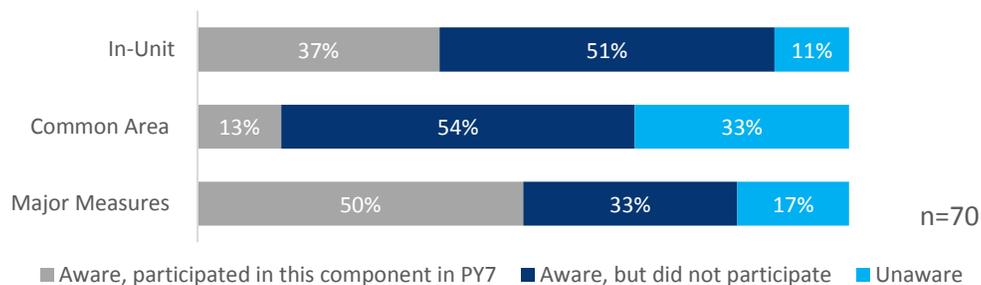
Table 13. Participant Suggestions for Program Improvement (Multiple Response)

Suggestions	Percent (n=70)
None	60%
More education on equipment and rebates	7%
Expand contractor options	7%
Improve installation schedules	6%
Expand measure mix	6%
Improve communication	6%
Other	10%

Awareness of and Participation in Other Program Components

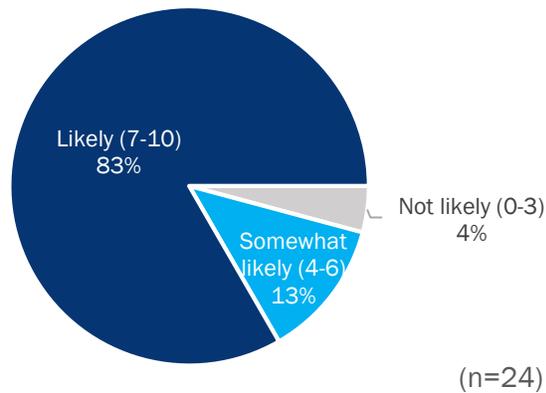
To explore potential participation across program components, the evaluation team asked property managers about their awareness of different program offerings. Figure 6 shows that only a small number of program participants had not heard of direct install upgrades in rental units (11%) or major measure upgrades (17%); however, one-third (33%) is not aware of opportunities to install common area lighting through the program.

Figure 6. Awareness of Multifamily Program Components among Participants



The evaluation team also found the potential for repeat participation at other customer facilities. In particular, one-third (34%) of the participating property managers/owners reported that they manage other multifamily properties that have not previously received Multifamily Program measures. The majority of them indicated that they would likely participate in the Multifamily Program with their other properties in the future (Figure 7).

Figure 7. Participant’s Likelihood to Participate at Other Properties



To identify any barriers to participation with other properties, the evaluation team also asked respondents who indicated that they had not participated at all of their multifamily properties over the past five years (24 respondents) why they had not done so. Not all offered an explanation, but those who did indicated that other properties were not eligible (8), that the project was not feasible (3), that the timing did not work (2), or that they only recently acquired the other properties (2). One respondent also reported that the program had no more funds available, and another one could not participate because the company lacked staff to install the measures.

Multifamily Program Awareness among Non-Participating Property Managers

The evaluation team leveraged the non-participating property manager/owner survey to explore awareness of the Multifamily Program among other property managers/owners in AIC service territory. Close to half of those we spoke with (eight of 20) reported that they were aware of the program.⁵ These customers said they learned about the program from various sources, including word-of-mouth (3 respondents), a phone call from AIC, a brochure, a contractor, or the internet (mentioned by one respondent each). Only one of them reported that, due to other priorities, they are unlikely to participate in the program next year.

3.4 Program Ally Satisfaction and Engagement

The program implementers worked with nine program allies to provide building shell upgrades through both the AIC and IPA programs. The program allies generated leads, conducted site visits to identify energy savings potential, and completed measure installations and paperwork on behalf of the program. Overall, two of the contractors who participate in both AIC and the IPA programs completed 85% of all PY7 building shell projects.

⁵ In contrast, interviews with program allies suggest that few property managers/owners are aware of the program. As noted in the methodology section of the report, data from the non-participant survey is intended to provide directional information, but may not be representative of the full population.

As noted in the Evaluation Tasks section of the report, the evaluation team interviewed four of nine program allies who represent over 90% of all building shell projects funded by the program. This section summarizes the findings from the four in-depth interviews.

Program Ally Involvement in the Multifamily Sector

- **Prior Involvement in the Multifamily Sector:** Before participating in the program, contractor involvement in the multifamily sector was limited. In particular, all four contractors reported providing very few or no services to the multifamily sector in AIC service territory. While two of the contractors explained they still mainly focus on single-family homes, the other two contractors indicated that the majority of their work in AIC service territory is now related to the Multifamily Program because their business model is geared towards program participation.⁶
- **Location of Program Projects:** The two contractors who completed the majority of Multifamily Program building shell projects served all of AIC's service territory. The other contractors with whom we spoke focused on buildings in the north or the south of the service territory.

Program Marketing

- **Participant Identification and Outreach:** Program allies used a mix of strategies to identify prospective program participants. One contractor conducted outreach through industry associations and events, while others used online searches, drive-bys and cold calling. In addition, one contractor indicated taking a more passive approach and waiting for customers to approach them. All contractors suggested that awareness of the Multifamily Program is low among property managers/owners. Nevertheless, they felt that the level of marketing done by the program was appropriate given that allies exhaust any funds for major measure upgrades quickly.
- **Referrals to Other Programs:** All the program allies with whom we spoke indicated that they regularly refer customers to the program's direct install component, as well as other AIC program offerings where appropriate. The other programs that contractors mentioned referring customers to include the All Electric Homes Program and the Home Efficiency Standard Program.

Program Processes

- **Training:** The Program facilitated a kick-off meeting at the beginning of PY7, as well as quarterly meetings to discuss program changes or challenges, which program allies described as useful. Program allies generally felt that they do not need any additional training because the implementer is responsive to any issues that may arise throughout the year.
- **Reservation System:** Allies described the reservation system as useful, fair, and easy to navigate but raised three related issues. One contractor explained that the reservation system resulted in a heavier workload during the first half of the program year and subsequent difficulties in managing staffing thereafter. Another contractor noted that the reservation system led to a slower project turnaround as it took approximately 10-15 days to receive a reservation number. Finally, one contractor indicated that some allies were unable to complete projects for their reserved funds. It is important to note that

⁶ A review of the program database showed that these two contractors completed more than 80% of all Multifamily building shell projects.

to avoid potential shortfalls in savings despite a filled project pipeline, CSG has now set an expiration date on reserved funds, which require program allies to complete projects in a set timeframe.

- **Ease of Customer Participation:** Program allies described program participation for property managers/owners as relatively easy. They reported that property managers were most concerned about accessing tenant units and allocating their staff to accompany program allies working within these units. However, despite these comments, the participating property manager/owner survey did not confirm these concerns.

Program Ally Satisfaction & Recommendations

- **Satisfaction with the Program:** Program allies are satisfied with their participation in the program, and gave satisfaction scores between 8 and 9 on a 10 point scale, where zero is not at all satisfied and 10 is extremely satisfied. In general, they highlighted that communication between program staff and allies had improved in comparison to earlier program years and that the introduction of the reservation system was generally helpful.
- **Recommendations for Improvement:** Although program allies described the program processes and requirements as easy and appropriate, they raised the following issues and associated recommendations to improve the program:
 - Two contractors indicated that participation would be easier for them if the paperwork was revised to fit more projects on a single form and if digital forms were available.
 - One contractor noted that incentive payments to program allies took approximately six weeks and that faster payment would be helpful.

3.5 Market Characterization

The market characterization study draws upon multiple primary and secondary data sources. The principal source of secondary information is the 2009-2013 American Community Survey (Census data), though we also draw on AIC customer data. The Census data provides information on the number of units in multifamily structures, the year those units were built, as well as important socio-demographic data on building occupants. The principal source of primary data is surveys of participating and non-participating property managers. These surveys provide valuable information about building ownership structure, how buildings are managed, and how key decisions are made. Key findings from the market characterization study, as summarized below, fall into four main categories. The complete market characterization study, with accompanying tables and graphics, can be found in Appendix B.

Number and Location of Multifamily Buildings

- There are approximately 156,103 multifamily housing units in AIC's service area. These units are located in approximately 15,167 buildings, almost 80% of which contain nine (9) or fewer units.
- Renters occupy 150,001 (96.1%) of the 156,103 units in 3+ unit buildings, meaning that very few units within multifamily buildings in AIC's service area are owner occupied.
- The majority of multifamily buildings are located in the very largest urban areas, including: Peoria, Bloomington/Normal, Champaign, Springfield, and St. Louis. Not surprisingly, nearly all of the very largest buildings (i.e., those with 20+ units) are also located in these metropolitan areas.

- Buildings eligible to participate in the program (3+ units and market rate) tend to be both located on the outskirts of major metropolitan areas (i.e., the suburbs) and in more rural communities. They also tend to be smaller (i.e., contain 9 or fewer units).

Characteristics of Units within Multifamily Buildings

- Roughly 75% of multifamily housing units in AIC's service area (here defined as 2+ units)⁷ were built after 1959.
- According to participating property managers, electricity is the most common space heating (74%) and water heating (67%) fuel type in participating multifamily buildings within AIC's service area.
- Participating property managers also report that the vast majority of the participating multifamily units within AIC's service area have either room or central air conditioning (85%) and nearly all tenants pay their own electricity (93%) and gas (89%) bills.

Characteristics of Building Occupants

- Occupants of multifamily dwellings are significantly younger than occupants of single-family homes. Compared to single-family dwellers, they are also more transient, more likely to be single or two-person households, and more likely to have incomes below \$50,000 annually.

Characteristics of Multifamily Property Management Firms

- Two-thirds (67%) of all multifamily units operated by survey respondents' companies are managed by a small group of companies (12%)—suggesting a high concentration of the market.
- Property managers are most likely to consult with contractors and internal staff when making building improvement decisions. The property owner, however, is the ultimate decision maker in the vast majority of situations, with upfront costs and budget considerations as key inputs.
- Energy efficiency is a strong consideration in the decision-making process most of the time. However, relatively few firms have an energy policy or a staff member responsible for managing energy use.

3.6 Impact Evaluation

The following sections provide participation rates, measure verification rates, and gross and net impacts for the PY7 IPA Multifamily Program.

3.6.1 Participant Verification

The evaluation team verified participants and installation rates in PY7 through a review of the program-tracking database. As part of our review, we checked for errors and overall data quality. Table 14 summarizes program participation in terms of the projects and unique customers found in the database.

⁷ Multifamily is defined here as 2+ units because this is the way building age is reported within the Census data, which are provided in a manner that does not allow one to create alternative groupings (i.e., more granular data is not available).

Table 14. Summary of PY7 Program Participation

Component	Number of Projects ^a	Number of Customers by Component
Common Area Lighting	47	35
Major Measures	896	99
Total	943	120

^a The number of projects are based on unique Project ID.

As noted throughout the report, participating property managers/owners install a variety of lighting measures through the program in common areas. Additionally, the program incentivizes building shell measures, such as air sealing and attic insulation for participants with electric heating. Table 15 provides an overview of the measures installed based on the team’s review of the program-tracking database.

Table 15. Summary of Verified PY7 Participation by Measure Type Based on Database Review

Project Type	Measure	Installed Location	Unit	# of Measures	Verification Rate
Common Area	Linear Fluorescent HPT8	Common Area Interior	Fixture	179	1.0
	Modular CFL		Lamp	161	1.0
	LED Exit Sign		Exit Sign	71	1.0
	Occupancy Sensor		Sensor	31	1.0
Major Measures	Air Sealing	N/A	CFM	3,382,957	1.0
	Attic Insulation	N/A	SqFt	2,394,867	1.0
Total				5,778,266	1.0

Note: Verification rate = number of verified measures ÷ number of reported measures.

3.6.2 Ex Post Gross Impact Results

Overall, total ex post first-year annual gross energy and demand impacts for the PY7 IPA Multifamily Program are 15,437 MWh and 3.93 MW. In addition, the gross realization rates are 115% for electric savings and 184% for demand savings. Table 16 presents the ex post impacts and the calculated realization rate by measure. Explanations of specific adjustments and calculations are included in the sections that follow for measures with realization rates greater than or less than 100%.

Table 16. PY7 IPA Multifamily First-Year Ex Post Gross Impacts

Measure	Ex Ante Gross Impacts		Ex Post Gross Impacts		Gross Realization Rate ^a	
	MW	MWh	MW	MWh	MW	MWh
Air Sealing	1.928	9,742.9	3.549	11,513.3	1.84	1.18
Attic Insulation (R-11 to R-49)	0.170	3,193.9	0.336	3,451.3	1.98	1.08
Attic Insulation (R-19 to R-49)	0.031	404.0	0.038	409.9	1.24	1.01
LED Exit Sign	0.003	18.4	0.003	21.4	1.00	1.16
Modular CFLs (interior)	0.002	15.3	0.002	17.7	1.00	1.16
HPT8 Linear Fluorescent	0.001	10.0	0.001	10.0	1.01	1.00
Modular CFLs (exterior)	0.000	7.5	0.000	7.5	1.21	1.00
Occupancy Sensor	0.002	6.1	0.002	6.1	1.00	1.00
Total	2.137	13,398.0	3.932	15,437.2	1.84	1.15

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

Note: Numbers may not total due to rounding.

There are a number of reasons for the differences between ex post and ex ante gross savings. To ensure that the team identified the reasons for any key discrepancies, we spoke with CLEAResult about potential reasons for the differences found through our analysis and summarize them in Table 17. We describe the basis for measure-level realization rates in more detail following the table.

Table 17. Explanation of Gross Realization Rate Differences by Measure

Measure	Gross Realization Rate		Source of Discrepancy			
	MW RR	MWh RR	Waste Heat Factor	Heating Penalty Algorithm	Unable to Access	Other (Specified)
Air Sealing	1.84	1.18			X	
Attic Insulation (R-11 to R-49)	1.98	1.08			X	
Attic Insulation (R-19 to R-49)	1.24	1.01			X	
Modular CFLs (interior)	1.00	1.16	X	X		
Modular CFLs (exterior)	1.21	1.00				- Misapplied demand ex ante value
HPT8 Linear Fluorescent	1.01	1.00				- Rounding error for demand ex ante value
LED Exit Sign	1.00	1.16	X	X		
Occupancy Sensor	1.00	1.00				

Overall, inputs for air sealing and attic insulation have the largest impact on program level realization rates. Given that air sealing measures account for 73% and attic insulation account for 27% of the reported energy program savings, any differences within these measures affect the program savings significantly. 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.

- **Undetermined Discrepancy for Major Measures:** As noted in the table, the team was unable to assess key reasons for differences between ex post and ex ante savings for major measures such as air sealing and insulation. This was due to the fact that documentation provided by the implementer did not include the variable assumptions for the deemed ex ante values applied in the program-tracking database.
- **Application of Waste Heat Factors:** The ex ante energy savings included the waste heat factor penalty for all interior common area lighting, which lowered the energy savings. However, consistent with past evaluations, and per agreement between ICC staff and AIC regarding the treatment of waste heat factors for goal attainment, we did not include waste heat factor penalties for lighting in the calculation of ex post savings. Therefore, ex post savings were higher. (The heat factor penalties are included in the calculation of the cost-effectiveness of the program. We present this information in Appendix E.)
- **Incorrect Heating Penalty Algorithm:** The ex ante heating penalty for interior common area lighting is not based on the heating penalty algorithm provided in the IL-TRM V2.0. Instead, ex ante heating penalties are calculated using the energy savings algorithm from the IL TRM.
- **Incorrectly Applied Ex Ante Demand Savings:** Ex ante demand savings applied savings for exterior modular CFLs incorrectly. The per unit ex ante demand savings is 0.00018 kW/fixture. However, the database applies demand savings inconsistently across all 100 fixtures: 0 kW/fixture for 17% of fixtures, 0.00017 kW/fixture for 58% of fixtures, 0.00013 kW/fixture for 8% of fixtures, 0.00033 kW/fixture for 6% of fixtures, and only 11% of fixtures had the correct demand ex ante value of 0.00018 kW/fixture applied. Had all fixtures applied the 0.00018 kW/fixture, the demand realization rate would be 100%.
- **Ex Ante Demand Savings Rounding Error:** The demand realization rate for linear fluorescent fixtures is 101% due to a small rounding error in the ex ante demand savings value. Instead of applying the savings value of 0.0082 kW/fixture (as seen in the implementer ex ante assumptions spreadsheet), the linear fluorescent fixtures in the database applied 0.008182 kW/fixture. The difference is insignificant and only underestimates ex ante demand savings by 1%.

3.6.3 Net Impacts

The total net energy and demand impacts for the PY7 IPA Multifamily Program are 15,437 MWh and 3.93 MW. The net realization rate is 115% for electric savings and 184% for demand savings, as shown in Table 18. Outside of gross savings adjustments, there are no differences between ex ante and ex post net savings.

Table 18. PY7 IPA Multifamily Program Net Impacts by Measure

Measure	Ex Ante Net Impacts		Ex Post Net Impacts		Net Realization Rate ^a	
	MW	MWh	MW	MWh	MW	MWh
Air Sealing	1.928	9,742.9	3.549	11,513.3	1.84	1.18
Attic Insulation (R-11 to R-49)	0.170	3,193.9	0.336	3,451.3	1.98	1.08
Attic Insulation (R-19 to R-49)	0.031	404.0	0.038	409.9	1.24	1.01
LED Exit Sign	0.003	18.4	0.003	21.4	1.00	1.16
Modular CFLs (interior)	0.002	15.3	0.002	17.7	1.00	1.16
HPT8 Linear Fluorescent	0.001	10.0	0.001	10.0	1.01	1.00
Modular CFLs (exterior)	0.000	7.5	0.000	7.5	1.21	1.00
Occupancy Sensor	0.002	6.1	0.002	6.1	1.00	1.00
Total	2.137	13,398.0	3.932	15,437.2	1.84	1.15

^a Net Realization Rate = ex post net value ÷ ex ante net value.

Note: Numbers may not total due to rounding.

4. Key Findings and Recommendations

PY7 evaluation activities addressed both impact and process issues. The impact work consisted of an analysis of the program database, related engineering work, and the application of NTG ratios provided through the IPA bidding process. The process work consisted of surveying both participating (70) and nonparticipating (20) property managers, program and implementation staff, and key trade allies. Finally, based largely on Census data and AIC customer data, the evaluation team completed a market characterization study. From these evaluation activities, we highlight the following findings and recommendations.

Multifamily Market Characterization

- There are approximately 156,103 multifamily housing units in AIC's service area. These units are located in approximately 15,167 buildings, almost 80% of which contain nine or fewer units.
- Eligible multifamily properties (i.e., 3+ units and market rate) tend to be located on the outskirts of major metropolitan areas (i.e., the suburbs) or in more rural communities. They also tend to be smaller (i.e., contain nine or few units).
- Occupants of multifamily buildings, compared to their single-family counterparts, tend to be younger, more transient, more likely to be single- or two-person households, and have lower incomes.

Program Implementation

A number of key changes took place in PY7 that had positive impacts on the program. The program began to cover the full cost of select common area lighting measures, brought a QA/QC inspector on board, and systematically tracked budget expenditures and associated trade ally activities (particularly for major measures). In addition, research with participants and non-participants provided insight into program delivery and outreach.

- **Key Finding #1:** Participating property managers are highly satisfied with the program and those with additional properties are likely to participate in the future. Contractors also appear to be happy with the program, noting that communications between program staff and trade allies have improved over time.
 - **Recommendation:** The ownership and management of multifamily properties appears to be highly concentrated, meaning a relatively small percentage of property management firms oversee a high percentage of all multifamily buildings. As a result, it is imperative to ensure that current participants have positive program experiences. A consistent commitment to QA/QC and a timely resolution of outstanding issues/problems should remain in use to ensure current participants continue to partake in the program.
- **Key Finding #2:** The vast majority of participating property managers are aware of all three program components (i.e., in-unit direct install, common area direct install, major measures), suggesting that all parties involved in the multifamily program are doing a good job making sure participating property managers are aware of all program possibilities. About one-half of nonparticipating property managers are aware of the program. However, it is possible that awareness is lower as program allies suggest that few property managers and owners are aware of the program.
 - **Recommendation:** Continue to emphasize that all parties involved in the multifamily program promote all three program components. Awareness of the various program components, among

Key Findings and Recommendations

participating property managers, appears to be high. Therefore, the future goal is to maintain present awareness levels by continuing to focus on cross-component marketing.

- **Recommendation:** Additional outreach, across multiple communication channels, may be needed to increase awareness among nonparticipating property managers. Industry events and associations, including associated publications, may be a good way of reaching these individuals. Outreach should also include contractors and equipment manufacturers as both groups are common sources of information for nonparticipating property managers. Communications should emphasize the program's ability to help property managers reduce operating costs.
- **Key Finding #3:** Building owners plays a critical role in approving building and efficiency upgrades and are particularly motivated to reduce building operating costs.
- **Recommendation:** It is important to develop strategies to engage building owners, as the central decision maker, in conversations about potential energy efficiency projects. Associated with this, property managers should be provided with information that will support them in pitching energy efficiency upgrades to building owners.

A. Appendix - Market Characterization: Detailed Findings

Provided under a separate cover.

B. Appendix - Data Collection Instruments



Participating
Property Manager S



Non-Participant
Property Manager S



Program Ally IDI
Guide

C. Appendix - Multifamily Program Assumptions and Algorithms

In PY7, the impact evaluation efforts estimated gross impact savings for the Residential Multifamily Program by applying savings algorithms from the Illinois Statewide Technical Reference Manual (TRM) V2.0 (2013)⁸ 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.

Lighting Algorithms

Modular Compact Fluorescent Lighting (CFLs)

Multifamily common areas have algorithm input values in both the commercial and residential sections of the TRM (Section 4.5 and 5.5.1, respectively). We chose to use the residential information to match previous analyses. Residential inputs have lower hours of use for exterior lighting and lower waste heat factors for both cooling and heating.

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

Equation 1. Modular 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 19. Baseline Wattages for Modular CFLs

Measure	EISA Adjusted ^a	Baseline Wattage
Modular (Pin-based) CFL – Interior	Yes	72
Modular (Pin-based) CFL – Exterior	Yes	72

^a The EISA schedule requires baseline adjustments to measures with incandescent baseline wattages of 100W (as of June 2012).

WattsEE = Wattage of installed equipment

Table 20. Installed Wattage of Modular CFLs

Measure	Installation Location	WattsEE
Modular (Pin-based) CFL	Common Area Interior	23.5
Modular (Pin-based) CFL	Common Area Exterior	25.0

ISR = In-service rate or the percentage of units rebated that get installed = 96.9%

⁸ Illinois Statewide Technical Reference Manual for Energy Efficiency V2.0, June 7, 2013. Effective June 1, 2013.

Hours = Annual operating hours

Table 21. Annual Hours of Use for Modular CFLs

Measure	Installation Location	Hours
Modular (Pin-based) CFL	Common Area Interior	5,950
Modular (Pin-based) CFL	Common Area Exterior	1,643

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

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

Table 22. Energy and Demand Waste Heat Factors for Modular CFLs

Measure	Installation Location	WHF _e	WHF _d
Modular (Pin-based) CFL	Common Area Interior	1.04	1.07
Modular (Pin-based) CFL	Common Area Exterior	1.00	1.00

CF = Summer Peak Coincidence Factor

Table 23. Coincidence Factors for Modular CFLs

Measure	Installation Location	CF
Modular (Pin-based) CFL	Common Area Interior	0.750
Modular (Pin-based) CFL	Common Area Exterior	0.004

Linear Fluorescent Lighting

The algorithm input values for linear fluorescent lighting are from the commercial section of the TRM (Section 4.5). The residential section of the TRM does not include linear fluorescent lighting. However, the waste heat factors for both cooling and heating are higher in the commercial section of the TRM when compared to the waste heat factors for residential lighting. We felt this was appropriate for linear fluorescent lighting since the program installs new fixtures with a ballast replacement which would ultimately result in higher heating penalties.

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

Equation 2. Linear Fluorescent Algorithms

$$\text{Energy Savings: } \Delta kWh = ((\text{WattsBase} - \text{WattsEE}) / 1000) * \text{ISR} * \text{Hours} * \text{WHF}_e$$

$$\text{Demand Savings: } \Delta kW = ((\text{WattsBase} - \text{WattsEE}) / 1000) * \text{ISR} * \text{WHF}_d * \text{CF}$$

Where:

WattsBase = Wattage of existing equipment = 32W⁹

WattsEE = Wattage of installed equipment (actual wattage of installed measure) = 25W

⁹ Baseline wattage equivalent for a retrofit installation of HPT8 (25W) linear fluorescent fixture as stated in Table A-2 in IL TRM V2.0

Appendices

ISR	= In-service rate or the percentage of units rebated that get installed = 100% ¹⁰
Hours	= Annual operating hours for common area installs in MF buildings = 5,950 hours/year
WHF _e	= Waste heat factor for energy (accounts for cooling savings from efficient lighting) = 1.34
WHF _d	= Waste heat factor for demand (accounts for cooling savings from efficient lighting) = 1.57
CF	= Summer Peak Coincidence Factor = 0.75

LED Exit Signs

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

Equation 3. LED Exit Sign Algorithms

$$\text{Energy Savings: } \Delta kWh = ((\text{WattsBase} - \text{WattsEE}) / 1000) * \text{Hours} * \text{WHF}_e$$

$$\text{Demand Savings: } \Delta kW = ((\text{WattsBase} - \text{WattsEE}) / 1000) * \text{WHF}_d * \text{CF}$$

Where:

WattsBase	= Wattage of existing incandescent exit sign = 35W
WattsEE	= Wattage of installed LED exit sign = 2W
Hours	= Annual operating hours = 8,766 hours/year
WHF _e	= Waste heat factor for energy (accounts for cooling savings from efficient lighting) = 1.04
WHF _d	= Waste heat factor for demand (accounts for cooling savings from efficient lighting) = 1.07
CF	= Summer Peak Coincidence Factor = 1.0

Occupancy Sensors

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

Equation 4. Lighting Control Occupancy Sensor Algorithms

$$\text{Energy Savings: } \Delta kWh = kW_{\text{controlled}} * \text{Hours} * \text{ESF} * \text{WHF}_e$$

$$\text{Demand Savings: } \Delta kW = kW_{\text{controlled}} * \text{WHF}_d * (\text{CF}_{\text{baseline}} - \text{CF}_{\text{occupancy}})$$

¹⁰ 100% ISR per IL TRM V2.0 for completed application form with sign off that equipment is not placed in storage.

Appendices

Where:

- kW_{controlled} = Total wattage controlled by each occupancy sensor = 0.06 kW¹¹
- Hours = Annual operating hours of light fixtures being controlled = 5,950 hours/year
- ESF = Energy savings factor that represents the reduction in operating hours = 41% (Wall mounted occupancy sensors)
- WHF_e = Waste heat factor for energy (accounts for cooling savings from efficient lighting) = 1.34
- WHF_d = Waste heat factor for demand (accounts for cooling savings from efficient lighting) = 1.57
- CF_{baseline} = Summer Peak Coincidence Factor for fixtures without occupancy sensors = 0.75
- CF_{occupancy} = Summer Peak Coincidence Factor for fixtures controlled by occupancy sensors = 0.15

Lighting Measures Heating Penalty

The evaluation team determined heating penalties 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.

Common Area Lighting Heating Penalties

The fuel type for interior common areas is unknown for all measures with the exception of LED Exit Signs. The IL TRM assumes gas heating when the heating fuel type is unknown. The evaluation team determined gas heating penalties for lighting installed in common areas using the algorithms below.

Table 24. Heating Penalty Algorithms for Common Area Lighting

Measure	Heating Fuel	Heating Penalty Algorithm
Modular CFL	Unknown (Assumed Gas)	$\Delta\text{therms} = -(((\text{WattsBase} - \text{WattsEE}) / 1000) * \text{ISR} * \text{Hours} * \text{HF} * 0.03412) / \text{nHeat}$
Linear Fluorescent T8	Unknown (Assumed Gas)	$\Delta\text{therms} = -(((\text{WattsBase} - \text{WattsEE}) / 1000) * \text{ISR} * \text{Hours} * \text{-IFTherms})$
LED Exit Sign	Gas	$\Delta\text{therms} = -(((\text{WattsBase} - \text{WattsEE}) / 1000) * \text{ISR} * \text{Hours} * \text{HF} * 0.03412) / \text{nHeat}$
LED Exit Sign	Electric Resistance	$\Delta\text{kWh} = -(((\text{WattsBase} - \text{WattsEE}) / 1000) * \text{Hours} * \text{ISR} * \text{HF}) / \text{nHeat}$

¹¹ CSG confirmed that one occupancy sensor controls four 15W CFLs for a total of 60W controlled per sensor.

Where:

WattsBase = Wattage of existing equipment

Table 25. Baseline Wattages for Common Area Lighting

Measure	WattsBase
Modular CFL	72 Watts
Linear Fluorescent T8	32 Watts
LED Exit Sign	35 Watts

WattsEE = Wattage of installed equipment

Table 26. Efficient Wattages for Common Area Lighting

Measure	WattsEE
Modular CFL	23.5 Watts
Linear Fluorescent T8	25 Watts
LED Exit Sign	2 Watts

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

Table 27. Installation Rates for Common Area Lighting

Measure	ISR
Modular CFL	96.9%
Linear Fluorescent T8	100.0%
LED Exit Sign	100.0%

Hours = Annual operating hours

Table 28. Hours for Common Area Lighting

Measure	Hours/Yr
Modular CFL	5,950
Linear Fluorescent T8	5,950
LED Exit Sign	8,766

HF = Heating factor = 0.49

η_{Heat} = Efficiency of heating equipment

Table 29. Efficiency of Heating Equipment for Common Area Lighting

Heating Fuel	η_{Heat}	Units
Gas	0.7	AFUE
Electric Resistance	1.0	COP

IFTherms = Waste heat factor that accounts for the increase in gas space heating due to the decrease in rejected heat from efficient lighting = 0.015

Table 30 summarizes the heating penalties for the lighting measures installed in common areas offered through the program.

Table 30. Heating Fuel Penalties for Common Area (Interior) Lighting

Measure	Heating Equipment	ΔkWh	Δtherms
Modular CFL	Unknown (Assumed Gas)	n/a	- 6.68
Linear Fluorescent T8	Unknown (Assumed Gas)	n/a	- 0.62
LED Exit Sign	Gas	n/a	- 6.91
LED Exit Sign	Electric Resistance	- 141.75	n/a

Occupancy Sensor Heating Penalties

The evaluation team determined heating penalties for lighting where hours of use are reduced due to the installation of lighting controls. Occupancy sensors for this program were installed on fixtures that are located within interior common areas. Heating penalties are calculated for gas heating fuel only, as the fuel type for interior common areas in which occupancy sensors are installed is unknown. The IL TRM assumes gas heating fuel when the heating fuel type is unknown.

Equation 5. Heating Penalty Algorithms for Occupancy Sensors

$$\text{Heating Therm Savings: } \Delta\text{therms} = \Delta\text{kWh} * -IF\text{Therms}$$

Where:

ΔkWh = Energy savings per installed occupancy sensor = 196.1 kWh

IFTherms = Waste heat factor that accounts for the increase in gas space heating due to the decrease in rejected heat from efficient lighting = 0.015

Table 31 summarizes the heating penalties for the lighting measures where occupancy sensors are installed.

Table 31. Heating Fuel Penalties for Fixtures with Occupancy Sensors

Measure	Heating Equipment	Δtherms
Occupancy Sensors	Gas Heating ^a	-2.94

^a Heating fuel type unknown. IL TRM assumes gas heating when heating fuel type is unknown.

Air Sealing Algorithms

The evaluation team determined ex post air sealing savings using the algorithms below. The program-tracking database only includes air sealing for customers with electric heating. We did not include air sealing savings algorithms for gas heating. Cooling savings were calculated only for those where a central air conditioning unit exists based on information from the program-tracking database.¹²

¹² 794 (87%) records out of the 896 who received air sealing measures have central air conditioning (based on data in program-tracking database).

Equation 6. Air Sealing Algorithms

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

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

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

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

Where:

- CFM_existing = Infiltration at 50 Pascals as measured by blower door before air sealing (actual value from database)
- CFM_new = Infiltration at 50 Pascals as measured by blower door after air sealing (actual value from database)
- N_Cool = Conversion factor from leakage at 50 Pascal to leakage at natural conditions = 18.5¹³
- CDD = Cooling Degree Days (applied per participant based on location)

Table 32. 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

¹³ Assumed CZ2 Normal Exposure.

η_{Cool} = Seasonal Energy Efficiency Ratio (SEER) of cooling system (used actual from database when available)

Table 33. Cooling Efficiency Assumptions for Air Sealing

Information Provided	Number of Records (N= 896)	Manufactured Year	η_{Cool} (SEER)
No Central Air Conditioning ^a	102	n/a	n/a
Actual SEER	602	n/a	Actual
Manufactured Year	157	Before 2006	10.0
Manufactured Year	16	After 2006	13.0
None ^b	19	n/a	9.3

^a Cooling savings associated with air sealing was excluded from the ex post impacts for those without central air conditioning systems.

^b For those where the actual SEER and manufactured year is unknown we determined the average existing cooling efficiency using the actual SEER for all participants with central cooling (n=601)

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

Table 34. 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 = 15.75¹⁴

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

Table 35. 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 (used actual from database when available)

¹⁴ Applied average of 1, 1.5, 2, and 3-story buildings for normal exposure in CZ2.

Table 36. Electric Heating Efficiency Assumptions for Air Sealing

Information Provided	Number of Records (N=896)	Manufactured Year	ηHeat (COP)
Actual COP	421	n/a	Actual
None (Electric Resistance)	461	n/a	1.00
None (Heat Pump)	3	Before 2006	1.70
None (Heat Pump)	11	After 2006	1.92

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

Table 37. 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

Attic Insulation Algorithms

The evaluation team determined ex post attic insulation savings using the algorithms below. The program-tracking database only includes attic insulation for customers with electric heating. We did not include attic insulation savings algorithms for gas heating. Cooling savings were calculated only for those where a central air conditioning unit exists based on information from the program-tracking database.¹⁵

Equation 7. Attic Insulation Algorithms

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

$$\Delta kWh_{cooling} = (((1/R_{old} - 1/R_{new}) * A_{attic} * (1-Framing_factor/2)) * 24 * CDD * DUA) / (1000 * \eta_{Cool})$$

$$\Delta kWh_{heating} = (((1/R_{old} - 1/R_{new}) * A_{attic} * (1-Framing_factor/2)) * 24 * HDD) / (\eta_{Heat} * 3412)$$

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

¹⁵ 618 (90%) records out of the 684 who received attic insulation measures have central air conditioning (based on data in program-tracking database).

Appendices

Where:

- R_{new} = Total attic assembly R-value after the installation of additional insulation (see Equation 8 for assembly R-value algorithms)
- R_{old} = R-value of existing attic assembly and any existing insulation with a minimum of R-5 (see Equation 8 for assembly R-value algorithms)
- A_{attic} = Total area of insulated attic (sq.ft.) (actual value from database)
- Framing_factor = Adjustment to account for area of framing = 0.15 (framing factor included in the assembly R-value algorithms; see Equation 8)
- CDD = Cooling Degree Days (applied per participant based on project location)

Table 38. 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
- η_{Cool} = Seasonal Energy Efficiency Ratio (SEER) of cooling system (used actual from database when available)

Table 39. Cooling Efficiency Assumptions for Attic Insulation

Information Provided	Number of Records (N= 684)	Manufactured Year	η_{Cool} (SEER)
No Central Air Conditioning ^a	66	n/a	n/a
Actual SEER	547	n/a	Actual
Manufactured Year	60	Before 2006	10.0
Manufactured Year	1	After 2006	13.0
None ^b	10	n/a	9.3

^a Cooling savings associated with attic insulation was excluded from the ex post impacts for those without central air conditioning systems.

^b For those where the actual SEER and manufactured year is unknown we determined the average existing cooling efficiency using the actual SEER for all participants with central cooling (n=601).

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

Table 40. Heating Degree Days by Climate Zone

Climate Zone	HDD 60
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 (used actual from database when available)

Table 41. Electric Heating Efficiency Assumptions for Attic Insulation

Information Provided	Number of Records (N=684)	Manufactured Year	η_{Heat} (COP)
Actual COP	253	n/a	Actual
None (Electric Resistance)	419	n/a	1.00
None (Heat Pump)	1	Before 2006	1.70
None (Heat Pump)	11	After 2006	1.92

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

Table 42. 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

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 value using the ASHRAE Isothermal Planes method (page 27.3, ASHRAE Fundamentals, 2013).
- This method includes the IL TRM framing factor within the calculations as shown below.
- Equation 8 was not applied to calculate assembly R-values for pre-existing attic insulation for those with R-values less than 5. These cases were assigned an assembly R-value of 5 for attic insulation.

The following algorithms were used to calculate the assembly R-values for attic insulation:

Equation 8. Attic Assembly R-value Algorithms

$$\text{Attic Assembly R-value} = ((1/R\text{-value}_{\text{database}}) * \% \text{ of Assembly} + 1/R\text{-value}_{\text{Joist}} * \text{Framing_Factor}/2) + (R\text{-value}_{\text{indoor air film}} + R\text{-value}_{\text{plywood}} + R\text{-value}_{\text{gypsum}} + R\text{-value}_{\text{indoor air film}})$$

Where:

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

Framing_factor = Adjustment to account for area of framing = 0.15

Figure 8. 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	16.22
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		18.9
	U value		0.28		U value		0.05
	% of assembly	0.925	0.075		% of assembly	0.925	0.075
	U of assembly	0.28			U of assembly	0.05	
	R of assembly	3.58			R of assembly	18.88	

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

D. Appendix - Response Rate Methodology

Given that survey response rates are calculated and presented for all of the program surveys, below we present a definition and explanation of how we calculated the rate. 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 the American Association for Public Opinion Research (AAPOR).¹⁶ For various reasons, 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. The formulas used to calculate RR3 are presented below. The definitions of the letters used in the formulas are displayed in the Survey Disposition tables in the Methodology section of the report.

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

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

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 gives the percentage of participants who completed an interview out of all of the participants with whom we actually spoke. We used AAPOR Cooperation Rate 1 (COOP1), which is calculated as:

$$COOP1 = I / (I + R)$$

The approach to calculating response rates differs slightly for Internet-based surveys. In these instances, the survey response rate is the number of completed surveys divided by the total number of potentially eligible respondents in the sample. The quality of the email list is a key factor in determining the eligibility of participants who do not respond to the email but also do not bounce back. This calculation assumes a high-quality list in which all respondents are eligible except those who reply with an accepted reason why they are not eligible (e.g., employee of client).

¹⁶ 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 43 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. 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 are reduced by 2,410 kWh and 984 therms after the application of waste heat factors.

Table 43. PY7 WNCF Gross Impacts (Including Heating Penalties)

	kWh	kW	Therms
Gross Savings	15,437,233	3,932	0
Heating Penalty	- 2,410	0	- 984
Total Gross Savings with Heating Penalty	15,434,824	3,932	- 984

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. The fuel type for interior common areas is unknown for all measures with the exception of LED Exit Signs. The IL TRM assumes gas heating when the heating fuel type is unknown. We calculated heating penalties for 61 modular CFLs, 179 linear fluorescent fixtures, 71 LED Exit Signs, and 31 occupancy sensors resulting in total gross heating penalties of 2,410 kWh and 984 therms. Table 44 summarizes the heating penalty for these four measures.

Table 44. Heating Penalties by Measure

Measure	kWh	Therms
Modular CFLs	0	- 407
Linear Fluorescent	0	- 112
LED Exit Sign	- 2,410	- 373
Occupancy Sensor	0	- 91
Total Heating Penalty	- 2,410	- 984

Note: Numbers may not total due to rounding

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
Managing Director

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