

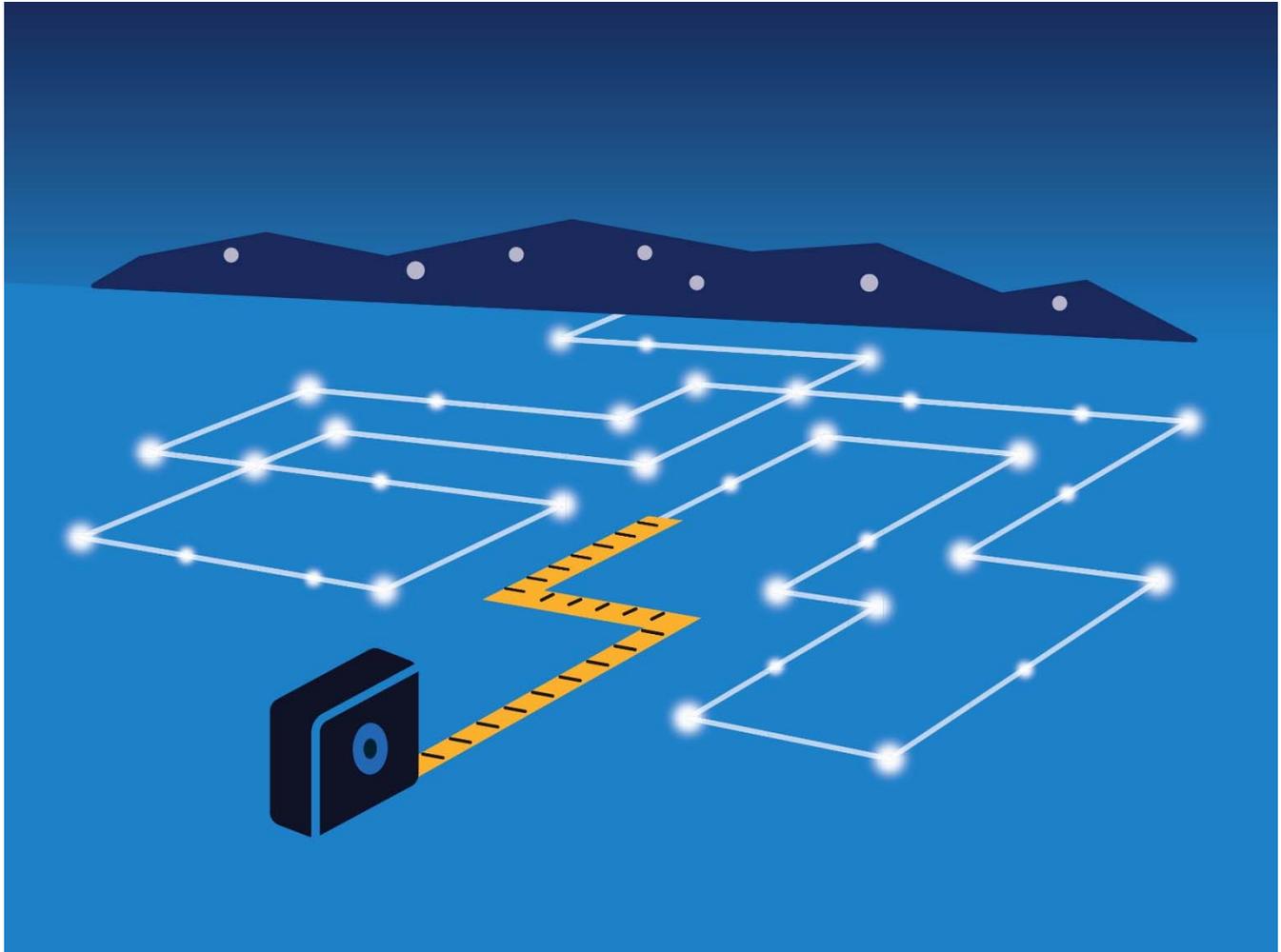


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Impact and Process Evaluation of the 2016 Illinois Power Agency Small Business Linear LED Lighting Program

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CADMUS

NAVIGANT



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Table of Contents

1. Executive Summary	1
2. Evaluation Approach	3
2.1 Research Objectives.....	3
2.2 Evaluation Tasks.....	3
2.3 Sources and Mitigation of Error.....	4
3. Detailed Evaluation Findings.....	5
3.1 Program Design and Implementation	5
3.2 Program Performance and Participation.....	5
3.3 Impact Results	8
4. Key Findings and Recommendations	11
Appendix A. Linear LED Lighting Program Assumptions and Algorithms	12
Appendix B. Cost-Effectiveness Inputs.....	14

Table of Tables

Table 1. PY9 Gross and Net Linear LED Lighting Program Impacts.....	1
Table 2. PY9 Evaluation Activities	3
Table 3. Possible Sources of Error	4
Table 4. PY9 Program Performance against Energy Savings Goal.....	5
Table 5. PY9 Linear LED Lighting Program Performance and Participation	6
Table 6. PY9 Linear LED Lighting Program Verified Measure Quantities	8
Table 7. PY9 Linear LED Lighting Program Gross Impacts	9
Table 8. PY9 Linear LED Lighting Program Gross Impacts by Measure.....	9
Table 9. Reasons for Differences in Realization Rates per Measure	9
Table 10. Linear LED Lighting Program Net Impacts	10
Table 11. Baseline Wattages for Linear LEDs	12
Table 12. PY9 Linear LED Gross Impacts (Including Heating Penalties)	14

Table of Figures

Figure 1. Percentage of PY9 Projects and Ex Post Net MWh by Facility Type	6
Figure 2. Linear LED Lighting Program Customer and Program Ally Participation in PY9	7

1. Executive Summary

The PY9 Small Business Linear LED Lighting Program was implemented by Matrix Energy Services (Matrix) and offers incentives to small business customers in Ameren Illinois Company (AIC)’s DS-2 rate class to replace T8 and T12 fixtures with high-efficiency linear LED lamps. Participating customers received a free energy audit, a report with recommended LED lighting measures, and direct installation of program measures. While measures are installed by program allies (PAs), the program relies on participating customers to provide support by having their own maintenance staff assist in the installation process, or by providing access to key equipment. Customers who are not able to provide this assistance are asked to contribute a small co-pay. The program offers participants a zero-interest financing option to help with this cost.

Over the course of PY9, 411 eligible customers completed 411 projects through the program, achieving 5,170 MWh in ex post net energy savings—45% of the program’s goal of 11,467 net MWh. The program performed below expectations due to implementation challenges, including a program delay near the beginning of PY9 and a mid-year marketing hold, and differences between ex ante and ex post impacts.

The evaluation of the PY9 Linear LED Lighting Program involved both process and impact assessments. However, given Illinois’ passage of the Future Energy Jobs Bill (SB 2814), which brings an end to Illinois Power Agency (IPA) funding of energy efficiency programs after PY9, the evaluation team conducted a limited process evaluation, which included a review of program-tracking data and program materials, and interviews with program administrators and implementation staff. Our impact evaluation research efforts involved applying savings algorithms and assumptions from the Illinois Statewide Technical Reference Manual for Energy Efficiency (IL-TRM), and the application of Illinois Stakeholder Advisory Group (SAG)-approved net-to-gross ratios (NTGR).

Program Impacts

Table 1 summarizes the electric energy and demand savings from the PY9 Linear LED Lighting Program. The program achieved ex ante gross savings of 9,770 MWh and ex post gross savings of 5,809 MWh, yielding a 59% gross realization rate. The evaluation team then applied the SAG-approved NTGR of 0.89 to the ex post gross impacts to estimate the ex post net impacts of 5,170 MWh for energy savings and 0.93 MW for demand savings.

Table 1. PY9 Gross and Net Linear LED Lighting Program Impacts

	Ex Ante Gross	Realization Rate	Ex Post Gross	NTGR	Ex Post Net
Energy Savings (MWh)					
Total MWh	9,770	59%	5,809	0.89	5,170
Demand Savings (MW)					
Total MW	N/A ^a	N/A	1.05	0.89	0.93

^a The program did not report ex ante gross demand savings.

Key Findings and Recommendations

In PY9, the Linear LED Program achieved ex post net energy and demand savings of 5,170 MWh and 0.93 MW, respectively across 411 participants. The program did not meet its net electric energy savings goal of 11,467 MWh or participation goal of 515 participants. Program staff attributed poor program performance to contractual and customer service issues that delayed the program launch and suspended program enrollment

in February 2017 and differences between ex ante and ex post impacts. The following findings and recommendations for the program are based on the results of our program evaluation:

- **Key Finding #1:** Outcomes of the PY9 evaluation found several program delivery issues which resulted in a six-week marketing hold. These issues included an oversubscription of program measures that resulted in customers signing up for program measures and later being told that they couldn't receive incentives for those measures, lack of verification to confirm customer eligibility that resulted in invoicing issues, and poor quality installations that impacted data quality.
- **Recommendation:** Moving forward, it's imperative for AIC's implementation contractors to conduct extensive training to educate program staff and PAs on program eligibility requirements, incentives and payment structure, customer service, onsite assessments, and installation of program measures. By strengthening a consistent commitment to Quality Assurance/Quality Control (QA/QC), the implementers can minimize these occurrences and ensure smooth and effective delivery of future small business programs.
- **Key Finding #2:** Discrepancies between ex ante and ex post savings values are primarily driven by differences in baseline wattages, in-service rates (ISRs), and project-specific assumptions such as hours of use (HOU), waste heat factors (WHFs), and coincidence factors (CFs). For project-specific assumptions, the implementer applied a single value across all projects while the evaluation team assigned IL-TRM values based on the project building type.
- **Recommendation:** In order to minimize discrepancies between ex ante and ex post analysis for future program measures, the evaluation team recommends that the implementer apply IL-TRM assumptions using project-specific data such as building type. With the application of project-specific inputs, calculated savings will be more representative of actual savings at the project level, and ultimately at the program level.

2. Evaluation Approach

The evaluation of PY9 Linear LED Lighting Program involved both process and impact assessments. The specific research objectives and evaluation activities conducted are outlined below.

2.1 Research Objectives

This evaluation addresses program performance in PY9 and the overall objective of the evaluation is to provide estimates of gross and net electric savings associated with the program. As such, the PY9 impact evaluation answers the following questions:

- What were the estimated gross electric and demand impacts from this program?
- What were the estimated net electric and demand impacts from this program?

Given that this is the last year of the Linear LED Lighting Program, the evaluation team conducted a limited process assessment to answer the following questions:

- Program Participation
 - What were the characteristics of participating customers? How many projects were completed? By how many different customers? What types of projects?
 - Did customer participation meet expectations? If not, how different was it and why?
- Program Design and Implementation
 - Was the program implemented as planned? If not, what changes were made, and why?
 - What, if any, implementation challenges occurred in PY9, and how were they overcome?

2.2 Evaluation Tasks

Table 2 summarizes the PY9 evaluation activities conducted for the Linear LED Lighting Program.

Table 2. PY9 Evaluation Activities

Activity	PY9 Process	PY9 Impact	Forward Looking	Details
Program Staff Interviews	✓			Gathered information about program marketing and implementation.
Program Materials Review	✓	✓		Reviewed program data to assess program operations in PY9.
Impact Analysis		✓		Calculated gross and net impacts using the IL-TRM V5.0 and SAG-approved NTGR values for PY9.

2.2.1 Program Staff Interviews

The evaluation team completed in-depth interviews with AIC program administrators, Leidos (IPA Oversight), and Matrix Energy (implementation staff) in June and July, 2017. The interviews explored implementation changes, program performance, program participation, and marketing and outreach during PY9.

2.2.2 Program Materials Review

The evaluation team conducted a comprehensive review of all tracking data and program materials, including the program implementation plan, program marketing materials, and the PY9 program-tracking database.

2.2.3 Impact Analysis

The evaluation team used the IL-TRM V5.0 to calculate ex post gross savings associated with the measures installed through the program. For net impacts, the evaluation team applied the SAG-approved NTGR of 0.89 to ex post gross savings.

2.3 Sources and Mitigation of Error

Table 3 provides a summary of possible sources of error associated with research tasks conducted for Linear LED Lighting Program. The sources of error below are outlined below.

Table 3. Possible Sources of Error

Research Task	Survey Errors		Non-Survey Errors
	Sampling Errors	Non-Sampling Errors	
Impact Analysis	N/A	N/A	Analysis errors

Non-Survey Errors

- **Analysis Errors**
 - **Impact Analysis:** The evaluation team applied IL-TRM V5.0 assumptions and algorithms to the participant data in the tracking database to calculate gross impacts and applied the SAG-approved NTGR to calculate net impacts. To minimize analysis error, the evaluation team had all calculations reviewed by a separate team member to verify that calculations were performed accurately.

3. Detailed Evaluation Findings

The following section of the report provides detailed findings related to program processes and program impacts.

3.1 Program Design and Implementation

The PY9 Linear LED Lighting Program was implemented by Matrix Energy Services and offers incentives to small business customers in Ameren Illinois Company (AIC)'s DS-2 rate class to replace T8 and T12 fixtures with high-efficiency linear LED lamps. Participating customers received a free energy audit, a report with recommended LED lighting measures, and direct installation of program measures. While measures are installed by program allies (PAs), the program relies on participating customers to provide support by having their own maintenance staff assist in the installation process, or by providing access to key equipment. Customers who are not able to provide this assistance are asked to contribute a small co-pay. The program offers participants a zero-interest financing option to help with this cost.

The program relied on three Matrix staff to market the program, conduct energy assessments, and generate leads for PAs. Matrix staff implemented a three-phase approach to marketing: (1) mailing AIC-approved letters and fliers to eligible target customers, (2) following-up with potential customers via Matrix's in-house call center, and (3), conducting in-person meetings to generate leads. Typically, an assessment of the facility was performed at the time of the first meeting in order to successfully engage small business customers. Once a customer is enrolled into the program, Matrix staff conducted door-to-door canvassing within that neighborhood to further promote the program.

In addition to outreach efforts, Matrix staff also took on the role of training PAs and conducting QA/QC inspections. According to program staff, allies were trained over the phone to ensure accurate installation of program measures. Matrix staff also conducted field inspections on the first six projects installed by each PA and targeted a 20% post-inspection rate for larger and more complex projects.

3.2 Program Performance and Participation

3.2.1 Program Performance

As seen in Table 4, the program achieved 5,170 MWh in ex post net energy savings, which accounted for 45% of its goal. The program also achieved 80% of its participation goal.

Table 4. PY9 Program Performance against Energy Savings Goal

Metric	Goal	Actual or Ex Post Net	Percentage of Goal
Energy Savings (MWh)	11,467	5,170	45%
Participants	515	411	80%

Table 5 provides a high-level comparison of various program performance and participation metrics in PY9. Over the course of PY9, 411 eligible customers completed 411 projects through the Linear LED Lighting Program. The projects were completed across 7 PAs.

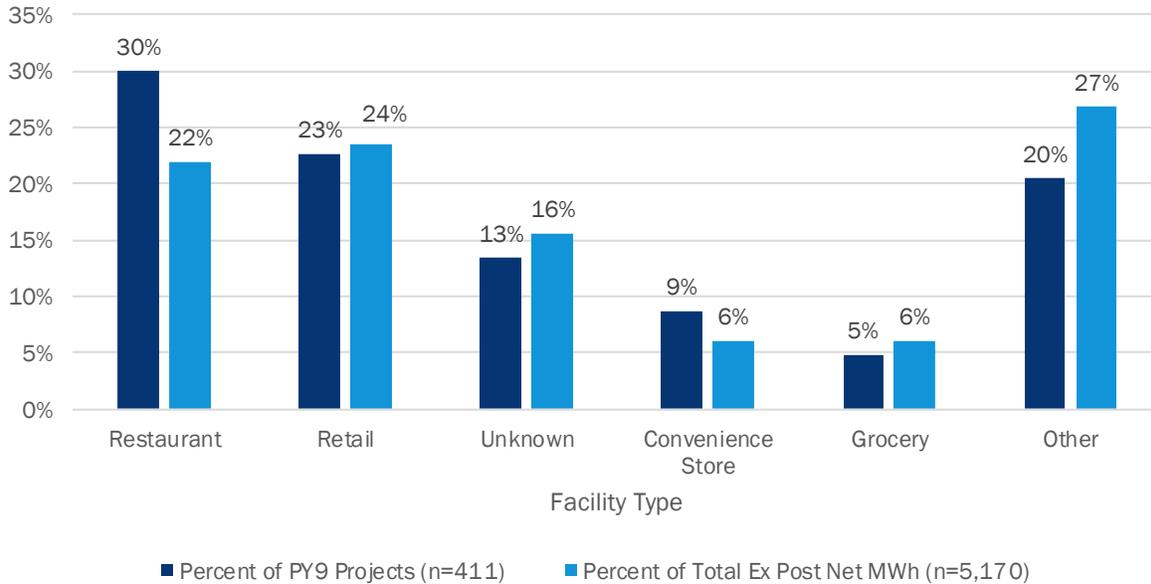
Table 5. PY9 Linear LED Lighting Program Performance and Participation

Metric	Outcome
Energy Savings Goal (MWh)	11,467
Ex Post Net Savings (MWh)	5,170
Program Participants	411
Projects Completed	411
Participating PAs	7

3.2.2 Program Participation Analysis

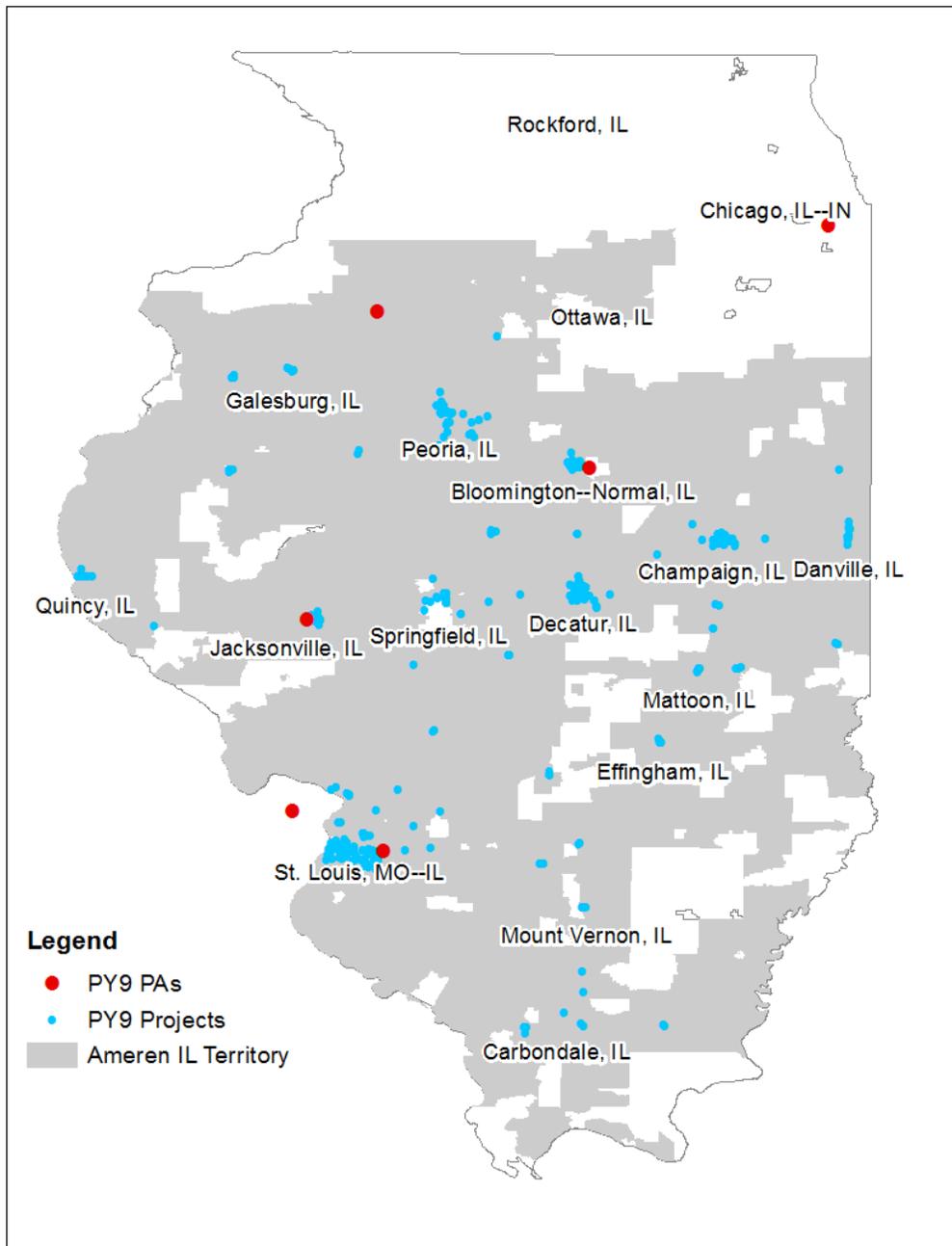
As seen in Figure 1, over half of the PY9 projects were completed in restaurants and retail facilities (53%). While restaurants completed more projects compared to retails, ex post net energy savings from retail facilities (1,218 MWh) was slightly higher than savings from restaurants (1,134 MWh).

Figure 1. Percentage of PY9 Projects and Ex Post Net MWh by Facility Type



The Linear LED Lighting Program served small business customers from throughout AIC’s service territory as shown in Figure 2. Overall, program activity was greater in urban areas such as Peoria, Decatur, and St. Louis, and lower in the southern portion of AIC’s territory, particularly in Mount Vernon and Carbondale. Additionally, PAs were distributed across the AIC service territory with the exception of one ally who was located in Chicago.

Figure 2. Linear LED Lighting Program Customer and Program Ally Participation in PY9



3.2.3 Barriers to Program Implementation

The Linear LED Lighting Program experienced a three-month delay in the beginning of PY9 due to contractual issues. The implementation staff worked with AIC administrators to finalize the implementation contract and the program officially launched in September 2016. Additionally, AIC placed the program on a six-week marketing hold in February 2017 so the implementation staff could resolve the following issues:

- **Oversubscription of Program Measures:** The program was very popular with small business customers due to the low-cost LED measures. As a result, funding for high-demand measures quickly ran out and the Matrix staff oversubscribed program measures. AIC received complaints from customers who had enrolled in the program but never received the installed measures. To resolve this issue, Matrix Energy had to redirect customers to install the promised measures through the AIC C&I Standard Program.
- **Lack of Verification to Confirm Customer Eligibility:** According to program staff, there were several invoicing issues that were caused by discrepancies in customer eligibility. Some customers who were enrolled in the program were not eligible to receive program measure because they were not DS-2 rate code customers.
- **Poor Quality Installations:** QA/QC inspections from the IPA Oversight Team revealed several issues with quality of installations and discrepancies between what was actually installed and what was invoiced.

3.3 Impact Results

The following sections outline the results of the gross and net impact analysis for the PY9 Linear LED Lighting Program.

3.3.1 Measure Verification

For PY9, the evaluation team applied the final-year ISR from the IL-TRM V5.0 to develop a verified measure quantity. Table 6 summarizes install quantities by measure type.

Table 6. PY9 Linear LED Lighting Program Verified Measure Quantities

Measure ²	Ex Ante Measure Quantity ¹ (a)	Ex Post ISR ² (b)	Verified Measure Quantity (a*b)
Linear LED 4ft, 12W LED T8 Lamp (T8 Base)	39,867	98%	39,070
Linear LED 4ft, 12W LED T8 Lamp (T12 40W EEMag Ballast)	20,922	98%	20,504
Total	60,789	98%	59,573

¹ Source: PY9 Final Program Tracking Database

² The 30 measure names in the program-tracking database were simplified into two measures for reporting purposes.

³ Ex post ISRs are from the IL-TRM V5.0. The evaluation team applied the final lifetime ISR rather than first-year year ISR as PAs directly installed program measures. Therefore, the evaluation team assumed that no measures were placed in storage.

3.3.2 Ex Post Gross Impact Results

The overall ex post gross impact savings are 5,809 MWh and 1.05 MW, seen in Table 7. The gross realization rate for electric energy is 59%. The evaluation team calculated ex post savings using inputs and algorithms from the IL-TRM V5.0.

Table 7. PY9 Linear LED Lighting Program Gross Impacts

Program	Ex Ante Gross Impacts ^a		Ex Post Gross Impacts		Gross Realization Rate ^b	
	MW	MWh	MW	MWh	MW	MWh
Linear LED Lighting	N/A	9,770	1.05	5,809	N/A	59%

^a Source: PY9 Final Program Tracking Database. The program did not report ex ante gross demand savings.

^b Gross realization rate = ex post gross value ÷ ex ante gross value

Table 8 summarizes the gross impact results by measure. Measure categories are sorted from largest to smallest based on ex ante energy savings. The evaluation team presents potential reasons for differences between ex ante and ex post gross impacts following the table, and provides specific inputs for all ex post savings estimates in Appendix A.

Table 8. PY9 Linear LED Lighting Program Gross Impacts by Measure

Measure	Verified Measure Quantity	Ex Ante Gross MWh	Ex Post Gross		Realization Rate MWh
			MW	MWh	
Linear LED 4ft, 12W LED T8 Lamp (T8 Base)	39,070	5,287	0.66	3,621	68%
Linear LED 4ft, 12W LED T8 Lamp (T12 40W EEMag Ballast)	20,504	4,484	0.39	2,188	49%
Total	59,573	9,770	1.05	5,809	59%

Differences in ex post and ex ante gross savings stem from differences in input values for the savings algorithms for each measure. The evaluation team reviewed all ex ante assumptions and identified the sources of these differences. Table 9 summarizes these findings with additional descriptions provided below.

Table 9. Reasons for Differences in Realization Rates per Measure

Measure	MWh Realization Rate	Source of Discrepancies		
		Baseline Wattage Assumption	ISR	Project-Specific Assumptions
Linear LED 4ft, 12W LED T8 Lamp (T8 Base)	68%	✓	✓	✓
Linear LED 4ft, 12W LED T8 Lamp (T12 40W EEMag Ballast)	49%	✓	✓	✓

The Linear LED Lighting Program replaced T8 and T12 fixtures with linear LEDs. T8 replacements accounted for 54% of ex ante claimed energy savings and T12 replacements accounted for the remaining 46%. A more detailed discussion of the discrepancy sources presented in Table 9 is outlined below. Note that changes to inputs may increase or decrease savings. The combination of all changes to inputs results in the overall realization rates for a specific measure.

- Project-Specific Assumptions:** For each project, the evaluation team applied IL-TRM values for hours of use (HOU), waste heat factors for energy (WHFe), waste heat factors for demand (WHFd), and coincidence factors (CF) based on the project building type provided in the program-tracking data. For the ex ante analysis, the implementer applied fixed assumptions for HOU, WHFe, WHFd and CF across all projects regardless of building type. Differences in project-specific assumptions were the main driver of the lower realization rates observed in Table 9.
- Baseline Wattage Discrepancies:** The implementer applied a weighted baseline wattage of 29.6 watts for T8 fixtures and 41.9 watts for T12 fixtures. For the ex post analysis, the evaluation team applied

baseline wattages per the IL-TRM V5.0 which assumes a baseline wattage of 32 watts for T8 fixtures and 34 watts for T12 fixtures. Although this increased ex post savings for T8 fixtures and decreased savings for T12 fixtures, the difference between ex post and ex ante wattages were not large enough to offset the effects of the project-specific assumption discrepancies outlined above.

- **In-Service Rates (ISR):** For the ex post analysis, the evaluation team applied the final lifetime ISR of 98% per the IL-TRM V5.0. However, ex ante savings assumed an ISR of 100%, which resulted in a slight decrease in ex post savings.

3.3.3 Ex Post Net Impact Results

To determine the overall net savings associated with the Linear LED Lighting Program, the team applied the SAG-approved NTGR (0.89) to ex post gross savings. As a result, the program achieved ex post net energy savings of 5,170 MWh and a net realization rate of 59% for energy savings.

Table 10. Linear LED Lighting Program Net Impacts

Program	Ex Ante Net Impacts		Ex Ante NTGR	Ex Post NTGR	Ex Post Net Impacts	
	MW	MWh			MW	MWh
Linear LED Lighting	N/A ^a	8,696	0.89	0.89	0.93	5,170
Net Realization Rate^b					N/A	59%

^a The program did not report ex ante gross demand savings.

^b Net realization rate = ex post net value ÷ ex ante net value.

4. Key Findings and Recommendations

In PY9, the Small Business Linear LED Program achieved ex post net energy and demand savings of 5,170 MWh and 0.93 MW, respectively across 411 participants. The program did not meet its net electric energy savings goal of 11,467 MWh or participation goal of 515 participants. Program staff attributed poor program performance to contractual and customer service issues that delayed the program launch and suspended program enrollment in February 2017 and differences between ex ante and ex post impacts. The following findings and recommendations for the program are based on the results of our program evaluation:

- **Key Finding #1:** Outcomes of the PY9 evaluation found several program delivery issues which resulted in a six-week marketing hold. These issues included an oversubscription of program measures that resulted in customers signing up for program measures and later being told that they couldn't receive incentives for those measures, lack of verification to confirm customer eligibility that resulted in invoicing issues, and poor quality installations that impacted data quality.
- **Recommendation:** Moving forward, it's imperative for AIC's implementation contractors to conduct extensive training to educate program staff and PAs on program eligibility requirements, incentives and payment structure, customer service, onsite assessments, and installation of program measures. By strengthening a consistent commitment to QA/QC, the implementers can minimize these occurrences and ensure smooth and effective delivery of future small business programs.
- **Key Finding #2:** Discrepancies between ex ante and ex post savings values are primarily driven by differences in baseline wattages, ISRs, and project-specific assumptions such as HOU, WHFs, and CFs. For project-specific assumptions, the implementer applied a single value across all projects while the evaluation team assigned IL-TRM values based on the project building type.
- **Recommendation:** In order to minimize discrepancies between ex ante and ex post analysis for future program measures, the evaluation team recommends that the implementer apply IL-TRM assumptions using project-specific data such as building type. With the application of project-specific inputs, calculated savings will be more representative of actual savings at the project level and, ultimately, at the program level.

Appendix A. Linear LED Lighting Program Assumptions and Algorithms

In PY9, the impact evaluation efforts estimated gross impact savings for the Linear LED Lighting Program by applying savings algorithms from the IL-TRM V5.0 to the information provided in the program-tracking database.

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

A.1 Linear LEDs

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

Equation 1. LED Algorithms

$$Energy\ Savings\ (\Delta kWh) = \left(\frac{Watts_{Base} - Watts_{EE}}{1000} \right) * Hours * WHFe$$

$$Demand\ Savings\ (\Delta kW) = \left(\frac{Watts_{Base} - Watts_{EE}}{1000} \right) * CF * WHFd$$

Where:

Watts_{Base} = Wattage of T8 or T12 lamp (Table 11)

Table 11. Baseline Wattages for Linear LEDs

Measure Description	Watts _{Base}	Notes/Reference
Linear LED 4ft, 12W LED T8 Lamp (T8 Base)	32	IL-TRM V5.0
Linear LED 4ft, 12W LED T8 Lamp (T12 40W EEMag Ballast)	34	

Watts_{EE} = Wattage of installed LED lamp = 12W

Hours = Annual operating hours (varies by building type per IL-TRM V5.0)

WHFe = Waste heat factor for energy that accounts for cooling savings from efficient lighting (varies by building type per IL-TRM V5.0)

WHFd = Waste heat factor for demand that accounts for cooling savings from efficient lighting (varies by building type per IL-TRM V5.0)

CF = Summer peak coincidence factor (varies by building type per IL-TRM V5.0)

A.2 Linear LED Heating Penalty Algorithms

The evaluation team determined heating penalties using the algorithms below and the assumption that all projects use gas heat per the IL-TRM V5.0. Based on the agreement between the ICC and AIC, the evaluation team did not include heating penalties in the ex post energy savings, but will include this in the data for the PY9 cost-effectiveness analysis.

Equation 2. LED Heating Penalty Algorithms

$$\Delta Therms = \left(\frac{Watts_{Base} - Watts_{EE}}{1000} \right) * Hours * -IFTherms$$

Where:

Watts_{Base} = Wattage of T8 or T12 lamp (Table 11)

Watts_{EE} = Wattage of installed LED lamp = 12W

Hours = Annual operating hours (varies by building type per IL-TRM V5.0)

IFTherms = Waste heat factor that accounts for the increase in gas space heating due to the decrease in rejected heat from efficient lighting (varies by building type per IL-TRM V5.0)

Appendix B. Cost-Effectiveness Inputs

Table 12 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.

Table 12. PY9 Linear LED Gross Impacts (Including Heating Penalties)

	MWh	MW	Therms
Gross Savings	5,809	1.10	N/A
Lighting Heating Penalty	N/A	N/A	-108,166
Total Gross Savings with Heating Penalty	5,809	1.10	-108,166

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 evaluation team applied heating penalties to 59,573 LED lamps based on building type. The program-tracking database does not provide the heating fuel type, therefore the evaluation team applied gas heat waste heat factors as specified in the IL-TRM V5.0. The total heating penalty for lighting measures is -108,166 therms, as seen in Table 12.

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