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Evaluation of the 2016 (PY8) Illinois Power Agency Residential Multifamily Program

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1. Executive Summary

This report presents results from Program Year 8 (PY8) of the Illinois Power Agency (IPA) Multifamily Program, which was implemented from June 1, 2015 to May 31, 2016, by implementation contractor CLEAResult and its pool of program allies. As with PY7, multifamily program offerings in the Ameren Illinois Company (AIC) service territory are split between the IPA Multifamily Program and another multifamily program sponsored by AIC (referred to as the AIC Multifamily Program), which is also implemented by CLEAResult, along with Leidos.[1]

Together, the two programs offer multifamily customers three program components: common-area lighting (IPA and AIC), major measures for the building shell (IPA and AIC), and measures for tenant units (AIC only). CLEAResult's program allies deliver the major measures component, which includes lead generation, program enrollment, and completion of major measure installations. In contrast, CLEAResult delivers the direct install components themselves (common area lighting and in-unit), which include lead generation, program enrollment, and completion of direct installations (except for smart thermostats, which the implementer provides for property staff to install). Where applicable, CLEAResult and the program allies share leads with one another across the major measures and direct install components, so that property managers[2] are exposed to all applicable measures. Further, from the customer perspective, these programs and their components function as one offering.

In terms of program delivery, the Multifamily Program provides a variety of the common area lighting (LED exit signs, linear fluorescents, modular CFLs, and occupancy sensors) and major measures, such as air sealing and attic insulation for buildings with electric heat.[3] As a result of PY8 installations, the Multifamily Program was expected to contribute 36,333,751 kWh in electric savings in PY8. These goals represented an increase relative to PY7.

Our evaluation of the Multifamily Program included impact and process assessments.[4] We reviewed program materials and program-tracking data and interviewed program administrators and implementation staff. Our quantitative research included surveys of property managers who completed upgrades through the program. We also collected and analyzed data to support updated net to gross ratios (NTGRs) for prospective application to the Multifamily Program's components. Below we present the key findings of the PY8 IPA evaluation.

Program Impacts

Overall, the ex post net energy and demand savings from the PY8 Multifamily Program were 33,973 MWh and 3.01 MW, respectively (Table 1). The evaluation team verified all program measures through a review of the program-tracking database, and applied NTGRs from the Illinois Statewide Technical Reference Manual for Energy Efficiency Version 4.0[5] (IL-TRM V4.0). Based on this review, the program's realization rates for gross savings range from 72% to 94%; differences between ex ante gross and ex post gross savings calculations are due to variances in savings assumptions for specific measures.

[1] Hereafter, except where noted, "Multifamily Program" refers to the IPA Multifamily Program.

[2] We use the term "property manager" to refer to both property managers and property owners.

[3] The AIC Multifamily Program sponsors the remaining types of common area lighting (standard and specialty CFLs), major measures for buildings with gas heat, and the entire in-unit direct installation component.

[4] Several evaluation activities were completed in conjunction with the AIC Multifamily Program evaluation (program administrator and program implementer interviews, property manager survey, and net-to-gross ratio calculations for prospective application). The evaluation team provides results from the evaluation of the AIC Multifamily Program in a separate report.

[5] Illinois Statewide Technical Reference Manual for Energy Efficiency Version 4.0. Effective June 2015.

Table 1. PY8 Net Multifamily Program Impacts

	Ex Ante Gross	Gross Realization Rate	Ex Post Gross	NTGR[a]	Ex Post Net
Energy Savings (MWh)					
Total MWh	38,678	94%	36,226	0.94	33,973
Demand Savings (MW)					
Total MW	4.41	72%	3.17	0.95	3.01

[a] The NTGRs are estimated at a measure level but are shown in aggregate for the program here.

Program staff achieved the PY8 Multifamily Program savings presented above through implementation of 2,431 projects at 3,743 multifamily buildings (June 2015–May 2016). Most participants completed projects through the major measures (N=465) component, with a small number of property managers completing common area upgrades (N=14). Combined across the AIC and IPA multifamily programs, participation continues to grow year over year.

Relative to the PY7 program, which achieved ex post net energy savings of 15,437 MWh, the PY8 program achieved energy savings that were 120% higher in PY8 (33,973 MWh). However, the program's demand savings decreased by 23% from 3.93 MW in PY7 to 3.01 MW in PY8.

Key Findings and Recommendations

The Multifamily Program is achieving its stated goals to provide measures that enable energy savings and lower operating costs in market-rate multifamily housing. In PY8, the program achieved ex post net energy and demand savings of 33,973 MWh and 3.01 MW, respectively. Although the program achieved success in using additional marketing and expanding the pool of program allies to better recruit additional properties, the program fell somewhat short of its electric savings goal. Program implementers noted that a contributing factor may have been the fact that major measure installations tended to be smaller than planned, meaning that more properties were needed to meet the goal.

The Multifamily Program functioned in PY8 similarly to previous program years, but a few small changes were made to meet the higher program savings goals. The first change was allowing additional program allies to support the electric major measures component. This change expanded the pool of allies from one (a large statewide company) to a mix of several allies that included smaller regional companies. Overall, the implementer felt that the addition of local allies was beneficial. Second, given that the market is relatively mature, program administrators explored new program marketing opportunities and, as a result, delivered marketing presentations at several regional landlord-association meetings. According to program staff, these meetings were a "target-rich environment" that generated several new leads for the Multifamily Program.

Overall, program managers report that the Multifamily Program operated smoothly and effectively in PY8. Moreover, interviews with participating property managers suggest that participants are generally satisfied with all aspects of the program. The following findings and recommendations for the program are based on the results of our program evaluation:

- **Key Finding #1:** Outcomes of the PY8 evaluation found several small issues with the ex ante savings assumptions. In some cases, ex ante calculations applied inconsistent assumptions to energy (kWh) and demand (kW) savings calculations (e.g., LED exit sign baseline wattage). In other cases, ex ante savings used an average assumption for all projects, but the ex post analysis identified project-specific attributes in the program-tracking database (HVAC equipment age) that could have been used to develop project-specific ex ante savings assumptions. Finally, the evaluation team also found some

instances where program-tracking data did not reflect characteristics of the installed measures (such as actual pre- and post-insulation R-values).

- **Recommendation #1:** The evaluation team makes several recommendations with respect to the data tracked by the implementer, as well as the implementer's ex ante savings calculation approaches, namely:
  - Thoroughly review savings assumptions to verify that assumptions used in both energy and demand savings calculations are consistent.
  - Use data collected by the implementer, such as participant zip code and age of heating and cooling equipment, to inform savings calculations.
  - Review the program-tracking databases prior to submitting them to the evaluation team to minimize these types of discrepancies

- **Key Finding #2:** Participating property managers tended to be satisfied with their PY8 Multifamily Program experiences. For example, most participating property managers were highly satisfied with the program's key features, including the available measure offerings, the specific measures that they received, the rebate or discount amount, the program staff, and the contractors that installed upgrades. About one-half of the property managers with whom we spoke thought that there was nothing that the program needed to change to improve. The minority of respondents who did offer suggestions indicated that the program could improve the property manager experience by offering more measures, by increasing the visibility and depth of program marketing, or by offering different contractors.

- **Key Finding #3:** The program implementer and the program allies worked together to channel properties across major measures and direct install (in-unit, common area) components where applicable, but few properties (4%) participated in multiple components in PY8. Per the implementer, some property owners participate in multiple components across the span of multiple program years. Thus, the program's cumulative level of cross-component participation is likely to be higher than what annual evaluation data represent. Some of the property managers who completed only major measures upgrades in PY8 expressed a relatively high level of interest in available common area and in-unit offerings, and some individual property managers provided survey responses indicating that they were unaware of program components that they did not participate in. As some property managers may return to complete additional components in future years, the program may be able to capture more savings by formalizing its cross-component marketing procedures.
  - **Recommendation #3:** Continue to promote collaboration between program allies and program implementers to ensure that all property managers are aware of all program components available to them. As the program brings in a growing number of program allies, program implementers may find it beneficial to formalize the process by which program allies share direct install opportunities discovered at properties receiving major measures. The goal is to ensure that all property managers are consistently well informed about all types of savings opportunities.

- **Key Finding #4:** PY8 participants were generally satisfied with the mix of measures offered through the program, but some expressed interest in additional measures. A minority of respondents suggested that they would be interested in receiving additional types of measures through the program, including efficient windows and doors, HVAC upgrades, and insulation for walls and other parts of the building shell.

2. Evaluation Approach

The Project Year 8 (PY8) evaluation of the Illinois Power Agency (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 IPA and program implementation staff, and surveys with property managers. [6] We estimated ex post gross impacts by reviewing PY8 program-tracking data and applying the Illinois Statewide Technical Reference Manual for Energy Efficiency Version 4.0[7] (IL-TRM V4.0). We calculated PY8 ex post net savings by applying Illinois Stakeholder Advisory Group (SAG)-approved net-to-gross ratios (NTGRs) to ex post gross savings. In general, the team coordinated evaluation activities between the IPA Multifamily Program and the similar Ameren Illinois Company (AIC) Multifamily Program.

2.1 Research Objectives

The objective of the evaluation of PY8 of the Multifamily Program was to provide estimates of gross and net electric savings associated with the program. In particular, the PY8 impact evaluation answered the following questions:

1. What were the estimated gross energy and demand impacts from this program?
2. What were the estimated net energy and demand impacts from this program?
3. What was the estimated NTGR for in-unit direct install measures, common area direct install measures, and major measures to be applied starting in PY10?[8]

The evaluation team also explored a number of process-related research questions as part of the PY8 evaluation.[9] Through these questions, we explored key changes to the program, as well as the remaining market potential for the program in future years.

4. Program Participation
    a. How many projects were completed? By how many different customers? What types of projects?
    b. Did customer participation meet expectations? If not, how different was it and why?
    c. How many customers participated in more than one component?
5. Program Design and Implementation
    a. Did the program implementation change compared to PY7? If so, how and why and was this an advantageous change?
    b. What implementation challenges occurred in PY8, and how did the program overcome them?

[6] We use the term “property manager” to refer to both property managers and property owners.

[7] Illinois Statewide Technical Reference Manual for Energy Efficiency Version 4.0. Effective June 2015.

[8] As discussed further in the evaluation report, the evaluation team ultimately did not update the NTGR for common area measures given the low number of participants who received these measures in PY8.

[9] The evaluation team conducted these activities in conjunction with the AIC Multifamily Program.

6. Opportunities for Program Improvement
    a. What changes could the program make to improve the customer experience?
    b. What additional measures could the program offer to generate additional program savings? Which of these measures provide a relatively greater savings opportunity? Which are of greatest interest to participants?

2.2 Evaluation Tasks

Table 2 summarizes the evaluation activities conducted for the PY8 evaluation of the Multifamily Program.

Table 2. Summary of PY8 Multifamily Program Evaluation Activities

Activity	PY8 Process	PY8 Impact	Forward Looking	Details
Program Staff Interviews	✓			Conducted interviews with IPA and CLEAResult program managers to understand changes in program design and implementation.
Review of Program-Tracking Data and Materials	✓	✓		Reviewed the PY8 database, relevant administrative program reports, and marketing and outreach materials to document program design and changes.
Participating Property Manager Survey	✓	✓	✓	Conducted telephone surveys with participating property managers to collect data needed to update direct install and major measure NTGRs and to explore the experiences of property managers with the program and their interest in receiving additional energy efficiency measures.
Impact Analysis		✓		Conducted an engineering analysis of all measures installed during PY8.

Note: All activities were conducted in conjunction with the AIC Multifamily Program.

2.2.1 Program Staff Interviews

In June 2016, the evaluation team conducted in-depth interviews with the IPA program manager and with the CLEAResult program manager. The interviews provided the evaluation team with insights about program performance and program changes during PY8.

2.2.2 Review of Program-Tracking Data and Materials

In addition to program staff interviews, the evaluation team reviewed program materials, including the PY8 Multifamily Program Implementation Plan, a customer satisfaction survey conducted by the implementer, and program marketing materials. These materials included a marketing presentation that program staff made at a regional meeting of landlords during PY8. The team also reviewed the program-tracking database to examine the type of data that was tracked and to obtain data for both the process and impact analysis.

2.2.3 Participating Property Manager Survey

The evaluation team conducted quantitative telephone interviews with 57 property managers who participated in at least one component of the IPA or AIC Multifamily Program during PY8. Forty-five of these survey respondents (79%) participated in the IPA program. Property manager interviews focused on gathering

information needed to calculate NTGRs for the major measures (AIC and IPA offerings) and most in-unit measures (AIC only). We did not pursue interviews with property managers who participated only in the common area components (AIC or IPA offerings) because we did not expect that response rates to a census attempt of these customers would gather enough data to reliably estimate a NTGR for the offering. Interviews also collected information about participant satisfaction and interest in receiving additional energy efficiency measures. Detailed information on the NTGR analysis is provided in Appendix E.

Given this interviewing approach, the participant population for this survey included property managers either who received major measures through either the IPA or AIC program or who received in-unit direct install measures through the AIC program. (A minority of these property managers received common area lighting in addition to their major measures and/or in-unit upgrades. As a result, we present the same property manager survey findings in this report and in the AIC Multifamily Program report.)

Sample Design

Given the size of the participant population, the evaluation team did not sample property managers for this survey effort. Instead, we tried to contact all program property manager participants (including both the IPA and AIC programs). For the purpose of NTGR estimation, capturing the views of IPA and AIC participants as a group was deemed a reasonable approach, as customers were likely to consider similar motivating factors when deciding to participate in either offering. Moreover, customers in both programs experienced relatively similar program design and delivery (i.e., program factors) once they decided to participate.

We took a number of steps to develop a participant population frame from IPA and AIC program-tracking data. Sample development is discussed in more detail below. In total, the evaluation team identified 402 unique property manager contacts and completed 57 interviews. We fielded the survey from October 11, 2016 to October 25, 2016.

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

Sample Development

As the property manager survey was designed to ask participants about the rarest measures received through either program (the IPA program, the AIC program, or both), we combined the IPA and AIC Multifamily Programs' tracking databases for sample development. Since databases received from the implementer used different systems of unique identifiers for properties and projects, we developed a method to bring all records to the property street address level (including building number, if provided in both program-tracking datasets).[10] Table 3 shows the resulting participant population across both the IPA and AIC programs in terms of unique properties. More than three-quarters of PY8 properties (77%) received upgrades through the IPA program or

[10] Original identifiers in the AIC and IPA datasets (Project ID and Property ID) represented different groupings of property components, both within and across datasets. Based on our review of the datasets, *unique Project IDs* represented a tenant unit, several tenant units in a building, a whole building, several buildings within a multifamily complex, or a multifamily complex. In addition, a single unit, building, or complex each had either one or multiple Project IDs. While a single property's physical makeup might consist of either an individual building or a multi-building complex, for merging datasets, we defined a property as a unique street address, including building number. Where needed, we aggregated tenant units to the level of a street address for merging.

through both the IPA and AIC programs. Within the IPA program, all properties received major measures (100%) with few customers receiving common area lighting (<1%).[11]

Table 3. Overview of PY8 Multifamily Properties by Component and Program

Program Component Participation	Properties	% of Properties (n=4,432)	AIC Program Only (n=1,003)	IPA Program Only (n=3,308)	Both Programs (n=121)
Major Measures	4,022	91%	72%	100%	3%
In-Unit Measures	223	5%	22%	0%	0%
Common Area Lighting	13	<1%	<1%	<1%	0%
Multiple Components, including:	174	4%	5%	<1%	97%
Common Area and In-Unit	*47*	*1%*	*4%*	*n/a*	*2%*
Common Area and Major Measures	*3*	*0%*	*0%*	<1%	*2%*
In-Unit and Major Measures	*106*	*2%*	*1%*	*n/a*	*79%*
Common Area, In-Unit, Major Measures	*18*	*0%*	*0%*	*n/a*	*13%*
Total	4,432	100%	100%	100%	100%

Note: Due to rounding, column totals may not sum to 100%.

From this population of IPA and AIC program participants, we developed a sample frame for survey fielding. We removed duplicate contacts (based on phone number and property address) and cleaned duplicate phone numbers. The sample frame also excluded property managers who completed only IPA or AIC program common area lighting projects or who had no contact number or contact name. We attempted a census of program participants in the resulting sample frame (n=402).

For each respondent, we focused the NTGR battery on one measure type installed at one of the participant's properties to reduce the length of the survey and minimize respondent fatigue. For participants who completed upgrades at multiple properties or received multiple types of measures, we asked about the property that had the rarest measure in terms of rarity among all participants (i.e., we prioritized properties with measures that fewer participants installed in order to capture in-unit projects which were rarer in the population). Therefore, if a participant installed programmable thermostats, faucet aerators, and air sealing, the NTGR battery asked them to think only about their programmable thermostats (i.e., the rarest measure).

To expand coverage of PY8 savings through the NTGR survey, we also asked respondents whether their decision making for the selected measure was the same as their decision to install up to one additional measure that they received through the same program component (e.g., another in-unit measure or major measure). If the participant reported that both measures fell under the same decision-making process, we included the second measure in the NTGR analysis along with the first measure.

As shown in Table 4, Table 5 and Table 6, the sample frame and completed surveys generally represent the population-wide distribution of PY8 participants across the IPA and AIC programs, in terms of their extent of participation with multiple properties and in multiple measures, and across individual measures provided through the programs. Participants who responded to the survey most commonly both owned and managed the participating properties (56%), while 32% of respondents only managed properties and 12% only owned properties. Most survey participants installed multiple types of measures (96% of participants) and several

[11] The sample preparation method differs somewhat from past years, so total property counts are not comparable across years. In PY7, we were limited to a dataset with project numbers and telephone numbers and therefore selected properties based on unique phone numbers only.

participants completed upgrades at multiple properties (37% of participants). For participants who completed upgrades at multiple properties or received multiple types of measures we prioritized projects based on rarity to capture in-unit projects (which were rarer in the population), the survey responses were somewhat more heavily concentrated among participants who completed more-prevalent major measures (air sealing and insulation).

Table 4. AIC and IPA Representation among the Sample Frame and Completed Surveys

PY8 Participation	Percent of Property Managers (n=402)	Percent of Completed Surveys (n=57)
Program		
IPA	65%	74%
AIC	27%	21%
Both AIC and IPA	8%	5%
Total	100%	100%

Table 5. Extent of Program Participation among Sample Frame and Completed Surveys

Participation Category	Percent of Property Managers (n=402)	Percent of Completed Surveys (n=57)
Installed Multiple Types of Measures	94%	96%
Completed Upgrades at Multiple Properties	37%	32%

Table 6. Completed Multifamily Program Participant Interviews

Measure	Population[a]		Sample Frame[b]		Completed Surveys[c]	
	Participants[c]	%	Participants[c]	%	Participants[c]	%
Air Sealing	343	77%	318	79%	49	86%
Attic Insulation	351	79%	324	81%	51	89%
In-Unit Lighting	131	29%	101	25%	n/a	n/a
Faucet Aerator	112	25%	97	24%	10	18%
Showerhead	110	25%	94	23%	9	16%
Programmable Thermostat	67	15%	59	15%	6	11%
Common Area Lighting	64	14%	0	0%	n/a	n/a
Total	445	n/a	402	n/a	57	n/a

[a] Participants are counted once for each measure received at any property.
[b] Participants are counted once for each of the measures at the property selected for the survey.
[c] Participants are counted once for each of the measures asked about in the survey (we asked about up to two of all measures actually received at any property).

Survey Disposition and Response Rate

Table 7 presents the final survey dispositions for the participating property manager survey.

Table 7. Participating Property Manager Survey Dispositions

Category Key	Disposition	Total
I	Complete	57
N	Eligible Incomplete Interview	4
X1	Survey-Ineligible Property	14
U1	Household with Undetermined Eligibility	124
X2	Not a Property	25
U2	Undetermined if Property	178
e1	Estimated proportion of cases of unknown survey eligibility that are eligible	81%
e2	Estimated proportion of cases of unknown properties eligibility that are eligible	67%
Total Participants in Sample		402

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

Table 8. Participating Property Manager Survey Response and Cooperation Rate

AAPOR Rate	Percentage
Response Rate #3	26%
Cooperation Rate #3	32%

AAPOR = American Association for Public Opinion Research.

2.2.4 Impact Analysis

Gross Impact Analysis

To determine the gross impacts for the Multifamily Program, we applied the savings algorithms and input assumptions from the IL-TRM V4.0 and the V4.0 Errata Measures memo[12] using information provided in the program-tracking database. We outline the algorithms used to calculate all evaluated gross program savings in Appendix A, along with all input variables.

[12] V4.0 Errata Measures documenting 13 errata changes to the IL-TRM 4.0 as recommended by the Technical Advisory Committee. Effective 06/01/2015

Net Impact Analysis

The evaluation team calculated PY8 ex post net impacts by applying SAG-approved NTGRs to ex post gross savings by measure. Table 9 summarizes the measure-level NTGRs used to calculate PY8 Multifamily Program net savings.

Table 9. NTGRs by Measure Category

Measure Category	NTGR
Common Area Lighting	0.83
Air Sealing	0.96
Attic Insulation	0.88

The evaluation team has conducted research to update NTGRs for prospective application starting in PY10. These NTGR methods are presented in Appendix C.

2.3 Sources and Mitigation of Error

Table 10 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 10. Potential Sources of Error

Research Task	Survey Error		Non-Survey Error
	Sampling	Non-Sampling	
Program Staff Interviews	▪ n/a	▪ n/a	▪ n/a
Secondary Data Review	▪ n/a	▪ n/a	▪ Data processing error
Participating Property Manager Survey	▪ No sampling error since it was an attempted census	▪ Sample frame error ▪ Measurement error ▪ Non-response and self-selection bias ▪ Data processing error	▪ n/a
Impact Analysis	▪ n/a	▪ n/a	▪ Data processing error

The evaluation team took a number of steps to mitigate the potential sources of error throughout the planning and implementation of the PY8 evaluation.

Survey Error

- **Non-Sampling Error:**
  - **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 property manager survey due to the difficulty in forming the sample frame from the program-tracking data. Section 2.2.3 describes

how we attempted to improve the property manager sample frame development in PY8 to allow us to better generalize to the population of property managers.

- **Measurement Error:** We addressed both the validity and reliability of quantitative data through multiple strategies. First, we relied on the experience of the evaluation team to create questions that, at face value, appear to measure the idea or construct that they are intended to measure. We reviewed the questions to ensure that we did not ask double-barreled questions (i.e., questions that ask about two subjects, but with only one response) or loaded questions (i.e., questions that are slanted one way or another). 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 IPA and Illinois Commerce Commission (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 pretested each survey instrument, monitored the participating property manager interviews as they were being conducted, and reviewed the pretest survey data for the property manager survey. We also used the pretests to assess whether the length of the survey was reasonable and reduced survey length as needed.

- **Non-Response and Self-Selection Bias**: Given the response rate of 26% for the participating property manager survey, there is the potential for non-response bias. 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 where available to determine whether those we spoke with were significantly different from those who did not respond to the survey with regard to types of measures installed. The frequency of measures installed by property managers in the population was very similar to the frequency of measures installed by property managers who completed the survey.[13]

- **Data Processing Error**: The team addressed processing error through interviewer training, as well as quality checks of completed survey data. Opinion Dynamics interviewers on the property manager survey went through rigorous training before they began interviewing. Interviewers received a general overview of the research goals and the intent of the survey instrument. Through survey monitoring, members of the evaluation team also provided guidance on proper coding of survey responses. In addition, we carried out continuous, random monitoring of all telephone interviews and validation of at least 10% of every interviewer's work.

Non-Survey Error

- Data Processing Error

  - **Gross Impact Calculations**: We applied IL-TRM V4.0 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.

[13] The percentage of respondents who completed air sealing was 8% higher for property managers who responded to the survey than the percentage of property managers who completed air sealing in the population. The difference in rates of measure installation between the property manager population and those who completed the survey was less than 2% for all other measures

- **Net Impact Calculations:** We applied the deemed NTGRs 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 Process Findings

3.1.1 Program Description

The Multifamily Program offers incentives and services that enable energy savings and lower operating costs in market-rate multifamily housing. Starting in PY7, multifamily program offerings in IPA service territory have been split between the IPA Multifamily Program and the AIC Multifamily Program. There are three main components offered through the IP and AIC programs: measures for tenant units, lighting for buildings' common areas, and major measures for air sealing and attic insulation (also referred to as shell measures). The IPA Multifamily Program does not sponsor any in-unit measures, but does sponsor most types of common area lighting (all non-CFL installations) and major measures for buildings with electric heat, which comprises most of the major measures offering. The AIC Multifamily Program sponsors all of the measures installed in tenant units (CFLs for permanent light fixtures, faucet aerators, low-flow shower heads, and programmable thermostats), remaining common area lighting (standard and specialty CFLs), and major measures for buildings with gas heat.

Program staff believe that this separation has not had a lasting impact on customers, as many customers can't tell the difference between the IPA and AIC programs. Thus, since PY7, little has changed within the IPA Multifamily Program.

Program administrators deliver measures using a hybrid approach that leverages program implementation staff from CLEAResult, as well as program allies. Program delivery still differs somewhat by program component within the IPA program. For the major measures component, program allies (recruited by the implementer) are responsible for generating leads, bringing customers into the major measures (shell) component of the program, and performing all major measure installations. In contrast, the program implementer conducts outreach and recruitment of participants for the common area lighting direct installation component of the program. Table 11 provides a summary of the multifamily offerings available in the IPA service area. Note that the program implementer and program allies present all offerings as a single program to the customer. IPA provides incentives to participants for the major measures component on a performance basis in terms of total CFM reduction. The IPA program offers a variety of common area measures to multifamily buildings, including T-8 lighting, LED exit signs, and occupancy sensors, at no cost to the property manager. Property managers are responsible for the installation of common area measures, which is carried out by the property maintenance staff or a third-party contractor.

As appropriate opportunities arise, program allies and program administrators who implement the IPA and AIC programs share promising leads with one another so that property managers can participate in both programs as well as multiple components (major measures, in-unit, common area) if appropriate. Although the implementer follows up on all potential direct installation opportunities identified through program allies' major measures site reports, some allies take a more proactive approach to cross-component participation and invite the implementer to join them at on-site meetings where there may be an opportunity to complete direct install measures.

Table 11. Multifamily Program Offerings in the IPA Service Area

Program Component	IPA Program	AIC Program
In-Unit Measures *CFLs for permanent light fixtures, faucet aerators, low-flow shower heads, and programmable thermostats*	Not offered	Available to any AIC multifamily customer CLEAResult recruits participants and installs all measures except thermostats, which property manager installs
Major Measures *Air sealing and attic insulation*	Available to AIC multifamily customers with electric heat Program allies recruit participants and install all measures	Available to AIC multifamily customers with gas heat Program allies recruit participants and install all measures
Common Area Lighting *Lighting measures vary by program*	Available to any AIC multifamily customer CLEAResult recruits participants and installs lighting (T-8 lighting, modular CFLs, LED exit signs, occupancy sensors)	Available to any AIC multifamily customer CLEAResult recruits participants and installs lighting (standard CFLs, specialty non-modular CFLs)

3.1.2 Program Design and Implementation

The Multifamily Program focuses on the market rate multifamily housing sector. The program's objective is to provide a range of services and incentives that result in lower operating costs and better bottom lines for property managers, as well as lower costs of living and increased comfort for their tenants.

Program Design Changes

In PY8, the program's savings goals increased relative to PY7. Thus, while IPA did not plan any significant design changes for the Multifamily Program in PY8, the program did adapt implementation slightly over the course of the year to better meet these goals. Namely, IPA staff decided to open the program to additional program allies to better meet savings goals for attic insulation and tried a new outlet for property manager recruitment. Program staff spoke about the Multifamily Program at mandatory landlord meetings held by the City of Peoria. According to program staff, these meetings proved to be a "target-rich environment" attended by more than 1,000 multifamily property managers. By attending, the program achieved several new leads for the Multifamily Program.

Program Goal Achievement

As a result of PY8 installations, the Multifamily Program was expected to achieve 36,335 MWh in electric savings. Nevertheless, despite slight program design changes discussed above and the resulting increase in program participation, the PY8 program fell slightly short of the higher PY8 goals. The program achieved 33,973 MWh of electric savings, which was 94% of the program's goal.

3.1.3 Property Manager Participation and Experience

PY8 Program Participation

Program staff implemented 2,431 unique projects through the Multifamily Program at 3,308 properties. As Table 12 shows, these 2,431 unique projects nearly always installed major measures (99%).

Table 12. PY8 Multifamily Program Participation

IPA Program Component	Unique Projects Receiving Measure (#)	Share of Projects Receiving IPA Measures (%)
Major Measures	2,406	99%
Air Sealing	2,377	98%
Attic Insulation	2,315	95%
Common Area Lighting	25	1%
Total	**2,431**	100%

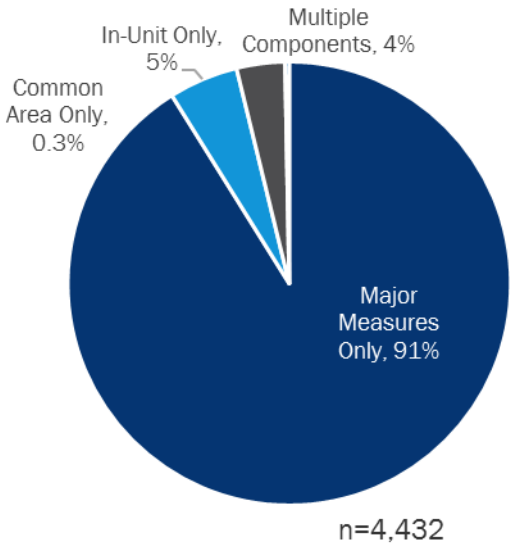
Note: Because some projects received multiple measures, totals for program and within components do not sum to the 1,128 unique projects and the percentages do not sum to 100%.

PY8 IPA and AIC Cross-Program Participation

As discussed above, multifamily offerings in IPA's service area included several components (for tenant units, common area, and building shell) and these offerings are split between the IPA program and the AIC program. To assess uptake of different components across the two programs, the team reviewed participation in both. Across the two programs, program staff completed projects in 4,432 multifamily buildings.[14] Based on the heating fuel used at properties that received major measure upgrades, 75% of these projects were completed through the IPA program. In general, PY8 participation trends for the combined IPA and AIC offerings were similar to past years, with most properties receiving major measures (Figure 1). Program staff indicated that they generally make property managers aware of other within-program components when appropriate. However, few properties (4%) participated in more than one component during the program year, which is on par with most recent program years (e.g., 8% in PY7). As some property managers complete multiple components over the span of multiple years (according to the implementer), rates of cross-component participation within a given program year are a lower-bound estimate of overall engagement with multiple parts of the offerings over the course of several years. Tracking cumulative cross-component participation across multiple program years was not included in the scope of this analysis, but could help to better understand the full effect of the implementer's marketing efforts.

[14] Defined by number of buildings with unique street addresses.

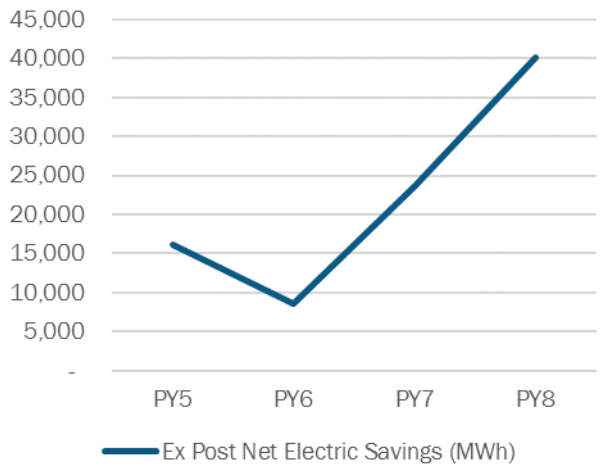
Figure 1. Multifamily Property Upgrades by Component Type (IPA and AIC programs)



Trends in Participation

Figure 2 plots the growth in ex post net electric savings from the IPA and AIC multifamily programs from PY5 through PY8. The combined electric savings from the IPA and AIC programs increased by 69% from PY7, to 44,711 MWh in PY8.

Figure 2. Multifamily Program Electric Savings (MWh) from PY5 through PY8 (AIC and IPA Programs)



Property Manager Satisfaction and Program Engagement

Property managers were satisfied with all aspects of the Multifamily Program, according to responses from the property manager survey. Some property managers who participated only in the major measures component expressed an interest in receiving additional program measures that are available through the common area offering and the AIC Multifamily Program's in-unit direct install component. Other property managers expressed interest in several additional measures not currently offered through either the IPA or the AIC program (discussed below). About one-half of the property managers also provided recommendations for program improvements. Independent of the evaluation team's efforts, the program implementer conducted a separate customer satisfaction survey to understand property managers' satisfaction with program allies and other program components. The implementer's survey identified results consistent with the PY8 evaluation, showing that most property managers were very satisfied with the program. Ninety percent of the 75 property managers they surveyed said that they were either definitely likely to or very likely to recommend the program to others.

Entry into the Program

Multifamily property managers are recruited to the program through outreach from program staff or program allies. During the participant survey, we asked property managers how they had heard about the multifamily program (Table 13). Most commonly, property managers recalled learning about the program through direct outreach from a program representative (33%) or a contractor (26%), although some recalled first hearing about the program via word of mouth (11%). In PY8, one way that Ameren's program staff marketed the program was by making presentations at multifamily property managers' association meetings in Peoria; 7% of property managers recalled hearing about the program through this channel (unaided). Overall, these sources of awareness are consistent with the program's marketing strategies.

Table 13. Property Managers' Sources of Awareness about the Multifamily Program (Multiple Response)

Source of Awareness	Percent of Respondents (n=57)[a]
Direct outreach from an AIC representative	33%
Contractor	26%
Another property manager or friend[b]	11%
Association meeting	7%
Other	5%
Brochure/Flyer	5%
Website[b]	5%
Email[b]	4%

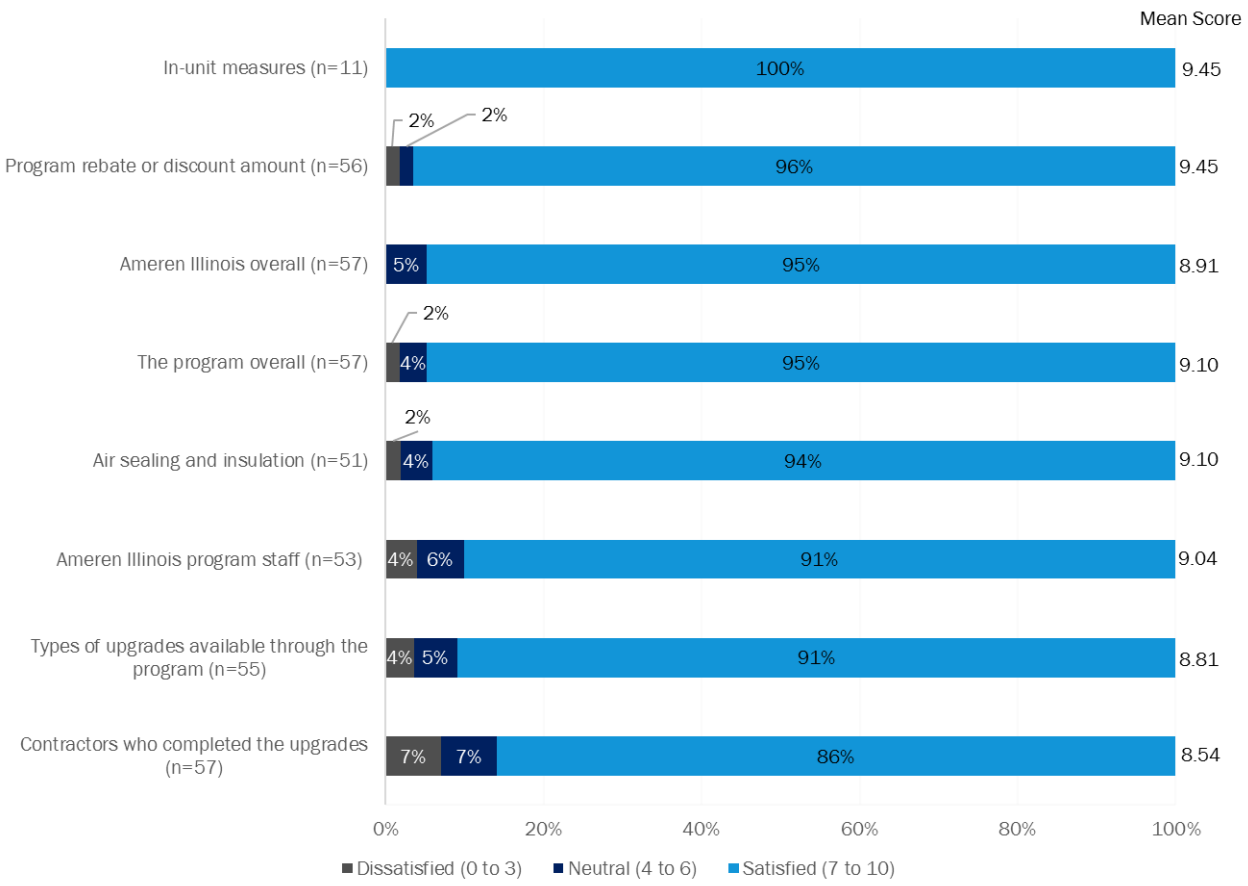
[a] Two respondents indicated that they did not know where they had heard about the program.
[b] This question was asked as an open-ended question with pre-coded response categories (not read). Sources marked with "[b]" are categories developed from "Other" responses not included in the pre-coded list of responses.

Satisfaction and Recommendations for Improvement

The evaluation team explored property managers' satisfaction with the program and asked about suggestions for program improvement. All results in this section are developed from survey respondents, which include a mix of property managers who participated in the IPA program, the AIC program, or both programs. The majority of property managers (95%) were satisfied[15] with the multifamily programs overall. Similarly, 95% of participants said that they were satisfied with AIC overall (the utility). As shown in Figure 3, program satisfaction remained high across all program elements.

[15] A score of 7, 8, 9, or 10 on a scale of 0 to 10, where 0 means "very dissatisfied" and 10 means "very satisfied."

Figure 3. Property Manager Satisfaction with Multifamily Program Components



While major issues with the programs were rare (according to the property manager survey), about one-half of survey respondents (54%) offered recommendations for program improvement. Respondents' suggestions for program improvement correspond to the components of the program about which participants were least satisfied (types of upgrades available and contractor performance). Specifically, respondents most commonly suggested that the programs could be improved by offering more measures (18%), increasing the visibility and depth of program marketing (10%), and offering different contractors (8%) (Table 14). The four respondents who suggested using a different contractor all received major measure upgrades.

Table 14. Property Managers' Suggestions for Multifamily Program Improvement (Multiple Response)

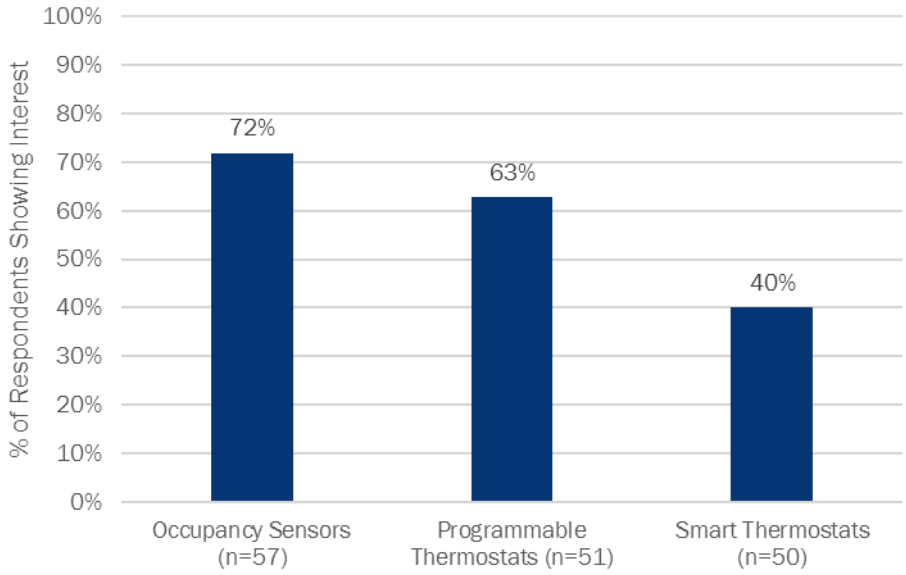
Suggestions	Percent (n=50)
Offer more measures	18%
Increase visibility and depth of marketing[a]	10%
Use a different contractor[a]	8%
Offer a higher-quality product[a]	6%
Higher incentives	2%
Other[b]	10%

[a] Indicates categories developed from open-ended responses.
[b] Other suggestions included extending the program to rental properties that have fewer than three units per building (e.g., single-family rentals and 2-unit rentals), more follow-up from AIC representatives, and speeding up the delivery of free measures.

Interest in Additional Measures

As the programs are relatively mature, program staff are exploring additional measures that they could add to the programs to achieve additional savings in the multifamily sector. However, as the PY8 cross-component participation analysis (above) showed, not all property managers currently take advantage of all of the programs' existing offerings. Thus, there may be room to expand participation in existing offerings in addition to considering adding new measures to the mix. As part of the PY8 property manager survey, we investigated property managers' relative interest in existing measures that they did not install during the program year (occupancy sensors and programmable thermostats (an AIC offering)), as well as one measure that the AIC program could consider adding in future years (smart thermostats). Of the respondents who did not install occupancy sensors, 72% would be interested in them in the future. Similarly, 63% of the respondents who did not install programmable thermostats would be interested in them in the future (Figure 7).

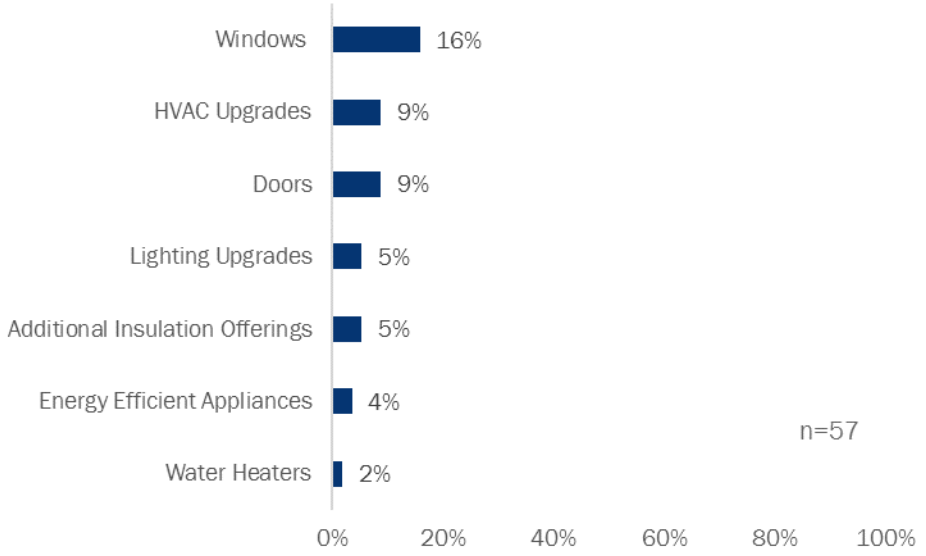
Figure 4. Property Manager Interest in Existing and Potential Program Measures



Note: Respondents who received occupancy sensors or programmable thermostats in PY8 were not asked about these measures.

We also explored respondents' interest in new measures that the IPA and AIC programs could potentially offer in the future. Property managers were also asked to recommend specific measures that they would be interested in seeing offered through the multifamily programs in the future. About one-half (47%) suggested at least one measure for the program's consideration. As shown in Figure 5, energy-efficient windows (16%) and doors (9%) were the most commonly suggested measures. Several respondents (9%) suggested that IPA should consider offering services to upgrade the efficiency of heating and air conditioning (AC) units. Interestingly, three respondents suggested that the programs should offer light bulbs or common area lighting measures. These measures are already offered through the programs. On one hand, it is possible that some of these respondents' properties were not good candidates for these measures. However, the findings could also suggest that that not all eligible property managers were aware of cross-component measure offerings during the program year.

Figure 5. Future Energy Efficiency Upgrades of Interest to Property Managers



In-Unit Maintenance Responsibilities

Most property managers reported that tenants were responsible for controlling their own energy usage in their units. To illustrate, most property managers (79%) reported that tenants were responsible for paying their own electricity bills and most (75%) reported that tenants were responsible for replacing broken or burnt-out light bulbs in their units. In addition, property managers reported that almost all tenants (97%) had control over the heating and AC in their units.

3.2 Impact Assessment

To estimate ex post gross savings for the program, the evaluation team applied in-service rates (ISRs) and savings algorithms from the IL-TRM V4.0 using program-tracking database inputs. The evaluation team applied the SAG-approved NTGRs to ex post gross savings to determine ex post net impacts.

3.2.1 Measure Verification

The program offers a variety of measures to participants, including common area lighting measures and building shell retrofits (i.e., major measures). To determine the verified measure quantities, the evaluation team applied ISRs provided in the IL-TRM V4.0 to ex ante measure quantities. Table 15 provides the ISRs for each measure.

Table 15. PY8 Multifamily Program Measure Quantities and In-Service Rates

Measure	Installed Location	Units	Ex Ante Measure Quantity	ISR	Verified Measure Quantity[a]
Air Sealing	Interior	CFM	9,656,393	100%	9,656,393
Attic Insulation		Sq. ft.	7,654,139	100%	7,654,139
Linear Fluorescent HPT8		Fixture	175	100%	175
Linear Fluorescent HPT8		Bulb	146	100%	146
Modular CFL		Fixture	98	97%	95
Modular CFL	Exterior	Fixture	82	97%	80
LED Exit Sign	Interior	Exit Sign	77	100%	77
Occupancy Sensor		Sensor	24	100%	24
		Total	17,311,134	100%	17,311,129

[a] Verified measure quantity = ex ante quantity * ISR.
Note: Numbers may not total due to rounding.

3.2.2 Ex Post Gross Impact Results

The total ex post gross energy and demand savings impacts for the PY8 Multifamily Program were 36,226 MWh and 3.17 MW, respectively, and gross realization rates for energy and demand savings were 94% and 72%, respectively (Table 16).

Table 16. PY8 Multifamily Program Gross Impacts

Program	Ex Ante Gross[a]		Ex Post Gross		Gross Realization Rate[b]	
	MWh	MW	MWh	MW	MWh	MW
Multifamily Program	38,678	4.41	36,226	3.17	94%	72%

[a] Source of ex ante savings: PY8 program-tracking database.
[b] Gross Realization Rate = ex post gross value ÷ ex ante gross value.

As shown in Table 17, overall ex post gross impacts were lower than ex ante gross impacts. This was driven primarily by lower realization rates for air sealing and attic insulation measures, which collectively accounted for 99% of ex ante program savings.

Table 17. PY8 Multifamily Gross Impacts by Measure

Measure	Verified Measure Quantity	Ex Ante Gross		Ex Post Gross		Gross Realization Rate[a]	
		MWh	MW	MWh	MW	MWh	MW
Air Sealing	9,656,393	28,679	3.93	26,610	2.62	93%	67%
Attic Insulation (R-11 to R-49)	6,620,712	9,137	0.41	8,817	0.49	96%	118%
Attic Insulation (R-19 to R-49)	1,033,427	766	0.05	659	0.05	86%	91%
HPT8 Linear Fluorescent	321	55	0.009	74	0.01	135%	105%
Modular CFLs (interior)	95	17	0.004	29	0.004	173%	100%
LED Exit Sign	77	14	0.003	23	0.003	161%	100%
Modular CFLs (exterior)	80	6	0.00002	10	0.001	151%	6,822%
Occupancy Sensor	24	4	0.001	5	0.001	134%	90%
Total	**17,311,129**	**38,678**	**4.41**	**36,226**	**3.17**	**94%**	**72%**

[a] Gross Realization Rate = ex post gross value ÷ ex ante gross value.
Note: Numbers may not total due to rounding.

Differences in ex post and ex ante gross savings stem from differences in input values for the savings algorithms for each measure. In particular, differences in the inputs for air sealing and attic insulation had the largest impact on program-level realization rates. Because air sealing measures accounted for 74% and attic insulation accounted for 25% of the total program ex ante energy savings, any differences within these measures affected the program savings significantly. Table 18 summarizes the source of differences between ex ante and ex post gross savings.

Table 18. Reasons for Realization Rates, Per Measure

Measure	Gross Realization Rate		Source of Discrepancy			
	MWh	MW	Waste Heat Factor	HVAC Efficiency	CDD, HDD, LM, FLH[a]	Other (Specified)[b]
Air Sealing	93%	67%		✓	✓	• Included cooling savings for participants without central air conditioners (CACs) or heat pumps •
Attic Insulation - (R-11 to R-49)	96%	118%			✓	• Included cooling savings for participants without CACs or heat pumps • Incorrectly applied per-unit demand impact value
Attic Insulation - (R-19 to R-49)	86%	91%			✓	• Included cooling savings for participants without CACs or heat pumps
HPT8 Linear Fluorescent	135%	105%	✓			
Modular CFLs (interior)	173%	100%	✓			
LED Exit Sign	161%	100%	✓			• Baseline wattage
Modular CFLs (exterior)	151%	6,822%				• Hours of use (HOU) and coincidence factor (CF)
Occupancy Sensor	134%	90%	✓			

[a] CDD = Cooling Degree Days, HDD = Heating Degree Days, LM = Latent Multiplier, FLH = Full Load Cooling Hours.
[b] Describes incorrect ex ante assumptions and calculation methods.

Through our discussions with CLEAResult, we identified the sources of the differences between ex ante and ex post savings. In some cases, these differences meant that ex ante savings were higher than ex post savings, while in other cases, they meant that ex ante savings were lower than ex post savings. The combination of all inputs brings about the overall realization rate for a specific measure. We describe the differences in ex ante and ex post savings calculations in detail below.

- **Air Sealing and Attic Insulation Issues:**
  - **CDD, HDD, LM, and FLH:** Ex ante savings calculations for major measures used CDD, HDD, LM, and FLH values for Springfield, IL, for all projects regardless of project location. In the ex post savings analysis, the team applied CDD, HDD, LM, and FLH values for the property's city that was provided in the program-tracking database. In comparison to our city-specific analysis, the ex ante Springfield inputs were not representative of all PY8 properties. For example, the average CDD for the PY8 population was 1,337, which is higher than the Springfield value of 1,108. As a result, the per-measure ex post savings are 4% higher for air sealing and 5% higher for attic insulation.
  - **HVAC Efficiency:** Ex ante savings for major measure projects applied a weighted average cooling efficiency of 11.1 Seasonal Energy Efficiency Ratio (SEER) based on the assumption that 65% of the cooling equipment was manufactured before 2006 and that 35% was manufactured in 2006 or after. In our ex post analysis, we used the cooling equipment age provided in the program-tracking database to assign the appropriate cooling efficiency as stated in the IL-TRM V4.0. For participants without cooling equipment age, we applied an average of 10.5 SEER, derived from participants with equipment age (n=3,164). As a result, ex post savings are 0.5% lower for air sealing and 0.3% lower for attic insulation when compared to ex ante estimates.
  - **Included Savings for Participants without CACs or Heat Pumps.** Ex ante savings for major measures included savings for participants without CACs or heat pumps, while ex post calculations excluded these participants as prescribed in the IL-TRM V4.0. Therefore, ex post energy and demand savings are on average 10% and 36% lower than ex ante savings, respectively.
  - **Incorrectly Applied Per-Unit Demand Impact Value.** For attic insulation (R-11 to R-49) measures, the program-tracking database applied a per-measure savings value of 0.00006 kW per square foot of insulation (total ex ante demand savings / total square footage installed). However, during our evaluation, CLEAResult provided us with an additional spreadsheet with all inputs that they used to determine per-unit ex ante savings. In this spreadsheet, the ex ante per-unit demand savings were calculated as 0.00012 kW per square foot of insulation installed through the program, which is consistent with the ex post per-unit demand savings value. As such, ex post demand savings is twice as much as ex ante demand savings.
- **Lighting Measure Issues:**
  - **Waste Heat Factors:**
    - **Applied Incorrect Waste Heat Energy Factor:** Ex ante energy savings applied the waste heat energy factor from the IL-TRM V3.0 instead of the values from the IL-TRM V4.0. Table 19 shows the effect on ex post savings due to waste heat factor issues.

Table 19. Effect on Ex Post Savings Due to Waste Heat Factor Discrepancies

Measure	Ex Ante Assumptions			Ex Post Assumptions			% Change in Ex Post Savings	
	WHFe	WHFd	Resource	WHFe	WHFd	Resource	kWh	kW
HPT8 Linear Fluorescent	1.34	1.57	IL-TRM V3.0	1.37	1.42	IL-TRM V4.0	2%	−10%
LED Exit Sign	1.34	1.07		1.04	1.07		−22%	0%
Occupancy Sensors	1.34	1.57		1.37	1.42		−2%	10%

Note: A negative percentage indicates that ex post savings are lower than ex ante estimates.

- **Included Electric Heating Penalties**: Ex ante energy savings included the electric heating penalties for LED exit signs, linear fluorescent fixtures, modular CFLs, and occupancy sensors. However, consistent with past evaluations, and per agreements between ICC staff and IPA staff regarding the treatment of waste heat factors, we did not include waste heat factor heating penalties for lighting in the calculation of ex post savings. As such, ex post energy savings are between 31% and 73% higher than ex ante estimates on a measure-by-measure basis (see Table 20).

Table 20. Effect on Ex Post Savings Due to Inclusion of Heating Penalty

Measure	% Change in Ex Post Energy Savings
HPT8 Linear Fluorescent	32%
LED Exit Sign	32%
Modular CFLs (interior)	73%
Occupancy Sensors	31%

- **Incorrectly Calculated Heating Penalties:** The evaluation team also noted that the ex ante heating penalties for all lighting measures were incorrectly calculated such that ex ante applied the heating penalty algorithm for commercial lighting installations instead of multifamily lighting installations. Although this error does not have an impact on gross savings (because heating penalties are excluded from ex post calculations), the evaluation team felt it was worth mentioning, as heating penalties are used to determine cost-effectiveness of common area lighting measures.

- **Baseline Wattage for LED Exit Signs:** Ex ante energy savings for LED exit signs applied a baseline wattage of 23 watts, which is based on the assumption that 50% of the baseline equipment is incandescent (35W) and 50% is CFL (11W). However, the implementer confirmed that the program replaced only incandescent signs, and therefore ex post calculations used 35W. As such, ex post energy savings are 52% higher than ex ante savings. On the other hand, ex ante demand savings are calculated using the baseline wattage of 35W, which is consistent with the ex post assumption.

- **Hours of Use for Modular CFLs:** Ex ante savings for exterior modular CFLs applied the IL-TRM V3.0 HOU value (1,643 hours/year) instead of the IL-TRM V4.0 value (2,475 hours/year). As a result, ex post energy savings are 51% higher than ex ante estimates.

- **Coincidence Factor for Modular CFLs:** Ex ante demand savings for exterior modular CFLs applied the IL-TRM V3.0 CF (0.4%) instead of the IL-TRM V4.0 CF (27.3%). As such, ex post demand savings are 68 times the size of ex ante demand savings. Although this is a large difference for modular

CFL savings, the change is small relative to total program savings because exterior modular CFL demand savings are less than 1% of the program's total demand savings (on an ex ante basis).

3.2.3 Ex Post Net Impact Results

The evaluation team calculated PY8 ex post net savings by applying SAG-approved NTGRs to ex post gross savings (see Table 21).

Table 21. PY8 Multifamily Program Net Impacts

Program	Ex Ante Net		Ex Post Net	
	MWh	MW	MWh	MW
Multifamily Program	36,341	4.20	33,973	3.01
Net Realization Rate			**94%**	**72%**

4. Key Findings and Recommendations

The Multifamily Program is achieving its stated goals to provide measures that enable energy savings and lower operating costs in market-rate multifamily housing. In PY8, the program achieved ex post net energy and demand savings of 33,973 MWh and 3.01 MW, respectively. Program managers reported that the Multifamily Program operated smoothly and effectively in PY8. As noted in detail below, research with participating property managers points to high levels of satisfaction. The following findings and recommendations for the program are presented below:

- **Key Finding #1:** Outcomes of the PY8 evaluation found several small issues with the ex ante savings assumptions. In some cases, ex ante calculations applied inconsistent assumptions to energy (kWh) and demand (kW) savings calculations (e.g., LED exit sign baseline wattage). In other cases, ex ante savings used an average assumption for all projects, but the ex post analysis identified project-specific attributes in the program-tracking database (HVAC equipment age) that could have been used to develop project-specific ex ante savings assumptions. Finally, the evaluation team also found some instances where program-tracking data did not reflect characteristics of the installed measures (such as actual pre- and post-insulation R-values).
  - **Recommendation #1:** The evaluation team makes several recommendations with respect to the data tracked by the implementer, as well as the implementer's ex ante savings calculation approaches, namely:
    - Thoroughly review savings assumptions to verify that assumptions used in both energy and demand savings calculations are consistent.
    - Use data collected by the implementer, such as participant zip code and age of heating and cooling equipment, to inform savings calculations.
    - Review the program-tracking databases prior to submitting them to the evaluation team to minimize these types of discrepancies
- **Key Finding #2:** Participating property managers tended to be satisfied with their PY8 Multifamily Program experiences. For example, most participating property managers were highly satisfied with the program's key features, including the available measure offerings, the specific measures that they received, the rebate or discount amount, the program staff, and the contractors that installed upgrades. About one-half of the property managers with whom we spoke thought that there was nothing that the program needs to change to improve. The minority of respondents who did offer suggestions indicated that the program could improve the property manager experience by offering more measures, by increasing the visibility and depth of program marketing, or by offering different contractors.
- **Key Finding #3:** The program implementer and the program allies worked together to channel properties across major measures and direct install (in-unit, common area) components where applicable, but few properties (4%) participated in multiple components in PY8. Per the implementer, some property owners participate in multiple components across the span of multiple program years. Thus, the program's cumulative level of cross-component participation is likely to be higher than what annual evaluation data represent. Some of the property managers who completed only major measures upgrades expressed a relatively high level of interest in available common area and in-unit offerings, and some individual property managers provided survey responses indicating that they were unaware of program components that they did not participate in. As some property managers may

return to complete additional components in future years, the program may be able to capture more savings by formalizing its cross-component marketing procedures.

- **Recommendation #3:** Continue to promote collaboration between program allies and program implementers to ensure that all property managers are made aware of all program components available to them. As the program brings in a growing number of program allies, program implementers may find it beneficial to formalize the process by which program allies share direct install opportunities discovered at properties receiving major measures. The goal is to ensure that all property managers are consistently well informed about all types of savings opportunities.

- **Key Finding #4:** PY8 participants were generally satisfied with the mix of measures offered through the program, but some expressed interest in additional measures. A minority of respondents suggested that they would be interested in receiving additional types of measures through the program, including efficient windows and doors, HVAC upgrades, and insulation for walls and other parts of the building shell.

Appendix A. Data Collection Instruments

AIC and IPA PY8 Multifamily Program

AIC and IPA PY8 Multifamily Program

Appendix B. Response Rate Methodology

The survey response rate is the number of completed interviews divided by the total number of potentially eligible respondents. We calculated the response rate (Response Rate 3 [RR3]) using the standards and formulas set forth by the AAPOR.[16] The formulas used to calculate RR3 are presented below.

Equation 1. AAPOR RR3

$$RR3 = \frac{I}{\left(I + N + e1(U1 + e2 * U2)\right)}$$

Where:

$$e1 = \frac{(I + N)}{(I + N + X1)}$$

$$e2 = \frac{(I + N + X1 + U1)}{(I + N + X1 + U1 + X2)}$$

And where:

I = Completed interview
N = Eligible incomplete interview
X1 = Survey-ineligible household
U1 = Household with undetermined eligibility
X2 = Not a household
U2 = Undetermined if household
e1 = Estimated proportion of cases of unknown survey eligibility that are eligible
e2 = Estimated proportion of cases of unknown household/business eligibility that are eligible

We also calculated a cooperation rate, which is the number of completed interviews divided by the total number of eligible sample units with whom we started an interview or survey. We used AAPOR Cooperation Rate 3 (COOP3) for the telephone survey of property managers, which is calculated as:

Equation 2. AAPOR COOP3

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

Where:

I = Completed interview
N = Eligible incomplete interview
R = Refusal

[16] *Standard Definitions: Final Dispositions of Case Codes and Outcome Rates for Surveys*, AAPOR Revised 2016. http://www.aapor.org/AAPOR_Main/media/publications/Standard-Definitions20169theditionfinal.pdf

Appendix C. Engineering Analysis Algorithms

In PY8, the impact evaluation efforts estimated gross impact savings for the IPA Residential Multifamily Program by applying savings algorithms from the IL-TRM V4.0 to the information in the program-tracking database.

We present the algorithms and input variables used to calculate all evaluation program savings below.

C.1 Lighting Algorithms

Modular CFLs

Multifamily common areas have algorithm input values in both the commercial and residential sections of the IL-TRM V4.0 (Section 4.5 and 5.5, 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. All variable assumptions are from the IL-TRM V4.0 unless otherwise referenced.

Equation 3. Modular CFL Algorithms

Energy Savings: $\Delta kWh = ((WattsBase - WattsEE) / 1{,}000) * ISR * Hours * WHF_e$

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

Where:

WattsBase = Wattage of existing equipment

Table 22. Baseline Wattages for Modular CFLs

Measure	EISA Adjusted[a]	Baseline Wattage	Resource
Modular (Pin-based) CFL – Interior	Yes	72	IL-TRM V4.0
Modular (Pin-based) CFL – Exterior	Yes	72	

[a] The Energy Independence and Security Act (EISA) schedule requires baseline adjustments to measures with incandescent baseline wattages of 100W (as of June 2012).

WattsEE = Wattage of installed equipment

Table 23. Installed Wattage of Modular CFLs

Measure	Installation Location	WattsEE
Modular (Pin-based) CFL	Common Area Interior	23
Modular (Pin-based) CFL	Common Area Exterior	23

ISR = In-service rate of installed CFLs= 96.9%[17]

Hours = Annual operating hours (see Table 24)

[17] Based on IL-TRM V4.0.

Table 24. 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	2,475

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 25. Energy and Demand Waste Heat Factors for Modular CFLs

Measure	Installation Location	WHFe	WHFd
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 26. 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	0.273

Linear Fluorescent Lighting

The algorithm input values for linear fluorescent lighting are from the commercial section of the IL-TRM V4.0 (Section 4.5). The residential section of the IL-TRM V4.0 does not include linear fluorescent lighting. However, the waste heat factors for both cooling and heating are higher in the commercial section of the IL-TRM V4.0 when compared to the waste heat factors for residential lighting. We felt that this was appropriate for linear fluorescent lighting, because the program installs new fixtures with a ballast replacement that would ultimately result in higher heating penalties.

The evaluation team determined ex post lighting savings using the algorithms below. All variable assumptions are from the IL-TRM V4.0 unless otherwise referenced.

Equation 4. Linear Fluorescent Algorithms

Energy Savings: $\Delta kWh = ((WattsBase - WattsEE) / 1{,}000) * ISR * Hours * WHF_e$

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

Where:

WattsBase = Wattage of existing equipment = 32W for lamp replacements and 96W for fixture replacements

WattsEE = Wattage of installed equipment (actual wattage of installed measure) = 25W for lamp replacements and 50W for fixture replacements

ISR = In-service rate of installed linear fluorescent lamps/fixtures = 100%[18]

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) = 1.37

WHF_d = Waste heat factor for demand (accounts for cooling savings from efficient lighting) = 1.42

CF = Summer Peak Coincidence Factor = 0.75

C.2 LED Exit Sign Algorithms

The evaluation team determined ex post lighting savings using the algorithms below. All variable assumptions are from the IL-TRM V4.0 unless otherwise referenced.

Equation 5. LED Exit Sign Algorithms

Energy Savings: $\Delta kWh = ((WattsBase - WattsEE) / 1{,}000) * Hours * WHF_e$

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

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

C.3 Occupancy Sensor Algorithms

The evaluation team determined ex post lighting savings using the algorithms below. All variable assumptions are from the IL-TRM V4.0 unless otherwise referenced.

Equation 6. Lighting Control Occupancy Sensor Algorithms

$$Energy\ Savings: \Delta kWh = kW_{controlled} * Hours * ESF * WHF_e$$

$$Demand\ Savings: \Delta kW = kW_{controlled} * WHF_d * (CF_{baseline} - CF_{occupancy})$$

[18] According to CLEAResult, linear fluorescent measures must be installed to qualify for rebates; therefore, the ISR is assumed to be 100% based on the IL-TRM 4.0.

Where:

$kW_{controlled}$ = Total wattage controlled by each occupancy sensor = 0.06 kW[19]

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) = 1.37

WHF_d = Waste heat factor for demand (accounts for cooling savings from efficient lighting) = 1.42

$CF_{baseline}$ = 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

C.4 Lighting Measures Heating Penalty

The evaluation team determined heating penalties using the algorithms below. Based on the agreement between the ICC and AIC, we did not include heating penalties in the ex post energy savings, but will include this in the data for the PY8 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 V4.0 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 27. Heating Penalty Algorithms for Common Area Lighting

Measure	Heating Fuel	Heating Penalty Algorithm
Modular CFL	Unknown (Assumed Gas)	Δtherms = - (((WattsBase – WattsEE) / 1,000) * ISR * Hours * HF * 0.03412) / nHeat)
Linear Fluorescent T8	Unknown (Assumed Gas)	Δtherms = - (((WattsBase – WattsEE) / 1,000) * ISR * Hours * - IFTherms)
LED Exit Sign	Gas	Δtherms = - (((WattsBase – WattsEE) / 1,000) * ISR * Hours * HF * 0.03412) / nHeat)
LED Exit Sign	Electric Resistance	ΔkWh = - (((WattsBase – WattsEE) / 1,000) * Hours * ISR * HF) / nHeat)

[19] CLEAResult confirmed that one occupancy sensor controls four 15W CFLs for a total of 60W controlled per sensor.

Where:

WattsBase = Wattage of existing equipment

Table 28. Baseline Wattages for Common Area Lighting

Measure	WattsBase
Modular CFL – Interior	72 Watts
Modular CFL – Exterior	72 Watts
Linear Fluorescent T8 Fixture	96 Watts
1 – Lamp Linear Fluorescent T8	32 Watts
LED Exit Sign	35 Watts

WattsEE = Wattage of installed equipment

Table 29. Efficient Wattages for Common Area Lighting

Measure	WattsEE
Modular CFL– Interior	23 Watts
Modular CFL – Exterior	23 Watts
Linear Fluorescent T8 Fixture	50 Watts
1 – Lamp Linear Fluorescent T8	25 Watts
LED Exit Sign	2 Watts

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

Table 30. Installation Rates for Common Area Lighting

Measure	ISR	Resource
Modular CFL – Interior	96.9%	IL-TRM V4.0
Modular CFL – Exterior	96.9%	
Linear Fluorescent T8 Fixture	100.0%	
1– Lamp Linear Fluorescent T8	100.0%	
LED Exit Sign	100.0%	

Hours = Annual operating hours

Table 31. Hours for Common Area Lighting

Measure	Hours/Year
Modular CFL– Interior	5,950
Modular CFL – Exterior	2,475
Linear Fluorescent T8 Fixture	5,950
1 – Lamp Linear Fluorescent T8	5,950
LED Exit Sign	8,766

HF = Heating factor = 0.49

ηHeat = Efficiency of heating equipment

Table 32. Efficiency of Heating Equipment for Common Area Lighting

Heating Fuel	ηHeat	Units
Gas	0.7	AFUE
Electric Resistance	1.0	Coefficient of Performance (COP)

IFTherms = Waste heat factor that accounts for the increase in gas space heating due to the decrease in rejected heat from efficient lighting = 0.050

Table 33 summarizes the heating penalties for the lighting measures installed in common areas offered through the program.

Table 33. Heating Fuel Penalties for Common Area (Interior) Lighting

Measure	Heating Equipment	ΔkWh	Δtherms
Modular CFL	Unknown (Assumed Gas)	n/a	−6.75
Linear Fluorescent T8	Unknown (Assumed Gas)	n/a	−13.69
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 HOU are reduced due to the installation of lighting controls. Occupancy sensors for this program were installed on fixtures that were located within interior common areas. Heating penalties are calculated for electric resistance heating and gas heating fuel.

Equation 7. Heating Penalty Algorithms for Occupancy Sensors

$$Heating\ Electric\ Savings: \Delta kWh * -IFkWh$$

$$Heating\ Therm\ Savings: \Delta therms = \Delta kWh * -IFTherms$$

Where:

ΔkWh = Energy savings per installed occupancy sensor = 200.5 kWh

IFkWh = Waste heat factor that accounts for the increase in electric space heating due to the decrease in rejected heat from efficient lighting = 1.153

IFTherms = Waste heat factor that accounts for the increase in gas space heating due to the decrease in rejected heat from efficient lighting = 0.050

Table 34 summarizes the heating penalties for the lighting measures where occupancy sensors are installed.

Table 34. Heating Fuel Penalties for Fixtures with Occupancy Sensors

Measure	Heating Equipment	ΔkWh	Δtherms
Occupancy Sensors	Gas Heating	n/a	−7.32
	Electric Resistance	−168.8	n/a

C.5 Air Sealing Algorithms

The evaluation team determined ex post air sealing savings using the algorithms below. All variable assumptions are from the IL-TRM V4.0 unless otherwise referenced. Because the program-tracking database includes only 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 CAC unit or heat pump exists based on information from the program-tracking database.

Equation 8. Air Sealing Algorithms

Energy Savings: $\Delta kWh = \Delta kWh\_cooling + \Delta kWh\_heating$

$$\Delta kWh\_cooling = [(((CFM50\_existing - CFM50\_new) / N\_cool) * 60 * 24 * CDD * DUA * 0.018) / (1{,}000 * \eta Cool)] * LM$$

$$\Delta kWh\_heating = [(((CFM50\_existing - CFM50\_new) / N\_heat) * 60 * 24 * HDD * DUA * 0.018) / (3{,}412 * \eta Heat)]$$

$$Demand\ Savings: \Delta kW = (\Delta kWh\_cooling / FLH\_cooling) * CF$$

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 = 18.5[20]

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

Table 35. 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

[20] Assumed CZ2 Normal Exposure.

ηCool = Seasonal Energy Efficiency Ratio (SEER) of cooling system (applied per participant based on existing equipment age provided in database)

Table 36. ηCool for Air Sealing Measures

Cooling Equipment Age	CAC/Heat Pump SEER
Before 2006	10.0
During or after 2006	13.0
Unknown[a]	10.5

[a] For measures where the cooling equipment age is not provided in the database (n=21), we calculated an average cooling efficiency based on SEER values derived from measures with cooling equipment age information (n=1,617).

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

Table 37. Latent Multiplier by Climate Zone

Climate Zone	Latent Multiplier
1 (Rockford)	3.3
2 (Chicago)	3.2
3 (Springfield)	3.7
4 (Belleville)	3.6
5 (Marion)	3.7

N_heat = Conversion factor from leakage at 50 Pascal to leakage at natural conditions = 15.75[21]

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

Table 38. 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

ηHeat = Efficiency of space heating equipment (used actual from database when available)

Table 39. ηHeat for Air Sealing Measures

Existing Heating Equipment	Equipment Age	COP
Heat Pump	Before 2006	1.70
	2006–2014	1.92
Electric Resistance	n/a	1.00

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

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

Table 40. 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 = Summer Peak Coincidence Factor (varies by cooling equipment type)

Table 41. Coincidence Factors by Cooling Equipment

Cooling Equipment	CF
Central Air Conditioner	0.68
Heat Pump	0.72

C.6 Attic Insulation Algorithms

The evaluation team determined ex post attic insulation savings using the algorithms below. All variable assumptions are from the IL-TRM V4.0 unless otherwise referenced. Since the program-tracking database includes only 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 CAC unit based on information from the program-tracking database.[22]

Equation 9. Attic Insulation Algorithms

$$\text{Energy Savings: } \Delta kWh = \Delta kWh\_cooling + \Delta kWh\_heating$$

$$\Delta kWh\_cooling = (((1 / R\_old - 1/R\_new) * A\_attic * (1 - Framing\_factor)) * 24 * CDD * DUA) / (1{,}000 * \eta Cool)$$

$$\Delta kWh\_heating = (((1 / R\_old - 1/R\_new) * A\_attic * (1 - Framing\_factor) * ADJ_{attic}) * 24 * HDD) / (\eta Heat * 3412)$$

$$\text{Demand Savings: } \Delta kW = (\Delta kWh\_cooling / FLH\_cooling) * CF$$

Where:

R_old = Total attic assembly R-value prior to installing insulation (assumed R-11 or R-19 per implementer. For attic insulation we added R-0.68 (indoor air film) and R-0.15 (3/4" plaster) to account for total assembly R-value.[23]

[22] 618 (90%) records out of the 684 who received attic insulation measures have CAC (based on data in program-tracking database).

[23] We used the ASHRAE Isothermal Planes method (page 27.3, ASHRAE Fundamentals, 2013) to determine the R-values for indoor air film and ¾" plaster.

Table 42. Pre Assembly R-value for Attic Insulation

Measure	Pre R-value
Attic Insulation (R-11 to R-49)	11.83
Attic Insulation (R-19 to R-49)	19.83

R_new = Total attic assembly R-value after the installation of additional insulation (assumed R-49 per implementer). For attic insulation we added R-0.68 (indoor air film) and R-0.15 (3/4" plaster) to account for total assembly R-value.

Table 43. Post Assembly R-value for Attic Insulation

Measure	Post R-value
Attic Insulation (R-11 to R-49)	49.83
Attic Insulation (R-19 to R-49)	49.83

A_attic = Total area of insulated attic (ft^2)

Framing_factor = Adjustment to account for area of framing = 0.07

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

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

Table 44. Cooling Degree Days by Climate Zone

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

DUA = Discretionary Use Adjustment = 0.75

ηCool = Seasonal Energy Efficiency Ratio (SEER) of cooling equipment (applied per participant based on existing equipment age provided in database)

Table 45. ηCool for Attic Insulation Measures

Cooling Equipment Age	CAC/Heat PumpSEER
Before 2006	10.0
During or after 2006	13.0
Unknown[a]	10.6

[a] For measures where the cooling equipment age is not provided in the database (n=20), we calculated an average cooling efficiency based on SEER values derived from measures with cooling equipment age information (n=1,547).

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

Table 46. 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

ηHeat = Efficiency of space heating equipment (used actual from database when available)

Table 47. ηHeat for Attic Insulation Measures

Existing Heating Equipment	Equipment Age	COP
Heat Pump	Before 2006	1.70
	2006–2014	1.92
Electric Resistance	n/a	1.00

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

Table 48. 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 = Summer Peak Coincidence Factor (varies by cooling equipment type)

Table 49. Coincidence Factors by Cooling Equipment

Cooling Equipment	CF
Central Air Conditioner	0.68
Heat Pump	0.72

Appendix D. Cost-Effectiveness Inputs

Table 50 presents total gross impacts for IPA 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 IPA 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 7,877 kWh and 5,381 therms after the application of waste heat factors.

Table 50. PY8 Multifamily Program Gross Impacts (Including Heating Penalties)

	kWh	kW	Therms
Gross Savings	36,226,433	3,172	0
Heating Penalty	−7,877	0	−5,381
Total Gross Savings with Heating Penalty	36,218,556	3,172	−5,381

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 and occupancy sensors. The IL-TRM V4.0 assumes gas heating when the heating fuel type is unknown. We calculated heating penalties for 98 modular CFLs, 321 linear fluorescent fixtures, 77 LED exit signs, and 24 occupancy sensors, resulting in total gross heating penalties of 7,877 kWh and 5,381 therms. Table 51 summarizes the heating penalty for these four measures.

Table 51. Total Heating Penalties by Measure

Measure	kWh	Therms
Modular CFLs	0	−661
Linear Fluorescent	0	−4,393
LED Exit Sign	−7,371	−173
Occupancy Sensor	−506	−154
Total Heating Penalty	**−7,877**	**−5,381**

Appendix E. NTGR Results

In PY8, the evaluation team conducted research with participating property managers to update the Multifamily Program's NTGRs for application in PY10. Consistent with prior program years, we developed the NTGRs using self-reported information from computer-assisted telephone interviewing (CATI) surveys with participating property managers. We used this participant survey data to develop estimates of free-ridership (FR) and participant spillover (PSO). Consistent with past years, we do not incorporate an estimate of non-participant spillover (NPSO) for this program.

Key Findings

Table 52 presents the results of our PY8 net-to-gross (NTG) analysis for application in PY10. Overall, the team found low to moderate levels of FR among property managers participating in the multifamily programs. Our spillover (SO) analysis found a PSO rate of 0.4% for electric measures and 0.0% for gas measures among all multifamily program participants. As shown below, the updated NTGRs for the major measures and in-unit program components range from 0.71 to 1.0 for gas measures and from 0.79 to 0.86 for electric measures. NTGRs were not calculated for common area measures in PY8 because the number of property managers that received these measures was small. The same NTGRs are recommended for both the AIC program and the IPA program.

Table 52. Updated Multifamily NTGRs from PY8 Research with Participating Property Managers[a]

Component	FR		PSO	NTGR (1 – FR + SO)
	n	%		
Electric (kWh)				
Insulation (sq. ft.)	674,954	14%	0.4%	86%
Air Sealing (CFM)	612,312	14%	0.4%	86%
In-Unit Measures	141	21%	0.4%	79%
Gas (Therms)				
Insulation (sq. ft.)	233,034	29%	0%	71%
Air Sealing (CFM)	12,138	20%	0%	80%
In-Unit Measures	374	0%	0%	100%

[a]Measure counts include measures with both gas and electric savings. Measures with both gas and electric savings comprised 33% of insulation measures, 1% of air sealing measures, and 8% of in-unit measures.

NTGR Background

Net impact evaluation is generally described in terms of estimating program attribution. Program attribution accounts for the portion of gross energy savings associated with a program-supported measure or behavior change that would not have been realized in the absence of the program. The portion of ex post gross savings that are program-induced savings, indicated as a NTGR, is made up of FR and SO and is calculated as (1 – FR + SO). FR is the portion of the program-achieved verified gross savings that would have been realized absent the program and its interventions. SO is generally classified into participant and non-participant SO. PSO occurs when participants take additional energy-saving actions that are influenced by the program but did not receive program support. NPSO is the reduction in energy consumption and/or demand by customers who did not participate in the program yet were influenced by it.

The Illinois evaluation teams have worked with the ICC and the Illinois SAG to create a standard Illinois statewide NTGR approach for use in Illinois energy efficiency evaluation, measurement, and verification work. Per the NTGR Methods attachment to the Illinois TRM,[24] all NTGR data collection and analysis activities for program types covered by the attachment that began after June 1, 2016 must conform to the statewide NTGR methods. This evaluation conforms with these requirements.

Free-Ridership

Methodology

Free-riders are program participants who would have implemented the incented energy-efficient measure(s) even without the program. FR estimates are based on a series of questions that explore the influence of the program in participants' decisions to make the energy-efficient installations as well as actions the participant likely would have taken had the program not been available.

As prescribed by the Residential Multifamily Protocol in the NTG Methods attachment, we tested three specifications of the FR algorithm. Each specification of the algorithm consists of two main scores: an influence of program components score and a no-program score (counterfactual). The algorithms employ supplementary adjustments that account for an order effect (when the customer learned about the program relative to deciding to complete the upgrade), as well as the program's influence on the upgrade timing and quantity. All of the subscores serve as separate estimators of FR and can take on a value of 0 to 10, where a higher score means a lower level of FR and a higher NTGR. The overall FR score for a project is the average of the program influence score and the no-program score (combined with the order, timing, and quantity adjustments as applicable) divided by 10. The FR score for each project thus ranges from 0 (no FR) to 1 (100% FR).

The two scores included in the algorithm and their adjustments are described below.

1. **Program Influence Score**. The Preliminary Program Influence Score is based on the importance of program components and an order adjustment. The program components portion of the score is based on a series of four questions per measure that ask respondents to rate the importance of program components in their decision to install the energy-efficient equipment, using a scale of 0 to 10 (where 0 is "Not at all important" and 10 is "Very important"). Program components considered include the availability of the incentive (stated as "free offerings," in the case of common area and in-unit measures), recommendations from program staff, recommendations from an IPA account manager, and information from program marketing materials. As will be seen below in the Final Program Influence score, greater importance of the program components means a lower level of FR.

   In addition to program components, the Preliminary Program Influence Score incorporates an Order Adjustment (i.e., a Temporal Sequence Adjustment) to account for the order in which a participant learned about the program and decided to perform upgrades. This adjustment is based on a question that asks respondents to indicate whether they learned about the program before or after they decided to install upgrades through the program. For a customer who learned about the program *after* deciding to perform upgrades, the program was less influential in the participant's decision to undertake the project and the customer is more likely to be a free-rider. On the other hand, learning about the program *before* having decided to perform upgrades means a lower level of FR. The order adjustment score is implemented as a

[24] Illinois Statewide Technical Reference Manual for Energy Efficiency: Attachment A – Illinois Statewide Net-to-Gross Methodologies. February 8, 2016.

scaling factor (0.5) on the Preliminary Program Influence Score (maximum program component rating) as follows:

Preliminary Program Influence Score

= *(Maximum Program Component Rating), if learned about program* before *deciding to complete upgrade* after *learned about program*

= *(Maximum Program Component Rating) * 0.5, if learned about program* after *decided to perform upgrade*

When the adjustment is applied, the Final Program Influence Score is higher than the Preliminary Program Influence Score, reflecting greater levels of FR. For example, if a respondent provided a maximum program component rating of 8, but indicated that he learned about the program after deciding to install the upgrade, the Preliminary Program Influence Score would be (8 * 0.5) = 4. If the respondent had indicated that he learned about the program before deciding to install the upgrade, the Preliminary Program Influence Score would be higher (8).

Then, the Final Program Influence FR score is calculated as:

Final Program Influence FR Score

= *10 – (Preliminary Program Influence Score)*

Continuing the examples from above, if a respondent's Preliminary Program Influence Score was 8, the Final Program Influence FR Score would be (10 – 8) = 2. The Final Program Influence FR Score would be higher if this respondent indicated that he learned about the program after deciding to install the upgrade (10 – 4) = 6.

2. No-Program Score. This score is based on the participant's self-reported likelihood to have installed the exact same type of energy-efficient equipment without the program, using scale of 0 to 10 (where 0 is "Not at all likely" and 10 is "Very likely"). The Preliminary Program Influence FR Score is calculated as:

   Preliminary No-Program Score

   = *Likelihood to Install Same Equipment*

   A greater likelihood of participating without the program means higher level of FR. In cases where the participant is highly likely to have installed the same type of equipment without the program (7, 8, 9, or 10 on the 0–10 scale), the algorithm accounts for the program's influence on the timing and quantity of measures installed through the project. Timing and quantity adjustments are detailed below. These adjustments are incorporated for applicable cases as follows:

   Final No-Program Score

   = *(Likelihood to Install Same Equipment + Timing & Quantity Adjustment) / 2*

3. Timing and Quantity Adjustments to the No-Program Score. Even if the participant was highly likely to have installed the same type of equipment without the program, the program still might have influenced the participant to undertake the project sooner than he would have otherwise, or to have installed a larger quantity of the equipment. The algorithm adjusts the Preliminary No-Program Score downward to credit the program's influence on timing and/or quantity in those cases where the respondent would have been

highly likely to have performed the same upgrades without the program (i.e., a high Preliminary No-Program Score). We ask the timing and quantity questions only of program participants who had considerable probability of installing high-efficiency equipment even if they had not participated in the program (thus making timing and quantity conditional on efficiency).

The timing and quantity adjustments are calculated as:

Timing Score = *Likelihood to Install Measures in Similar Time Frame*

Quantity Score = *10 − Likelihood to Install Fewer Measures*

Later upgrades without the program mean a lower level of FR. A timing score of 10 means that there is no evidence the program changed the time frame in which the upgrade would have been implemented, while a lower value of the timing score means that the program caused the upgrade to be implemented sooner.

Similarly, installing fewer upgrades without the program means a lower level of FR. A quantity score of 10 means that there is no evidence the program changed the number of upgrades completed, while a lower value of the quantity score means that the program caused the participant to implement more upgrades than he otherwise would have.

If either the timing score or 10-quantity score is less than the Preliminary No-Program Score, the two scores are averaged to create a composite timing and quantity adjustment:

Timing and Quantity Adjustment

= *(Likelihood to Install Measures in Similar Time Frame + [10 − Likelihood to Install Fewer Measures]) /2*

Averaging the Timing and Quantity Adjustment Factor with the Preliminary No-Program Score (described above) provides the program with credit for accelerating the timing of the program and/or the number of measures installed.

This evaluation team implemented and analyzed the following three specifications of the FR algorithm.

- **Core Algorithm:** (Final Program Influence Score + Final No-Program Score) / 2
- **Alternative Algorithm 1:** (Final Program Influence Score + ([Preliminary No-Program Score + Timing Score + Quantity Score] / 3) / 2
- **Alternative Algorithm 2:** (Final Program Influence Score + Preliminary No-Program Score + Timing Score + Quantity Score) / 4

In addition, we provide a sensitivity analysis on the program influence score adjustment, as specified in the IL-TRM V4.0.

- **Sensitivity Analysis on Core Algorithm:** (Preliminary Program Influence Score + Final No-Program Score) / 2

Per the IL-TRM V4.0, we followed the Core Multifamily NTGR Algorithm to develop the NTGR based on PY8 participation and to be applied in PY10. However, we are reporting on Alternative Algorithm 1, Alternative Algorithm 2, and the Sensitivity Analysis on the Core Algorithm to support algorithm review and revisions going forward.

Addressing Triggered Consistency Checks

The IL-TRM V4.0 advises including consistency checks to address the possibility of conflicting responses to FR elicitation questions. We implemented this guidance by using six consistency checks to determine whether participants provided consistent responses across the program influence score, the no-program score, and the order in which they learned about the program and decided to install the upgrades. Twenty-three percent of survey respondents triggered a consistency check (Table 53). As recommended in the IL-TRM V4.0, we completed follow-up interviews with respondents who triggered the consistency checks; we reached 6 of the 13 respondents and were able to revise all inconsistencies.

Table 53. Consistency Checks

#	Consistency Check	Number of Respondents Triggering Check
1	Learned about program after decision to upgrade: Program factors were important in decision to do the upgrade	7
2	Highly likely to do same upgrade without program: Program factors were important in decision to do the upgrade	6
3	Learned about program after decision to upgrade: Would be unlikely to install same equipment on own without program	7
4	Learned about program after decision to upgrade: Would be likely to install fewer equipment upgrades on own without program	0
5	Highly unlikely to do same upgrade without program: No program factors were important in decision to do the upgrade	0
6	Learned about program after decision to upgrade: Would be unlikely to install same equipment on own and in the same time period without program	0

Follow-up interviews with four of the seven respondents who specified a high program component or influence score—but said that they learned about the program after they decided to do the project—resulted in one of two outcomes (Consistency Checks 1 and 3). Three participants clarified that they actually learned about the program *before* they made the decision to go through with the project, while one clarified that they had a general idea to do some energy efficiency upgrades before learning of the program, but that the program's discount played a persuasive role in their decision to actually start implementing the project. Based on these follow-up responses with four respondents, we changed all of the affected respondents' answers to the order effect question, such that these participants were credited with learning about the program before deciding to do the project.

During follow-up interviews with two of the six respondents who triggered Consistency Check 2, we found that respondents appeared to have misunderstood the questions when originally asked during the survey, as the respondents then clarified that they would *not* have done the project if it wasn't for the program. In these cases, we changed all of the six affected respondents' likelihood to have done the same upgrade without program to less than 7.

We used the database with consistency-check-based corrections for NTGR calculations.

Results

To produce final weighted FR estimates by component, we weighted survey responses from each completed interview by the ex post gross savings of the associated measure discussed during that interview. Table 54 presents the FR scores generated by the core algorithm (recommended for prospective application in PY10) and three supplementary algorithms prescribed by the IL-TRM V4.0. As shown in Table 52, the core and alternative algorithms all provide very similar estimates of FR.

Table 54. Alternate Free-Ridership Scores Tested During Analysis

Component	Measures (n=)	Core Algorithm	Core Algorithm, Sensitivity Analysis	Alternative Algorithm 1	Alternative Algorithm 2
Electric (kWh)					
Insulation (sq. ft.)	674,954	14%	14%	14%	16%
Air Sealing (CFM)	612,312	14%	14%	14%	16%
In-Unit Measures	141	21%	21%	21%	21%
Gas (Therms)					
Insulation (sq. ft.)	233,034	29%	29%	29%	29%
Air Sealing (CFM)	12,138	20%	20%	20%	20%
In-Unit Measures	374	0%	0%	0%	0%

Participant Spillover

Methodology

PSO refers to the installation of energy-efficient measures by program participants who were influenced by the program but who did not receive an incentive. An example of PSO is a property manager who installed incented equipment in one property and, as a result of the positive experience, installs additional equipment at another property but does not request an incentive (outside SO). In addition, the participant may install additional equipment, without an incentive, at the same property because of the program (inside SO). For the Multifamily Program, participants included in the SO calculations had to meet two criteria) the customer must have installed an energy-efficient measure that did not receive a rebate and the customer must have reported that the program had a high level of influence on his or her decision to install the measure.[25]

We examined both inside and outside SO in projects from lighting and non-lighting end-uses using participant responses to the CATI surveys and callbacks, as necessary. We conducted an engineering analysis of participant responses to determine the savings associated with measures identified as SO.

After calculating the SO savings present in our sample, we use Equation 10 to develop the program PSO rate for application to the IPA and AIC multifamily programs.

Equation 10. Participant Spillover Rate

$$\text{PSO } Rate = \frac{Total\ SO_{Participant\ Sample}}{Total\ Ex\ Post\ Gross\ Program\ Savings_{Participant\ Sample}}$$

Results

Two property managers out of the 57 who completed the survey specified that the program influenced them to install energy-efficient measures outside of the program without receiving a rebate. Based on our review of the survey data, PSO savings were achieved for performing tune-ups on existing heat pumps servicing both common areas and apartment units and for installing additional CFLs in common areas. Table 55 provides the IL-TRM V4.0 algorithms that we used to determine the per-measure savings for each SO measure. Table 56provides the assumptions and per-measure values used to populate the algorithms.

[25] The customer must have answered an 8 or higher on a 0–10 point scale where 0 means “no influence” and 10 means “greatly influenced.”

Table 55. Spillover Measure Algorithms

Measure	Units	kWh Savings Equation	kW Savings Equation	Source
CFLs (Common Area Interior)	Per Lamp	(WattsBase – WattsCFL) / 1,000 * HOU * WHFe * ISR	(WattsBase – WattsCFL) / 1,000 * WHFd * ISR * CF	IL-TRM V4.0
Heat Pump Tune-Up	Per Heat Pump	(FLHcool * Clg_capacity * (1 / SEER)) / 1,000 * Mfe) + (FLHheat * Htg_capacity * (1 / HSPF) / 1,000) * Mfe)	(Clg_capacity * (1 / EER) / 1,000) * Mfd * CF	IL-TRM V4.0

Table 56. Spillover Measure Assumptions and Per Measure Savings

Spillover Measure	Energy Savings (kWh/unit)	Demand Savings (kW/unit)	Units	Quantity	Source	Assumptions
CFLs (Common Area Interior)	223.86	0.029	Per Lamp	14.74	– IL-TRM V4.0 – PY8 Multifamily Program Database	One participant indicated installing additional CFLs in interior common areas. It was assumed the new CFLs replaced incandescent lamps. The quantity of installed CFLs is unknown, therefore the evaluation team assumed the average quantity per property in the PY8 program-tracking data for 13W, 20W, and 23W CFLs installed in interior common areas (914 lamps installed in 62 properties = average 14.74 lamps per property). We applied the average deemed ex-post per-measure savings for 13W, 20W, and 23W CFLs (average 223.86 kWh/lamp) based on assumptions from the IL-TRM V4.0.
Heat Pump Tune-Up	633.21	0.038	Per Heat Pump	8.00	– IL-TRM V4.0 – PY8 Multifamily Database – RECS 2009 Data[a] – ENERGY STAR® Sizing Guidelines[b] – HVAC Heating and Cooling Proper System Sizing[c]	One participant indicated performing tune-ups on eight existing heat pumps that service both common areas and apartment units. We applied IL-TRM V4.0 default values for full load cooling and heating hours based on the project location specified in the PY8 tracking database (Springfield, IL). The cooling capacity was determined using 2009 RECS data, which indicate that the average Midwest multifamily unit is about 957 square feet. We then use the ENERGY STAR Sizing Guidelines to determine the appropriate cooling capacity needed to condition a 957 square foot space (24,000 BTU). The heating capacity was calculated by applying a factor of 40 BTU/square foot (Zone 3, IL) from the North Carolina State University article entitled "HVAC Heating and Cooling Proper System Sizing"[c] to determine the appropriate heating capacity needed to condition a 957 square foot space (38,280 BTU). All other variables come from the IL-TRM V4.0.

[a] Residential Energy Consumption Survey (RECS); http://www.eia.gov/consumption/residential/
[b] http://www.energystar.gov/ia/partners/bldrs_lenders_raters/downloads/SizingGuidelines.pdf.
[c] https://energy.ces.ncsu.edu/hvac-heating-and-cooling-systems/.

As Table 57 shows, the estimated total SO in our sample was 8,366 kWh and 0.73 kW, while total program gross savings of the overall participant sample equaled 2,218,798 kWh and 254 kW. Our estimated SO rates are therefore 0.4% (kWh) and 0.3% (kW).

Table 57. Total Spillover Savings

Measure	kWh	kW
CFLs	3,300	0.43
Heat Pump Tune-up	5,066	0.30
Total	8,366	0.73
Total Verified Savings for Surveyed Sample	2,218,798	253.59
% Spillover	0.4%	0.3%

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