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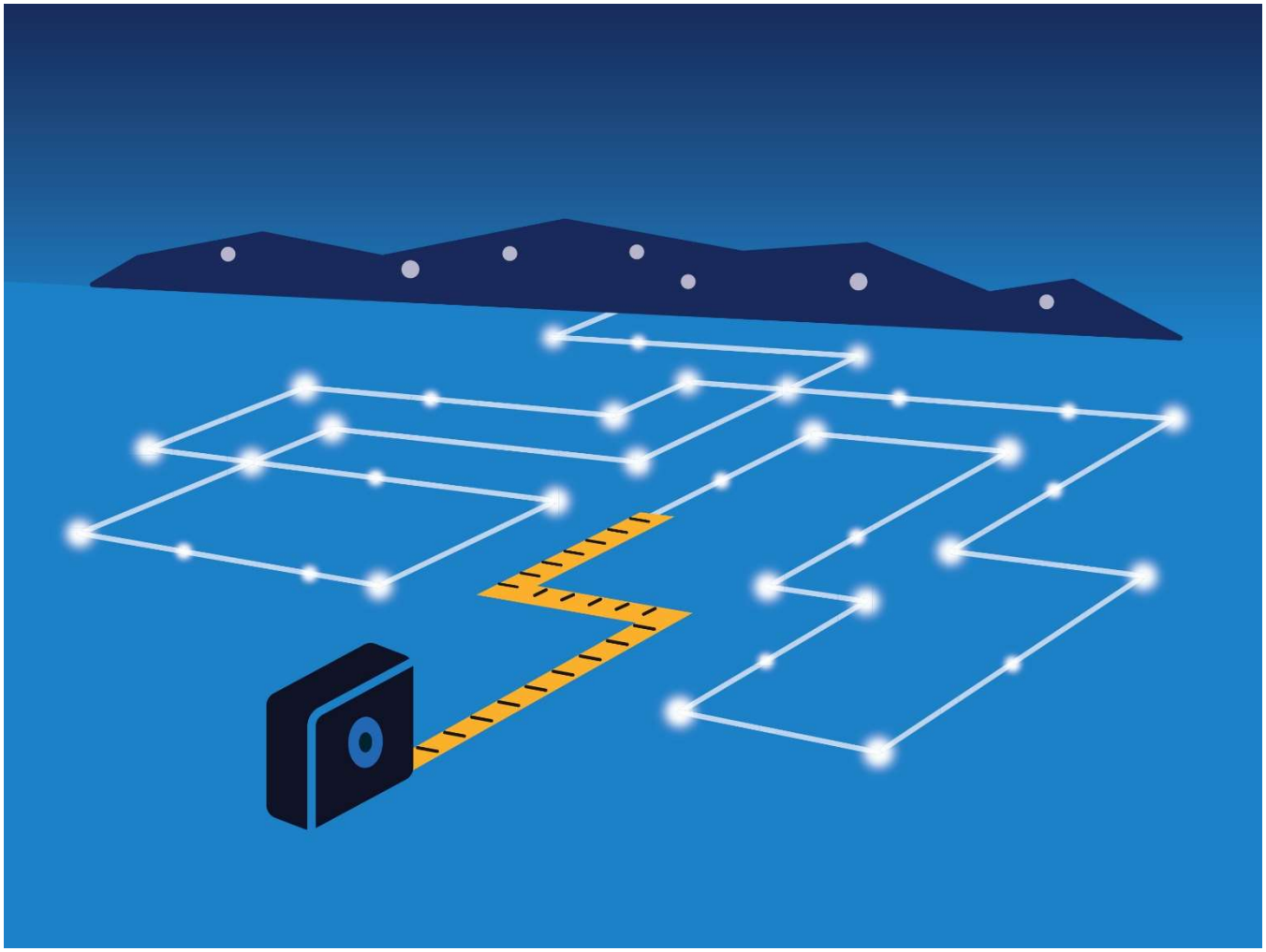

Impact and Process Evaluation of the 2016 Illinois Power Agency Private Sector Enhanced Building Optimization Program

Final

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CADMUS

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1. Executive Summary

This report presents results from the evaluation of the Private Sector Enhanced Building Optimization Program implemented by 360 Energy Group from June 1, 2016 to May 31, 2017 (also referred to as Program Year 9 [PY9]). The program is one of ten stand-alone Illinois Power Agency (IPA) programs and was approved for a single year of operation.

The program was designed to provide HVAC optimization strategies to small business customers in Ameren Illinois Company (AIC)'s DS-2 rate class and targets businesses in the private sector including retail centers, small office buildings, and private schools that fit the program criteria. The Private Sector Enhanced Building Optimization Program consists of three main components, any of which may be utilized by a participant:

- **Tune-Up:** A free comprehensive tune-up of under-maintained packaged roof top units and split systems. Tune-ups include a thorough cleaning/checking of the HVAC equipment and the installation of new filters and cogged V-belts.
- **Direct Install:** Installation of programmable thermostats and scheduling/setting back existing programmable thermostats by program allies.
- **HVAC Optimization Assessment:** A free analysis to identify low-cost optimization strategies targeting HVAC energy savings. After the assessment, the customer receives a Customer Selection Form (CSF) detailing cost, energy savings, and incentives for additional optimization measures such as demand controlled ventilation, enthalpy economizer optimization, and dynamic cycle management.

Along with 360 Energy Group staff, the program leveraged a network of six qualified and pre-approved mechanical contractors (program allies) who performed tune-ups, directly installed measures, and implemented the customer-desired HVAC optimization strategies identified through the assessment. However, only one eligible customer completed a project through the program in PY9 achieving 328 MWh in ex post net electric savings, 6% of the program goal. Program staff attributed the savings shortfall to time constraints in gaining traction for the program, not being able to work on roof-top HVAC units during the winter months, and low program ally participation.

The evaluation of the program involved both process and impact assessments. The process evaluation included a review of program-tracking data and program materials, as well as interviews with program administrators and implementation staff. The impact evaluation involved applying savings algorithms and assumptions from the Illinois Statewide Technical Reference Manual for Energy Efficiency Version 5 (IL-TRM V5.0), and the application of Stakeholder Advisory Group (SAG)-approved net-to-gross ratios (NTGR).

Key findings from the PY9 evaluation are presented below.

Program Impacts

Table 1 summarizes the electric energy and demand savings from the PY9 Private Sector Enhanced Building Optimization Program. The program had one participant during its year of operation. The program achieved 328 MWh for both ex ante and ex post gross savings, which resulted in a 100% gross realization rate. The evaluation team then applied the SAG-approved NTGR of 1.00 to the ex post gross impacts to estimate the ex post net impacts of 328 MWh for energy savings and 0.05 MW for demand savings.

Table 1. PY9 Private Sector Enhanced Building Optimization Program Net Impacts

	Ex Ante Gross	Realization Rate	Ex Post Gross	NTGR	Ex Post Net
Energy Savings (MWh)					
Total MWh	328	100%	328	1.00	328
Demand Savings (MW)					
Total MW	N/A	N/A	0.05	1.00	0.05

Note: The program did not report ex ante gross demand savings.

Key Findings and Recommendations

Overall, the program performed poorly against its goals, achieving only 6% of its targeted energy savings, which may have been due to the measures being unpopular and/or unfamiliar to small businesses, in addition to the seasonality of the program. The following detailed findings and recommendations for the program are based on the results of the program evaluation:

- **Key Finding #1:** One year of program operation was not long enough for the measures to become popularized and for the program to gain traction with both program allies and participants.
  - **Recommendation:** If HVAC tune-up services are included in future AIC small business programming, program implementers and administrators may expect that it will take time to gain traction across the service territory. Additionally, potential participants expressed interest in multi-year contracts for HVAC tuning and optimization.
- **Key Finding #2:** Participation was low throughout the program year, which may have been due to a lack of interest in the program offerings and/or ineffective recruitment of participants.
  - **Recommendation:** If HVAC tune-up and optimization measures are offered in future program years, a recruitment framework and marketing strategy should be planned prior to program implementation. Program implementation staff reported that program allies were not as effective as anticipated in recruiting participants. As such, implementers and program allies should work closely together to market the program and track recruitment progress.
- **Key Finding #3:** The program tracking database did not provide demand savings.
  - **Recommendation:** The evaluation team was unable to calculate a realization rate for demand, as the program-tracking database did not include ex ante demand savings. We recommend including demand savings for future evaluations.

2. Evaluation Approach

The evaluation of PY9 of the IPA Private Sector Enhanced Building Optimization Program involved both process and impact assessments. We outline the research objectives and methodology employed below.

2.1 Research Objectives

The overall objective of the PY9 evaluation is to assess program performance, a central component of which is providing estimates of gross and net electric savings associated with the program. The evaluation team sought to answer the following impact and process related questions:

Impact Questions

1. What were the estimated gross electric and demand impacts from this program?
2. What were the estimated net electric and demand impacts from this program?

Process Questions

3. Program Participation
    a. What were the characteristics of participating customers? 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?
4. Program Design and Implementation
    c. Was the program implemented as planned? If not, what changes were made, and why?
    d. 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 IPA Private Sector Enhanced Building Optimization Program.

Table 2. PY9 Evaluation Activities

Activity	Impact	Process	Forward Looking	Details
Program Staff Interviews		✓		Gather information about program marketing and implementation.
Program Materials Review	✓	✓		Review of program data to assess program operations in PY9.
Impact Analysis	✓			Calculate 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 360 Energy Group (implementation staff) in June 2017. These 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 1.00 to 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 the IPA Private Sector Enhanced Building Optimization Program. The evaluation team discusses the sources of error 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

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

3.1 Program Design and Implementation

The IPA Private Sector Enhanced Building Optimization Program was adopted through the IPA procurement plan process for the first time in PY9. This single-year program provided HVAC optimization strategies to small business customers in AIC's DS-2 rate class, specifically those businesses in the private sector including retail centers, small office buildings, and private schools that fit the program criteria. According to the eligibility criteria, eligible buildings must have a packaged rooftop or split system HVAC unit that does not have a standing maintenance contract or has not received a tune-up within the past 3 years (36 months), and is larger than 5-tons in size.

The IPA Private Sector Enhanced Building Optimization Program was implemented by 360 Energy Group and relied on a network of program allies. The program consisted of three main components:

- **Tune-Up:** A free comprehensive tune-up of under-maintained packaged roof top units and split systems. Tune-ups include a thorough cleaning/checking of the HVAC equipment and the installation of new filters and cogged V-belts.
- **Direct Install:** Installation of programmable thermostats and scheduling/setting back existing programmable thermostats by program allies.
- **HVAC Optimization Assessment:** A free analysis to identify low-cost optimization strategies targeting HVAC energy savings. After the assessment, the customer receives a Customer Selection Form (CSF) detailing cost, energy savings, and incentives for additional optimization measures such as demand controlled ventilation, enthalpy economizer optimization, and dynamic cycle management.

Along with the 360 Energy Group program staff, the program leveraged a network of qualified and pre-approved mechanical contractors (program allies) who performed tune-ups and directly installed measures and implemented the customer-desired HVAC optimization strategies. Program staff qualified all program leads, provided guidance to program allies, performed some of the HVAC Optimization Analyses, verified measure implementation, and paid eligible incentives to customers/program allies.

The program was primarily marketed and delivered through the program allies, as well as through email and telephone marketing by program staff. The program relied on program allies to identify quality leads from their existing customer base and relationships. Program staff also leveraged pre-existing relationships with qualified AIC customers and performed outreach to new customers, providing an approved program ally list to interested parties.

Program staff negotiated pricing with pre-approved providers based on the pre-determined scope of work and directly paid program allies for services rendered for tune-ups, direct install, and advanced optimization measures under the IPA Private Sector Enhanced Building Optimization Program.

3.2 Program Performance and Participation

3.2.1 Program Performance

The program achieved 6% of its intended energy savings and served one participant. Table 4 compares the program's performance to its energy savings goals.

Table 4. PY9 Program Performance against Energy Savings Goal

Metric	MWh
Goal	5,632
Ex Post Net Savings	328
% of Goal	6%

3.2.2 Program Participation

The program had one participant over its year of operation. Participants were recruited directly through phone calls. Though initially program allies were expected to recruit participants, the approach was not effective.

3.2.3 Barriers to Program Implementation

Program staff attributed shortfalls in meeting program goals primarily to the short, one-year lifespan of the program. The lifespan of the program affected results in the following ways:

- **Business were not familiar with the technology offered by the program:** The program implementer cited challenges in recruiting participants. Unlike more common energy efficiency measures such as LED lighting, HVAC tune-ups and optimization were new concepts to participants. The program implementer described the first and only year of the program as being at the bottom of an innovation diffusion curve, where the technology has not been readily adopted. Given more time in the market, the implementer believes higher participation rates may have been seen.

- **Difficulty recruiting program allies:** Implementation staff reported difficulty recruiting program allies because of the steep learning curve associated with performing the program tasks. In addition, because the program was only approved for one year, potential program allies were reluctant to invest time in becoming proficient in the program offerings.

- **Length of time needed to complete projects:** Implementation staff noted that businesses expressed interest in multi-year HVAC tune-up contracts, which were not possible given 360 Energy Group's contract with AIC. Given the lead time and approvals needed to perform work on HVAC systems, businesses were also reluctant to begin the participation process with the chance that work would not be completed by the deadline for the program.

- **Seasonal barriers to completing projects:** According to program implementation staff, all program marketing materials and implementation plans were approved by August 23rd, 2016. After approval,

the program began recruiting allies and customers. However, it took a number of months for successful recruitment, by which time the HVAC tune-up season was ending[1].

3.3 Impact Results

The following sections outline the results of the gross and net impact analysis for the PY9 IPA Private Sector Enhanced Building Optimization Program.

3.3.1 Gross Impacts

Overall, the program achieved a realization rate of 100%, and total gross energy and demand ex post impacts of 328 MWh and 0.05 MW. We provide detailed results in the following sub-sections.

Measure Verification and In-Service Rates

The evaluation team applied measure specific in-service rates from the IL-TRM V5.0 to develop verified measure quantities list (Table 5).

Table 5. Private Sector Enhanced Building Optimization Program Verified Measure Quantities

Measure Category	Ex Ante Measure Quantity[a] (a)	Ex Post In-Service Rate[b] (b)	Verified Measure Quantity (a*b)
AC Tune-up	10	100.00%	10
V-belt	8	100.00%	8
Programmable Thermostat (Direct Install)	5	100.00%	5
Programmable Thermostat (Scheduling)	5	100.00%	5
Total	**28**	**N/A**	**28**

[a] Source: AIC PY9 Optimization Program Tracking Database
[b] Ex post in-service rates are from the IL-TRM V5.0.

Ex Post Gross Impact Results

Table 6 summarizes the PY9 ex post gross impacts associated with the IPA Private Sector Enhanced Building Optimization Program. The overall ex post gross impact savings for PY9 are 328 MWh and 0.05 MW resulting in a gross realization rate for electric savings of 100%.

[1] The HVAC tune-up season typically ends in October or November, due to inclement weather and the necessity of working on rooftops.

Table 6. Private Sector Enhanced Building Optimization Program Gross Impacts

Program	Ex Ante Gross Impacts[a]		Ex Post Gross Impacts	
	MW[b]	MWh	MW	MWh
Private Sector Enhanced Building Optimization	N/A	328	0.05	328
Gross Realization Rate[c]			**N/A**	**100%**

[a] Source: AIC PY9 Optimization Program Tracking Database
[b] The program did not report ex ante gross demand savings
[c] Gross realization rate = ex post gross value ÷ ex ante gross value

Table 7 summarizes the gross impact results by measure. Measure categories are sorted from largest to smallest based on ex ante energy savings. We provide specific inputs for all ex post savings estimates in Appendix A.

Table 7. Private Sector Enhanced Building Optimization Program Ex Post Gross Impacts

Measure Category	Verified Measure Quantity	Ex Ante Gross			Ex Post Gross			Realization Rate	
		MW[a]	MWh	% of Ex Ante MWh	MW	MWh	% of Ex Post MWh	MW[a]	MWh
Programmable Thermostat (Scheduling)	5	N/A	132	40.1%	-	132	40.1%	N/A	100%
Programmable Thermostat (Direct Install)	5	N/A	125	38.2%	-	125	38.2%	N/A	100%
AC Tune-up	10	N/A	69	21.0%	0.04	69	21.0%	N/A	100%
V-belt	8	N/A	2	0.6%	0.00	2	0.6%	N/A	100%
Grand Total	**28**	**N/A**	**328**	**100.0%**	**0.05**	**328**	**100.0%**	**N/A**	**100%**

[a] The program did not report ex ante gross demand savings

The Evaluation Team reviewed all ex ante calculations and algorithms and found no discrepancies between ex ante and ex post savings. Ex Post Net Impact Results

In determining the overall net savings associated with the Private Sector Enhanced Building Optimization Program, the team applied the SAG-approved NTGR of 1.00. Thus, the ex post net savings are equal to the ex post gross savings of 328 MWh and 0.05 MW, with an overall net realization rate of 100%.

Table 8. Private Sector Enhanced Building Optimization Program Net Impacts

Program	Ex Ante Net Impacts		Ex Ante NTGR	Ex Post NTGR	Ex Post Net Impacts	
	MW[a]	MWh			MW	MWh
Private Sector Enhanced Building Optimization	N/A	328	1.00	1.00	0.05	328
				Net Realization Rate[b]	N/A	100%

[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

Overall, the program performed poorly against its goals, achieving only 6% of its targeted energy savings, which may have been due to the measures being unpopular and/or unfamiliar to small businesses, in addition to the seasonality of the program. The following detailed findings and recommendations for the program are based on the results of the program evaluation:

- **Key Finding #1:** One year of program operation was not long enough for the measures to become popularized and for the program to gain traction with both program allies and participants.
  - **Recommendation:** If HVAC tune-up services are included in future AIC small business programming, program implementers and administrators may expect that it will take time to gain traction across the service territory. Additionally, potential participants expressed interest in multi-year contracts for HVAC tuning and optimization. Because recruitment for these particular measures may take longer and/or require permission to employ, we recommend utilizing a multi-year contract system to keep participants engaged. Further, yearly HVAC tune-ups are practical from an energy efficiency and engineering perspective.
- **Key Finding #2:** Participation was low throughout the program year, which may have been due to a lack of interest in the program offerings and/or ineffective recruitment of participants.
  - **Recommendation:** If HVAC tune-up and optimization measures are offered in future program years, a recruitment framework and marketing strategy should be planned prior to program implementation. Program implementation staff reported that program allies were not as effective as anticipated in recruiting participants. As such, implementers and program allies should work closely together to market the program and track recruitment progress.
- **Key Finding #3:** The program tracking database did not provide demand savings.
  - **Recommendation:** The evaluation team was unable to calculate a realization rate for demand, as the program-tracking database did not include ex ante demand savings. We recommend including demand savings for future evaluations.

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Appendix A. Private Sector Enhanced Building Optimization Program Assumptions and Algorithms

In PY9, the impact evaluation efforts estimated gross impact savings for the IPA Private Sector Enhanced Building Optimization Program by applying savings algorithms from the Illinois Statewide Technical Reference Manual (TRM) V5.0 (2016)[2] to the information provided in the program-tracking database.

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

A.1 Air Conditioner Tune-up

The evaluation team determined ex post savings for air conditioner tune-ups using the algorithms below. The energy and demand savings algorithms are from the IL-TRM V5.0. However, the IL-TRM does not provide guidance when actual pre and post efficiencies are unknown. Therefore, the evaluation team referenced a Department of Energy (DOE) Building America report[3] to determine these efficiencies. All other assumptions come from the IL-TRM V5.0 unless otherwise noted.

Equation 1. Air Conditioner Tune-up Algorithms[4]

$$Energy\ Savings\ (\Delta kWh) = Capacity * \left(\frac{1}{EER_{pre}} - \frac{1}{EER_{post}}\right) * EFLH$$

$$Demand\ Savings\ (\Delta kW) = Capacity * \left(\frac{1}{EER_{pre}} - \frac{1}{EER_{post}}\right) * CF$$

$$EER_{pre} = EER_{baseline} * (1 - M)^{Age}$$

$$EER_{post} = EER_{pre} + \left(EER_{pre} * \%_{improvemen}\ \right)$$

Where:

Capacity	= Size of air conditioner in units of kBTUh (1 ton = 12 kBTUh) = Actual
$EER_{baseline}$	= Energy Efficiency Ratio of pre-retrofit air conditioner when new = 9.1 EER[3]
EER_{pre}	= Energy Efficiency Ratio of the air conditioner prior to a tune-up = Calculated
EER_{post}	= Energy Efficiency Ratio of the air conditioner after the tune-up = Calculated

[2] Illinois Statewide Technical Reference Manual for Energy Efficiency V5.0. Effective June 1, 2016.

[3] Building America U.S. Department of Energy. Building America Performance Analysis Procedures for Existing Homes. Space Conditioning / Air Distribution. May 2006. https://www.nrel.gov/docs/fy06osti/38238.pdf

[4] Energy and demand algorithms from IL-TRM V5.0 Section 4.4.1

EFLH = Equivalent Full Load Hours for cooling (varies by building type per IL-TRM V5.0 Section 4.4)

CF = Summer Peak Coincidence Factor = 91.3%

M = Maintenance Factor = 3%[5]

Age = Age of equipment in years = Varies by age in database

$\%_{improvement}$ = Efficiency improvement for air conditioner tune-up = 17.4%[6]

A.2 V-belts for HVAC Systems

The evaluation team determined ex post savings for HVAC V-belts using the algorithms below. All assumptions come from the IL-TRM V5.0 unless otherwise noted.

Equation 2. V-belt Algorithms[7]

$$Energy\ Savings\ (\Delta kWh) = kW_{Connected} * Hours * ESF$$

$$Demand\ Savings\ (\Delta kW) = kW_{Connected} * ESF$$

$$kW_{Connected} = \frac{HP * 0.746 * Load\ Factor}{n_{Motor}}$$

Where:

$kW_{Connected}$ = Total connected wattage to the motor (in units of per 1,000 watts)

Hours = Total fan run hours (varies by building type)

ESF = Energy Savings Factor = 2%

HP = Size of motor measured in horsepower = Actual

Load Factor = Motor load factor = 80%

n_{Motor} = Motor efficiency = 87%

[5] Building America U.S. Department of Energy. Building America Performance Analysis Procedures for Existing Homes. Space Conditioning / Air Distribution. May 2006. https://www.nrel.gov/docs/fy06osti/38238.pdf

[6] ASHRAE Report. Field Performance Assessment of Package Equipment to Quantify Benefits of Proper Service. May 2010.

[7] Energy and demand algorithms from IL-TRM V5.0 Section 4.4.30

A.3 Programmable Thermostat (Direct Install and Scheduling)

The evaluation team determined ex post savings for installing programmable thermostats and or scheduling existing programmable thermostats using the algorithms below. All assumptions come from the IL-TRM V5.0 unless otherwise noted.

Equation 3. Programmable Thermostat (Direct Install and Scheduling) Algorithms[8]

$$Energy\ Savings\ (\Delta kWh) = Baseline\ Energy\ Use - Proposed\ Energy\ Use * Capacity$$

The baseline and proposed energy use algorithms vary by building type and fan mode for occupied periods. For a full list of algorithms refer to the IL-TRM V5.0 Section 4.4.18. For PY9, one participant (across multiple HVAC units) installed new programmable thermostats (direct install) and scheduled their existing programmable thermostat (scheduled). These adjusted took place in an office setting on a college campus. Therefore, the evaluation team applied the following energy use algorithm for a low-rise office building. The fan mode was assumed to be continuous since mechanical codes require continuous fan operation for commercial buildings to comply with ventilation requirements.

Equation 4. Electric Energy Use Algorithm for Low-Rise Office (Continuous Fan Mode)

$$Energy\ Use\ (\Delta kWh) = CZ + Fu * (7.082 * T_c - 41.199 * T_h + 18.734 * W_s * 3288.55) + T_c * (0.205 * W_s - 34.929)$$

Where:

Baseline Energy Use = Total energy consumption prior to adjusting or scheduling thermostats

Proposed Energy Use = Total energy consumption after adjusting or scheduling thermostats

Capacity = Size of air conditioner in units of tons = Actual

CZ = Climate zone coefficient (varies by building type and fan mode) =5,188

Fu = Fan mode during unoccupied periods = 0 for continuous

T_c = Degrees of cooling setback (°F); 0 for pre; 8 for post

T_h = Degrees of heating setback (°F); 0 for pre; 0 for post

W_s = Weekly Hours thermostat is in occupied mode; 168 for pre; Actual for post

[8] Energy and demand algorithms from IL-TRM V5.0 Section 4.4.18 and Section 4.4.25

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