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Evaluation of the 2016 (PY8) Ameren Illinois Company Residential Multifamily Program

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CADMUS

NAVIGANT

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1. Executive Summary

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

Together, the two programs offer AIC multifamily customers three program components: common area lighting (AIC and IPA), major measures for the building shell (AIC and IPA), 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 all of the in-unit measures (CFLs for permanent light fixtures, faucet aerators, low-flow shower heads, and programmable thermostats); standard and specialty CFLs for common areas; and major measures, such as air sealing and attic insulation at buildings with gas heat.[3] As a result of PY8 installations, the Multifamily Program was expected to contribute 26.6% of the overall PY8 residential portfolio's electric savings (8,512 MWh) and 5.3% of the residential portfolio's gas savings (164,940 therms). 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 and of tenants living in upgraded units. 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 AIC evaluation.

Program Impacts

Overall, the ex post net savings from the PY8 Multifamily Program were 6,173 MWh, 1.21 MW, and 279,047 therms (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

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

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

[3] The IPA Multifamily Program sponsors the remaining types of common area lighting (LED exit signs, linear fluorescents, modular CFLs, and occupancy sensors) and major measures for buildings with electric heat. The IPA Multifamily Program does not sponsor any in-unit direct installs.

[4] Several evaluation activities were completed in conjunction with the IPA 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 IPA Multifamily Program in a separate report.

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

105% to 129%; differences between ex ante gross and ex post gross savings calculations are due to variances in savings assumptions for specific measures.

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	6,033	105%	6,306	0.99	6,173
Demand Savings (MW)					
Total MW	1.09	115%	1.25	0.97	1.21
Gas Savings (Therms)					
Total Therms	260,432	129%	335,926	0.84	279,047

[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 1,128 projects at 1,724 multifamily buildings.[6] Most participants completed projects through the in-unit component (N=599) or major measures component (N=462), with fewer completing common area lighting upgrades (N=67).

Relative to the PY7 program, which achieved net energy and demand savings of 8,306 MWh and 1.72 MW, respectively, the PY8 program achieved significantly lower savings (26% and 30% declines, respectively). However, the program's gas savings increased by 17% from 239,163 therms in PY7 to 279,047 therms 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 savings of 6,173 MWh, 1.21 MW, and 279,047 therms. While the program exceeded its gas savings goal, the program fell short of its electric savings goal despite increased participation garnered from additional marketing and expanding the pool of program allies. Program implementers attributed the savings shortfall to having installed a lower-savings mix of direct installation measures, with fewer direct installs at electric-fueled buildings than planned (and more at gas-fueled properties) and a less-efficient mix of CFL measures than planned.

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 reported that the Multifamily Program operated smoothly and effectively in PY8. Moreover, interviews with participating property managers and their tenants suggest that participants were

[6] The number of projects is smaller than the number of buildings because some project IDs encapsulated upgrades at multiple buildings.

generally satisfied with all aspects of the program. 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, the program-tracking platform did not calculate ex ante savings in instances where measure records (programmable thermostats and major measures) were missing key project information that is used as inputs to savings calculations (e.g., HVAC equipment age and participant zip code/city). This caused the ex ante savings to underrepresent total savings.
  - **Recommendation #1:** It is imperative to ensure that the program-tracking platform does not mistakenly exclude measures with incomplete information from ex ante savings calculations. By strengthening a consistent commitment to quality assurance/quality control (QA/QC), the implementers can minimize these occurrences by reviewing data entry as well as the algorithms and the assumptions programmed in Amplify (the program-tracking database).
- **Key Finding #2:** Participating property managers and their tenants 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 whom we spoke with 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. Tenants also appeared to be happy with the measures that the program installed in their units.
- **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 they did suggest that the program could offer additional measures. For example, property managers who did not receive programmable thermostats through the PY8 program expressed moderate interest in both programmable thermostats and a potential new offering of

"smart" thermostats. A minority of respondents suggested additional measures, including efficient windows and doors, HVAC upgrades, and insulation for walls and other parts of the building shell.

- **Key Finding #5:** Tenant self-reports suggested that, prior to program upgrades, incandescents and CFLs made up the majority of permanent fixture lighting, with a minority of LED and halogen lights in service. Most tenants interviewed for the evaluation were familiar with CFLs (96%) and many were already using them in at least a few of their unit's permanent fixtures before the PY8 program (65%). In contrast, fewer tenants recalled using any LEDs in permanent fixtures (4%), and few recalled recently purchasing any LEDs. Although most markets are seeing declining opportunities for lighting savings as the market becomes more efficient and efficient lighting saturation increases, tenant survey data suggest that LEDs will offer a greater opportunity for in-unit lighting savings moving forward, compared to CFLs.
  - **Recommendation #5:** Starting in PY10, the Multifamily Program is already planning to switch from a CFL-based in-unit offering to an LED-based in-unit offering. The results of this evaluation provide additional support for this change.

2. Evaluation Approach

The Project Year 8 (PY8) evaluation of the Ameren Illinois Company (AIC) 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 AIC and program implementation staff, and surveys with tenants and property managers.[7] 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[8] (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 AIC Multifamily Program and the similar Illinois Power Agency (IPA) Multifamily Program.[9]

2.1 Research Objectives

The objective of the evaluation of PY8 of the Multifamily Program was to provide estimates of gross and net electric and gas 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?[10]

The evaluation team also explored a number of process-related research questions as part of the PY8 evaluation.[11] 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?

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

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

[9] Hereafter, except where noted, "Multifamily Program" refers to the AIC Multifamily Program.

[10] As discussed further in this 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.

[11] The evaluation team conducted these activities in conjunction with the IPA 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 AIC 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.
Tenant Survey	✓		✓	Conducted web surveys with tenants who received direct install measures to gather data related to LED adoption, including information about tenants' recent lighting purchases, installations, and replacement behaviors.
Impact Analysis		✓		Conducted an engineering analysis of all measures installed during PY8.

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

2.2.1 Program Staff Interviews

In June 2016, the evaluation team conducted in-depth interviews with the AIC 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 and program marketing materials. These materials included a marketing presentation that AIC 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 AIC or IPA Multifamily Program during PY8. Fifteen of these survey respondents (26%) participated in the AIC 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. Further, the program staff do not anticipate offering CFLs for tenant units in future years. Therefore, we did not collect data to develop a NTGR for prospective application to in-unit CFLs. 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 IPA 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 AIC and IPA programs). For the purpose of NTGR estimation, capturing the views of AIC and IPA 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 AIC and IPA 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 AIC program, the IPA program, or both), we combined the AIC and IPA 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).[12]

[12] 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

Table 3 shows the resulting participant population across both the AIC and IPA programs in terms of unique properties. One-quarter of PY8 properties (25%) received upgrades through the AIC program or through both the AIC and IPA programs. Within the AIC program, most properties received major measures (72%) and in-unit measures (22%), with few customers receiving common area lighting (<1%) or a mix of these AIC offerings (5%).[13] Among the few properties that received upgrades from both the AIC and IPA programs, the most common form of cross-program participation involved in-unit upgrades from the AIC program and major measures through the IPA program.

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, and 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 AIC and IPA 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 AIC or IPA 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.

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.

[13] 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.

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 AIC and IPA 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 participants completed upgrades at multiple properties (37% of participants). For these participants, 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%
Shower Head	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 Percentage of Cases of Unknown Survey Eligibility That Are Eligible	81%
e2	Estimated Percentage 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 Tenant Survey

We conducted an internet survey with 71 tenants residing in units that received in-unit measures through the program.[14] The main goals of the survey were to explore tenants' lighting purchase behaviors, program satisfaction, and interest in potential program measures. We fielded two waves of the survey with a sample of tenants between September 13, 2016 and November 18, 2016.

Sample Design

We cleaned the Multifamily Program tracking data provided in August 2016 by CLEAResult. The raw tracking dataset included the addresses of dwelling units that received in-unit upgrades. We identified unique tenant units by street address and tenant unit number; where necessary, we disaggregated program-tracking data provided at the level of a whole building or series of units to develop a dataset where each unique record was a tenant unit. After these processing steps, we drew a simple random sample of records for inclusion in the tenant survey.

[14] We also provided tenants with the option of calling the evaluation team to complete the survey over the phone. Overall, 25% of respondents opted for the telephone.

Survey Fielding, Disposition, and Response Rate

We fielded the survey using a mail-push-to-web method because street addresses were the only tenant contact method provided in program-tracking data (i.e., the data included neither tenant phone numbers nor tenant email addresses). In total, we mailed letters inviting 1,650 tenants living in upgraded units to take the survey and followed up with a reminder postcard. Each letter contained a link to the survey, as well as a unique PIN that participants typed into the web survey for response tracking. We allowed the tenants to complete the survey over a time frame of approximately 2 weeks upon receipt of the letter. We provided survey participants with a $25 incentive for completing the survey.

The total number of mailings (1,650) included two waves of survey fielding. The first wave was delivered to 750 sample points. We added a second wave of 900 letters after response issues in the first wave, namely, a higher-than-expected rate of undeliverable mailings and a higher-than-expected rate of ineligible participants who screened out of the survey after visiting the survey website. We discuss these fielding issues in more detail below. Of the 1,650 customers invited to take the survey, 71 eligible customers completed it.

Table 9. Tenant Survey Sample Design

Analysis Level	Units
Population	10,112
Sample Frame	1,650
Completed Surveys	74
Surveys Included in Analysis (removing duplicate entries)	71

Note: Population determined by number of unique tenant addresses in program-tracking data.

Based on this sample design, the team achieved a precision of ±10 % at the 90% confidence level.

Mailing List Quality and Current Tenant Eligibility

Many of the addresses provided in the program-tracking data did not comply with U.S. Postal Service format. After 136 survey invitation letters (18%) were returned undeliverable during the first wave, we attempted to determine the correct address by either comparing letters' addresses against the U.S. Postal Service database or verifying the right address based on phone calls to rental complex staff. Where possible, we updated the address and sent a supplemental invitation letter instead of a reminder postcard. We did not correct addresses for undeliverable mail during the second wave. In total across both waves, undeliverable mail affected 282 sample points (17%).

Because one of the goals of the PY8 survey was to determine the types of lighting installed in tenant units' permanent fixtures pre-upgrade, the PY8 survey was limited to residents living in the upgraded unit prior to the upgrade. Thus, the PY8 survey instrument included a new screening question that asked when tenants had moved into their unit. During sample size planning, we had not accounted for significant tenant turnover, and in fact found during fielding that 45% of tenants who attempted to take the survey during the first wave had moved into their unit after program measures were installed (per program-tracking data). We screened these customers out of the participant survey because the survey focused on determining the types of lighting in customer homes prior to participation.

Survey Disposition and Response Rate

Table 10 presents the final survey dispositions for the tenant survey.

Table 10. Tenant Survey Dispositions

Category Key	Disposition	Total
I	Complete	71
N	Eligible Incomplete Interview	5
X1	Survey-Ineligible Household	57
U1	Household with Undetermined Eligibility	1,235
X2	Not a Household	282
U2	Undetermined if Household	0
e1	Estimated Percentage of Cases of Unknown Survey Eligibility That Are Eligible	57%
e2	Estimated Percentage of Cases of Unknown Household/Business Eligibility That Are Eligible	83%
Total Participants in Sample		**1,650**

Table 11 provides the response and cooperation rates. Appendix B describes the methodology to calculate response rates in more detail.

Table 11. Tenant Survey Response Rate

AAPOR Rate	Percentage
Response Rate 3	9%
Cooperation Rate 3	91%

2.2.5 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[15] 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.

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 12 summarizes the measure-level NTGRs used to calculate PY8 Multifamily Program net savings.

[15] 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

Table 12. NTGRs by Measure Category

Measure Category	NTGR	
	Electric	Gas
In-Unit CFL	0.95	n/a
Common Area CFL	0.83	n/a
Aerator	1.06	1.00
Shower Head	1.00	0.94
Thermostat	1.04	0.98
Air Sealing	0.96	0.81
Attic Insulation	0.88	0.75

The evaluation team 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 13 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 13. 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
Tenant Survey	▪ Sampling Error	▪ Sample frame error ▪ Measurement error ▪ Non-response and self-selection bias ▪ Data processing error	▪ n/a
Participating Property Manager Survey	▪ No sampling error because 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 against potential sources of error throughout the planning and implementation of the PY8 evaluation.

Survey Error

- **Sampling Error:**
  - The evaluation team designed the tenant survey sample to achieve 90% confidence and +/-10% relative precision. We surveyed 71 customers out of a population of 10,112 households. At the 90% confidence level, we achieved a precision of +/- 10% assuming a coefficient of variation of

0.50. The actual precision of each survey question will differ depending on the variance of the responses to each question.

- **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 and tenant surveys due to the difficulty in forming the sample frame from the program-tracking data. Section 2.2.3 and Section 3.1.4 describe how we attempted to improve the property manager and tenant 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 AIC 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 and the tenant 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 and 9% for the tenant survey, there is the potential for non-response bias. For the property manager survey, 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.[16] For the tenant survey, we sent out an additional wave of surveys to ensure that we had an adequate sample size to generalize to the population of tenant units, as described in Section 0.
  - **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

[16] 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.

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.
  - **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 AIC service territory have been split between the AIC Multifamily Program and the IPA Multifamily Program. There are three main components offered through the AIC and IPA 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 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), some types of common area lighting (standard and specialty CFLs), and major measures for buildings with gas heat. The IPA Multifamily Program does not sponsor any in-unit measures, but does sponsor the remaining types of common area lighting (all non-CFL installations) and major measures for buildings with electric 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 AIC and IPA programs. Thus, since PY7, little has changed within the AIC 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 AIC program. Specifically, the program implementer conducts outreach and recruitment of participants for the direct installation components of the program (in-unit and common area). The implementer installs all common area lighting and most of the in-unit measures. The exception is programmable thermostats, which the implementer provides to participating property managers for installation by property staff. In contrast, program allies (recruited by the implementer) are responsible for generating leads, bringing customers into the major (shell) measures component of the program, and performing all major measure installations. Table 14 provides a summary of the multifamily offerings available in the AIC service area. Note that the program implementer and program allies present all offerings as a single program to the customer. Major measure offerings are provided at no cost to the property manager, and the discounts for common area lighting and in-unit measures cover measure costs for those aspects of the program.

As appropriate opportunities arise, program allies and program administrators who implement the AIC and IPA programs have an informal process to 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 14. Multifamily Program Offerings in the AIC Service Area

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

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 AIC 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, AIC 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 contribute 26.6% of the overall PY8 residential portfolio's electric savings (8,512 MWh) and 5.3% of the residential portfolio's gas savings (164,940 therms). To meet these goals, the implementer expected to serve around 9,500 individual multifamily units and 300 buildings during PY8. Due to increased program savings goals in PY8 and to early findings that properties were achieving less savings per property than planned, program staff reported that the program needed to serve more units than planned.

In all, the program served 11,797 units and thereby achieved 124% of the multifamily unit participation goal. Nevertheless, despite slight program design changes discussed above and the resulting increase in program participation, the PY8 program fell short of the higher PY8 goals. The program achieved 6,173 MWh of electric savings, which is 73% of the program's electric goal (8,512 MWh) and 279,047 in gas savings, which is 69% higher than the gas savings goal of 164,940 therms. According to program staff, lower savings on the electric side can be partially explained by low adoption of programmable thermostats in electrically heated units.

Program implementers also suggested that part of the savings shortfall was due to a lower-than-expected potential to install high-efficiency CFLs at properties, due to higher-than-expected rates of CFL saturation pre-upgrade.

3.1.3 Property Manager Participation and Experience

PY8 Program Participation

Program staff implemented 1,128 unique projects through the Multifamily Program at 1,724 buildings (804 street addresses, when building numbers are omitted). As Table 15 shows, these 1,128 unique projects most frequently installed in-unit measures (53%) or major measures (41%).

Table 15. PY8 Multifamily Program Participation

AIC Program Component	Projects (#)	Share of Projects Receiving AIC Measures (%)
In-Unit Measures	599	53%
In-Unit CFLs	504	45%
Low-Flow Shower Head	324	29%
Programmable Thermostat	155	14%
Faucet Aerator	329	29%
Major Measures	462	41%
Air Sealing	374	33%
Attic Insulation	449	40%
Common Area Lighting	67	6%
Total	**1,128**	**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%.

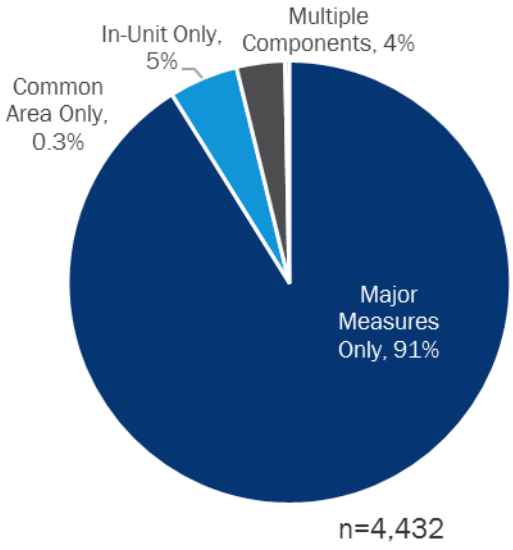
PY8 AIC and IPA Cross-Program Participation

As discussed above, multifamily offerings in AIC's service area included several components (for tenant units, common area, and building shell) and these offerings are split between the AIC program and the IPA 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.[17] 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 AIC and IPA offerings were similar to past years, with most properties receiving major measures (Figure 1). Program staff indicated that they generally made 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

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

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.

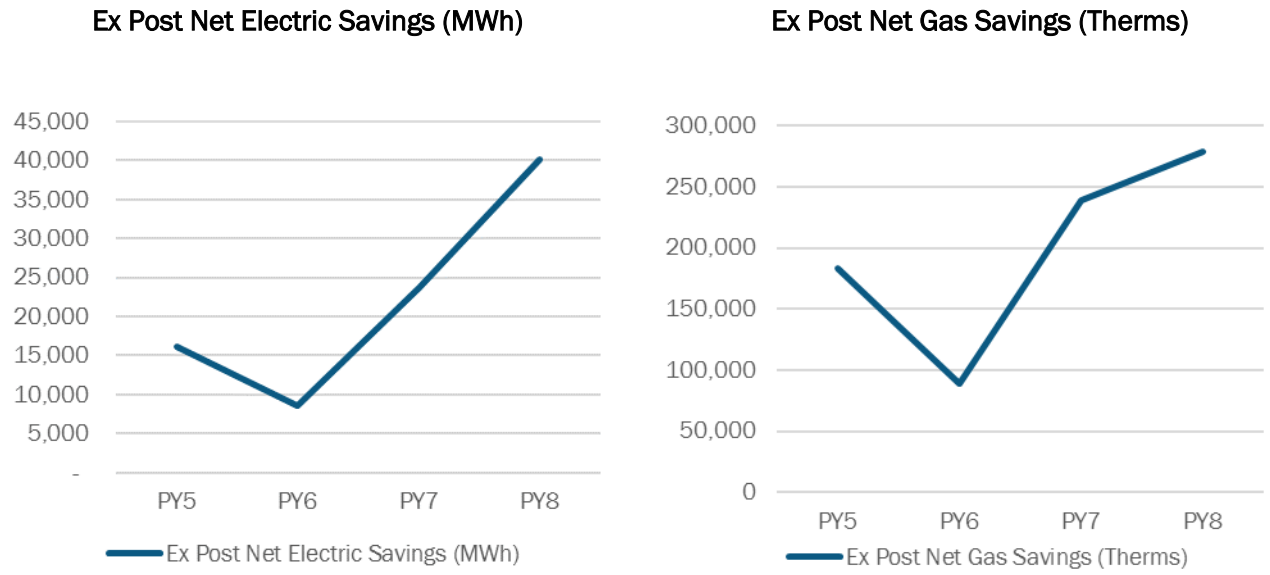
Figure 1. Multifamily Property Upgrades by Component Type (AIC and IPA Programs)



Trends in Participation

Figure 2 plots the growth in ex post net electric and gas savings from the AIC and IPA multifamily programs between PY5 and PY8. The combined electric savings from the AIC and IPA programs increased by 69% from PY7, to 44,711 MWh in PY8. Combined gas savings also increased, by 17% from PY7 to 279,047 therms in PY8.

Figure 2. Multifamily Program Ex Post Net Savings 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. They also expressed an interest in additional program measures (i.e., measures that are currently available through the program), as well as additional measures the program could offer. Property managers also provided recommendations for program improvements.

Entry into the Program

Multifamily property managers are recruited into 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 16). 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 16. 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%

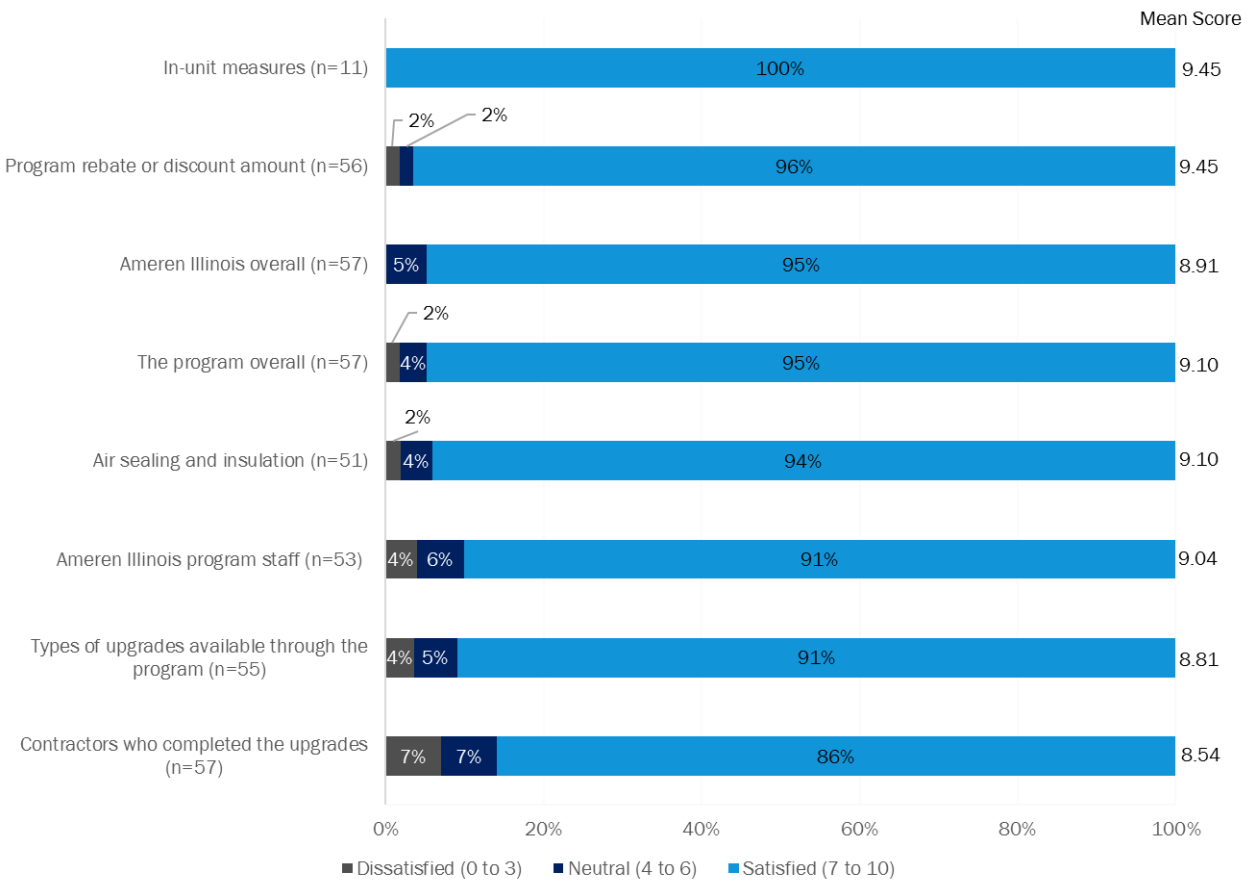
[a] Two respondents indicated that they did not know where they had heard about the program.
[b] This question was asked as an open-ended question with pre-coded response categories (not read). Sources marked with "[b]" are categories developed from "Other" responses not included in the pre-coded list 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 AIC program, the IPA program, or both programs. The majority of property managers (95%) were satisfied[18] with the multifamily programs overall. Similarly, 95% of participants said that they were satisfied with AIC overall. As shown in Figure 3, program satisfaction remained high across all program elements.

[18] 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 programs 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 17). The four respondents who suggested using a different contractor all received major measure upgrades.

Table 17. Property Managers' Suggestions for Multifamily Program Improvement (Multiple Response)

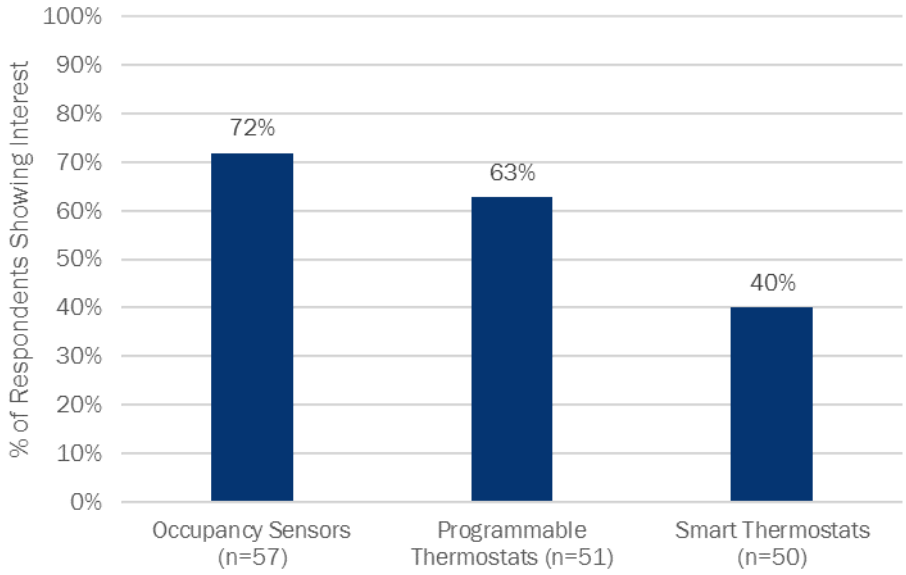
Suggestions	Percent (n=50)
Offer more measures	18%
Increase visibility and depth of marketing[a]	10%
Use a different contractor[a]	8%
Offer a higher-quality product[a]	6%
Higher incentives	2%
Other[b]	10%

[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), as well as one measure that the 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 interesting in them in the future (Figure 7).

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



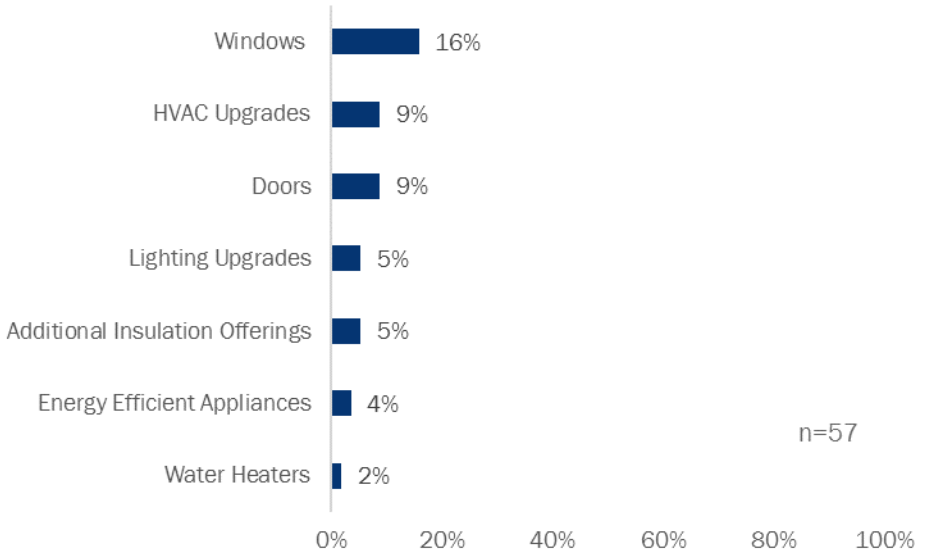
Note: Respondents who received occupancy sensors or programmable thermostats in PY8 were not asked about these measures.

We also explored respondents' interest in new measures that the programs could potentially offer in the future. One of these new measures of interest is smart thermostats. While interest in smart thermostats was somewhat lower than interest in programmable thermostats, just under one-half of property managers (40%) who had not recently installed programmable thermostats through the program still expressed interest in installing smart thermostats in their tenants' units (Figure 4). Survey data suggest that property managers' interest in installing smart thermostats may be sensitive to the price a property manager could be asked to pay through the program. During the survey, property managers were informed that smart thermostats typically have a retail value of $250, and were then asked if they would be interested in installing smart thermostats through the program at two different price points. Compared to the share of respondents interested in free smart thermostats (40%), slightly fewer respondents (30%) expressed interest in smart thermostats if they had to pay a discounted cost of $50 apiece. While a fair number of respondents who were interested in smart thermostats may be willing to pay a small copay for them, few participants (12%) were interested in a smart thermostat offering if they had to pay $100 per unit. The 2016 Ameren Illinois Demand Side Management

Market Potential Study[19] reported findings from a meta-analysis of studies examining potential energy savings from smart thermostats; these results suggest that smart thermostats may provide marginally higher savings over programmable thermostats. Given that property managers' interest in programmable thermostats was not appreciably different from their level of interest in smart thermostats, program staff could consider offering smart thermostats as an option to achieve marginally greater savings in future program years.

Property managers were also asked to recommend specific measures that they would be interested in seeing offered through 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 AIC should consider offering services to upgrade the efficiency of heating and air conditioning (AC) units. Interestingly, three respondents suggested that AIC should offer light bulbs or common area lighting measures. These measures are already offered through the program. 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.

[19] Applied Energy Group (AEG). Ameren Illinois Demand Side Management Market Potential Study: Volume 4- Appendices. April 2016.

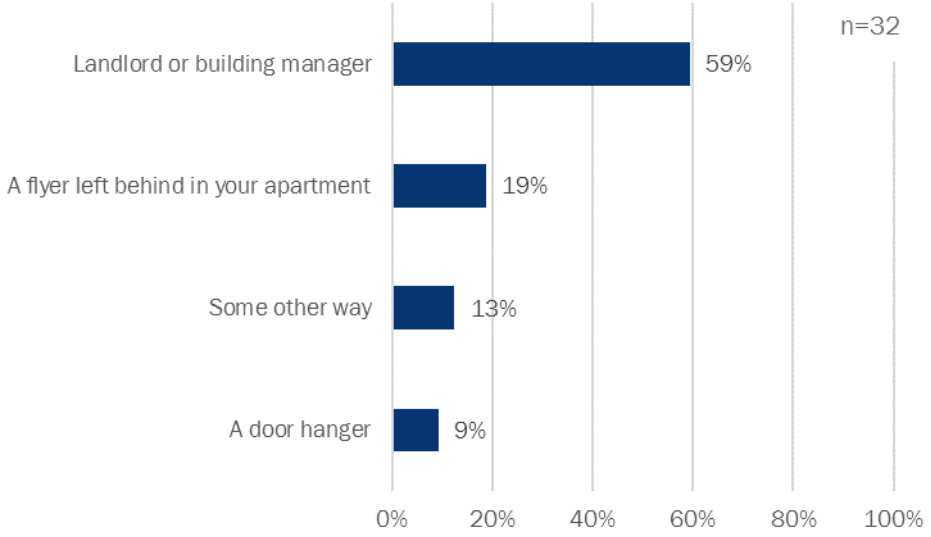
3.1.4 Tenant Program Experience

Program Satisfaction and Awareness

Most tenant respondents (76%) were satisfied[20] with the measures that they received; on average, tenants gave a satisfaction score of 8.13 on a 0–10 scale, where 0 is "extremely dissatisfied" and 10 is "extremely satisfied."

The AIC program used several outreach channels to inform tenants about upcoming upgrades to their units and leveraged these materials to inform tenants that AIC sponsors the energy-efficient upgrades. Outreach channels included door hangers with AIC branding left at tenant units, as well as word of mouth from program allies and property maintenance staff. While tenant participants' awareness that AIC sponsors the program did not influence the savings attributed to the Multifamily Program, AIC program staff did consider these outreach activities as an opportunity to promote a positive customer relationship. When we asked tenants about their awareness of the program, just over one-half of respondents (47%) were aware that the free energy efficiency measures were provided to them by AIC. Figure 6 shows that tenants who were aware of the Multifamily Program most frequently learned about the program through their landlord or building manager (59%). If AIC is interested in boosting tenant awareness for purposes of public relations or channeling to other relevant programs (e.g., the upstream lighting program), it might wish to consider developing additional educational materials or talking points that landlords can use to educate tenants about the energy efficiency upgrades in their units.

Figure 6. Multifamily Tenants' Sources of Awareness about the Multifamily Program (Multiple Choice)



Lighting Purchase Behavior

The tenant survey asked a series of questions to assess tenants' lighting awareness, explore their recent purchases, and determine their role in replacing lighting in their unit's permanent fixtures. These survey

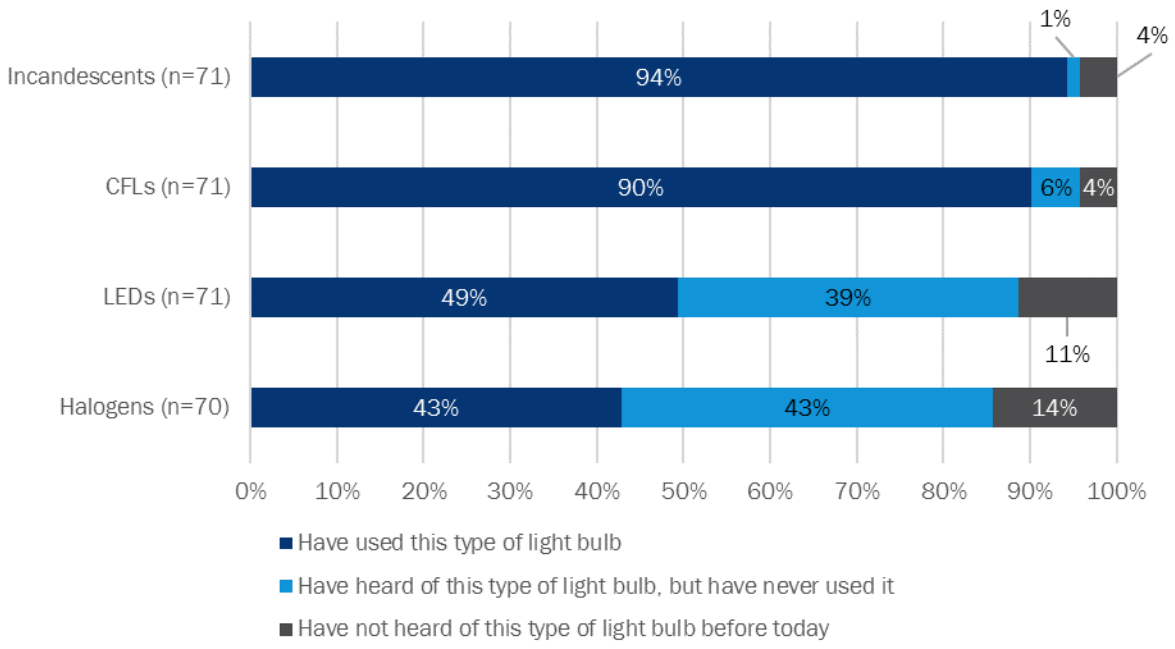
[20] A score of 7, 8, 9, or 10 on a scale of 0 to 10, where 0 means "extremely dissatisfied" and 10 means "extremely satisfied."

questions follow up on PY6 research about who replaces permanent lighting in tenant units and helped explore opportunities for future tenant-oriented program offerings. Because the Multifamily Program replaces lighting in permanent fixtures (such as ceiling lights), but not portable lighting (such as table lamps), we asked tenants to focus on lighting purchase and replacement for their unit's permanent fixtures and clarified that respondents should not focus on portable lighting.

Corroborating property manager survey findings, the PY8 tenant survey indicates that many tenants are the key decision-makers when it comes to replacing bulbs in their unit's permanent fixtures. Per responding tenants, most tenants (94%) are responsible for paying their own electricity bills. Similarly, most tenants reported that they make most of the decisions about what to install in permanent fixtures, rather than their landlord or property manager. Specifically, three-quarters (75%) of tenants we interviewed said that they were responsible for replacing burnt-out lights in permanent fixtures. Of the respondents who were responsible for replacing permanent fixture bulbs, 65% recalled purchasing bulbs for these applications in the past year.

Markets for residential lighting are changing rapidly, with improving technology and falling prices. To provide the program with an updated snapshot of tenants' awareness and use of efficient lighting, we also asked tenants to describe their experience with common lighting technologies. Figure 7 shows that most tenants are familiar with or have used conventional bulbs, as 95% of tenants had heard of or used incandescent light bulbs and 96% had heard of or used CFL light bulbs before the AIC program upgraded their units. These findings are in line with PY6 in-home lighting audits in the AIC service territory, which found that 95% of renters had installed at least one CFL. Most tenants in the PY8 program have also heard of or used LEDs (88%), although fewer respondents have used LEDs (49%) than have used CFLs (90%).

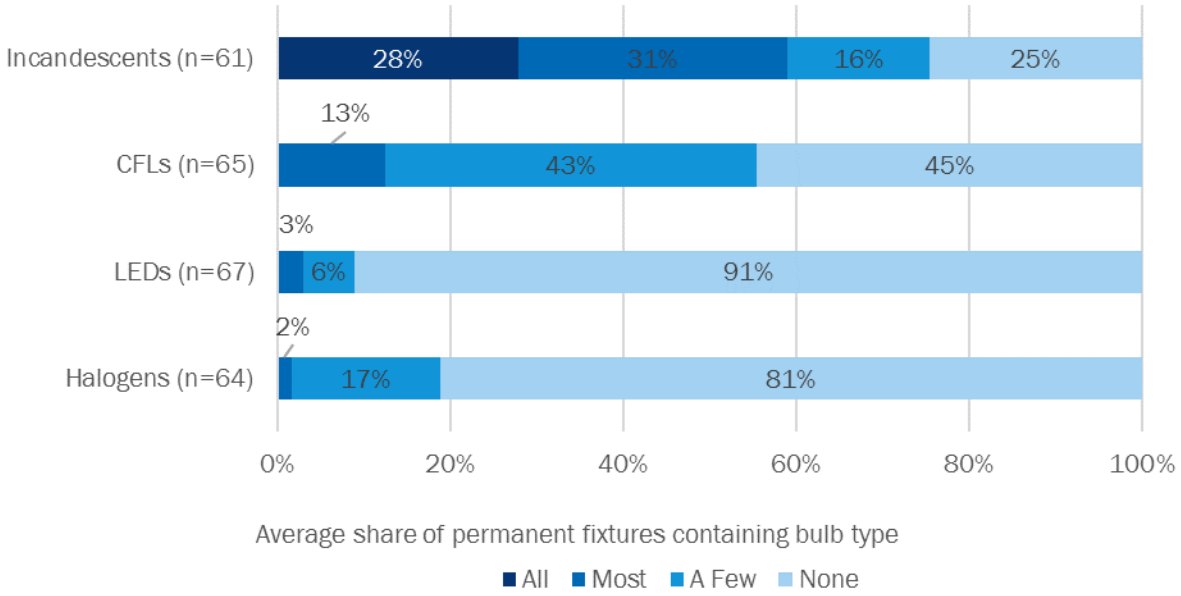
Figure 7. Tenants' Level of Experience with Selected Bulb Types (Self-Report)



To further characterize lighting usage in multifamily dwelling units, we asked respondents to describe the share of permanent lighting fixtures in their home that contained selected bulb technologies before AIC had provided CFL lighting upgrades through the Multifamily Program. Respondents most commonly recalled using incandescent bulbs in their permanent fixtures, with 75% of tenants reporting that they used at least a few

incandescents in permanent fixtures. Fewer tenants (56%) recalled using any CFLs in permanent fixtures prior to the upgrade, and just 9% of respondents recalled using any LEDs prior to the program.

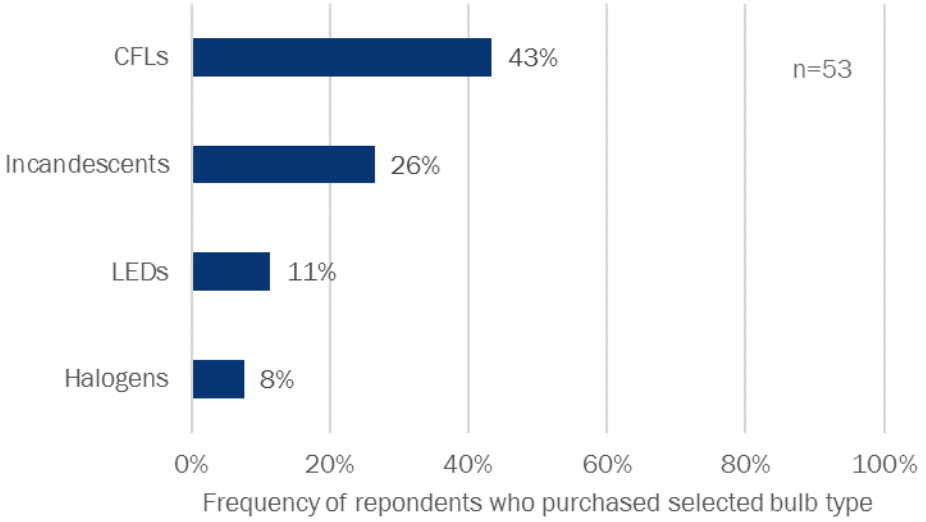
Figure 8. Share of Tenants' Permanent Fixtures Containing Selected Bulb Types Pre-Upgrade (Self-Report)



Note: Five respondents indicated that they were not sure if their sockets contained CFLs, incandescent bulbs, or halogens, and four respondents indicated that they were not sure if their sockets contained LEDs.

We asked the tenants who were responsible for purchasing light bulbs for their unit (n=53) whether they had purchased any of the selected bulb types in the past year. Figure 9 shows that these tenants most commonly purchased CFLs (43%) and/or incandescent bulbs (26%) for their permanent fixtures. Tenants tended to purchase these more conventional types of light bulbs more frequently than LEDs (11%) and halogen bulbs (8%).

Figure 9. Share of Tenants Who Recently Purchased Lighting Technologies



Note: Based on tenants who are responsible for replacing lighting in their unit's permanent fixtures.

Throughout the United States, lighting markets are seeing declining opportunities for lighting savings as the market becomes more efficient and efficient lighting saturation increases. Taken together, self-reports from the tenant survey suggest two main implications for AIC's in-unit lighting offering.

First, despite the overall large share of participants who are familiar with efficient lighting, self-report data suggest that tenants are using a mix of efficient and less-efficient lighting in their permanent fixtures. Instances in which tenants use less-efficient lighting represent continued opportunities for the program to capture in-unit lighting savings. On the other hand, the program would achieve less savings at properties where customers were already using CFLs in at least some permanent fixtures before the program upgrades. Although these data are self-reported and subject to some reporting bias, the findings do suggest that the program may see fewer opportunities per tenant unit over time. To monitor efficient lighting usage in tenant unit permanent fixtures over time, the program may find it valuable to take note of CFL use in permanent fixtures during initial property assessments.

Second, although AIC's upstream lighting program offers discounted LEDs at a range of retailers throughout its service area, and many tenants have used LEDs before (49%), few tenants recalled purchasing LEDs in the past year (11%) and even fewer recall installing any LEDs in permanent fixtures prior to the program (9%). Given that LEDs offer increased savings opportunities over CFLs, low LED use in permanent fixtures supports AIC's plans to switch from a CFL-based offering to an LED-based offering in PY10. These self-reports should be interpreted as ballpark estimates, as they are likely to capture some customers who are confused about lighting technologies (e.g., mistaking halogens for incandescents or LEDs for CFLs). Even so, the tenant results suggest that the Multifamily Program may have an opportunity to pick up where the upstream program leaves off, providing additional education to tenants about LEDs and capturing savings from permanent fixture installations, and could be an effective in-unit lighting measure for AIC to offer as it moves away from a CFL-based offering. Tenant survey data suggest that LEDs will offer a greater opportunity than CFLs for in-unit lighting savings moving forward.

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 interior in-unit and common area lighting measures,[21] in-unit water-savings measures and temperature controls, and major measures (air sealing and attic insulation). To determine the verified measure quantities, the evaluation team applied ISRs provided in the IL-TRM V4.0 to ex ante measure quantities. Table 18 provides the ISRs for each measure.

Table 18. PY8 Multifamily Program Measure Quantities and ISRs

Measure	Unit	Ex Ante Measure Quantity	ISR	Verified Measure Quantity[a]
Air Sealing	CFM	2,637,318	100%	2,637,318
Attic Insulation	Sq. Ft.	2,481,177	100%	2,481,177
CFL - Low	Bulb	36,729	97%	35,590
Specialty CFL - 14W globe	Bulb	19,892	97%	19,275
Specialty CFL - 9W candelabra	Bulb	12,168	97%	11,791
Faucet Aerator (electric water heater)	Aerator	7,861	93%	7,311
CFL - Medium	Bulb	7,408	97%	7,178
Faucet Aerator (gas water heater)	Aerator	4,388	93%	4,081
Shower Head 2.0 gpm (electric water heater)	Shower Head	4,138	95%	3,931
Programmable Thermostat	Thermostat	3,292	100%	3,292
Specialty CFL - 15W reflector, interior	Bulb	2,626	97%	2,545
Shower Head 2.0 gpm (gas water heater)	Shower Head	2,481	95%	2,357
CFL - 20W – Common Area Lighting (CAL)	Bulb	599	97%	580
CFL - High	Bulb	370	97%	359
Specialty CFL - 9W candelabra - CAL	Bulb	306	97%	297
Specialty CFL - 15W reflector, interior - CAL	Bulb	212	97%	205
CFL - 23W - CAL	Bulb	158	97%	153
CFL - 13W - CAL	Bulb	157	97%	152
Specialty CFL - 14W globe - CAL	Bulb	109	97%	106
Total[b]		**5,221,389**	**100%**	**5,217,698**

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

[21] The AIC Multifamily Program's lighting offerings differ from those of the IPA Multifamily Program, which only offered interior and exterior common area lighting measures.

3.2.2 Ex Post Gross Impact Results

The total ex post gross impacts for the PY8 Multifamily Program were 6,306 MWh, 1.25 MW, and 335,926 therms. As shown in Table 19, ex post gross impacts were higher than ex ante gross impacts, with gross realization rates of 105% for energy savings, 115% for demand savings, and 129% for therm savings.

Table 19. PY8 Multifamily Program Gross Impacts

Program	Ex Ante Gross[a]			Ex Post Gross			Gross Realization Rate[b]		
	MWh	MW	Therms	MWh	MW	Therms	MWh	MW	Therms
AIC Multifamily	6,033	1.09	260,432	6,306	1.25	335,926	105%	115%	129%

[a] Source of ex ante savings: PY8 program-tracking database.
[b] Gross Realization Rate = ex post gross value ÷ ex ante gross value * 100.

As shown in Table 20 and Table 21, although gross realization rates varied by measure, ex post impacts by measure are almost always higher than ex ante impacts.

Table 20. PY8 Multifamily Program Gross Electric 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	1,276,588	592	0.39	638	0.48	108%	124%
Attic Insulation	1,224,866	119	0.11	147	0.14	124%	129%
Standard CFLs - In-Unit	43,127	1,022	0.10	1,090	0.10	107%	96%
Specialty CFLs - In-Unit	3,611	1,141	0.13	1,156	0.13	101%	100%
Faucet Aerator	7,311	509	0.22	509	0.22	100%	100%
Shower Head	3,931	1,168	0.13	1,167	0.13	100%	100%
Programmable Thermostat	1,942	1,151	n/a	1,256	n/a	109%	n/a
Standard CFLs - Common Area	886	181	0.002	193	0.03	107%	1,014%
Specialty CFLs - Common Area	608	150	0.003	151	0.02	100%	756%
Total	**2,592,869**	**6,033**	**1.09**	**6,306**	**1.25**	**105%**	**115%**

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

Table 21 summarizes the ex post gross gas impacts by measure; all realization rates are greater than 100%.

Table 21. PY8 Multifamily Program Gross Gas Impacts by Measure

Measure	Verified Measure Quantity	Ex Ante Gross Therms	Ex Post Gross Therms	Gross Realization Rate[a]
Air Sealing	1,360,730	177,255	178,244	101%
Attic Insulation	1,256,311	71,319	81,503	114%
Standard CFLs - In-Unit	43,127	−25,042	0	n/a
Specialty CFLs - In-Unit	33,611	−26,537	0	n/a
Faucet Aerator	4,081	13,513	14,179	105%
Shower Head	2,357	34,908	34,913	100%
Programmable Thermostat	1,350	22,911	27,086	118%
Standard CFLs - Common Area	886	−4,437	0	n/a
Specialty CFLs - Common Area	608	−3,456	0	n/a
Total	**2,703,061**	**260,432**	**335,926**	**129%**

[a] Gross Realization Rate = ex post gross value ÷ ex ante gross value * 100.
Note: Numbers may not total due to rounding.

Differences in ex ante and ex post gross savings stemmed from differences in input values for the savings algorithms for each measure. In particular, differences in the inputs for lighting and programmable thermostats had the largest impact on program-level realization rates for electric impacts. Because lighting and programmable thermostat measures accounted for 41% and 19% of the total program ex ante energy savings, respectively, any differences within these measures affected the program savings significantly. Similarly, differences in inputs for attic insulation and programmable thermostats had the largest impact on program-level realization rates for gas impacts as they accounted for 27% and 9% of the total program ex ante gas savings, respectively. Table 22 summarizes the sources of differences between ex ante and ex post gross savings.

Table 22. Reasons for Realization Rates per Measure

Measure	Gross Realization Rate			Source of Discrepancy			
	MWh	MW	Therms	Coincidence Factor (CF)	Waste Heat Factor	Full Load Cooling Hours (FLH)	Other (Specified)[a]
Air Sealing	108%	124%	101%			✓	• Some projects are excluded from savings calculations due to missing input assumptions in database • Some projects included electric savings for measures with window AC units
Attic Insulation	124%	129%	114%			✓	
Standard CFLs – In-Unit	107%	96%	n/a	✓	✓		
Specialty CFLs – In-Unit	101%	100%	n/a		✓		
Programmable Thermostat	109%	n/a	118%				• Some projects are excluded from savings calculations due to missing climate zone data • Incorrect electric heating consumption
Faucet Aerator	100%	100%	105%				• Applied incorrect per-unit gas savings value
Standard CFLs - Common Area	107%	1,014%	n/a	✓	✓		
Specialty CFLs - Common Area	100%	756%	n/a	✓	✓		

[a] Describes incorrect ex ante assumptions and calculation methods.

Through our discussions with the implementer, we identified the sources of the differences between ex ante and ex post savings. In some cases, these differences meant that ex ante savings are higher than ex post savings, while, in other cases, they meant that ex ante savings are 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 Insulation Discrepancies:**
  - **Full Load Cooling Hours:** Ex ante savings calculations for major measures (air sealing and attic insulation) used the FLH values for single-family applications instead of multifamily installations. Thus, ex post per-measure demand savings are on average 10% higher than ex ante estimates.
  - **Excluded Measures Due to Missing Variable Assumptions:** The program-tracking database (Amplify) does not include ex ante savings for several installations of air sealing and attic insulation that were missing inputs to savings algorithms for the measures (i.e., HVAC equipment age and participant's city or zip code). These savings inputs are used to assign heating and cooling equipment efficiencies, as well as weather data from the IL-TRM V4.0. In our ex post analysis, we estimated savings for the cases that had missing inputs by applying the average pre-upgrade cooling efficiency value of 10.3 Seasonal Energy Efficiency Ratio (SEER) to participants without equipment age information (n=671, or 15% of records). For cases that were missing city or zip

code of the installation location, we assigned cooling degree days (CDD) and heating degree days (HDD) based on the actual project location (provided to us by the implementer in a separate database). Because ex ante savings calculations did not capture these cases, ex post savings are between 0.1% and 14% higher than ex ante estimates (see Table 23).

Table 23. Effect on Ex Post Savings Due to Missing Variables

Measure	Missing HVAC Efficiencies			Missing City/Zip Code		
	kWh	kW	Therms	kWh	kW	Therms
Air Sealing	0%	13.8%	0%	0.3%	0.4%	0.1%
Attic Insulation	10%	11.0%	11%	0.2%	0.3%	0%

- **Included Savings for Window AC Units.** For air sealing and attic insulation measures, electric cooling savings should be included only if the participant has a central air conditioner (CAC) or heat pump. Ex ante electric savings incorrectly included savings for participants with window AC units. As prescribed in the IL-TRM V4.0, we did not calculate ex post savings for the participants with window AC units; as a result, ex post energy and demand savings are 1.5% lower than ex ante savings.

- **Programmable Thermostat Discrepancies:**

  - **Missing Climate Zone Data:** Ex ante savings excluded 333 measures (10% of total thermostats) where the program-tracking database did not provide the participant's zip code or city, one of which is required to assign the appropriate HDD from the IL-TRM V4.0. In our ex post analysis, we included these cases by assigning the correct HDD based on the actual project location (provided by the implementer in a separate database). As a result, ex post results are 7% higher for energy savings and 18% higher for gas savings compared to the ex ante analysis.

  - **Electric Heating Consumption:** There were 196 measures (5% of total thermostats) where ex ante and ex post savings applied different electric heating consumption values due to differences in climate zone assumptions. As a result, ex post per-measure energy savings are 1% higher compared to the ex ante analysis.

- **Standard and Specialty CFL Discrepancies:**

  - **Waste Heat Factor:** Ex ante energy savings included the waste heat factor heating penalty for 9% of all in-unit CFLs and 8% of all common area lighting measure. However, consistent with past evaluations, and per agreements between ICC staff and AIC 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. This results in higher ex post savings (approximately 4%) compared to ex ante.

  - **Coincidence Factor:** Ex ante demand reduction for in-unit standard CFLs applied the CF for residential direct installs (0.074) instead of in-unit multifamily bulbs (0.071). Similarly, ex ante demand savings applied the residential CF values for specific standard and specialty CFLs (range across affected products: 0.074 to 0.121) instead of the CF value for common area multifamily bulbs (0.75). For this reason, ex post demand savings are 4% lower than ex ante demand savings for in-unit standard CFLs. For common area CFLs, ex post demand savings are approximately eight times as large as ex ante estimates.

- **Faucet Aerators Discrepancies:**
  - **Per-Unit Gas Savings Assumption:** Ex ante gas savings for 1,302 measures (11% of all faucet aerators) applied a per-unit gas savings value of 2.72 therms instead of 3.23 therms per aerator. In our ex post analysis we applied a per-unit gas savings value of 3.23 therms per aerator for all measures. As a result, ex post gas savings are 5% higher than ex ante estimates.

3.2.3 Ex Post Net Impacts Results

The evaluation team calculated PY8 ex post net impacts by applying SAG-approved NTGRs to ex post gross savings (see Table 24). Ex ante impacts are calculated using the same NTGRs except for common area lighting measures, which used a NTGR of 0.95[22] instead of 0.83.

Table 24. PY8 Multifamily Program Net Impacts

Program	Ex Ante Net			Ex Post Net		
	MWh	MW	Therms	MWh	MW	Therms
Multifamily Program	5,947	1.07	206,371	6,173	1.21	279,047
Net Realization Rate[a]				**104%**	**114%**	**135%**

[a] Net Realization Rate = ex post net value ÷ ex ante net value * 100.

[22] While the implementer used the SAG-approved NTGR of 0.95 for *in-unit* CFLs (derived from AIC's Multifamily Program), the evaluation team used the NTGR of 0.83 (derived from IPA's Multifamily Program) for CFLs installed *in common areas* as it better aligns with the location of these installed CFLs.

4. Key Findings and Recommendations

In PY8, the Multifamily Program continued to be implemented by CLEAResult, with AIC administering in-unit measures, common area CFLs, and major measures for properties with gas heat and IPA administering all other common area lighting and major measures for customers with electric heat. PY8 was characterized by limited program implementation changes relative to PY7, with cross-program channeling conducted on a limited basis and minor enhancements to the property manager outreach strategy.

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 savings of 6,173 MWh, 1.21 MW, and 279,047 therms. Program managers reported that the Multifamily Program operated smoothly and effectively in PY8. As noted in detail below, research with participating property managers and tenants living in units receiving upgrades point 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, the program-tracking platform did not calculate ex ante savings in instances where measure records (programmable thermostats and major measures) were missing key project information that is used as inputs to savings calculations (e.g., HVAC equipment age and participant zip code/city). This caused the ex ante savings to underrepresent total savings.
  - **Recommendation #1:** It is imperative to ensure that the program-tracking platform does not mistakenly exclude measures with incomplete information from ex ante savings calculations. By strengthening a consistent commitment to quality assurance/quality control (QA/QC), the implementers can minimize these occurrences by reviewing data entry as well as the algorithms and the assumptions programmed in Amplify (the program-tracking database).
- **Key Finding #2:** Participating property managers and their tenants 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 whom we spoke with think that there is 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. Tenants also appeared to be happy with the measures that the program installed in their units.
- **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 they did suggest that the program could offer additional measures. For example, property managers who did not receive programmable thermostats through the PY8 program expressed moderate interest in both programmable thermostats and a potential new offering of "smart" thermostats. A minority of respondents suggested additional measures, including efficient windows and doors, HVAC upgrades, and insulation for walls and other parts of the building shell.

- **Key Finding #5:** Tenant self-reports suggested that, prior to program upgrades, incandescents and CFLs made up the majority of permanent fixture lighting, with a minority of LED and halogen lights in service. Most tenants interviewed for the evaluation were familiar with CFLs (96%) and many were already using them in at least a few of their unit's permanent fixtures before the PY8 program (65%). In contrast, fewer tenants recalled using any LEDs in permanent fixtures (4%), and few recalled recently purchasing any LEDs. Although most markets are seeing declining opportunities for lighting savings as the market becomes more efficient and efficient lighting saturation increases, tenant survey data suggest that LEDs will offer a greater opportunity for in-unit lighting savings moving forward, compared to CFLs.

  - **Recommendation #5:** Starting in PY10, the Multifamily Program is already planning to switch from a CFL-based in-unit offering to an LED-based in-unit offering. The results of this evaluation provide additional support for this change.

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.[23] 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

The approach to calculating response rates differed slightly for the tenant web survey. In this case, the survey response rate is the number of completed surveys divided by the total number of potentially eligible

[23] *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

respondents in the sample. The quality of the address list is a key factor in determining the eligibility of participants who did not attempt to take the survey but also did not bounce back (undeliverable mailing). This calculation assumes a high-quality list in which all respondents are eligible except those who reply with an accepted reason that they are not eligible (e.g., employee of client, not a tenant).

Appendix C. Engineering Analysis Algorithms

In PY8, the impact evaluation efforts estimated gross impact savings for the Residential AIC 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 CFL 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 3. Standard and Specialty 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 25. Baseline Wattages for Lighting Measures

Measure	EISA Adjusted[a]	Baseline Wattage	Resource
Standard Spiral CFL – 13W	Yes	43	IL-TRM V4.0
Standard Spiral CFL – 20W	Yes	53	
Standard Spiral CFL – 23W	Yes	72	
Specialty CFL – 9W Candelabra	No	40	
Specialty CFL – 14W Globe	No	60	
Specialty CFL – 15W Reflector	No	65	

[a] The Energy Independence and Security Act (EISA) schedule required baseline adjustments to measures with incandescent baseline wattages of 100W (as of June 2012), 75W (as of June 2013), and 60W (as of June 2014).

WattsEE = Wattage of installed CFL (see Table 26)

Table 26. CFL Wattages for Lighting Measures

Measure	CFL Wattage	Resource
Standard Spiral CFL – 13W	13	Actual installed CFL wattage
Standard Spiral CFL – 20W	20	
Standard Spiral CFL – 23W	23	
Specialty CFL – 9W Candelabra	9	
Specialty CFL – 14W Globe	14	
Specialty CFL – 15W Reflector	15	

ISR = In-service rate of installed CFLs= 96.9%[24]

Hours = Annual operating hours (see Table 27)

Table 27. Annual Hours of Use for Lighting Measures

Installation Location	Measure	Hours
Common Area	Standard Spiral CFL – 13W	5,950
	Standard Spiral CFL – 20W	
	Standard Spiral CFL – 23W	
	Specialty CFL – 9W Candelabra	
	Specialty CFL – 14W Globe	
	Specialty CFL – 15W Reflector	
In-Unit	Standard Spiral CFL – 13W	793
	Standard Spiral CFL – 20W	
	Standard Spiral CFL – 23W	
	Specialty CFL – 9W Candelabra	1,190
	Specialty CFL – 14W Globe	639
	Specialty CFL – 15W Reflector	861

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

Table 28. Coincidence Factors for Lighting Measures

Installation Location	Measure	CF
Common Area	Standard Spiral CFL – 13W	0.75
	Standard Spiral CFL – 20W	
	Standard Spiral CFL – 23W	
	Specialty CFL – 9W Candelabra	
	Specialty CFL – 14W Globe	
	Specialty CFL – 15W Reflector	
In-Unit	Standard Spiral CFL – 13W	0.070
	Standard Spiral CFL – 20W	
	Standard Spiral CFL – 23W	
	Specialty CFL – 9W Candelabra	0.121
	Specialty CFL – 14W Globe	0.075
	Specialty CFL – 15W Reflector	0.091

[24] Based on the IL-TRM V4.0.

C.2 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.

In-Unit Heating Penalties

The evaluation team determined heating penalties for different heating fuel types for lighting installed in multifamily units using the algorithms below. For measures where the heating fuel type is unknown, the IL-TRM V4.0 assumes gas heating.

Equation 4. Heating Penalty Algorithms for In-Unit Lighting

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

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

Where:

WattsBase = Wattage of existing equipment (see Table 25)

WattsEE = Wattage of installed equipment (actual wattage used)

ISR = In-service rate or the percentage of units rebated that get installed = 96.9%[25]

Hours = Annual operating hours (see Table 27)

HF = Heating factor = 0.49

ηHeat = Efficiency of heating equipment (see Table 29).

Table 29. ηHeat for Lighting Heating Penalties

Measure	ηHeat	Units
Electric Resistance	1.00	Coefficient of Performance (COP)
Gas Heating	0.70	Annual Fuel Utilization Efficiency (AFUE)
Unknown	0.70	Annual Fuel Utilization Efficiency (AFUE)

[25] Based on the IL-TRM V4.0.

Table 30 summarizes the per-measure heating penalties for the six lighting measures installed in multifamily units offered through the program by heating equipment type.

Table 30. Per-Measure Heating Fuel Penalties for In-Unit CFL Lighting

Heating Equipment	Measure	ΔkWh	Δtherms
Electric Resistance	Standard Spiral CFL – 13W	-11.30	n/a
	Standard Spiral CFL – 20W	-12.43	n/a
	Standard Spiral CFL – 23W	-18.45	n/a
	Specialty CFL – 9W Candelabra	-17.52	n/a
	Specialty CFL – 14W Globe	-13.96	n/a
	Specialty CFL – 15W Reflector	-20.44	n/a
Gas Heating	Standard Spiral CFL – 13W	n/a	-0.55
	Standard Spiral CFL – 20W	n/a	-0.61
	Standard Spiral CFL – 23W	n/a	-0.90
	Specialty CFL – 9W Candelabra	n/a	-0.85
	Specialty CFL – 14W Globe	n/a	-0.68
	Specialty CFL – 15W Reflector	n/a	-1.00

Common Area Lighting Heating Penalties

The fuel type for interior common areas is unknown. 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.

Equation 5. Heating Penalty Algorithms for Common Area Lighting

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

Where:

WattsBase = Wattage of existing equipment (see Table 25)

WattsEE = Wattage of installed equipment (actual wattage used)

ISR = In-service rate or the percentage of units rebated that get installed = 96.9%[26]

Hours = Annual operating hours (see Table 27)

HF = Heating factor = 0.49

ηHeat = Efficiency of heating equipment =0.70 AFUE

[26] Based on the IL-TRM V4.0.

Table 31 summarizes the per-measure heating penalties for the lighting measures installed in common areas offered through the program.

Table 31. Per-Measure Heating Fuel Penalties for Common Area (Interior) CFL Lighting

Heating Equipment	Measure	Δtherms
Gas Heating[a]	Standard Spiral CFL – 13W	-4.13
	Standard Spiral CFL – 20W	-4.54
	Standard Spiral CFL – 23W	-6.75
	Specialty CFL – 9W Candelabra	-4.27
	Specialty CFL – 14W Globe	-6.33
	Specialty CFL – 15W Reflector	-6.89

[a] IL-TRM 4.0 assumes gas heating when heating fuel type is unknown. All common area lighting had an unknown heating type.

C.3 Water Heating Conservation Measure Algorithms

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

Equation 6. Low-Flow Shower Head Algorithms

*Energy Savings: ΔkWh = %ElectricDHW * ((GPM_base * L_base – GPM_low * L_low) * Household * SPCD * 365.25 / SPH) * EPG_electric * ISR*

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

*Therm Savings: ΔTherms = %FossilDHW * ((GPM_base * L_base – GPM_low * L_low) * Household * SPCD * 365.25 / SPH) * EPG_gas * ISR*

Equation 7. Low-Flow Faucet Aerator Algorithms

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

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

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

Where:

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

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

GPM_base = Flow rate of the baseline shower head or faucet aerator (see Table 32)

GPM_low = As-used flow rate of the low-flow shower head or faucet aerator (see Table 32)

Table 32. GPM for Water Heating Measures

Measure	GPM_base	GPM_low
Faucet Aerator	1.39	0.94
Shower Head	2.67	1.75

L_base = Length (in minutes) per baseline shower head or baseline faucet (see Table 33)

L_low = Length (in minutes) per low-flow shower head or low-flow faucet (see Table 33)

Table 33. L_base for Water Heating Measures

Measure	Minutes
Faucet Aerator	6.9
Shower Head	7.8

Household = Average number of people in household for multifamily units = 2.10

SPCD = Showers per capita per day = 0.60

SPH = Shower heads per household for multifamily units = 1.30

DF = Drain factor = 79.5% (unknown location)

FPH = Faucets per household for multifamily units = 2.50 (unknown location)

EPG_electric = Energy per gallon of hot water supplied by electric water heater (see Table 34)

EPG_gas = Energy per gallon of hot water supplied by gas water heater (see Table 34)

Table 34. EPG for Water Heating Measures

Measure	EPG_electric	EPG_gas
Faucet Aerator	0.0919	0.0046
Shower Head	0.1168	0.0058

ISR = In-service rate of installed low-flow shower heads and low-flow aerators for multifamily units

Table 35. ISR for Water Heating Measures

Measure	ISR	Resource
Faucet Aerator[a]	93%	IL-TRM V4.0
Shower Head	95%	

[a] Unknown location of installation. Average ISR for kitchen and bathroom.

Hours = Annual recovery hours for shower head or faucet use

Table 36. Hours for Water Heating Measures

Measure	Hours
Faucet Aerator[a]	50
Shower Head	248

[a] Hours of use for multifamily with unknown location.

CF = Summer Peak Coincidence Factor

Table 37. Coincidence Factors for Water Heating Measures

Measure	CF
Faucet Aerator	0.0220
Shower Head	0.0278

C.4 Programmable Thermostat Algorithms

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

Equation 8. Programmable Thermostat Algorithms

$$\Delta kWh\_heating\ (electric\ heat) = \%ElectricHeat * Elec\_Heating\_Consumption * Heating\_Reduction * HF * Eff\_ISR$$

$$Gas\ Savings\ (gas\ heat):\ \Delta Therms = \%FossilHeat * Gas\_Heating\_Consumption * Heating\_Reduction * HF * Eff\_ISR$$

$$\Delta kWh\_heating\ (gas\ heat\ furnace\ fan\ run\ time\ reduction) = \Delta Therms * F_e * 29.3$$

Where:

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

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

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

Table 38. Electric Heating Consumption by Climate Zone

	kWh	
Climate Zone	Electric Resistance	Heat Pump
1 (Rockford)	21,741	12,789
2 (Chicago)	20,771	12,218
3 (Springfield)	17,789	10,464

4 (Belleville)	13,722	8,072
5 (Marion)	13,966	8,215

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

Table 39. Gas Heating Consumption by Climate Zone

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

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

HF = Household factor to adjust heating consumption for multifamily homes = 65%

Eff_ISR = Percentage of thermostats installed and effectively programmed = 100% (Direct Install)[27]

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

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. Since the program-tracking database does not include air sealing for those with electric heating, we did not include air sealing savings algorithms for electric heating.

Equation 9. Air Sealing Algorithms

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

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

$$Gas\ Savings\ (gas\ heat): \Delta Therms = (((CFM50\_existing - CFM50\_new)/N\_heat) * 60 * 24 * HDD * 0.018) / (\eta Heat * 100{,}000)$$

Where:

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

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

[27] Based on the IL-TRM V4.0.

N_Cool = Conversion factor from leakage at 50 Pascal to leakage at natural conditions = 18.5[28]

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

Table 40. 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 Central AC (applied per participant based on existing equipment age provided in database)

Table 41. ηCool for Air Sealing Measures

Cooling Equipment Age	CAC SEER
Before 2006	10.0
During or after 2006	13.0
Unknown[a]	10.4

[a] For measures where the cooling equipment age is not provided in the database (n=60), we calculated an average cooling efficiency based on SEER values derived from measures with cooling equipment age information (n=296).

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

Table 42. 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[29]

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

[28] Assumed CZ2 Normal Exposure.

[29] Applied average of 1, 1.5, 2, and 3-story homes for homes with normal exposure in CZ2.

Table 43. 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 =0.70 for gas heating

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

Table 44. 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 for Central ACs= 0.68

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

C.6 Attic Insulation Algorithms

The evaluation 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 does not include attic insulation for those with electric heating, we did not include attic insulation savings algorithms for electric heating.

Equation 10. Attic Insulation Algorithms

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

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

$$Gas\ Savings\ (gas\ heat): \Delta Therms = (((1/R\_old - 1/R\_new) * A\_attic * (1\text{-}Framing\_factor) * ADJattic) * 24 * HDD) / (\eta Heat * 100{,}067\ Btu/therm)$$

Where:

R_old = Total attic assembly R-value prior to installing insulation (assumed R-11 per implementer; actual R-values per participant were unreliable).[30] For attic insulation, we added R-0.68 (indoor air film) and R-0.15 (¾" plaster) to account for total assembly R-value[31] = R-11.83

R_new = Total attic assembly R-value after the installation of additional insulation (assumed R-49 per implementer; actual post R-values per participant were unreliable.[32] For attic insulation we added R-0.68 (indoor air film) and R-0.15 (¾" plaster) to account for total assembly R-value.[33] = R-49.83

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

Framing_factor = Adjustment to account for area of framing = 0.07

ADJattic = 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 45. 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 Central AC (applied per participant based on existing equipment age provided in database)

[30] The program-tracking database included the pre-participation and post-participation R-values per participant. However, these data were collected by means of inconsistent methods, such as contractors that include actual and accurate values, blank values later populated by personnel with R-values identical to the measure name (not actual value), R-values not typical of installation application (those that exceed normal R-values), etc. The implementer advised that we not use this information for PY8. However, data collection for PY9 will represent accurate pre-participation and post-participation R-values that vary by participant and reflect the actual installed R-values for attic and wall insulation.

[31] 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.

[32] The program-tracking database included the pre-participation and post-participation R-values. However, these data were collected by means of inconsistent methods, such as contractors that include actual and accurate values, blank values later populated by personnel with R-values identical to the measure name (not actual value), R-values not typical of installation application (those that exceed normal R-values), etc. The implementer advised that we not use this information for PY8. However, data collection for PY9 will represent accurate pre- and post R-values that will reflect the actual installed R-values for attic insulation.

[33] 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 46. ηCool for Attic Insulation Measures

Cooling Equipment Age	CAC SEER
Before 2006	10.0
During or after 2006	13.0
Unknown[a]	10.3

[a] For measures where the cooling equipment age is not provided in the database (n=60), we calculated an average cooling efficiency based on SEER values derived from measures with cooling equipment age information (n=375).

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

Table 47. 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 =0.70 for gas heating

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 for Central ACs= 0.68

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

Appendix D. Cost-Effectiveness Inputs

Table 49 presents total gross impacts for AIC cost-effectiveness calculations. These values differ from those included in the main report due to the inclusion of heating penalties for lighting measures. This approach was taken based on discussions with AIC and past agreements between AIC and ICC staff that heating penalties would not be included in savings calculations for goal attainment. Overall, total gross program savings are reduced by 1% for kWh and 16% for therms after the application of waste heat factors.

Table 49. PY8 Multifamily Program Gross Impacts (Including Heating Penalties)

	kWh	kW	Therms
Gross Savings	6,305,841	1,254	335,926
Heating Penalty	−83,410	n/a	−55,406
Total Gross Savings with Heating Penalty	6,222,431	1,254	280,520

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 heating penalty was applied to 79,193 in-unit lamps and 1,541 interior common area lamps based on the specific heating fuel type (if known) and installed lamp type.

Common Area Lighting

The heating fuel type for all common area lighting is unknown. The IL-TRM V4.0 assumes gas heating when space heating fuel types are unknown. We applied gas heating waste heat factors to all 1,541 lamps installed within common areas. The total gross heating penalty for common area lighting measures is 7,893 therms.

In-Unit Lighting

The program-tracking database provided heating fuel types for only 21% (16,985 lamps) of all in-unit lighting measures. For the remaining 79% (62,208 lamps) of the in-unit lighting measures, where the heating fuel type was unknown, we assumed gas heating as prescribed by the IL-TRM V4.0. The total gross heating penalty for in-unit lighting measures is 83,410 kWh and 47,513 therms.

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 50 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 50. Updated Multifamily Program 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 IL-TRM V4.0,[34] 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 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 AIC 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

[34] 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 *deciding 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 and 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 51). 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 resolve all inconsistencies.

Table 51. 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 52 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 49, the core and alternative algorithms all provide very similar estimates of FR.

Table 52. 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.[35]

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 11 to develop the program PSO rate for application to the AIC and IPA multifamily programs.

Equation 11. Participant Spillover Rate

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

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 53 provides the IL-TRM V4.0 algorithms that we used to determine the per-measure savings for each SO measure. Table 54 provides the assumptions and per-measure values used to populate the algorithms.

[35] The customer must have answered an 8 or higher on a 0–10 scale, where 0 means "no influence" and 10 means "greatly influenced."

Table 53. 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 54. Spillover Measure Assumptions and Per-Measure Savings

Meas-ure	Energy Savings (kWh/unit)	Demand Savings (kW/unit)	Units	Quant.	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 55 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 55. 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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