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2023 Indiana Commercial & Industrial Portfolio EM&V Report

Volume I of II

Prepared for:

Indiana Michigan Power

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1. Introduction

Under contract with the Indiana Michigan Power (I&M), ADM Associates, Inc., (ADM) performed evaluation, measurement, and verification (EM&V) activities that confirmed the energy savings (kWh) and demand reduction (kW) realized through the energy efficiency programs that I&M implemented in Indiana during the during January 2023 through December 2023 (PY2023).

This chapter provides a summary of evaluation findings for the C&I program portfolio and presents information regarding the organization of the report.

1.1. Summary of Data Collection

Table 1-1 summarizes the number of verification sites reviewed for the ex post gross analysis.

Table 1-1 Number of Sampled Projects

Program	*Number of Sampled Projects*
Work Prescriptive	29
Work Custom	23
Work Direct Install	6
Work Strategic Energy Management	Census

Surveys were conducted to collect data on the program's impact on participants' decisions to install efficient equipment, as well as their feedback on the program. Table 1-2 summarizes the survey data collection completed for PY2023.

Table 1-2 Summary of Survey Data Collection

Survey	*Mode*	*Time Frame*	*Number of Contacts*	*Number of Completions*
Work Prescriptive and Custom Participant Survey	Email and phone follow up	November 2023, January 2024	237	48
Work Small Business Direct Install Participant Survey	Email and phone follow up	January 2024	9	5
Work Strategic Energy Management Participant Interviews	Telephone	December 2023	2	2

1.2. Impact Evaluation Findings

The savings variables presented in this evaluation report are defined in Table 1-3.

Table 1-3 Savings-Related Terminology

Variable	*Definition*
kWh Savings Goal	*kWh Savings Goal* is the energy savings goal cited in the applicable portfolio plan.
Ex Ante Gross kWh Savings	*Ex Ante Gross kWh Savings* are the annual energy savings reported by I&M and are typically obtained from I&M's DSM/EE Program Scorecard documents.

Variable	*Definition*
Gross Audited kWh Savings	*Gross Audited kWh Savings* are determined by reviewing tracking data presenting for any errors and adjusting *Ex Ante Gross kWh Savings* accordingly.
Gross Verified kWh Savings	*Gross Verified kWh Savings* are determined by applying an installation rate to the *Gross Audited kWh Savings*.[1] The installation rate is defined as the ratio of units that were installed (verified) to the number of units reported (claimed).
Ex Post Gross kWh Savings	*Ex Post Gross kWh Savings* are the realized annual gross kWh savings reflecting all adjustments made by ADM, without accounting for free ridership or spillover.
Ex Post Net kWh Savings	*Ex Post Net kWh Savings* are equal to *Ex Post Gross kWh Savings*, adjusted to account for free ridership and spillover.[2]
Ex Post Net Lifetime kWh Savings	*Ex Post Net Lifetime kWh Savings* is the *Ex Post Net kWh Savings* occurring over the course of the applicable measure effective useful life (EUL).
Gross Realization Rate	*Gross Realization Rate* is equal to *Ex Post Gross kWh Savings* divided by *Ex Ante Gross kWh Savings*.
Net-to-Gross Ratio	*Net-to-Gross Ratio* is equal to *Ex Post Net kWh Savings* divided by *Ex Post Gross kWh Savings*.
Free Rider[3]	A *free rider* is a program participant who would have implemented the program measure or practice in the absence of the program. Free riders can be: 1) total, in which the participant's activity would have completely replicated the program measure; 2) partial, in which the participant's activity would have partially replicated the program measure; or 3) deferred, in which the participant's activity would have completely replicated the program measure, but at a future time than the program's timeframe. The free ridership estimate are the savings attributable to free riders.

1 Gross Verified energy impacts will be equal to Gross Audited energy impacts for the Work Prescriptive, Work Custom, and Work Direct Install Programs as the in-service rate for these programs is 1.0.

2 ADM conducted a non-participant spillover study in 2021 to estimate non-participant spillover and concluded that there was not any qualifying non-participant spillover. Spillover savings presented in this report reflect participant spillover.

3 Northeast Energy Efficiency Partnerships (NEEP) EMV Glossary version 2.1. https://neep.org/media/4330

Variable	*Definition*
Spillover (Participant and Non-Participant)[4]	*Spillover* effects are reductions in energy consumption and/or demand caused by the presence of an energy efficiency program, beyond the program-related gross savings of the participants and without financial or technical assistance from the program. There can be participant and/or non-participant spillover. *Participant spillover* is the additional energy savings that occur when a program participant independently installs energy efficiency measures or applies energy saving practices after having participated in the efficiency program because of the program's influence. *Non-participant* spillover refers to energy savings that occur when a program non-participant installs energy efficiency measures or applies energy savings practices as a result because of a program's influence.

Based on the definitions presented in Table 1-3, Table 1-4 presents a summary of the components of the impact evaluation that are accounted for in savings variables presented in this report.

Table 1-4 Components of Impact Evaluation Accounted for in Savings Variables

Category	*Tracking Data Review*	*In-Service Rates*	*Ex Post Gross Analysis*	*Net-to-Gross Analysis*
Gross Audited	✓			
Gross Verified	✓	✓		
Ex Post Gross	✓	✓	✓	
Ex Post Net	✓	✓	✓	✓

ADM performed EM&V activities for each of the C&I programs offered by I&M during PY2023. Total C&I portfolio ex post gross energy savings are 70,797,081 kWh, while ex post net energy savings are 60,956,110 kWh, as shown in Table 1-5.

Table 1-5 Summary of Energy Savings – PY2023

Program Name	*Ex Ante Annual kWh Savings*	*Gross Audited kWh Savings*	*Gross Verified kWh Savings*	*Ex Post Annual Gross kWh Savings*	*Gross Realization Rate*	*Ex Post Annual Net kWh Savings*	*Net-to-Gross Ratio*	*Lifetime Net Ex Post kWh Savings*
Work Prescriptive	24,048,482	24,048,482	24,048,482	21,507,616	89%	19,009,424	88%	277,435,792
Work Custom	46,641,686	46,641,686	46,641,686	48,780,211	105%	41,437,433	85%	421,270,398
Work Strategic Energy Management	394,618	394,618	394,618	394,137	100%	394,137	100%	5,912,055
Work Direct Install	138,952	138,952	138,952	115,117	83%	115,117	100%	1,721,665
C&I Portfolio Totals	71,223,738	71,223,738	71,223,738	70,797,081	99%	60,956,110	86%	706,339,910

Total C&I portfolio ex post gross peak demand savings are 11,333.46 kW, while ex post net peak demand savings are 9,561.08, as shown in Table 1-6.

4 Ibid.

Table 1-6 Summary of Peak Demand Impacts – PY2023

Program Name	*Ex Ante Gross kW Savings*	*Gross Audited kW Savings*	*Gross Verified kW Savings*	*Ex Post Gross kW Savings*	*Gross Realization Rate*	*Ex Post Net kW Savings*	*Net-to-Gross Ratio*
Work Prescriptive	4,019.78	4,019.78	4,019.78	4,274.92	106%	3,708.17	87%
Work Custom	7,077.14	7,077.14	7,077.14	6,996.76	99%	5,791.13	83%
Work Strategic Energy Management	-	-	-	35.63	N/A	35.63	100%
Work Direct Install	25.59	25.59	25.59	26.16	102%	26.16	100%
C&I Portfolio Totals	11,122.51	11,122.51	11,122.51	11,333.46	102%	9,561.08	84%

1.3. Cost Effectiveness Evaluation Findings

ADM performed the following cost effectiveness tests for the programs: Total Resource Cost (TRC) test, Utility Cost Test, Participant Cost Test (PCT), and Ratepayer Impact Measure (RIM) test. A test score above one signifies that, from the perspective of the test, the program benefits were greater than the program costs. Table 1-7 shows the test results for each program.

Table 1-7 Summary of PY2023 Benefit-Cost Ratios

Program	*Program Administrator Cost Test (aka USCRT, or UCT)*	*Total Resource Cost Test*	*Ratepayer Impact Measure*	*Participant Cost Test*
Work Prescriptive	3.31	2.13	0.47	4.60
Work Custom	2.44	1.97	0.41	5.55
Work Strategic Energy Management	1.25	1.27	0.34	33.08
Work Direct Install	0.45	0.42	0.26	3.60
C&I Portfolio Total	2.68	2.00	0.43	5.19

1.4. Evaluation Findings and Recommendations

1.4.1. Work Custom and Prescriptive

Based on the results of the analysis, ADM identified the following key findings and recommendations I&M could consider as they implement their efficiency programs for commercial and industrial customers.

Overall, outreach changes and tactics appear to be increasing program participation. The level of program participation increased from PY2022 and PY2023.

Participants reported a positive experience with the program. Most participants (92%) were satisfied with the program overall and all respondents reported that the application process was somewhat or completely acceptable.

The analysis of deemed savings per unit for prescriptive HVAC measures, particularly for heat pump capacities of 65 KBTUh, reveals an overestimation issue. In the transition from the "2021-2022 IN MI Approved CI Pgm Targets Measures" workbook to the "2023 Indiana Pres Measure Workbook," the units for calculating savings shifted from per unit to per ton. This change causes a significant overestimation of energy savings, exemplified by a 20-ton heat pump, where savings are overestimated by a factor of 20 due to this unit conversion. Additionally, there's an inconsistency in expressing heating efficiency, with some models using a COP (coefficient of performance) value instead of an HSPF value, not accounting for the conversion factor of 3.412 x COP to align with kWh..

- **Recommendation 1:** To address reoccurrences of lower than expected savings for heat pumps of 5-ton capacity and above, it is recommended that: The deemed savings values for the 5-ton, 10-ton and 20-ton models be reset to per ton values, to align with the application units of tons. Also, to review the models that informed the deemed savings, to standardize the usage of HSPF (or COP x 3.412) instead of just the COP value.

While low-flow air nozzles offer significant potential for energy savings, there's a risk of overestimating these savings if actual usage hours are not accurately estimated.

- **Recommendation 2:** To ensure accurate estimation of energy savings, it is crucial to collect detailed attribute data related to the air blow-off operation. This includes the type of operation, duration of use per cycle, and the number of cycles per day, among other relevant parameters.

1.4.2. Work Direct Install

PY2023 was the first year of the program and saw some initial participation during the latter half of the program year. Although the 138,952 kWh in ex ante savings fell short of the savings goals, the program team's reported engagement with contractors and collaboration with chambers of commerce may help lay the foundation for increased participation in PY2024.

1.4.3. Work Strategic Energy Management

The SEM service is well designed. Program staff provided a detailed description of the SEM service offered to I&M's customers. The implementation team has staff dedicated to providing this service and is able to draw on broader company experience and support. Some key benefits and forms of support identified by the implementation contactor are identification of potential projects, operational planning, and engineering support, along with coaching to guide the broader team involved in the execution. Interviewed participants echoed these benefits citing the identification of the energy savings and useful engagement and reviews of data to understand energy use as key benefits.

The SEM program has been valued by participants. Both participants felt that the program delivered tangible benefits to them and that that their participation enabled them to identify energy saving improvements.

1.5. Organization of Report

ADM prepared two volumes for this report, and they provide information on the impact, process, and cost effectiveness evaluation of the Indiana Michigan Power portfolio of C&I programs implemented in Indiana during the 2023 program year. Volume I is organized as follows:

- Chapter 2: Work Prescriptive
- Chapter 3: Work Custom
- Chapter 4: Work Direct Install
- Chapter 5: Work Midstream
- Chapter 6: Work Strategic Energy Management
- Chapter 7: Cost Effectiveness Evaluation

See report Volume II for chapters that present reports of site-level gross energy impacts, survey instruments and tabulated survey response information.

2. Work Prescriptive

This chapter presents the results of both the impact and process evaluations of the Work Prescriptive Program that Indiana Michigan Power (I&M) offered to its non-residential customers during the period of January 2023 through December 2023.

The objectives of the evaluation were to:

- Complete project pre-approval reviews;
- Assess gross and net energy (kWh) savings and peak demand (kW) reductions resulting from participation in the program during the program year;
- Complete a limited process evaluation of the program; and
- Provide recommendations for program improvement as appropriate.

2.1. Program Description

This program targets non-residential customers eligible for prescriptive measures. These will include commercial, industrial, and institutional customers. For-profit, non-profit, and public agencies (such as schools) are eligible to participate.

Categories of eligible measures for this program include:

- Lighting
- Lighting controls
- HVAC systems
- Variable frequency drives
- Commercial refrigeration equipment
- Commercial kitchen equipment
- Compressed Air – Engineered Nozzle

2.2. Data Collection

2.2.1. Verification of Measures

2.2.1.1. Sampling Plan

ADM selected a sample of all 2023 C&I projects for which ADM performed measurement and verification (M&V) and calculated gross realized kWh savings and kW demand reductions.

ADM used a stratified sampling approach to develop the M&V sample. A stratified sampling approach allowed for a given statistical precision and confidence level target to be met with a smaller sample size than would have been allowed by simple random sampling. Strata boundaries were based on ex ante kWh energy savings. ADM selected a sample with enough sample units to facilitate estimation of program ex post kWh energy savings with 10% statistical precision at a 90% confidence level.

Completed program projects accumulated over the course of the program year, and sample selection occurred at multiple points in time. The timing of sample selection was contingent upon the timing of the completion of projects during the program year.

The table below shows the number of projects, ex ante gross kWh energy savings, and sampling statistics, by stratum, of the program sample.

Table 2-1 Population Statistics Used for Work Prescriptive Sample Design

Variable	*Stratum 1*	*Stratum 2*	*Stratum 3*	*Stratum 4*	*Stratum 5*	*Totals*
Strata boundaries (kWh)	> 1000000	350000 - 1000000	145000 - 350000	50000 - 145000	< 50000	
Number of projects	1	8	35	68	256	368
Total Ex Ante Annual kWh	1,651,478	4,205,541	7,708,609	6,002,748	4,480,106	24,048,482
Average kWh Savings	1,651,478	525,693	220,246	88,276	17,500	2,503,193
Std. dev. of kWh savings	N/A	120,313	47,923	27,156	13,313	208,706
Coefficient of variation	N/A	0.23	0.22	0.31	0.76	
Final design sample	1	6	6	6	10	29

2.2.1.2. Verification Data Collection Procedures

ADM used a combination of on-site visits and remote verifications to collect project-specific data. ADM performed on-site data collection for larger or more complicated projects that required more extensive data collection in the form of visual inspection, monitoring, and/or facility operating schedules and load factors. For less complex projects, data collected remotely was used to estimate savings.

2.2.1.2.1. On-site Data Collection Procedure

The visits to the sites of sampled projects were used to collect primary data on the measures implemented under the program. During an on-site visit, the field staff accomplished three major tasks:

- First, they verified the implementation status of all measures for which customers received incentives. They verified that the energy efficiency measures were installed correctly and still functioned properly.
- Second, they collected the physical data, when necessary, needed to analyze the energy savings that had been realized from the installed improvements and measures. Data was collected using a form that had been prepared specifically for the project in question after an in-house review of the project file.
- Third, they interviewed the contact personnel at a facility to obtain additional information on the installed system to complement the data collected from other sources.

Monitoring was conducted to gather additional information on the operating hours of the installed measures. Monitoring was conducted at sites for which ADM staff members determined that monitored data were necessary to minimize uncertainty associated with savings calculation of energy impacts. Monitoring was not considered necessary for sites for which other data sources and methods would support estimation of energy impacts with relatively less uncertainty.

2.2.1.2.2. Remote Data Collection Procedure

The following bulleted list summarizes the remote data collection procedures ADM followed. For remote data collection, ADM continued to use its practice of a detailed review of project invoicing and supporting documentation. ADM discussed any discrepancies between invoicing and documentation and incentivized measures identified in program tracking data with the customer contact. Additionally, ADM referenced CLEAResult's pre- and post-inspection forms, when available.

- For cases where the information needed was limited to the verification of the installation of the equipment, an ADM analyst contacted the site contact by email, with telephone follow-up as needed, to confirm the installation of the measure. For cases where more detailed information such as operations schedules or heating and cooling type was needed, ADM completed interviews guided by the information needs defined in the site-specific M&V plan. For these cases, a member of the ADM call center contacted the site contact to schedule a time for an interview with the analyst or an engineer, as appropriate. In some cases, ADM also requested site contacts to install monitoring equipment that ADM mailed to them if they had the technical resources available to support that activity and other M&V approaches were not feasible. ADM only took this approach for equipment that involved no safety risks to the customer. Additionally, customers were asked to send pictures of installed equipment such as motor nameplates. The site-specific M&V plan referred to the data collection plan for the site.
- For cases where Option B (retrofit isolation) would be applied, ADM requested energy use data collected through EMS systems or other onsite monitoring efforts implemented by site staff or their contractors, if available. As needed, and if acceptable to the customer, ADM scheduled video conferencing with its experienced engineers and field staff to assist customers with getting this data. As mentioned above, ADM may have mailed and asked customers to install and mail back monitoring equipment where the site staff had the technical resources to support the data collection effort and other M&V approaches were not viable. ADM only took this approach for equipment that involved no safety risks to the customer.
- Application of International Performance Measurement and Verification Protocol (IPMVP) Option C was used for custom measures where feasible, supplemented by information collected by telephone or email on schedule and equipment changes that may have occurred during the pre-and post-installation period.

2.2.2. Participant Survey

ADM administered a survey to Work Prescriptive and Work Custom participants to collect data for use in estimating net savings and obtaining feedback about participants' experience with the program. Table 2-2 summarizes the survey data collection efforts. To increase the response rate, ADM engaged participants through both email and telephone communications. A concise version of the survey, focusing exclusively on questions related to free ridership, was administered after we obtained a poor survey response in our initial attempt to recruit respondents by email.

Table 2-2 Summary of Work Prescriptive and Work Custom Data Collection

Survey	*Mode*	*Time Frame*	*Number of Contacts*	*Number of Completions*
Work Prescriptive and Custom Participant Survey	Email and phone follow up	November 2023, January 2024	237	48

2.3. Estimation of Ex Post Gross Savings

2.3.1. Methodology for Estimating Ex Post Gross Savings

2.3.1.1. Review of Documentation

I&M's program implementation contractor provided documentation for the sampled energy efficiency projects undertaken at customer facilities. ADM's first step in the evaluation effort was to review this documentation and other program materials that were relevant to the evaluation effort.

For each sampled project, ADM reviewed the available documentation (e.g., audit reports, savings calculation work papers, etc.) for each rebated measure, with attention given to the calculation procedures and documentation for savings estimates. Reviewed documents included program forms, reports, billing system data, weather data, and any other potentially useful data. For each application, ADM determined if the following types of information was available for each application:

- Documentation for the equipment changed, including (1) descriptions, (2) schematics, (3) performance data, and (4) other supporting information
- Documentation for the new equipment installed, including (1) descriptions, (2) schematics, (3) performance data, and (4) other supporting information
- Information about the savings calculation methodology, including (1) what methodology was used, (2) specifications of assumptions and sources for these specifications, and (3) correctness of calculations.

In addition to the above activities, ADM completed a review of program tracking data. The purpose of the review was to assess the sufficiency of the tracking data for supporting program implementation and evaluation. To this end, ADM reviewed the program data to verify tracking of the following fields, that the fields were populated (i.e., the data were not missing), and that the values were reasonable.

- Unique customer identifier, such as customer account number;
- Customer specific project data such as contact name and information, building type;
- Project milestone dates such as application submission date, application approval, incentive payment (where applicable);
- Measure specific information such as:
  - type of measure;
  - specific measure;
  - ex ante measure kWh energy savings and peak kW reductions;
  - measure attributes necessary to estimate measure savings (where applicable);
  - unique measure identifier (e.g., numeric or alpha-numeric code);
  - unit serial number (where applicable);
  - incremental costs / project costs
- Vendor/Contractor business name, contact name and information (where applicable);
- Incentive amounts; and
- Application status.

ADM provided recommendations, specifically regarding tracking measure level information, to the implementation contractor based on this review.

2.3.1.2. Procedures for Estimating Measure-Level Gross Energy Savings

A breakdown of sampled measures for the Work Prescriptive Program is below in Table 2-3.

Table 2-3 Breakdown of Sampled Prescriptive Measures

Measure Category	*Ex Ante Annual kWh Savings*	*Ex Post Annual Gross kWh Savings*	*Gross Realization Rate*
Chiller Tune-up	744,000	796,928	107%
Daylighting Control	433,452	33,984	8%
Engineered Nozzles Compressed Air	180,420	66,123	37%
Heat Pump	1,476,374	30,959	2%
Injection Molding	204,490	211,405	103%
LED Exit Sign	32,906	37,909	115%
LED Exterior Fixture	99,986	100,530	101%
LED Interior Fixture	1,411,907	1,151,444	82%
LED Low Bay	1,642	236	14%
LED Other	1,312,843	1,071,532	82%
Lighting Occupancy Sensors	866,105	618,905	71%
VFD Upgrade	211,480	217,180	103%
Total	6,975,606	4,337,135	62%

ADM calculated a kWh energy savings gross realization rate and a peak kW reduction gross realization rate for each site in the M&V sample. Sites with relatively high or low gross realization rates were analyzed to determine the reasons for the discrepancy between ex ante and ex post energy savings. The site-level gross impact analysis results for each M&V sample site are presented in Volume II of the report. These reports outline the data sources and analytical approaches employed in the calculation of measure impacts.

2.3.2. Results of Ex Post Gross Savings Estimations

The kWh gross realization rate is the ratio of sampled measure ex post gross kWh energy savings to sampled measure ex ante kWh energy savings. The kW gross realization rate is the ratio of sampled measure ex post gross kW demand savings to sampled measure ex ante kW demand savings. Since a stratified sampling approach was employed for this program, stratum-level kWh and kW gross realization rates were developed for each sampling stratum.

Program-level gross ex post gross kWh energy savings are calculated as follows:

- The ex-ante kWh energy savings of non-sampled measures are factored by the applicable stratum-level kWh gross realization rates to calculate ex post gross kWh energy savings for non-sampled measures.
- The ex post gross kWh energy savings of all sampled measures and all non-sampled measures are summed.

Program-level gross ex post gross kW demand savings are calculated as follows:

- The ex-ante kW demand savings of non-sampled measures are factored by the applicable stratum-level kW gross realization rates to calculate ex post gross kW savings for non-sampled measures.
- The ex post gross kW demand savings of all sampled measures and all non-sampled measures are summed.

2.3.2.1. Ex Post Gross kWh Savings

Table 2-4 displays the ex ante and ex post gross kWh savings of the Work Prescriptive Program including gross realization rates for sampled projects.

Table 2-4 Work Prescriptive Project-Level Ex Ante and Ex Post kWh Savings

Stratum	*Project Number*	*Measure*	*Ex Ante kWh Savings*	*Gross Ex Post kWh Savings*	*Project Gross Realization Rate*
1	134	Heat Pump	1,651,478	159,646	10%
2	104	Lighting Occupancy Sensors	547,691	547,691	100%
2	105	LED Troffer	487,654	136,167	28%
2	109	Chiller Tune-up	744,000	796,928	107%
2	114	LED High Bay	421,135	230,546	55%
2	118	LEDs & Daylighting Control	594,918	189,233	32%
2	126	Linear LED	588,461	436,447	74%
3	100	Engineered Nozzles Compressed Air	180,420	66,123	37%
3	101	Lighting Occupancy Sensors	332,231	188,169	57%
3	102	LED Relamp	215,706	210,664	98%
3	106	Linear LED	212,192	425,516	201%
3	117	LED High Bay	166,916	26,516	16%
3	119	Injection Molding	204,490	211,405	103%
4	107	Lighting Occupancy Sensors	117,014	63,552	54%
4	115	LED Relamp	54,736	88,560	162%
4	116	LED Relamp	58,840	89,333	152%
4	120	Lighting Occupancy Sensors	81,217	93,572	115%
4	122	LED Relamp	63,495	103,476	163%
4	127	LED High Bay	89,856	93,290	104%
5	108	Linear LED	33,385	52,603	158%
5	121	LED Relamp	37,912	59,644	157%
5	123	LED Exterior Fixture	15,336	14,717	96%
5	124	LED Relamp	10,506	6,274	60%
5	125	LED Relamp	2,627	1,402	53%
5	129	LED Relamp	3,119	1,386	44%
5	131	Linear LED	12,334	11,690	95%

Stratum	*Project Number*	*Measure*	*Ex Ante kWh Savings*	*Gross Ex Post kWh Savings*	*Project Gross Realization Rate*
5	132	Linear LED	16,154	8,974	56%
5	133	Linear LED	30,704	22,531	73%
5	135	LED Exterior Fixture	1,080	1,080	100%
All Non-Sample Projects			17,072,876	17,170,481	101%
Total			24,048,482	21,507,616	89%

Seven of the 29 sampled prescriptive projects had a realization rate that was higher than 110%.

- Projects 106, 108, 115, 116, 121, 122 (LED and Linear LED Relamp): These projects experienced variances between anticipated and actual energy savings mainly because initial estimates relied on deemed values. In contrast, ex-post analyses utilized comprehensive methods, including project documentation review, specification data collection, and interval electric billing data aggregation. This detailed approach often revealed higher actual hours of operation and efficient wattage variations than initially estimated, leading to higher gross energy savings realization rates.
- Project 120 (Lighting Occupancy Sensors): The expected vs. actual savings discrepancy was significantly influenced by the operational hours estimated. The ex-ante savings calculation for this custom measure was based on an annual operation hour assumption that far exceeded the range of metered and weighted hours determined through detailed ex-post analysis.

Fourteen prescriptive projects had realization rates lower than 90%.

- Project 134 (Heat Pump). The system was installed at a school undergoing renovation. The project featured a mix of gas heating and electric heat pump heating. A new construction baseline was applied, and site visits documented the installation of heat pumps and makeup air units, with a capacity discrepancy noted between project documentation (54 tons) and application (64 tons). Despite the total cooling capacity of 69 tons and heat pump heating capacity of 54 tons, the actual savings of 30,959 kWh were significantly lower than the anticipated 1,476,374 kWh. Savings calculations were based on effective full load hours for heating and cooling specific to a school in Fort Wayne.
- Project 100 (Engineered Nozzles for Compressed Air). ADM staff conducted a comprehensive review to verify savings, including assessing project documentation, compressor efficiency, and nozzle model data from installation photos, alongside manufacturer specifications. Annual usage for the blowoff operation was supported at 2,000 hours based on interval electric billing data and additional information from the project contact. The project achieved annual energy savings of 66,123 kWh and a peak demand reduction of 12.56 kW, resulting in a gross energy realization rate of 37%. Analysis identified the use of 1/8” diameter Exair 1010SS nozzles, aligning more closely

with ex-post savings per nozzle than the initially deemed savings for a different nozzle size.

- Projects 114, 117, 124, 125, 126, 129, 132, 133 (LEDs): A prevalent theme across these projects is the significant variance between expected (ex-ante) and actual (ex-post) energy savings, primarily attributed to initial reliance on deemed values for savings estimates. The detailed ex-post analysis, which included project documentation review, specific data collection on lighting and HVAC, and operational schedule estimation through interval electric billing data, often revealed different operational hours and wattages than those assumed.
- Project 105 (LEDs): This project experienced a notable discrepancy due to an error in project documentation, where the ex-ante savings for a specific measure were mistakenly equated to the total project savings, leading to a substantial overestimation. The rectification involved a thorough review of the final lighting survey and site verification against installed quantities, resulting in a realization rate of 28%.
- Projects 101, 107 (Lighting Occupancy Sensors). Both projects encountered discrepancies between expected (ex-ante) and actual (ex-post) energy savings due to the real-world operational dynamics not aligning with initial estimates. For project 101, the savings were lower than anticipated because the manufacturing facility operates around the clock (8,760 hours annually), and continuous motion on the production floor meant that the lights remained almost always on, reducing the effectiveness of occupancy sensors. Similarly, Project 107 found that extended lighting usage, due to three shifts and a weekend crew, resulted in fewer opportunities for energy savings through occupancy sensors than initially estimated.
- Project 118 (LEDs & Daylighting Controls): The discrepancy in expected versus actual energy savings was significantly influenced by an error in the application of deemed values for daylighting controls, despite the absence of daylight in the facility.

Table 2-5 presents the ex post annual gross kWh savings for the Work Prescriptive Program from January 2023 through December 2023.

Table 2-5 Ex Post Annual Gross kWh

Ex Ante Gross kWh Savings	*Gross Audited kWh Savings*	*Gross Verified kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
24,048,482	24,048,482	24,048,482	21,507,616	89%

2.3.2.2. Ex Post Gross kW Reductions

Table 2-6 presents the ex post peak kW reduction for the Work Prescriptive Program from January 2023 through December 2023.

Table 2-6 Ex Post Peak kW Reduction

Ex Ante Gross kW Savings	*Gross Audited kW Savings*	*Gross Verified kW Savings*	*Ex Post Gross kW Savings*	*Gross Realization Rate*
4,019.78	4,019.78	4,019.78	4,274.92	106%

2.4. Estimation of Ex Post Net Savings

The net savings analysis was used to determine what part of the gross energy savings achieved by program participants could be attributed to the effects of the program. The net savings attributed to program participants were the gross savings less free ridership, plus spillover.

2.4.1. Methodology for Estimating Free Ridership

A survey of program participants that asked them about the role of the program in their decision to implement the energy efficiency measures informed the net-to-gross analysis. ADM considered three factors to determine what percentage of savings could be attributable to free ridership. The three factors were:

- Plans and intentions of the firm to install a measure even without support from the program
- Influence that the program had on the decision to install a measure
- A firm's previous experience with a measure installed under the program

For each of these factors, ADM applied rules to develop binary variables indicating whether a participant's behavior showed free ridership. These rules made use of answers to questions on the decision-maker survey questionnaire.

The first factor required determining if a participant's intention was to install an energy efficiency measure even without the program. The answers to a combination of several questions were used with a set of rules to determine whether a participant's behavior indicated likely free ridership. Two binary variables accounted for customer plans and intentions: one, based on a more restrictive set of criteria that may describe a high likelihood of free ridership, and a second, based on a less restrictive set of criteria that may describe a relatively lower likelihood of free ridership.

The first, more restrictive criteria indicating customer plans and intentions that likely signify free ridership were as follows:

- The respondent answered "yes" to the following two questions: "Did you have plans to install the measure before participating in the program?" and "Would you have completed the [MEASURE] project even if you had not participated in the program?"
- The respondent answered "definitely would have installed" to the following question: "If the financial incentive from the [PROGRAM] had not been available, how likely is it that you would have installed [MEASURE] anyway?"

- The respondent answered "did not affect the timing of purchase and installation" to the following question: "How did the availability of information and financial incentives through the [PROGRAM] affect the timing of your purchase and installation of [MEASURE]?"
- The respondent answered "no, the program did not affect the level of efficiency that we chose for equipment" in response to the following question: "Did you purchase and install the [MEASURE] earlier than you otherwise would have without the program?"

The second, less restrictive criteria that indicate customer plans and intentions that likely signify free ridership are as follows:

- The respondent answered "yes" to the following two questions: "Did you have plans to install the [MEASURE] before participating in the program?" and "Would you have completed the [MEASURE] project even if you had not participated in the program?"
- The respondent answered either "definitely would have installed" or "probably would have installed" to the following question: "If the financial incentive from the [PROGRAM] had not been available, how likely is it that you would have installed [MEASURE] anyway?"
- The respondent answered "did not affect the timing of purchase and installation" to the question: "Did you purchase and install the [MEASURE] earlier than you otherwise would have without the program?" or the respondent indicated that while program information and financial incentives did affect the timing of equipment purchase and installation, in the absence of the program they would have purchased and installed the equipment within the next two years.
- The respondent answered "no, the program did not affect the level of efficiency that we chose for equipment" in response to the following question: "Did you choose equipment that was more energy-efficient than you would have chosen because of the program?"

The second factor requires determining if a customer reports that a recommendation from a Program representative or experience with the program was influential in the decision to install a particular piece of equipment or measure. The criterion indicating that program influence may signify a lower likelihood of free ridership is that either of the following conditions is true:

- The respondent answered "very important" to the following question: "How important was previous experience with the [Program Name] in making your decision to install [Equipment/Measure]?"
- The respondent answered "yes" to the following question: "Did a representative of the [Program Name] recommend that you install [Equipment/Measure]?"

The third factor requires determining if a participant in the program indicates that he or she had previously installed an energy efficiency measure like the one that they installed under the program without an energy efficiency program incentive during the last three years. A participant indicating that he or she had installed a similar measure is considered to have a likelihood of free ridership. The criteria indicating that previous experience may signify a higher likelihood of free ridership are as follows:

- The respondent answered "yes" to the following question: "Before participating in the [Program Name], had you installed any equipment or measure similar to [Rebated Equipment/Measure] at your facility?"
- The respondent answered "yes, purchased energy-efficient equipment but did not apply for a financial incentive" to the following question: "Has your organization purchased any energy-efficient equipment in the last three years for which you did not apply for a financial incentive through the [Program Name]?"

The four sets of rules just described are used to construct four different indicator variables that address free ridership behavior. For each customer, a free ridership value is assigned based on the combination of variables. With the four indicator variables, there are 12 applicable combinations for assigning free ridership scores for each respondent, depending on the combination of answers to the questions creating the indicator variables. Table 2-7 shows these values.

Table 2-7 Free Ridership Scoring

Indicator Variables				*Free Ridership Score*
Had Plans and Intentions to Install Measure without the Program? (Definition 1)	*Had Plans and Intentions to Install Measure without the Program? (Definition 2)*	*The Program had influence on Decision to Install Measure?*	*Had Previous Experience with Measure?*	
Y	Y	Y	Y	100%
Y	Y	N	Y	100%
Y	Y	N	N	100%
Y	Y	Y	N	67%
N	Y	N	Y	67%
N	Y	Y	Y	33%
N	Y	N	N	33%
N	N	N	Y	33%
N	Y	Y	N	0%
N	N	Y	Y	0%
N	N	Y	N	0%
N	N	N	N	0%

The free ridership assessment also included questions on the participants' financial ability to pay for the measures. These questions were used to assess the consistency of the responses to the questions used to score free ridership.

Responses are considered inconsistent if the respondent indicates that they were not financially able to install the equipment, but state that they have plans to install the equipment and would have installed it without the program incentive. There were no cases where respondents reported this and that they could not have afforded the measure without program support.

2.4.1.1. Methodology for Estimating Spillover

Program participants could implement additional energy saving measures without receiving a program incentive because they participated in the program. The energy savings resulting from these additional measures constitute program participant spillover effects.

To assess participant spillover savings, survey respondents are asked whether or not they implemented any additional energy saving measures for which they did not receive a program incentive. Respondents are also asked to provide information on the measures implemented for use in estimating the associated energy savings.

To determine if the savings from the reported measures were attributable to the program, survey respondents were asked questions about the degree to which their experience with the program influenced them to implement the measures and the likelihood of implementing the measures in the absence of the program. Specifically, respondents were asked the following questions:

- SO1: How important was your experience with the [PROGRAM_NAME] in your decision to install this lighting equipment?
- SO2: If you had NOT participated in the [PROGRAM_NAME], how likely is it that your organization would still have installed this lighting equipment?

ADM calculated the spillover score using Equation 2-1.

Equation 2-1

$$Spillover = Average(SO1, 10 - SO2)$$

Savings from measures associated with a spillover score greater than 7 were considered attributable to the program.

All survey response data were systematically reviewed by a researcher who was familiar with the portfolio. As part of this review, the researcher could determine whether the available information justifies modifying the spillover score calculated in accordance with the algorithm outlined below. The spillover score calculated in accordance with the algorithm outlined above could be revised in instances in which there were significant apparent inconsistencies between responses provided by the decision maker or in cases in which the responses were apparently invalidated by other information regarding the measure(s). Additionally, responses may be dropped in cases where respondents do not report sufficient information to estimate the savings associated with the measure implemented.

2.4.2. Results of Ex Post Net Savings Estimation

Table 2-8 summarizes the net ex post kWh savings and the net ex post kW demand reduction of the Work Prescriptive Program.

Table 2-8 Ex Post Net kWh and kW Savings

Category	*kWh*	*kW*
Ex Ante Gross Savings	24,048,482	4,019.78
Gross Audited Savings	24,048,482	4,019.78
Gross Verified Savings	24,048,482	4,019.78
Ex Post Gross Savings	21,507,616	4,274.92
Gross Realization Rate	89%	106%
Ex Post Free Ridership	2,498,192	566.75
Ex Post Non-Participant Spillover	-	-
Ex Post Participant Spillover	-	-
Ex Post Net Savings	19,009,424	3,708.17
Net-to-Gross Ratio	88%	87%
Ex Post Net Lifetime Savings	277,435,792	N/A

2.5. Process Evaluation

ADM completed a process evaluation of the PY2023 program. The following research activities informed the process evaluation.

- Interviews and discussions with program staff.
- Review of program documents and tracking data.
- A survey of program participants.

2.5.1. Process Evaluation Findings

ADM interviewed program staff and completed a survey of program participants. The interviews with program staff provided information on how the program was implemented in 2023, changes made since 2022, and key successes and challenges. Surveys provided feedback from customers on their perspective of program processes.

2.5.1.1. Program Operations

2.5.1.1.1. Roles and Responsibilities

ADM interviewed the I&M program manager who oversees the energy efficiency portfolios who began directly overseeing the C&I programs in the summer of PY2023. ADM also interviewed three CLEAResult implementation staff who primarily focused on facilitating outreach efforts, coordinating leads, and ensuring follow-ups.

2.5.1.1.2. Outreach and Marketing

The C&I program outreach has strategically prioritized top account engagement over the past year, focusing on major users in the state for PY2023. Efforts include gaining insights into planned capital projects spanning 2023 through 2025. Outreach also encompassed trade ally development, involving reengagement with existing allies and reaching out to new ones. Building networks with architects, engineering firms, capital investment groups, and industry-focused chapters are part of the comprehensive strategy. Collaborations with sustainability offices and economic development offices at both local and statewide levels further demonstrate multifaceted engagement efforts.

Outreach activities for the C&I programs have evolved over the past year, with a reduced focus on traditional events like trade shows and other public venues. Instead, outreach now primarily occurs through tabled events, often in collaboration with local Chamber of Commerce events or small business gatherings. CLEAResult specialists also conduct direct customer visits, working closely with internal staff, such as Key Account Managers and Customer Service Account Managers.

The specialists are refining their engagement strategies by utilizing tools like SEM and the Industrial Systems program to offer advanced services, including access to engineering support and facility assessments, particularly for major users. An achievement of the outreach specialists was re-engaging a commercial customer who had previously withdrawn from energy efficiency programs. Despite initially being ineligible for rebates in August due to their past decision to opt-out, the concerted efforts of the key account manager and CLEAResult enabled the customer to reconsider. Following a formal request to rejoin the C&I programs, the customer embarked on a project incorporating both custom and prescriptive energy-saving measures, scheduled to start this year and conclude in 2024.

In 2023, marketing strategies featured newsletters with HVAC updates and limited-time bonuses. Project-specific case studies created fact sheets for motel weather stripping, engineered nozzles, and compressed air leak studies and repairs. The C&I programs distributed two monthly newsletters—one internally for customers and the other by CLEAResult, targeting trade allies. Efforts were made to notify customers and trade allies about program-related information, such as increased incentive caps in Indiana, through coordinated updates between I&M and CLEAResult for timely releases and website updates.

Promotions and incentives in Indiana were a significant part of marketing efforts, with newsletters serving as a platform. The compressed air bonus, offering a 20% bonus on projects, aimed to encourage trade allies due to potential savings. The program directly engaged trade allies involved in these measures to convey information about promotions, particularly focusing on the successful compressed air campaign, which significantly increased program participation in energy-saving projects. To align with program changes, updates were made to applications, especially for prescriptive measures. Updated applications detail measures and associated rebates for clarity. Issues with custom measures are handled case by case, addressing recurring problems by not authorizing rebates but considering exception requests for genuine confusion. The manager underscores the availability of information on their website and the responsiveness of CLEAResult staff to participant inquiries.

Overall, outreach changes and tactics appear to be increasing program participation. Table 2-9 summarizes PY2022 and PY2023 participation and shows that program participation has increased.

Table 2-9 PY2022 and PY2023 Participation

Program	*Number of Projects*		*Ex Ante Savings*	
	PY2022	*PY2023*	*PY2022*	*PY2023*
Work Custom	153	258	17,595,760	46,641,686
Work Prescriptive	275	355	16,403,055	24,048,482
Work Direct Install	na	9	na	138,952

2.5.1.1.3. Program Changes to Measures and Incentives

Changes in PY2023 were geared towards streamlining offerings, simplifying engagement for both customers and contractors participating in the programs. I&M and CLEAResult discussed the various changes made to the C&I programs in PY2023. In October, incentive caps were increased to $250,000 per site or $500,000 per customer in response to larger incentive budgets. Additionally, earlier in the year, recommendations were implemented to transition some Custom measures to Prescriptive measures, streamlining available options and enhancing practicality. Furthermore, there has been a concerted effort to enhance the prescriptive program by incorporating injection molding, Variable Frequency Drive (VFD), and compressed air incentives into it.

2.5.1.1.4. Energy Efficiency Savings Program (EESP) with Allumia

CLEAResult's partnership with Allumia in Indiana aims to assist customers lacking capital for energy efficiency upgrades. Allumia's unique financing approach involves sharing half of the expected energy bill savings resulting from efficiency upgrades, allowing customers to reduce monthly expenses while covering project costs. Although the program's viability depends on customer size and project nature, with a focus on reasonable payback timelines, no projects have been completed yet.

Outreach for EESP, primarily led by CLEAResult specialists, targets smaller customers, while trade allies have been less proactive, possibly prioritizing their financing options. Despite potential projects, none have reached completion. Collaborative meetings between CLEAResult and Allumia focus on mutual collaboration, with Allumia actively generating leads. Allumia's services act as a rebate aggregator, streamlining processes and enhancing the impact of services for customers and trade allies in Indiana.

2.5.1.1.5. Contractor Outreach and Awareness

In Indiana, contractors for the programs are recruited through various channels, including customer inquiries, local market outreach specialists, and leads from new construction projects. Emphasis is on engaging local trade organizations and companies in neighboring utility areas. Ongoing initiatives continue to recruit more trade allies, with a steady monthly increase. Compressed air trade allies remain a focal point, with recent sales team training for new companies. Compressed air trade allies were incentivized with a 20% bonus to encourage participation.

Significant increases in energy-saving goals were noted, necessitating the engagement of new trade allies. The recruitment focus extends beyond compressed air, with plans to emphasize areas like

HVAC and heat pump technologies in the coming year. While specific plans were not detailed, there's an intention to expand recruitment into various specialized areas, such as weather stripping for refrigeration facilities and motels.

Additionally, future outreach plans include exploring opportunities in emerging technologies, exemplified by the recent enrollment of a company specializing in process automation system (PAS) overlay technology using machine learning and AI.

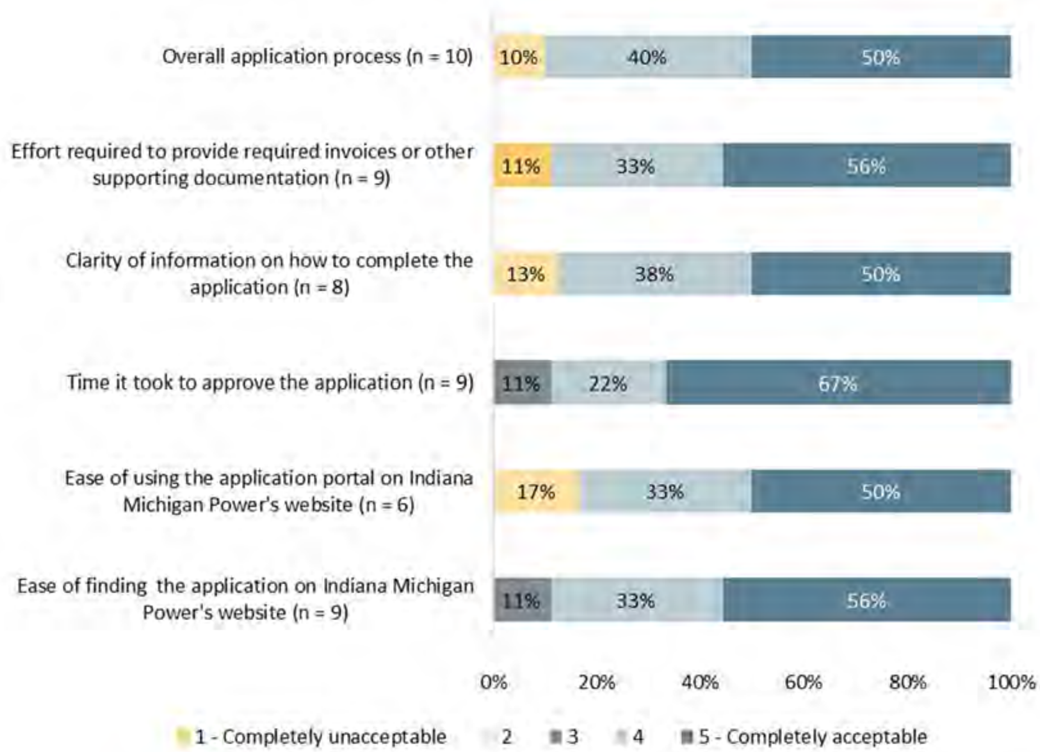
2.5.1.1.6. Successes and Challenges in 2023

Program staff attributed their success in 2023 to the effective focus on the industrial segment, particularly in compressed air efficiency measures. The I&M program manager credits a substantial portion of their success to CLEAResult's effective team and fieldwork.

2.5.1.2. Participant Survey Findings

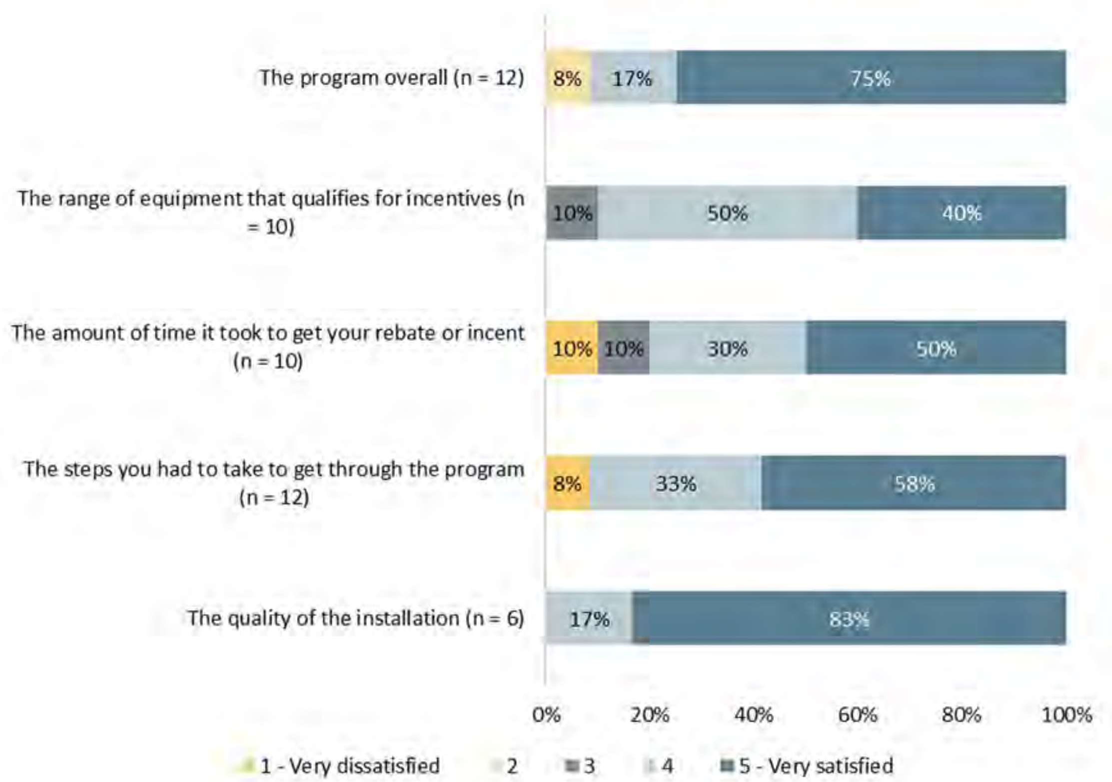
Respondents found the application process to be acceptable. Most respondents reported that the application process was somewhat or completely acceptable, while some aspects of the application process were rated as unacceptable by one of the respondents (see Figure 2-1). The dissatisfied respondent expressed dissatisfaction with the lengthy and inconsistent application process, citing delays despite prior experience with the same application. All but one respondent reported that they had a clear sense of who to go through for assistance with the application.

Figure 2-1 Acceptability of the Application Process



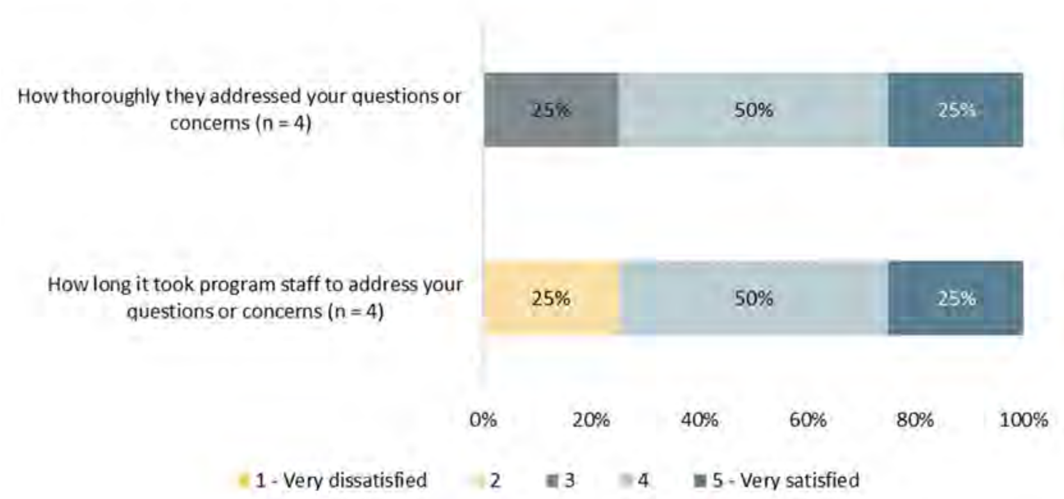
Most participants (92%) were satisfied with the program overall. One respondent did indicate that they were dissatisfied with the program overall, the steps involved with the program, and the time it took to get the rebate (see Figure 2-2). The dissatisfaction with the program stemmed from unacceptable timing compared to past experiences, and detailed data requirements. Respondents provided feedback about what they could change about the program. A few respondents suggested additional training, while many indicated they would not change anything. All respondents were satisfied with I&M as their electricity service provider.

Figure 2-2 Program Satisfaction



Among survey respondents who interacted with program staff, 75% expressed satisfaction with the promptness and thoroughness of the staff's responses to their questions (see Figure 2-3).

Figure 2-3 Timeliness and Thoroughness of Program Staff's Ability to Answer Questions



2.6. Findings and Recommendations

Based on the results of the analysis, ADM identified the following key conclusions and recommendations I&M could consider as they implement their efficiency programs for commercial and industrial customers.

Overall, outreach changes and tactics appear to be increasing program participation. The level of program participation increased from PY2022 and PY2023.

Participants reported a positive experience with the program. Most participants (92%) were satisfied with the program overall and all respondents reported that the application process was somewhat or completely acceptable.

The analysis of deemed savings per unit for prescriptive HVAC measures, particularly for heat pump capacities of 65 KBTUh, reveals an overestimation issue. In the transition from the "2021-2022 IN MI Approved CI Pgm Targets Measures" workbook to the "2023 Indiana Pres Measure Workbook," the units for calculating savings shifted from per unit to per ton. This change causes a significant overestimation of energy savings, exemplified by a 20-ton heat pump, where savings are overestimated by a factor of 20 due to this unit conversion. Additionally, there's an inconsistency in expressing heating efficiency, with some models using a COP (coefficient of performance) value instead of an HSPF value, not accounting for the conversion factor of 3.412 x COP to align with kWh..

- **Recommendation 1:** To address reoccurrences of lower than expected savings for heat pumps of 5-ton capacity and above, it is recommended that: The deemed savings values for the 5-ton, 10-ton and 20-ton models be reset to per ton values, to align with the application units of tons. Also, to review the models that informed the deemed savings, to standardize the usage of HSPF (or COP x 3.412) instead of just the COP value.

While low-flow air nozzles offer significant potential for energy savings, there's a risk of overestimating these savings if actual usage hours are not accurately estimated.

- **Recommendation 2:** To ensure accurate estimation of energy savings, it is crucial to collect detailed attribute data related to the air blow-off operation. This includes the type of operation, duration of use per cycle, and the number of cycles per day, among other relevant parameters.

3. Work Custom

This chapter presents the results of both the impact and process evaluations of the Work Custom Program that Indiana Michigan Power (I&M) offered to its non-residential customers from January 2023 through December 2023.

The objectives of the evaluation are to:

- Complete project pre-approval reviews;
- Assess gross and net energy (kWh) savings and peak demand (kW) reductions resulting from participation in the program during the program year;
- Complete a limited process evaluation of the program; and
- Provide recommendations for program improvement as appropriate.

3.1. Program Description

The Work Custom Program targets commercial and industrial accounts and provides incentives to implement efficiency measures not covered by the prescriptive program. The program provides an incentive of $0.05 per kWh saved for lighting measures, and $0.06 per kWh saved for non-lighting measures. The program measures include non-prescriptive lighting and HVAC, and refrigeration measures, compressed air measures, industrial process improvements, and retro-commissioning.

3.2. Data Collection

3.2.1. Verification of Measures

3.2.1.1. Sampling Plan

The sampling approach was combined for all C&I programs in 2023. The approach is described in Section 2.2.1.1 of this document on page 7.

The table below shows the number of projects, ex ante gross kWh energy savings, and sampling statistics, by stratum, of the program sample.

Table 3-1 Population Statistics Used for Work Custom Sample Design

Variable	*Stratum 1*	*Stratum 2*	*Stratum 3*	*Stratum 4*	*Stratum 5*	*Totals*
Strata boundaries (kWh)	> 1500000	600000 - 1500000	200000 - 600000	80000 - 200000	< 80000	
Number of projects	6	8	38	59	160	271
Total Ex Ante Annual kWh	14,235,233	7,244,359	12,520,324	7,900,115	4,741,655	46,641,686
Average kWh Savings	2,372,539	905,545	329,482	133,900	29,635	3,771,101
Std. dev. of kWh savings	882,670	268,623	103,522	38,716	20,657	1,314,188
Coefficient of variation	0.37	0.3	0.31	0.29	0.7	
Final design sample	6	3	7	3	4	23

3.2.1.2. Verification Data Collection Procedure

The data collection procedure for the Work Custom Program was the same as the approach described in Section 2.2 of this document on page 8.

3.2.2. Participant Survey

The survey data collection for the Work Custom Program is described in Section 2.5.1.2 of this document on page 23.

3.2.3. Staff Interviews

The staff interviews completed for the Work Custom Program is described in Section 2.5.1.1 of this document on page 20.

3.3. Estimation of Ex Post Gross Savings

3.3.1. Methodology for Estimating Ex Post Gross Savings

3.3.1.1. Review of Documentation

The process for reviewing program documentation for the Work Custom Program was the same as the approach described in Section 2.3.1.1 of this document on page 10.

3.3.1.2. Procedures for Estimating Measure-Level Gross Energy Savings

A breakdown of sampled measures for the Work Custom Program is below in Table 3-2.

Table 3-2 Breakdown of Sampled Custom Measures

Measure Category	*Ex Ante Annual kWh Savings*	*Ex Post Annual Gross kWh Savings*	*Gross Realization Rate*
Building Envelope	64,257	64,257	100%
Compressed Air Leak Repair	4,314,950	4,314,931	100%
HVAC Upgrade	205,527	150,234	73%
LED Other	9,411,009	9,366,725	100%
New Construction Lighting	4,565,757	5,443,111	119%
VSD Upgrade	1,892,294	1,892,294	100%
Total	20,453,794	21,231,552	104%

ADM calculated a kWh energy savings gross realization rate and a peak kW reduction gross realization rate for each site in the M&V sample. Sites with relatively high or low gross realization rates were analyzed to determine the reasons for the discrepancy between ex ante and ex post energy savings. The site-level gross impact analysis results for each M&V sample site are presented in Volume II of the report. These reports outline the data sources and analytical approaches employed in the calculation of measure impacts.

3.3.2. Results of Ex Post Gross Savings Estimation

The kWh gross realization rate is the ratio of sampled measure ex post gross kWh energy savings to sampled measure ex ante kWh energy savings. The kW gross realization rate is the ratio of sampled measure ex post gross kW demand savings to sampled measure ex ante kW demand savings. Since a stratified sampling approach was employed for this program, stratum-level kWh and kW gross realization rates were developed for each sampling stratum.

Program-level gross ex post gross kWh energy savings are calculated as follows:

- The ex-ante kWh energy savings of non-sampled measures are factored by the applicable stratum-level kWh gross realization rates to calculate ex post gross kWh energy savings for non-sampled measures.
- The ex post gross kWh energy savings of all sampled measures and all non-sampled measures are summed.

Program-level gross ex post gross kW demand savings are calculated as follows:

- The ex-ante kW demand savings of non-sampled measures are factored by the applicable stratum-level kW gross realization rates to calculate ex post gross kW savings for non-sampled measures.
- The ex post gross kW demand savings of all sampled measures and all non-sampled measures are summed.

3.3.2.1. Ex Post Gross kWh Savings

Table 3-3 displays the ex ante and ex post gross kWh savings of the Work Custom Program including gross realization rates for sampled projects.

Table 3-3 Work Custom Project-Level Ex Ante and Ex Post kWh Savings

Stratum	*Project Number*	*Measure*	*Ex Ante kWh Savings*	*Gross Ex Post kWh Savings*	*Project Gross Realization Rate*
1	200	New Construction Lighting	4,116,078	4,734,299	115%
1	201	LED Other	2,313,707	2,279,931	99%
1	202	Compressed air leak repair	2,141,733	2,141,508	100%
1	203	LED Other	2,102,772	1,986,581	94%
1	204	VSD Upgrade	1,892,294	1,892,294	100%
1	205	LED Other	1,668,649	1,632,384	98%
2	206	LED Other	1,427,283	1,820,969	128%
2	207	LED Other	1,179,743	915,783	78%
2	208	Compressed air leak repair	675,323	672,841	100%
3	210	New Construction Lighting	449,679	708,812	158%
3	211	Compressed air leak repair	296,444	296,444	100%
3	212	Compressed air leak repair	289,246	289,246	100%
3	213	Process improvement	205,527	150,234	73%
3	221	Compressed air leak repair	479,088	544,812	114%
3	222	Compressed air leak repair	257,055	190,737	74%
3	299	LED Other	500,893	500,907	100%
4	214	Compressed air leak repair	92,796	96,078	104%
4	215	LED Other	88,745	89,083	100%
4	216	Compressed air leak repair	83,266	83,266	100%
5	217	Weatherstripping	64,257	64,257	100%
5	218	LED Other	59,689	59,797	100%
5	219	LED Other	41,391	52,808	128%
5	220	LED Other	28,138	28,482	101%
All Non-Sample Projects			26,187,892	27,548,659	105%
Total			46,641,686	48,780,211	105%

Five of the 23 sampled prescriptive projects had a realization rate that was higher than 110%. The factors that resulted in the realization rates were idiosyncratic to the project and are summarized below.

- Project 221 (Compressed Air Leak Repair): The project had a higher realization rate for compressed air leak repair. This is related to the ex ante calculations using a control type that did not match the actual system. The initial model likely assumed a VSD control, which has a different power usage profile at zero flow compared to the actual Variable Displacement control observed. Variable Displacement controls, as indicated by the site pictures and CAGI sheets, have a zero-flow power significantly higher than zero, which was not accounted for in the ex-ante model.

- Projects 206, 219 (LED Lighting): The variance between anticipated and actual energy savings stemmed from two main factors: higher-than-expected lighting usage, as determined by on-site metering over a month showing extended hours of operation due to a three-shift schedule and a weekend crew, and lower-than-expected savings from occupancy sensors, attributed to the prolonged use of lighting which limited the potential for occupancy-controlled reductions.
- Project 200 (New Construction LED Lighting): The actual energy savings took into account varying hours of operation (3,000 to 8,760 hours) identified during site visits, compared to the uniform 4,500 hours assumed in the ex ante estimate.
- Project 210 (New Construction LED Lighting): A realization rate of 158% was observed, primarily due to actual hours of operation (4,888 hours) exceeding initial estimates (3,110 hours), and the actual efficient wattage (212W) being lower than initially estimated (214W).

Three of the 23 samples site had realization rate lower than 90%.

- Project 222 (Compressed Air Leak Repair): The discrepancy between anticipated (ex-ante) and actual (ex-post) savings primarily stemmed from an overestimation of the facility's operating hours. Initially assuming a 24/6 schedule, actual data revealed significant load reductions between shifts and on some weekends, leading to a revised estimate of 6,500 annual operating hours, down from the ex-ante estimate of 7,352 hours.
- Project 213 (Process Improvement): The actual energy savings of 150,234 kWh resulted in a realization rate of 73%. Discrepancies arose from differing methods of calculating savings, with one based on erroneous production data and the other on accurate hourly usage data. The peak demand savings were also adjusted due to a revised coincidence factor (CF), resulting in a decrease from the anticipated savings.
- Project 207 (LED Lighting): Initial savings estimates were based on an overestimated operation hour of 7,488, exceeding the actual metered and weighted hours range observed. Site visits and temporary metering adjusted the estimate to reflect actual usage patterns, including a near 24/7 operation during the harvest period, leading to a revised energy savings analysis based on weighted hours.

Table 3-4 Ex Post Annual Gross kWh

Ex Ante Gross kWh Savings	*Gross Audited kWh Savings*	*Gross Verified kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
46,641,686	46,641,686	46,641,686	48,780,211	105%

3.3.2.2. *Ex Post Gross kW Reductions*

Table 3-5 presents the ex post peak kW reduction for the Work Custom Program during the period January 2023 through December 2023.

Table 3-5 Ex Post Peak kW

Ex Ante Gross kW Savings	*Gross Audited kW Savings*	*Gross Verified kW Savings*	*Ex Post Gross kW Savings*	*Gross Realization Rate*
7,077.14	7,077.14	7,077.14	6,996.76	99%

3.4. Estimation of Ex Post Net Savings

3.4.1. Methodology for Estimating Ex Post Net Savings

The procedure for the estimation of net program-level kWh energy savings and program-level kW demand reductions was the same as the approach described in Section 2.4 of this document on page 16.

3.4.2. Results of Ex Post Net Savings Estimation

Table 3-6 summarizes the net ex post kWh savings and the net ex post kW demand reduction of the Work Custom Program.

Table 3-6 Ex Post Net kWh and kW Savings

Category	*kWh*	*kW*
Ex Ante Gross Savings	46,641,686	7,077.14
Gross Audited Savings	46,641,686	7,077.14
Gross Verified Savings	46,641,686	7,077.14
Ex Post Gross Savings	48,780,211	6,996.76
Gross Realization Rate	105%	99%
Ex Post Free Ridership	7,342,778	1,205.63
Ex Post Non-Participant Spillover	-	-
Ex Post Participant Spillover	-	-
Ex Post Net Savings	41,437,433	5,791.13
Net-to-Gross Ratio	85%	83%
Ex Post Net Lifetime Savings	421,270,398	N/A

3.5. Process Evaluation

Methods and findings related to the process evaluation of the Work Custom Program are presented in the Work Prescriptive Chapter in Section 2.5 on page 2020.

3.6. Findings and Recommendations

Applicable conclusions and recommendations are presented in Section 2.625.

4. Work Direct Install

This chapter presents the results of both the impact and process evaluations of the Work Direct Install Program that Indiana Michigan Power (I&M) offered to its non-residential customers during the period of January 2023 through December 2023.

The objectives of the evaluation were to:

- Assess gross and net energy (kWh) savings and peak demand (kW) reductions resulting from participation in the program during the program year;
- Document and assess quality assurance and control procedures;
- Complete a process evaluation of the program; and
- Provide recommendations for program improvement as appropriate.

4.1. Program Description

The Work Direct Install Program targets energy efficiency improvements in small commercial/retail establishments, food service facilities and grocery store/supermarkets with demand of less than 150 kW by providing onsite energy assessments and incentives for energy efficient lighting and refrigeration equipment. The program measures are installed by a program qualified trade ally.

Work Direct Install incentives are provided on a per unit of equipment basis and focus on lighting and refrigeration measures.

Incentives are capped at $3,000 per site and $21,000 per company, across all programs.

4.2. Data Collection

4.2.1. Verification of Measures

4.2.1.1. Sampling Plan

ADM selected a sample of all 2023 projects for which ADM performed measurement and verification (M&V) and calculated gross realized kWh savings and kW demand reductions.

ADM used a stratified sampling approach to develop the M&V sample. A stratified sampling approach allowed for a given statistical precision and confidence level target to be met with a smaller sample size than would have been allowed by simple random sampling. Strata boundaries were based on ex ante kWh energy savings. ADM selected a sample with enough sample units to facilitate estimation of program ex post kWh energy savings with 10% statistical precision at a 90% confidence level.

Completed program projects accumulated over the course of the program year, and sample selection occurred at multiple points in time. The timing of sample selection was contingent upon the timing of the completion of projects during the program year.

The table below shows the number of projects, ex ante gross kWh energy savings, and sampling statistics, by stratum, of the program sample.

Table 4-1 Population Statistics Used for Work Direct Install Sample Design

Variable	*Stratum 1*	*Stratum 2*	*Totals*
Strata boundaries (kWh)	> 15000	< 15000	
Number of projects	3	3	6
Total Ex Ante Annual kWh	89,750	49,202	138,952
Average kWh Savings	29,917	8,200	38,117
Std. dev. of kWh savings	3,688	2,937	6,624
Coefficient of variation	0.12	0.36	
Final design sample	3	3	6

4.2.1.2. Verification Data Collection Procedures

The data collection procedure for the Work Direct Install Program was the same as the approach described in Section 2.2 of this document on page 8.

4.2.2. Participant Survey

ADM administered a survey to Work Direct Install participants to collect data for use in estimating net savings and obtaining feedback about participants' experience with the program. Table 2-2 summarizes the survey data collection efforts. To increase the response rate, ADM engaged participants through both email and telephone communications. A concise version of the survey, focusing exclusively on questions related to free ridership, was administered to facilitate higher participation.

Table 4-2 Summary of Work Direct Install Data Collection

Survey	*Mode*	*Time Frame*	*Number of Contacts*	*Number of Completions*
Work Small Business Direct Install Participant Survey	Email and phone follow up	January 2024	9	5

4.3. Estimation of Ex Post Gross Savings

4.3.1. Methodology for Estimating Ex Post Gross Savings

4.3.1.1. Review of Documentation

The process for reviewing program documentation for the Work Direct Install Program was the same as the approach described in Section 2.3.1.1 of this document on page 10.

4.3.1.2. Procedures for Estimating Measure-Level Gross Energy Savings

A breakdown of sampled measures for the Work Direct Install Program is below in Table 4-3.

Table 4-3 Breakdown of Sampled Work Direct Install Measures

Measure Category	*Ex Ante Annual kWh Savings*	*Ex Post Annual Gross kWh Savings*	*Gross Realization Rate*
Exterior LED	21,171	13,108	62%
LED Case Lighting	4,575	631	14%
LED Interior Fixture	80,575	73,067	91%
LED Other	4,310	4,272	99%
Refrigeration Case	645	701	109%
Total	111,275	91,779	82%

ADM calculated a kWh energy savings gross realization rate and a peak kW reduction gross realization rate for each site in the M&V sample. Sites with relatively high or low gross realization rates were analyzed to determine the reasons for the discrepancy between ex ante and ex post energy savings. The site-level gross impact analysis results for each M&V sample site are presented in Volume II of the report. These reports outline the data sources and analytical approaches employed in the calculation of measure impacts.

4.3.2. Results of Ex Post Gross Savings Estimations

The kWh gross realization rate is the ratio of sampled measure ex post gross kWh energy savings to sampled measure ex ante kWh energy savings. The kW gross realization rate is the ratio of sampled measure ex post gross kW demand savings to sampled measure ex ante kW demand savings. Since a stratified sampling approach was employed for this program, stratum-level kWh and kW gross realization rates were developed for each sampling stratum.

Program-level gross ex post gross kWh energy savings are calculated as follows:

- The ex-ante kWh energy savings of non-sampled measures are factored by the applicable stratum-level kWh gross realization rates to calculate ex post gross kWh energy savings for non-sampled measures.
- The ex post gross kWh energy savings of all sampled measures and all non-sampled measures are summed.

Program-level gross ex post gross kW demand savings are calculated as follows:

- The ex-ante kW demand savings of non-sampled measures are factored by the applicable stratum-level kW gross realization rates to calculate ex post gross kW savings for non-sampled measures.
- The ex post gross kW demand savings of all sampled measures and all non-sampled measures are summed.

4.3.2.1. Ex Post Gross kWh Savings

Table 4-4 displays the ex ante and ex post gross kWh savings of the Work Direct Install Program including gross realization rates for sampled projects.

Table 4-4 Work Direct Install Project-Level Ex Ante and Ex Post kWh Savings

Stratum	*Project Number*	*Measure*	*Ex Ante kWh Savings*	*Gross Ex Post kWh Savings*	*Project Gross Realization Rate*
1	300	Exterior LED	33,774	19,933	59%
1	303	LED High Bay	29,549	28,015	95%
1	305	LED Interior Fixture	26,426	25,681	97%
2	301	LED Troffer	2,501	2,803	112%
2	302	Linear LED	10,824	8,502	79%
2	304	Linear LED	8,200	6,845	83%
All Non-Sample Projects			27,677	23,338	84%
Total			138,952	115,117	83%

Four of the six sampled prescriptive projects had a realization rate that was lower than 90% or higher than 110%.

- LED and Linear LED Projects (301, 300, 302, 304): The discrepancies between the expected (ex-ante) and actual (ex-post) energy savings across these projects are primarily due to the initial estimates being based on deemed values, while the ex-post analysis utilized specified methods for verification. Notably, the ex-post analyses revealed variations in operational hours and, for some projects, differences in efficient wattage from the initial estimates. The LED Troffer (301) and Exterior LED (300) projects highlighted specific discrepancies in operational hours for interior and exterior measures, with the Linear LED projects (302, 304) also showing a variance in efficient wattage, impacting the gross energy savings realization rates.

Table 4-5 presents the ex post annual gross kWh savings for the Work Direct Install Program from January 2023 through December 2023.

Table 4-5 Ex Post Annual Gross kWh

Ex Ante Gross kWh Savings	*Gross Audited kWh Savings*	*Gross Verified kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
138,952	138,952	138,952	115,117	83%

4.3.2.2. Ex Post Gross kW Reductions

Table 4-6 presents the ex post peak kW reduction for the Work Direct Install Program from January 2023 through December 2023.

Table 4-6 Ex Post Peak kW Reduction

Ex Ante Gross kW Savings	*Gross Audited kW Savings*	*Gross Verified kW Savings*	*Ex Post Gross kW Savings*	*Gross Realization Rate*
25.59	25.59	25.59	26.16	102%

4.4. Estimation of Ex Post Net Savings

4.4.1. Methodology for Estimating Ex Post Net Savings

The procedure for the estimation of net program-level kWh energy savings and program-level kW demand reductions was the same as the approach described in Section 2.4 of this document on page 16.

4.4.2. Results of Ex Post Net Savings Estimation

Table 3-6 summarizes the net ex post kWh savings and the net ex post kW demand reduction of the Work Direct Install Program.

Table 4-7 Ex Post Net kWh and kW Savings

Category	*kWh*	*kW*
Ex Ante Gross Savings	138,952	25.59
Gross Audited Savings	138,952	25.59
Gross Verified Savings	138,952	25.59
Ex Post Gross Savings	115,117	26.16
Gross Realization Rate	83%	102%
Ex Post Free Ridership	0	-
Ex Post Non-Participant Spillover	0	-
Ex Post Participant Spillover	0	-
Ex Post Net Savings	115,117	26.16
Net-to-Gross Ratio	100%	100%
Ex Post Net Lifetime Savings	1,721,665	N/A

4.5. Process Evaluation

ADM completed a process evaluation of the PY2023 program. The following research activities informed the process evaluation.

- Interviews and discussions with program staff.
- Review of program documents and tracking data.

4.5.1. Process Evaluation Findings

ADM interviewed program staff and completed a survey of program participants. The interviews with program staff provided information on how the program was implemented in 2023, changes made since 2022, and key successes and challenges. The survey of program participants focused on collecting data to support the estimation of net savings and no additional findings are presented for the process evaluation.

4.5.1.1. Program Launch and Operations

The Work Direct Install Program officially launched after the contract was signed with the implementation contractor in May. Although it operated in an abbreviated year, the manager highlighted achieving the first savings of approximately 45,000 kWh from a single project.

The Work Direct Install Program encountered initial challenges due to a misalignment between the measure list and market expectations. Reintroduction involved revising the measure list and reengaging with contractors and the small business market. Challenges in gaining small business participation included financial constraints, economic conditions, and supply chain issues affecting equipment costs. Ongoing efforts to recruit and engage trade allies, particularly in local recruitment, face challenges that may be addressed through increased incentives and adapting to contractor preferences for larger projects. Strategies encompass community-level engagement, creating marketing materials for Chamber of Commerce collaboration, and historically focusing on the retail and restaurant segments.

Several actions were implemented to boost interest and participation in the Work Direct Install Program. These actions encompassed a thorough review of the measure list, active engagement with contractors serving the small business sector, emphasis on recruiting local contractors, development of marketing materials, collaboration with chambers of commerce, and a strategic focus on the retail and restaurant sectors.

4.6. Findings and Recommendations

Based on the results of the analysis, ADM identified the following key conclusions and recommendations I&M could consider as they implement their efficiency programs for commercial and industrial customers.

PY2023 was the first year of the program and saw some initial participation during the latter half of the program year. Although the 138,952 kWh in ex ante savings fell short of the savings goals, the program team's reported engagement with contractors and collaboration with chambers of commerce may help lay the foundation for increased participation in PY2024.

5. Work Midstream

This chapter presents the results of both the impact and process evaluations of the Work Midstream Program that Indiana Michigan Power (I&M) offered to its non-residential customers during the period of January 2023 through December 2023.

The objectives of the evaluation were to:

- Assess gross and net energy (kWh) savings and peak demand (kW) reductions resulting from participation in the program during the program year;
- Document and assess quality assurance and control procedures;
- Complete a process evaluation of the program; and
- Provide recommendations for program improvement as appropriate.

5.1. Program Description

The Work Midstream Program provides rebates to offset a portion of the cost barriers inhibiting the local stocking practices for more efficient HVAC and cooking measures. The prescriptive rebates in this program are pre-determined cash reimbursements for typical energy efficiency measures undertaken by commercial and industrial end use customers.

Measure rebates in this program are designed with the intent to provide a partial offset of the incremental measure cost but serve to offset the cost for distributors to stock the more efficient measures eligible for rebates in this program.

The program may also provide encouragement for distributors through other incentives if they demonstrate through and provide sales data that stocking levels have improved through the use of the distributor's sales team, as applicable and as determined by I&M and its implementation partner for this program.

The Work Midstream Program did not see any participation in PY2023.

6. Work Strategic Energy Management

This chapter presents the results of both the impact and process evaluations of the Work Strategic Energy Management that Indiana Michigan Power (I&M) offered to its non-residential customers during the period of January 2023 through December 2023.

The objectives of the evaluation are to:

- Assess gross and net energy (kWh) savings and peak demand (kW) reductions resulting from participation in the program during the program year;
- Complete a process evaluation of the program; and
- Provide recommendations for program improvement as appropriate.

6.1. Program Description

The Work SEM Program provides a systematic approach to energy management within a commercial or industrial facility and is similar in concept to continual change practices and standards for business quality improvement, safety improvement, etc. SEM viability depends upon participating customer adoption and use of three elements:

1. Demonstrated commitment through policies, goals, and allocation of resources;

2. Demonstrated energy management planning and implementation; and

3. Implementing and using a system for measuring and reporting performance.

Accordingly, the Work SEM Program provides rebates, training, and energy savings identification and verification. Training rebates will provide for Building Operator Certification (BOC) training on a per-participant basis. Behavioral energy savings will be evaluated according to building type for those participating in the training.

SEM will also pay rebates based on a whole building assessment for energy savings, dependent upon the building type.

6.2. Data Collection

6.2.1. Verification of Measures

6.2.1.1. Sampling Plan

ADM performed measurement and verification (M&V) and calculated gross realized kWh savings and kW demand reductions for the single program project implemented during PY2023.

6.2.1.2. Verification Data Collection Procedures

In general, the data collection procedure for the Work SEM was the same as the approach described in Section 2.2 of this document on page 8. ADM used data collected by program implementers on the measures implemented through the program and other site-specific information on product schedules and trends in energy consumption. ADM will request the implementers statistical models used to estimate energy savings.

ADM supplemented data collected by the program with the collection of additional site-specific data on measures implemented, production changes and operating schedules, building automation system trend logs through telephone conversations and email exchanges with the site contact.

6.2.2. Participant Interviews

Interviews were completed with program participants that had implemented energy saving improvements in PY2023 to get their feedback on the process and understand how the program influenced the projects.

Table 6-1 Summary of Work SEM Participant Interviews

Survey	*Mode*	*Time Frame*	*Number of Contacts*	*Number of Completions*
Work Strategic Energy Management Participant Interviews	Telephone	December 2023	2	2

6.3. Estimation of Ex Post Gross Savings

6.3.1. Methodology for Estimating Ex Post Gross Savings

6.3.1.1. Review of Documentation

I&M's program implementation contractor provided documentation for the sampled energy efficiency projects undertaken at customer facilities. ADM's first step in the evaluation effort was to review this documentation and other program materials that were relevant to the evaluation effort.

6.3.1.2. Procedures for Estimating Measure-Level Gross Energy Savings

All sampled measures for the Work Strategic Energy Management Program were characterized as SEM upgrades. The savings were evaluated using an IPMVP Option C: Whole Facility Model approach.

Table 6-2 presents the ex ante and ex post kWh savings for the sampled measure.

Table 6-2 Breakdown of Sampled SEM Upgrades

Measure Category	*Ex Ante Annual kWh Savings*	*Ex Post Annual Gross kWh Savings*	*Gross Realization Rate*
Strategic Energy Management	394,618	394,137	100%

ADM calculated a kWh energy savings gross realization rate and a peak kW reduction gross realization rate for the M&V sample. The site-level gross impact analysis results for the M&V sample site are presented in Volume II of the report.

6.3.2. Results of Ex Post Gross Savings Estimations

The kWh gross realization rate is the ratio of sampled measure ex post gross kWh energy savings to sampled measure ex ante kWh energy savings. The kW gross realization rate is the ratio of sampled measure ex post gross kW demand savings to sampled measure ex ante kW demand savings. Since a stratified sampling approach was employed for this program, stratum-level kWh and kW gross realization rates were developed for each sampling stratum.

Program-level gross ex post gross kWh energy savings are calculated as follows:

- The ex-ante kWh energy savings of non-sampled measures are factored by the applicable stratum-level kWh gross realization rates to calculate ex post gross kWh energy savings for non-sampled measures.
- The ex post gross kWh energy savings of all sampled measures and all non-sampled measures are summed.

Program-level gross ex post gross kW demand savings are calculated as follows:

- The ex-ante kW demand savings of non-sampled measures are factored by the applicable stratum-level kW gross realization rates to calculate ex post gross kW savings for non-sampled measures.
- The ex post gross kW demand savings of all sampled measures and all non-sampled measures are summed.

6.3.2.1. Ex Post Gross kWh Savings

Table 6-3 displays the ex ante and ex post gross kWh savings of the Work SEM Program including gross realization rates for sampled projects.

Table 6-3 Ex Post Annual Gross kWh

Ex Ante Gross kWh Savings	*Gross Audited kWh Savings*	*Gross Verified kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
394,618	394,618	394,618	394,137	100%

6.3.2.2. Ex Post Gross kW Reductions

Table 6-4 presents the ex post peak kW reduction for the Work SEM Program from January 2023 through December 2023.

Table 6-4 Ex Post Peak kW Reduction

Ex Ante Gross kW Savings	*Gross Audited kW Savings*	*Gross Verified kW Savings*	*Ex Post Gross kW Savings*	*Gross Realization Rate*
-	-	-	35.63	N/A

6.4. Estimation of Ex Post Net Savings

6.4.1. Methodology for Estimating Ex Post Net Savings

The net savings analysis was used to determine what part of the gross energy savings achieved by program participants could be attributed to the effects of the program. The net savings attributed to program participants are the gross savings less free ridership, plus spillover.

6.4.1.1. Methodology for Estimating Free Ridership

During the participant interviews, information was gathered to assess the impact of the program on the energy-saving initiatives undertaken by participants. The discussions aimed to explore the program's role in both the discovery and execution of these projects, as well as to determine if any of the improvements had been previously recognized by the organizations involved.

The first respondent stated that their organization had not identified the measures they implemented with any degree of specificity. The respondent stated that the program enabled them to identify the measures or in some cases they were things they were generally aware of but not in a position to address without the support of the program.

For the second respondent, one measure had been previously identified by the organization, but they were not in the process of implementing it and the program support made implementing the measure a priority for the organization.

Given these responses, a net-to-gross ratio of 100% was assigned to the SEM projects.

6.4.2. Results of Ex Post Net Savings Estimation

Table 6-5 summarizes the net ex post kWh savings and the net ex post kW demand reduction of the Work SEM Program.

Table 6-5 Ex Post Net kWh and kW Savings

Category	*kWh*	*kW*
Ex Ante Gross Savings	394,618	-
Gross Audited Savings	394,618	-
Gross Verified Savings	394,618	-
Ex Post Gross Savings	394,137	35.63
Gross Realization Rate	100%	N/A
Ex Post Free Ridership	-	-
Ex Post Non-Participant Spillover	-	-
Ex Post Participant Spillover	-	-
Ex Post Net Savings	394,137	35.63
Net-to-Gross Ratio	100%	100%
Ex Post Net Lifetime Savings	5,912,055	N/A

6.5. Process Evaluation

ADM completed a process evaluation of the PY2023 program. The following research activities informed the process evaluation.

- Interviews and discussions with program staff.
- Review of program and project documentation.
- Interviews with program participants.

The objectives of the process evaluation were to:

- Understand and characterize the SEM program in terms of objectives, intended market, customer recruitment processes, participation process, and processes for assessing and reporting savings estimates.
- Obtain feedback from participants on the program.
- Identify opportunities for program improvement where applicable.

6.5.1. Process Evaluation Findings

6.5.1.1. Program Design and Operations

The Strategic Energy Management (SEM) program aims to facilitate energy efficiency projects in commercial and industrial sectors. Program staff characterize it as a holistic, high-touch, and high-service model that incorporates frequent check-ins and collaborative meetings. To encourage participation, the SEM program offers financial incentives. The incentives of 2 cents per kWh saved are typically awarded to participants at the end of the program year. However, if a higher incentive is available through a custom or prescriptive program for equipment replacements, participants may receive those incentives.

6.5.1.1.1. Program Staffing

I&M's program lead's role is more administrative in nature. The program lead oversees the program but is not involved in outreach, but has responsibilities primarily in managing the program budget and savings goals and providing administrative support for the program.

CLEAResult implements the program and is responsible for customer recruitment, engagement, managing participation, and estimating program savings.

The CLEAResult senior Strategic Energy Management coach, is primarily responsible for direct interactions with SEM participants. She guides them through the entire process of the SEM program. Her role is hands-on and participant-focused, making her a key point of contact for those undergoing the program. The program added a second Strategic Energy Management coach in 2023 to support the program. The SEM director for the eastern region, oversees higher-level tasks including managing contracts and broader strategy and expansion concepts, such as considering the possibility of a multifamily SEM.

The CLEAResult SEM team is further supported by a data team focused on SEM. This team is responsible for building regression energy models, which are used to claim savings. The SEM program also leverages the broader resources of the CLEAResult engineering team. This team, works on custom calculations and incentives, joins on-site visits to identify opportunities which, in the context of the program, are referred to as the opportunity register. The SEM team does not work with any external partners in delivering the SEM program.

6.5.1.1.2. Participant Identification and Recruitment

In the Strategic Energy Management (SEM) program, commitment from the participating business to engage in the energy management process is essential and the roles for participating business staff are segmented into three main groups:

- **The Energy Champion**: This individual is the primary point of contact who interfaces the most with the SEM program. They are responsible for scheduling check-ins and site visits.
- **The Executive Sponsor:** This person is higher up within the participating organization and provides the necessary authority. Their role is to support the Energy Champion in their data requests and facilitate smooth interaction between the organization and the program. They ensure that the program is among the organization's priorities despite other competing interests.
- **The Broader Energy Team**: This group is built and expanded upon throughout the course of the program. The Energy Champion may bring in anyone they feel could assist with different projects, encouraging cross-functional collaboration (like finance, data team members, HR, marketing). This team engages the organization to tackle behavior-based opportunities.

CLEAResult stated that the initial recruitment discussion with prospective businesses primarily involves the Energy Champion and the Executive Sponsor who commit the organization to engage in with SEM program.

Prior participation in incentive programs is considered by the SEM Team when recruiting participants as those participants are useful leads for participation in SEM. These businesses are often already interested in energy savings. Relatedly, the SEM program is especially beneficial for customers who have already implemented energy efficiency measures including the more easily identifiable measures like LED lighting replacements. Through participation, organizations can identify additional energy-saving opportunities.

As for challenges, the main concern for businesses is often the time commitment required. Participation in the program requires a few hours for a site visit, an hour for data collection, monthly half-hour check-ins, and a few workshops. The SEM Team noted that businesses with already high workloads might view this as an additional burden and decide to postpone their participation.

Other specific challenges noted by CLEAResult include issues like staffing shortages or high turnover rates. If the intended Energy Champion has left the organization or is newly recruited, businesses might need time to adjust. Further, some organizations may prioritize other non-SEM projects or production changes, leading them to postpone their participation in the SEM program. The program is flexible to accommodate these participants later when they're ready to engage.

6.5.1.1.3. Cohort Enrollment

The Strategic Energy Management (SEM) program enrolls participants into cohorts on a yearly basis, the size of which depends on the market. For first-year participants, cohort sizes can range from as small as four to as large as 10, with the possibility for participants to move into larger alumni cohorts in subsequent years. For I&M, the program is targeting cohorts of eight (8) businesses.

6.5.1.1.4. Participation Process

In the SEM program, once a customer expresses interest in participating, the key participation steps are as follows:

- **Data collection call and energy scan:** Scheduled within a month of the customer expressing interest, this involves a one-hour discussion providing background on equipment changes, occupancy changes, production details, etc., to help build the most accurate model for the customer's facility.
- **On-site visit:** After the data collection meeting, an on-site visit is organized to build an “opportunity register,” a comprehensive list of every opportunity the SEM team identifies.
- **First check-in:** A couple of weeks after the on-site visit, a review meeting is conducted to discuss the opportunities found and to assist the participant with prioritization based on ease and potential savings.
- **Kickoff discussion:** Around the same time, a kickoff discussion is conducted to establish program goals, identify the energy team, and reinforce the importance of having an energy team.
- **Monthly check-ins:** After the initial onboarding activities, monthly check-ins are conducted to discuss progress on projects, potential roadblocks, and any support required.

- **Workshops:** Towards the end of the year, participants are invited to a variety of workshops such as a modeling workshop (explaining how their energy model works), an engagement workshop (to involve the whole facility in the mission to reduce energy waste), and a celebration workshop (to acknowledge the savings achieved). The workshops ideally involve groups of participants from different organizations to encourage peer-to-peer learning and best practice sharing, although sometimes they may be conducted on a one-to-one basis or in small groups depending on scheduling or other challenges.
- **Alumni kickoff:** Following the end-of-year celebration, there is a kickoff for next year's alumni cohort, reflecting on the achievements of the past year and setting goals for the upcoming year.

CLEAResult noted that the trajectory for customers in the SEM program is variable, with participants often experiencing a significant onboarding process. During this phase, they build their energy teams and establish goals, which sometimes hampers the completion of projects in the first half of their participation year. However, as participants transition into their "alumni" years (any year after the first one, and potentially spanning several years), their energy savings may increase as they apply the foundational knowledge and organizational strategies they've developed.[5]

A significant factor influencing this trajectory noted by CLEAResult is the level of active engagement from the participant. Some participants might face challenges in their first year due to time constraints or organizational issues. These participants may opt for a pause in their participation with the intention to re-engage later.

CLEAResult estimated that around 85-90% of customers choose to continue into their alumni years. These years are less intensive and aim to help participants incorporate sustainable energy savings practices into their organization by providing trainings on additional technical topics are offered to foster continued learning and maintain participant engagement.

6.5.1.1.5. Opportunity Register

CLEAResult characterized the opportunity register in the SEM program as a "living document" that evolves over time. It is used as a tool during almost every check-in meeting. Participants are continually brainstorming and adding new ideas to the list, and while some initiatives may be deemed unfeasible, they're marked with a note for future consideration rather than removed from the list entirely. This allows for a historical record of ideas that were tabled and can be revisited later if circumstances change.

The maintenance of the opportunity register depends on the customer. Some customers take full ownership, updating it frequently and sharing updates with the CLEAResult SEM program team (SEM team). Others require more assistance, with the SEM team helping to update the document during check-in calls and sending the participant the updated version. The SEM team's goal is to

[5] This statement is based on interview participant observation of SEM programs implemented over longer durations in other jurisdictions.

build independence and enthusiasm in the participants for managing the register, but the team provides support where needed.

6.5.1.1.6. Key Elements of the Program

CLEAResult stated that the support provided by the SEM program includes identification of potential projects, operational planning, and engineering support, along with coaching to guide the broader team involved in the execution. In some cases, the focus could be more organization-oriented, encompassing changes in policies and charters. In general, CLEAResult noted that the needs and preferences of the customers can greatly vary, requiring the program to adopt a holistic approach and different customers may need differing levels of support with each of these key elements. The specific areas of focus can differ even for the same customer from one year to the next, suggesting the need for flexible, adaptive support that addresses changing needs over time.

The energy model and opportunity register are two concrete work products that CLEAResult indicated are valued by participants. These resources can serve as a hook for prospective participants because they help customers to see immediate value and also aid them in better understanding their own facilities.

CLEAResult also noted that survey responses from participants have indicated that participants appreciate the insights gained from energy modeling, the support received from coaches, and the chance to connect with peers to share best practices and work through challenges together.

While the SEM program does not directly provide Building Operator Certification (BOC) training at this time, providing BOC is seen as a strategic objective for the program in the future.

6.5.1.1.7. Data Sources and Project Tracking

The Strategic Energy Management (SEM) program relies on various data sources to build energy consumption models and track project progress. CLEAResult indicated that the primary data for these models is 15-minute interval data provided by I&M metering. In instances where different buildings on a campus have separate meters, each building might have its own unique model.

In addition to the utility data, the SEM program also requests occupancy, shutdown, and production data from participants. This participant-specific information aids in creating a more accurate energy consumption model. Participants are not required to submit any billing information as this data is directly obtained from the utility.

Regarding project tracking and energy savings reporting, SEM project savings are recorded officially on I&Ms scorecard at the end of the calendar year. While estimates might be available throughout the year based on the energy models, the final numbers recorded at the year's end are considered the definitive measure of a project's energy savings.

6.5.1.2. Participant Interview Findings

ADM conducted in-depth interviews with two SEM participants in different industries to gather insights into their roles in the program and energy management within their organization. The interviews provided valuable perspectives on energy management within their respective industries. The following section summarizes the findings from those interviews.

Roles and responsibilities

The first interviewed individual is a plant engineer at a coil coating plant that operates in the Indiana territory. The interviewee is primarily dealing with maintaining and improving the energy efficiency of their facility, specializing in the cleaning and painting of steel and aluminum coils. As the plant engineer, they manage the maintenance crew, ensuring timely preventive maintenance and actively work on process improvement to minimize downtime. They also have a role in energy management, having implemented various projects for energy savings.

The second interviewee, serving as the Vice President in an Indiana-based motor products company specializing in injection molding for automotive plastic parts, discussed their active involvement in various facets of the business. Their role includes day-to-day operations on the production floor, quality assurance, scheduling, financial oversight leveraging their accounting background, and human resources management. The interviewee emphasized their commitment to maximizing the company's profitability and overall success.

Awareness

The coil coating company learned about I&M's SEM program through an initial contact with a program representative, who proposed installing air nozzles to reduce energy consumption. This led to further discussions, including projects unrelated to the SEM program. The engagement expanded when working on a VFD project, connecting with other individuals from I&M. The company's involvement with the SEM service was described through an I&M letter, emphasizing the partnership dynamic where efforts from both sides contribute to energy efficiency. The company did not prioritize energy efficiency before joining the program, lacking a dedicated energy team, and being relatively short-staffed. The SEM service was described through forms and flyers, highlighting the collaborative nature and the flexibility for the company to dissolve the partnership if needed.

The automotive injection molding company did note recall the specific initiation of their involvement in I&M's SEM program but believed it might have been through a program representative who approached them. Their interest in the program stemmed from a past opportunity under previous ownership. Before participating in SEM, the company perceived issues with their electric bill and considered energy efficiency to be a significant, albeit not the top, priority. They had made efforts to reduce electricity usage before joining SEM. Regarding previous participation in other I&M programs, the company mentioned changing lighting but was unsure if it coincided with any specific program. The SEM service was described to them as providing low or no-cost ideas for energy efficiency, with a focus on specialized recommendations and rebates to recoup costs.

Energy Consumption Reduction Goals

The coil coating company currently lacks formal goals related to reducing energy consumption. The benefits of saving energy were recognized by the interviewed SEM participant, particularly in installing VFDs to enable soft starts, reduce equipment strain, and prolong equipment life. The respondent highlights additional advantages such as improved morale, enhanced productivity, and reduced errors through initiatives like lighting projects that positively impact the working environment. The respondent was drawn to participate in the SEM program by the willingness of the program to dedicate time and efforts to assist without any cost.

The automotive injection molding company has set formal goals related to reducing energy consumption, specifically targeting metrics like production hours per kWh, aiming to spend less while maintaining production levels. Lowering the cost of electricity was a key objective for the company in 2023. The decision to participate in I&M's SEM option was driven by the perceived low-cost opportunity it offered to improve energy usage and overall efficiency.

Program Influence

The coil coating company implemented several energy-saving changes in the past year, including installing VFDs on finish oven blowers, replacing air solenoid valves, and addressing air leaks. The SEM program positively contributed to the identification and implementation of these changes, especially in the context of the VFD project. The program's initial plant visit and ongoing support were deemed helpful, and there were no activities or support considered unhelpful. Some changes were identified by the organization before engaging with the program, particularly the VFDs and addressing air leaks, but the partnership with SEM elevated the priority of these initiatives. The organization did not decline any recommended changes at the time of the interview.

The automotive injection molding company made energy-saving changes in 2023 through the SEM program. An air leak check was conducted by a company in the spring, fixing 75% of the identified leaks, with the remaining addressed internally. Additionally, a barrel wrap was applied to one of the large presses. The SEM program significantly contributed to identifying and addressing air leaks, and while the company had some prior awareness of barrel wraps, the program encouraged their implementation. Ongoing support from the program involves data analysis based on production hours, shifts, and material consumption to identify areas for energy efficiency improvement. Challenges include providing the right data promptly. Some suggestions, like shutting down grinders, were deemed impractical due to operational constraints. Resistance to spending money on recommended changes poses a challenge, impacting the SEM program's effectiveness. The company did not anticipate ownership resistance to spending before deciding to participate in the program, but despite financial constraints, the company identified some energy-saving opportunities.

Program Experience

The experience of the coil coating company with CLEAResult I&M has been positive and valued tools provided for tracking energy consumption before and after upgrades, like data loggers for VFD installations. The respondent thought that while the cohort sessions initially seemed slow, they improved over time and helped foster understanding and collaboration. The onsite visit provided a comprehensive facility tour and helpful discussions. This respondent thought that participation has exceeded their expectations in terms of energy savings. There have been no drawbacks or complications observed from participating in SEM. The respondent also did not think there were are any barriers preventing or delaying energy-saving actions identified through the SEM program. The respondent suggests that potential reluctance from companies could stem from concerns about intellectual property, even with non-disclosure agreements in place. To encourage more companies to try SEM, the respondent recommends direct outreach by I&M. Effective messaging for convincing other customers could involve sharing general statements about average savings achieved without divulging specific company names, making it more appealing and relatable to potential participants.

The automotive injection molding company also relayed a positive experience working with the program. The team's effort and positivity, particularly during on-site sessions, were valued and the company appreciated the suggestions made. Additionally, the data-centric approach has facilitated productive conversations. The company has not identified any specific drawbacks or complications related to their participation in SEM.

Program Satisfaction

The coil coating company expressed appreciation for the program's personnel, noting their helpfulness in addition to the evident savings for the company. This respondent thought that the I&M SEM program offers better support and more answers to questions compared to other programs they have participated in. There were no specific suggestions for improvement offered by this customer in terms of the SEM program.

The automotive injection molding company was generally satisfied with the SEM program, but had some concerns about the costs to the company to fund the energy efficiency programs. They expressed a misunderstanding about the rider, expecting a reimbursement structure tied to actual energy savings rather than an automatic charge irrespective of savings.

6.6. Findings and Recommendations

Based on the results of the analysis, ADM identified the following key conclusions and recommendations I&M could consider as they implement their efficiency programs for commercial and industrial customers.

The SEM service is well designed. Program staff provided a detailed description of the SEM service offered to I&M’s customers. The implementation team has staff dedicated to providing this service and is able to draw on broader company experience and support. Some key benefits and forms of support identified by the implementation contactor are identification of potential projects, operational planning, and engineering support, along with coaching to guide the broader team involved in the execution. Interviewed participants echoed these benefits citing the identification of the energy savings and useful engagement and reviews of data to understand energy use as key benefits.

The SEM program has been valued by participants. Both participants felt that the program delivered tangible benefits to them and that that their participation enabled them to identify energy saving improvements.

7. Cost Effectiveness Evaluation

The following cost effectiveness tests were performed for each program: Total Resource Cost (TRC) test, Utility Cost Test (UCT), Participant Cost Test (PCT), and Ratepayer Impact Measure (RIM) test. A score above one signifies that, from the perspective of the test, the program benefits were greater than the program costs. The benefits and costs associated with each test are defined in Table 7-1.

Table 7-1 Summary of Benefits and Costs Included in each Cost Effectiveness Test

Variable	*Definition*	*PCT*		*UCT*		*RIM*		*TRC*	
		Benefit	*Cost*	*Benefit*	*Cost*	*Benefit*	*Cost*	*Benefit*	*Cost*
Incentives	Incentives paid to customers.	✓			✓		✓		
Program Installation Costs	Installation costs paid by program.				✓		✓		✓
Bill Savings /Lost Revenue	Reduction in electricity costs faced by customers as a result of implementation of program measures. Equal to revenue lost to the utility.	✓					✓		
Avoided Energy Costs	Energy-related costs avoided by utility.			✓		✓		✓	
Avoided Capacity Costs	Capacity-related costs avoided by utility, including T&D.			✓		✓		✓	
Incremental Costs	Incremental costs associated with measure implementation, as compared with what would have been done in absence of program.		✓						✓
Program Overhead Costs	Program costs other than incentive or installation costs.				✓		✓		✓

7.1. PY2023 Cost Effectiveness Evaluation

Table 7-2 through Table 7-5 summarize key financial benefit and cost inputs for the various tests along as well as the test results for each commercial and industrial program during PY2022.

Table 7-2 Work Prescriptive Program Cost Test Inputs and Results

Variable	PCT		UCT		RIM		TRC	
	Benefit	Cost	Benefit	Cost	Benefit	Cost	Benefit	Cost
Incentives	$ 1,229,271			$ 1,229,271		$ 1,229,271		
Program Installation Costs				$ -		$ -		$ -
Bill Savings (NPV)	$11,775,740							
Lost Revenue (NPV)						$17,322,177		
Avoided Energy Costs (NPV)			$ 6,394,539		$ 6,394,539		$ 6,394,539	
Avoided Capacity Costs (NPV)			$ 2,416,663		$ 2,416,663		$ 2,416,663	
Avoided T&D Costs (NPV)			$ 691,012		$ 691,012		$ 691,012	
Incremental Costs		$ 2,826,459						$ 2,826,459
Program Overhead Costs				$ 1,643,474		$ 1,643,474		$ 1,643,474
Total Benefits	$ 13,005,011		$ 9,502,214		$ 9,502,214		$ 9,502,214	
Total Costs	$ 2,826,459		$ 2,872,745		$ 20,194,922		$ 4,469,933	
Test Score	4.60		3.31		0.47		2.13	

Table 7-3 Work Custom Program Cost Test Inputs and Results

Variable	PCT		UCT		RIM		TRC	
	Benefit	Cost	Benefit	Cost	Benefit	Cost	Benefit	Cost
Incentives	$ 2,756,506			$ 2,756,506		$ 2,756,506		
Program Installation Costs				$ -		$ -		$ -
Bill Savings (NPV)	$19,834,878							
Lost Revenue (NPV)						$27,490,578		
Avoided Energy Costs (NPV)			$ 9,895,555		$ 9,895,555		$ 9,895,555	
Avoided Capacity Costs (NPV)			$ 2,705,430		$ 2,705,430		$ 2,705,430	
Avoided T&D Costs (NPV)			$ 811,504		$ 811,504		$ 811,504	
Incremental Costs		$ 4,073,769						$ 4,073,769
Program Overhead Costs				$ 2,742,628		$ 2,742,628		$ 2,742,628
Total Benefits	$ 22,591,384		$ 13,412,488		$ 13,412,488		$ 13,412,488	
Total Costs	$ 4,073,769		$ 5,499,134		$ 32,989,712		$ 6,816,397	
Test Score	5.55		2.44		0.41		1.97	

Table 7-4 Work Direct Install Program Cost Test Inputs and Results

Variable	PCT		UCT		RIM		TRC	
	Benefit	Cost	Benefit	Cost	Benefit	Cost	Benefit	Cost
Incentives	$ 11,676			$ 11,676		$ 11,676		
Program Installation Costs				$ -		$ -		$ -
Bill Savings (NPV)	$ 73,177							
Lost Revenue (NPV)						$ 107,790		
Avoided Energy Costs (NPV)			$ 39,915		$ 39,915		$ 39,915	
Avoided Capacity Costs (NPV)			$ 18,927		$ 18,927		$ 18,927	
Avoided T&D Costs (NPV)			$ 5,308		$ 5,308		$ 5,308	
Incremental Costs		$ 23,549						$ 23,549
Program Overhead Costs				$ 130,948		$ 130,948		$ 130,948
Total Benefits	$ 84,853		$ 64,150		$ 64,150		$ 64,150	
Total Costs	$ 23,549		$ 142,624		$ 250,414		$ 154,497	
Test Score	3.60		0.45		0.26		0.42	

Table 7-5 Work Strategic Energy Management Program Cost Test Inputs and Results

Variable	*PCT*		*UCT*		*RIM*		*TRC*	
	Benefit	*Cost*	*Benefit*	*Cost*	*Benefit*	*Cost*	*Benefit*	*Cost*
Incentives	$ 10,051			$ 10,051		$ 10,051		
Program Installation Costs				$ -		$ -		$ -
Bill Savings (NPV)	$ 251,059							
Lost Revenue (NPV)						$ 370,011		
Avoided Energy Costs (NPV)			$ 137,055		$ 137,055		$ 137,055	
Avoided Capacity Costs (NPV)			$ 25,849		$ 25,849		$ 25,849	
Avoided T&D Costs (NPV)			$ 7,246		$ 7,246		$ 7,246	
Incremental Costs		$ 7,892						$ 7,892
Program Overhead Costs				$ 126,211		$ 126,211		$ 126,211
Total Benefits	$ 261,109		$ 170,150		$ 170,150		$ 170,150	
Total Costs	$ 7,892		$ 136,262		$ 506,273		$ 134,104	
Test Score	33.08		1.25		0.34		1.27	

2023 Indiana Commercial & Industrial Portfolio EM&V Report

Volume II of II

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1. Introduction

Under contract with the Indiana Michigan Power (I&M), ADM Associates, Inc., (ADM) performed evaluation, measurement and verification (EM&V) activities to confirm the energy savings (kWh) and demand reduction (kW) realized through the demand side management programs that I&M implemented in Indiana in 2023.

This report is divided into two volumes providing information on the impact, process, and cost-effectiveness evaluation of the I&M portfolio of commercial and industrial programs implemented in Indiana during the 2023 program year. Volume II contains chapters presenting detailed information regarding evaluation methodologies, data collection instruments, and evaluation results. Volume II is organized as follows:

- Chapter 2: Site-Level Estimation of Ex Post Gross Energy Impacts
- Chapter 3: C&I Participant Survey Instrument
- Chapter 4: C&I Participant Survey Results

See report Volume I for narrative and summary information pertaining to the evaluation methods and results.

2. Site-Level Estimation of Ex Post Gross Energy Impacts

2.1. Sample ID 100

Executive Summary

Under a project represented by sample ID 100, a program participant received custom incentives from I&M for replacing existing air blow off nozzles with low air flow nozzles. The ex post annual energy savings are 66,123 kWh, with an ex post peak demand reduction of 12.56 kW. The project energy savings gross realization rate is 37%.

Project Description

The customer replaced existing standard air flow blow off nozzles (20) with low flow nozzles (20).

Measurement and Verification Effort

To verify the project savings, ADM staff reviewed project documentation, collected air compressor efficiency data, extracted model data from the nozzle installation pictures, and obtained manufacturer specification data. Interval electric billing data for one year was aggregated in one-hour periods, binned to the day of the week, to estimate the working schedule. The project contact provided additional information to support the 2,000 hours of annual usage for the blow off operation in the manufacturing plant.

The following savings algorithm was sourced from the *Engineer Nozzles measure, (Indiana TRM version 2.2).*

$$kWh_{savings} = QTY\ x(SCFM_{nozzle}\text{-}SCFM_{lowflow})\ x\ kW/CFM\ x\ Hours$$

$$kW_{savings} = kWh_{savings}\ x\ CF/\ Hours$$

Where:

$kWh_{savings}$	= *Annual energy savings*
QTY	=*Quantity nozzles placed in service*
$SCFM_{nozzle}$	= *1/8" diameter orifice,*
$SCFM_{lowflow}$	= *1/8" diameter orifice,*
Hours	= *Annual hours of use per blowoff gun*
kW/CFM	= *kW/CFM plant air compressor*
CF	= *Coincidence Factor for Peak Demand hours*

The table below presents ex ante and ex post energy savings, verified hours of operation, CFM of the repaired leak, and the compressor power efficiency.

Low Flow Air Nozzle Savings Algorithm Inputs

Variable	*Ex Ante*	*Ex Post*	*Ex Post Source*
Quantity	20	20	Project proposal

$SCFM_{nozzle}$	NA	21	Illinois TRM V10; Efficient Compressed Air Nozzles; 1/8”
$SCFMZ_{lowflow}$	NA	13	Manufacturer specification; Exair 1010SS; 1/8” orifice
kW/scfm	NA	0.1658	Recent air leak project savings calculator at same site
Hours	2,000	2,000	Site operates 8,760 hours
CF	1	0.38	IN TRM 2.2; Compressed air
kWh	180,420	66,133	Calculated
CF	1	0.38	IN TRM 2.2; Compressed air
kW	67.66	12.56	Calculated

Results

Gross Energy Impacts Summary

Measure Category	*kWh Savings*			*Ex Post Gross kW Savings*
	Ex Ante	*Ex Post*	*Realization Rate*	
Air Compressor	180,420	66,123	37%	12.56
Total	**180,420**	**66,123**	**37%**	**12.56**

The ex post annual energy savings are 66,123 kWh and the ex post peak demand reduction is 12.56 kW. The energy gross realization rate is 37%.

The product order form contained partial data information for both the 1/8” diameter orifice and the ¼” diameter orifice. The site provided installation photos of six handheld air blowoff tools with the new low flow air nozzle installed. All the pictures were representative of the 1/8” diameter Exair 1010SS nozzle. The ex-ante deemed savings per unit to be a diameter nozzle that the ex-ante deemed savings for the 1/8” diameter nozzle is 2,255 kWh which aligns closer to the ex-post savings per nozzle for this project at 3,306 kWh, than a nozzle.

The ex-post analysis also leveraged previous documents utilized for an air compressor project to determine the air compressor efficiency.

The ex-post peak demand savings (5.63 kW) is less than the ex-ante (14.83 kW), as the ex-post method applied the IN TRM coincidence factor for the compressed air nozzles, to the reduction in power demand.

2.2. Sample ID 101, 200

Executive Summary

Under projects represented by sampling ID's 101 and 200, a program participant received prescriptive and custom incentives from I&M for installing energy efficient lighting and lighting controls in the construction of a new facility.

The ex post energy savings are 4,922,468 kWh, peak demand savings are 441 kW, with an energy savings realization rate of 111%.

Project Description

The participant installed energy efficient lighting and lighting controls that exceeded the minimum building code required lighting power density, by building type, as specified within the standard: *Energy Standard for Buildings Except Low-Rise Residential Buildings (ASHRAE 90.1-2007).* The participant also installed exterior energy efficient lighting, exceeding the code-based lighting power allowance.

The efficient lighting included LED high bay fixtures, LED linear fixtures, LED exterior wall wash fixtures, and LED pole light fixtures, with all interior fixtures controlled by occupancy sensors.

Measurement and Verification Effort

The following algorithms for energy and coincident peak demand savings were sourced from the measure: *Lighting Systems, (Indiana TRM version 2.2).*

$$kWh_{Savings} = \left(\frac{Allowed\ LPD - Installed\ LPD}{1000}\right) \times Units \times HOU \times (HCIF_e)$$

$$kW_{Peak} = \left(\frac{Allowed\ LPD - Installed\ LPD}{1000}\right) \times Units \times CF \times (HCIF_d)$$

Where:

$kWh_{savings}$	= *Annual energy savings*
Allowed LPD	= *Allowed lighting power density per square foot per ASHRAE Standard 90.1-2007*
Installed LPD	= *Installed lighting power density per square foot*
Units	= *Square feet, lineal feet*
HOU	= *Indicates hours of usage for the fixture*
$HCIF_e$	= *Heating and Cooling Interactive Factor*
$HCIF_d$	= *Heating and Cooling Interactive Factor during Peak Demand hours*
CF	= *Coincidence Factor for Peak Demand hours*

Lighting Power Density Inputs Ex Ante compared to Ex Post and Annual Usage Hours

Measure	Ex Ante		Ex Post		Annual Hours		Area	LPD Allowed
	Qty	Watts	Qty	Watts	Ex Ante	Ex Post		
Installed								
A1	236	29	244	29	4500	4380	Mfg	1.3
B	23	40	23	40	4500	8760	Mfg	1.3
D1	28	28	28	28	4500	8760	Mfg	1.3
D2	196	35	204	35	4500	8760	Mfg	1.3
F	24	306	172	306	4500	8760	Mfg	1.3
G	335	48	335	48	4500	4380	Mfg	1.3
G1	35	182	35	182	4500	8760	Office	1.0
H4	55	36	55	36	4500	4380	Office	1.0
H6	14	25	14	25	4500	4380	Office	1.0
H8	114	52	114	52	4500	3000	Office	1.0
J	4	45	4	45	4500	3000	Office	1.0
K	6	30	6	30	4500	3000	Office	1.0
P4	1	74	1	74	4500	8760	Office	1.0
P8	31	74	31	74	4500	5400	Office	1.0
S1	NA	NA	70	409	4500	3000	Warehouse	0.8
Installed, non- certified,								
H4	55	36	55	36				
C7.5	NA	NA	3	35				
C8.5	NA	NA	3	39				
C11.5	NA	NA	8	53				
C18	NA	NA	7	83				
C22.5	NA	NA	4	104				

Lighting Energy Savings Calculations

Measure	Energy Usage LPD Baseline		Energy Usage Installed		Annual Hours		Ex Ante Annual kWh Savings	Ex Post Gross kWh Savings	Gross Realization Rate
	Ex Ante	Ex Post	Ex Ante	Ex Post	Ex Ante	Ex Post			
Lighting Manufacturing	5,369,446	3,710,873	1,253,368	568,828	5,400	8,760	3,855,933	4,083,020	109%
Lighting Office		350,400		168,557	5,400	4,380		181,842	
Lighting Warehouse		288,00		85,890	5,400	3,000		202,110	
Total	5,369,446	5,298,172	1,253,368	240	7,280	0.00	3,885,933	4,466,972	116%

All the exterior measures for the ex-post savings in the following table have savings. The ex-ante savings for the XA light fixtures above the exterior doorways were a negative savings in the project. The ex-post analysis determined the XA fixtures were placed above each 3' doorway and selected the appropriate LPD exterior bin for 20W/ft of doorway.

Exterior Lighting Power Density Inputs Ex Ante compared to Ex Post

Analysis	*Fixtures*	*Qty*	*Watts*	*Hours*	*LPD Exterior Bin*	*W/Unit*	*Size*	*Allowed Watts*	*Baseline kWh*	*Installed kWh*	*Annual kWh Savings*
Ex Ante	XA	57	51	4300	Walkway	0.15/ft	1750	1,750	7,525	12,500	(4,975)
Ex Post	XA	57	51	4300	Other building doors	20/ft	3,420	3,420	14,706	12,500	2,206
Ex Ante	Pole	68	255	4300	Parking	0.15/SF	542,060	81,309	349,629	84,508	265,121
		9	257								
Ex Post	Pole	68	255	4300	Parking	0.15/SF	542,060	81,309	349,629	84,508	265,121
		9	257								

Prescriptive Lighting Measure Analysis

Measure	*Quantity*	*Watts controlled*	*Annual Hours*	*$ESF_{eff} - ESF_{base}$*	*CF*	*Ex Ante Annual kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
Ceiling occupancy sensors	178	455	4,380	0.20	0.15	81,346	70,907	87%
Wall switch occupancy sensor	14	455	4,380	0.20	0.15	6,398	5,577	87%
High bay fixture occ sensor: Manufacturing area	491	409	8760	0.15	0.15	224,387	78,285	41%
High bay fixture occ sensor: Warehouse area		409	3000	0.20	0.15		13,252	
LED Exit Signs	100	Δ23W	8760	-	1.0	20,100	20,148	100%
Total						332,231	188,169	57%

Results

Realized Gross Savings

Measure Category	*kWh Savings*			*Realized Peak kW Reduction*
	Ex Ante	*Ex Post*	*Realization Rate*	
Custom LPD Interior	3,855,933	4,466,972	116%	436.99
Custom LPD Exterior	260,146	267,327	103%	0.00

Measure Category	*kWh Savings*			*Realized Peak kW Reduction*
	Ex Ante	*Ex Post*	*Realization Rate*	
Prescriptive Lighting	332,231	188,169	57%	4.95
Total	**4,448,310**	**4,922,468**	**111%**	**441.94**

The ex post energy savings compared to a code-based building are 4,922,468 kWh with a gross energy savings realization rate of 111%. The difference between the ex-ante and ex post savings estimates is due to the following factors:

- The ex-post savings analysis included the area specific hours of operation as identified during the site visit walkthrough, ranging from 3,000 to 8,760 hours. The ex-ante hours of operation were 4,500 for all areas.
- The ex-post savings for exterior lighting assigned the appropriate lighting bin category for each measure. The "XA" type lighting has positive energy savings for the ex-post model, and negative for the ex-ante after rebinning the fixtures to doorway lighting.
- The ex-post savings for lighting controls in the prescriptive program (168,021 kwh) is less than ex ante savings (312,131) as the savings factor was low since the manufacturing hours of operation are 8,760. The continuous motion on the production floor, along with the long sensitivity value of 0.5 hours, results in the lighting nearly always on.

The peak demand ex-post savings of 441.94 kW was less than the ex-ante savings of 661.22 kW.

2.3. Sample ID 102

Executive Summary

For project sample ID 102, a program participant received prescriptive incentives from I&M for installing efficient lighting in their building.

The ex post energy savings are 210,664 kWh and peak demand savings are 47.68 kW resulting in an energy savings realization rate of 98%.

Project Description

The participant replaced (2,638) fluorescent linear tube lamps with (2,638) 4' LED lamps.

Measurement and Verification Effort

To verify the project savings, ADM staff reviewed project documentation, existing lighting types, new lighting, methods of controlling the lighting and the HVAC types for each area. Interval electric billing data for one year was aggregated in one hour periods, binned to the day of the week, to estimate the working schedule.

The following algorithms for energy and coincident peak demand savings were sourced from the measure: *Lighting Systems, (Indiana TRM version 2.2).*

$$kWh_{savings} = \sum_{Area} \left[Hours\ x\ (Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed}) x\ Whf_{kWh} / 1000 \frac{W}{kW} \right]$$

$$kW_{savings} = \sum_{Area} \left[(Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed})\ x\ Whf_{kW}\ xCF / 1000 \frac{W}{kW} \right]$$

Where:

$kWh_{savings}$	= *Annual energy savings*
$kW_{savings}$	= *Annual coincident peak demand savings*
Qty	= *Quantity of fixtures or lamps*
W	= *Wattage of each fixture or lamp*
Hours	= *Lighting annual operating hours*
Whf	= *Waste heat factor for kW or kWh, IN TRM 2.2 by city & HVAC type*
CF	=*Coincident peak demand factor, IN TRM 2.2, by building type*

The variables for the energy savings algorithm are summarized in the following table.

Lighting Energy Savings Calculations

Measure	*Quantity*		*Wattage*		*Annual Hours*	*Waste Heat Factor*	*Ex Ante Annual kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
	Base	*Efficient*	*Base*	*Efficient*					
4' 1L T8 to LED 4' lamp	2,628	2,628	32	14	4,045	0.10	215,706	210,664	98%
Total							215,706	210,664	98%

Results

Realized Gross Savings

Measure Category	*kWh Savings*			*Realized Peak kW Reduction*
	Ex Ante	*Ex Post*	*Realization Rate*	
Prescriptive Lighting	215,706	210,664	98%	47.68
Total	**215,706**	**210,664**	**98%**	**47.68**

The ex post energy savings amounted to 210,664 kWh, with a gross energy savings realization rate of 98%. The primary variance between the expected and realized savings stems from the prescriptive ex-ante savings estimates use of a deemed value, in contrast to the ex-post analysis that applied the method described above. The verified hours of operation were 4,045, slightly less than the ex-ante projection of 4,056 hours.

The peak demand ex-post savings of 47.68 kW was greater than the ex-ante savings of 29.96 kW. The ex-ante savings estimate was a deemed value which was less than the realized savings.

2.4. Sample ID 104

Executive Summary

Under a project represented by sample ID 104, a program participant received prescriptive incentives from I&M for installing more efficient lighting in the interior and exterior of their building.

The ex post energy savings are 647,234 kWh and peak demand savings are 58.37 kW resulting in an energy savings realization rate of 118%.

Project Description

The participant installed (1250) LED 4' 25W lamps, (1450) LED 4' 16.5W lamps, (274) LED 4' 14W lamps, and (712) occupancy sensors.

Measurement and Verification Effort

To verify the project savings, ADM staff reviewed project documentation, existing lighting types, new lighting, methods of controlling the lighting and the HVAC types for each area. Interval electric billing data for one year was aggregated in one-hour periods, binned to the day of the week, to estimate the working schedule.

The following algorithms for energy and coincident peak demand savings were sourced from the measure: *Lighting Systems, (Indiana TRM version 2.2).*

$$kWh_{savings} = \sum_{Area}\left[Hours\ x\ (Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed}) x\ Whf_{kWh}/1000\frac{W}{kW}\right]$$

$$kW_{savings} = \sum_{Area}\left[(Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed})\ x\ Whf_{kW}\ xCF/1000\frac{W}{kW}\right]$$

Where:

$kWh_{savings}$	= *Annual energy savings*
$kW_{savings}$	= *Annual coincident peak demand savings*
Qty	= *Quantity of fixtures or lamps*
W	= *Wattage of each fixture or lamp*
$Hours$	= *Lighting annual operating hours*
Whf	= *Waste heat factor for kW or kWh, IN TRM 2.2 by city & HVAC type*
CF	=*Coincident peak demand factor, IN TRM 2.2, by building type*

The variables for the energy savings algorithm are summarized in the following table.

Lighting Energy Savings Calculations

Measure	*Quantity*		*Wattage*		*Annual Hours*	*Waste Heat Factor*	*Ex Ante Annual kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
	Base	*Efficient*	*Base*	*Efficient*					
4’ T5 to LED 4’ lamp	1250	1250	48	25	8,760	0.00	189,000	251,851	133%
4’ T8 to LED 4’ lamp	1725	1725	32	16.1	8,760	0.00	141,588	240,266	170%
None to Occupancy Sensor	0	712	-	82.9	8,760	0.00	217,103	155,118	71%
Total							**547,691**	**647,234**	**118%**

Results

Realized Gross Savings

Measure Category	*kWh Savings*			*Realized Peak kW Reduction*
	Ex Ante	*Ex Post*	*Realization Rate*	
Prescriptive Lighting	547,691	647,234	118%	58.37
Total	**547,691**	**647,234**	**118%**	**58.37**

The ex post energy savings are 647,234 kWh with a gross energy savings realization rate of 118%. The main difference between the expected and realized savings is due to the ex-ante savings estimate being based on a deemed value per unit while the ex-post analysis used the savings algorithm stated above. The verified hours of operation (8,760) are greater than the ex-ante hours (5,616). For the second measure the ex-ante savings estimate used the lower of two wattages for the 4’ lamp (14W and 16.5W). The ex-post analysis used (16.1W) which is the average of the wattages per purchased product.

The peak demand ex-post savings of 58.37 kW was greater than the ex-ante savings of 53.04 kW.

2.5. Sample ID 105

Executive Summary

Under project(s) represented by sample ID 105, a participant received prescriptive incentives from I&M for installing more efficient lighting, lighting controls and re-lamping existing fixtures, in their manufacturing building.

The ex post energy savings are 136,527 kWh, peak demand savings are 19.06 kW, with an energy savings realization rate of 28%.

Project Description

The participant replaced existing fluorescent lamps and fixtures with LED 2'x2', 2'x4' troffer kits (1592), LED low bay (2), LED fixtures (14) and lamp replacements (50).

Measurement and Verification Effort

To verify the project savings, ADM staff reviewed available project documentation and collected information on the existing lighting type, new lighting manufacturer model and specifications, lighting control methods, and the HVAC system type for each area. Additionally, staff visited the site to compare the installed quantities against the final lighting survey completed by the contractor. Interval electric billing data for one year was aggregated into one-hour periods, categorized by day of the week, to estimate the working schedule.

The following algorithms for energy and coincident peak demand savings were sourced from the measure: *Lighting Systems, (Indiana TRM version 2.2).*

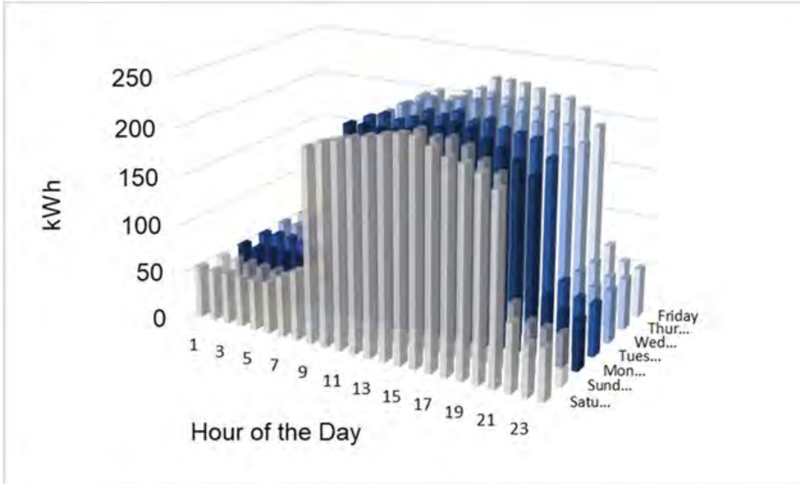
$$kWh_{savings} = \sum_{Area} \left[Hours\ x\ (Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed}) x\ Whf_{kWh} / 1000 \frac{W}{kW} \right]$$

$$kW_{savings} = \sum_{Area} \left[(Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed})\ x\ Whf_{kW}\ xCF / 1000 \frac{W}{kW} \right]$$

Where:

$kWh_{savings}$	= *Annual energy savings*
$kW_{savings}$	= *Annual coincident peak demand savings*
Qty	= *Quantity of fixtures or lamps*
W	= *Wattage of each fixture or lamp*
Hours	= *Lighting annual operating hours*
Whf	= *Waste heat factor for kW or kWh, IN TRM 2.2 by city & HVAC type*
CF	=*Coincident peak demand factor, IN TRM 2.2, by building type*

The figure below summarizes the site interval billing data by hour of the day and day of the week for a period of one year.



Interval billing data analysis

Building Area	*Annual Hours*
Facility	4,680
Emergency lighting	8,760

The variables for the energy savings algorithm and the energy savings are summarized in the following table.

Lighting Energy Savings Calculations

Measure	*Quantity*		*Wattage*		*Annual Hours*	*Waste Heat Factor*	*Ex Ante Annual kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
	Base	*Efficient*	*Base*	*Efficient*					
T8 to LED lamp	9	9	31	28	-	1.06	4,104	234	7%
T8 to LED lamp	3	3	31	28	4,680	1.06		42	
T8 to LED lamp	10	10	25	28	4,680	1.06		-	
T8 to LED lamp	8	8	49	56	4,680	1.06		-	
T8 to LED lamp	10	10	53	56	4,680	1.06		-	
T8 to LED lamp	10	10	18	21	4,680	1.06		-	
4' 3LT8 to LED Low Bay	2	2	74	50	4,680	1.06	1,641	236	24%
2' 1L T8 to LED kit	1	1	15	7	4,680	1.06	237,301	39	57%
3' 1L T8	2	2	18	10	4,680	1.06		84	
3' 1L T8	117	117	18	10	4,680	1.06		4,922	
4' 1L T8	116	116	25	13	4,680	1.06		6,698	
4' 1L T8	14	14	25	14	4,680	1.06		739	
4' 1L T8	7	7	25	14	8,760	1.06		692	

Measure	*Quantity*		*Wattage*		*Annual Hours*	*Waste Heat Factor*	*Ex Ante Annual kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
	Base	*Efficient*	*Base*	*Efficient*					
4' 1L T8	118	118	25	26	4,680	1.06		-	
4' 1L T8	12	12	25	27	4,680	1.06		-	
4' 1L T8	2	2	25	27	4,680	1.06		-	
2x2 2L T8	80	80	26	15	4,680	1.06		4,524	
2x2 2L T8	1	1	30	15	4,680	1.06		74	
2x2 2L T8	45	45	30	15	4,680	1.06		3,331	
2x2 2L T8	4	4	30	15	8,760	1.06		554	
4' 1L T8	7	7	35	26	8,760	1.06		598	
6' 2L T8	4	4	37	20	4,680	1.06		337	
6' 2L T8	37	37	37	20	4,680	1.06		3,113	
6' 2L T8	1	1	37	20	4,680	1.06		84	
3' 2L T5	31	31	46	25	4,680	1.06		3,260	
2x4 2L T8	1	1	49	15	4,680	1.06		170	
2x4 2L T8	13	13	49	25	4,680	1.06		1,566	
2x4 2L T8	33	33	49	25	4,680	1.06		3,975	
2x4 2L T8	753	753	49	25	4,680	1.06		90,698	
8' 2L T8	36	36	49	26	4,680	1.06		4,158	
4' 2L T8	1	1	49	27	4,680	1.06		110	
8' 2L T8	63	63	49	49	4,680	1.06		134	
4' 2L T5	30	30	62	34	4,680	1.06		4,108	
2' 1L T8	1	1	15	7	4,680	1.06		1	
2x4 2L T8	3	3	49	25	4,680	1.06	244,607	361	1%
2x4 2L T8	11	11	49	25	4,680	1.06		1,325	
Total							487,654	136,527	28%

Results

Realized Gross Savings

Measure Category	*kWh Savings*			*Realized Peak kW Reduction*
	Ex Ante	*Ex Post*	*Realization Rate*	
Prescriptive Lighting	487,654	136.527	28%	19.06
Total	**487,654**	**136,527**	**28%**	**19.06**

The ex post energy savings are 136,527 kWh with a gross energy savings realization rate of 28%. The difference between the ex-ante and ex post savings estimates is due to the following factors:

- The ex-ante savings for this project appear to have been double counted a portion of the installed measures. The ex-ante savings for the measure with 244,607 kWh savings could not be replicated. This measure is for retrofitting a quantity of 14 fixtures with expected savings of 244,607 kWh. The actual expected savings are 1,561 kWh. The number 244,607 is also the total sum of savings for the project, it looks to have been entered the measure savings instead of the project savings. The ex-ante savings for this project seem to have inadvertently double-counted some of the installed measures. Specifically, the ex-ante savings attributed to a measure that involved retrofitting 14 fixtures totaled 244,607 kWh. In contrast, the expected savings for this measure should have been 1,561 kWh. It appears that the figure of 244,607 kWh, which represents the total project savings, was mistakenly recorded as the savings for this single measure instead of the overall project savings.

- The applicant submitted a detailed lighting survey with existing fixtures, new fixtures, quantities and hours of use, with an expected savings of 126,734 kWh, significantly less than the ex-ante project savings projection of 487,654 kWh.
- The peak demand ex-post savings of 19.06 kW was less than the ex-ante savings of 91 kW. The same double counting of the energy savings carried over to the peak demand savings total.

2.6. Sample ID 106,299

Executive Summary

Under project(s) represented by sample ID 106, 299, a program participant received prescriptive and custom incentives from I&M for installing more efficient lighting in their building.

The ex post energy savings are 926,423 kWh and peak demand savings are 104.45 kW resulting in an energy savings realization rate of 130%.

Project Description

The participant installed (6) LED 2x2 retrofit kits, (44) LED high bay fixtures, (1247) LED 2x4 retrofit kits, (137) LED 15W lamps, and (143) occupancy sensors.

Measurement and Verification Effort

To verify the project savings, ADM staff reviewed available project documentation, collected the existing lighting type, new lighting manufacturer model and specification data, the lighting control methods and the type of HVAC for each area. Interval electric billing data for one year was aggregated in one-hour periods, binned to the day of the week, to estimate the working schedule.

The following algorithms for energy and coincident peak demand savings were sourced from the measure: *Lighting Systems, (Indiana TRM version 2.2).*

$$kWh_{savings} = \sum_{Area}\left[Hours\ x\ (Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed}) x\ Whf_{kWh} / 1000 \frac{W}{kW}\right]$$

$$kW_{savings} = \sum_{Area}\left[(Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed})\ x\ Whf_{kW}\ xCF / 1000 \frac{W}{kW}\right]$$

Where:

$kWh_{savings}$	= *Annual energy savings*
$kW_{savings}$	= *Annual coincident peak demand savings*
Qty	= *Quantity of fixtures or lamps*
W	= *Wattage of each fixture or lamp*
$Hours$	= *Lighting annual operating hours*
Whf	= *Waste heat factor for kW or kWh, IN TRM 2.2 by city & HVAC type*
CF	=*Coincident peak demand factor, IN TRM 2.2, by building type*

The variables for the energy savings algorithm are summarized in the following table.

Lighting Energy Savings Calculations

Measure	*Quantity*		*Wattage*		*Annual Hours*	*Waste Heat Factor*	*Ex Ante Annual kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
	Base	*Efficient*	*Base*	*Efficient*					
2L U-tubeT8 to LED Retrofit Kit	6	6	56	25	4,380	0.00	726	815	112%
4’ 1L T8 to LED 15W lamp	113	113	32	15	4,380	0.00	9,275	8,414	91%
4’ 3L T8 to LED Retrofit Kit	405	405	88	36	4,380	0.00	122,472	92,243	75%
HID to LED High Bay	44	44	1,080	240	7,280	0.00	36,115	269,076	745%
None to Occupancy Sensor	143	143	-	126	7,280	0.00	43,604	54,968	126%
Prescriptive Total							**212,192**	**425,517**	**201%**
8’ 2L T8 to LED Retrofit Kit	842	842	160	80	7,280	0.00	490,381	490,395	100%
8’ 4L T8 to LED 15W lamp	24	24	160	60	4,380	0.00	10,512	10,512	100%
Custom Total							**500,893**	**500,907**	**100%**

Results

Realized Gross Savings

Measure Category	*kWh Savings*			*Realized Peak kW Reduction*
	Ex Ante	*Ex Post*	*Realization Rate*	
Prescriptive Lighting	212,192	425,517	201%	51.43
Custom Lighting	500,893	500,907	100%	53.02
Total	**713,084**	**926,423**	**130%**	**104.45**

The ex post energy savings are 926,423 kWh with a gross energy savings realization rate of 140%. The main difference between the expected and realized savings is due to the Prescriptive ex-ante savings estimate being based on a deemed value while the ex-post analysis used the method stated above. The fourth measure has a baseline fixture wattage which causes the analysis to produce a much greater energy savings than the deemed estimate. In addition, the first, third and fourth measures verified efficient wattages (25W, 36W, and 240W, respectively) are greater than the ex-ante savings wattages (22W, 30W, and 180W, respectively).

The peak demand ex-post savings of 104.45 kW was greater than the ex-ante savings of 72.19 kW. The ex-ante savings estimate was a deemed value which was lower than the realized savings.

2.8. Sample ID 107, 206, & 219

Executive Summary

Under projects represented by sample IDs 107, 206 and 219, a participant received custom incentives from I&M for replacing fluorescent tube lighting fixtures with LED high bay fixtures.

The ex post energy savings are 1,937,329 kWh, peak demand savings are 335.23 kW, with an energy savings realization rate of 122%.

Project Description

The participant replaced 6L T5HO linear fluorescent fixtures (500) and 10L T5HO fixtures (500) with LED high bay fixtures (1,000) in a 24/7 manufacturing facility.

Measurement and Verification Effort

To verify the project savings, ADM examined available project documentation and collected data on the existing lighting type, new lighting manufacturer model and specifications, lighting control methods, and the HVAC system for each area. We also aggregated interval electric billing data over one year into one-hour periods, categorized by day of the week, to estimate the working schedule.

The following algorithms for energy and coincident peak demand savings were sourced from the measure: *Lighting Systems, (Indiana TRM version 2.2).*

$$kWh_{savings} = \sum_{Area}\left[Hours\ x\ (Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed}) x\ Whf_{kWh}/1000\frac{W}{kW}\right]$$

$$kW_{savings} = \sum_{Area}\left[(Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed})\ x\ Whf_{kW}\ xCF/1000\frac{W}{kW}\right]$$

Where:

$kWh_{savings}$	= *Annual energy savings*
$kW_{savings}$	= *Annual coincident peak demand savings*
Qty	= *Quantity of fixtures or lamps*
W	= *Wattage of each fixture or lamp*
$Hours$	= *Lighting annual operating hours*
Whf	= *Waste heat factor for kW or kWh, IN TRM 2.2 by city & HVAC type*
CF	=*Coincident peak demand factor, IN TRM 2.2, by building type*

The lighting in unique production areas, warehouses, and main aisles was metered, with the outcomes presented in the figures below.


Production1
1
0
1/9/2024
1/10/2024
1/11/2024
1/11/2024
1/12/2024
1/13/2024
1/14/2024
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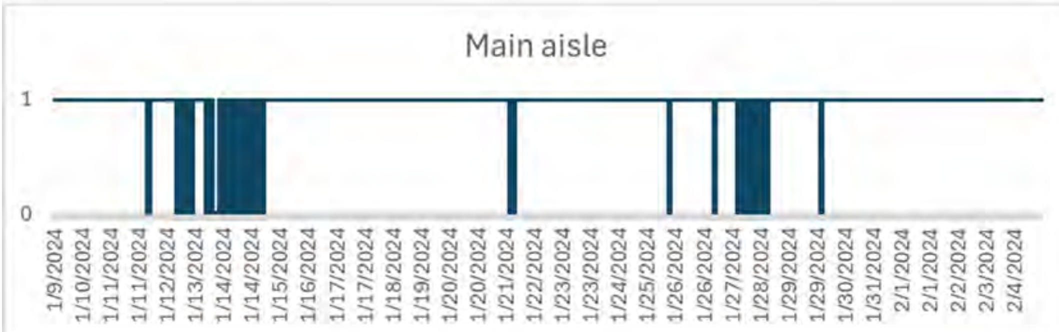
Main aisle
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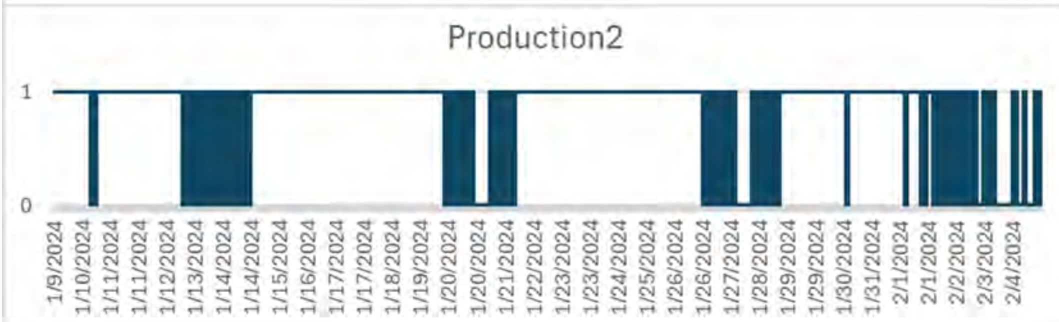
Production2
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0
1/9/2024
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1/11/2024
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1/13/2024
1/14/2024
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WIP
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Production3
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2/2/2024
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2/4/2024

These hourly profiles were annualized and applied to the appropriate lighting measure in the following table that summarizes the lighting inputs, ex ante, and ex post savings.

.

Lighting Energy Savings Calculations

Measure	Quantity		Wattage		Annual Hours	Waste Heat Factor	Ex Ante Annual kWh Savings	Ex Post Gross kWh Savings	Gross Realization Rate
	Base	Efficient	Base	Efficient					
LED T8 Replacement	60	60	48	15	6,032	1.00	9,072	11,944	132%
Occupancy Sensors	354	354	-	115	7,758	1.00	107,942	51,608	48%
LED high bay fixture	705	321	351	110	7,022	1.00	1,161,494	1,489,757	128%
LED high bay fixture	187	185	351	150	7,209	1.00	207,431	273,120	132%
LED high bay fixture	15	15	351	240	6,634	1.00	9,116	11,046	121%
LED high bay fixture	48	48	257	40	6,032	1.00	57,028	62,830	110%
LED high bay fixture	33	33	351	165	6,032	1.00	33,606	37,025	110%
Total							**1,585,688**	**1,937,329**	**122%**

Results

Realized Gross Savings

Measure Category	kWh Savings			Realized Peak kW Reduction
	Ex Ante	Ex Post	Realization Rate	
Prescriptive Lighting	117,014	63,552	54%	9.50
Custom Lighting	1,468,674	1,873,777	128%	325.74
Total	**1,585,688**	**1,937,329**	**122%**	**335.23**

The ex post energy savings are 1,937,329 kWh with a gross energy savings realization rate of 122%. The difference between the ex-ante and ex post savings estimates is due to the following factors:

- The on-site metered hours for a period of one month identified more annualized hours of lighting usage than the ex-ante estimate. The site has 3 shifts of 24 hours plus a smaller weekend crew. Although the weekend hours were less than weekday, the lighting was on at the main aisle and a production area.
- The savings factor from occupancy sensors was lower than anticipated in the ex-ante analysis due to extended lighting usage, which resulted in fewer opportunities for reductions controlled by occupancy.

2.9. Sample ID 108, 220

Executive Summary

Under project(s) represented by sample ID 108, 220, a program participant received prescriptive and custom incentives from I&M for installing more efficient lighting in their building.

The ex post energy savings are 81,085 kWh and peak demand savings are 14.58 kW resulting in an energy savings realization rate of 132%.

Project Description

The participant installed (92) LED high bay fixtures, (69) LED retrofit kits, (38) LED track heads, and (20) LED 2x2 fixtures. There were also (20) lamps removed.

Measurement and Verification Effort

To verify the project savings, ADM staff reviewed project documentation, existing lighting types, new lighting, methods of controlling the lighting and the HVAC types for each area. Interval electric billing data for one year was aggregated in one hour periods, binned to the day of the week, to estimate the working schedule.

The following algorithms for energy and coincident peak demand savings were sourced from the measure: *Lighting Systems, (Indiana TRM version 2.2).*

$$kWh_{savings} = \sum_{Area} \left[Hours\ x\ (Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed}) x\ Whf_{kWh} / 1000 \frac{W}{kW} \right]$$

$$kW_{savings} = \sum_{Area} \left[(Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed})\ x\ Whf_{kW}\ xCF / 1000 \frac{W}{kW} \right]$$

Where:

$kWh_{savings}$	= *Annual energy savings*
$kW_{savings}$	= *Annual coincident peak demand savings*
Qty	= *Quantity of fixtures or lamps*
W	= *Wattage of each fixture or lamp*
Hours	= *Lighting annual operating hours*
Whf	= *Waste heat factor for kW or kWh, IN TRM 2.2 by city & HVAC type*
CF	=*Coincident peak demand factor, IN TRM 2.2, by building type*

The variables for the energy savings algorithm are summarized in the following table.

Lighting Energy Savings Calculations

Measure	*Quantity*		*Wattage*		*Annual Hours*	*Waste Heat Factor*	*Ex Ante Annual kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
	Base	*Efficient*	*Base*	*Efficient*					
4’ 6L T8 to LED High Bay	92	92	222	120	4,978	0.13	33,385	52,603	158%
Prescriptive Total							**33,385**	**52,603**	**158%**
4’ 2L T8 to LED Retrofit Kit	5	31	79	34	4,978	0.13	(4,276)	(3,711)	87%
4’ 4L T8 to LED Retrofit Kit	26	26	59	46	4,978	0.13	1,922	1,880	98%
4’ 2L T8 to LED Retrofit Kit	26	12	112	29	4,978	0.13	14,587	14,379	99%
5’ 2L T8 to LED Track Head	12	38	72	46	4,978	0.13	(5,243)	(4,913)	94%
4’ 1L to LED 2x2 fixture	59	20	59	20	4,978	0.13	17,509	17,260	99%
2’ 2L T8 to delamping	20	0	32	-	4,978	0.13	3,639	3,588	99%
Custom Total							**28,138**	**28,482**	**101%**

Results

Realized Gross Savings

Measure Category	*kWh Savings*			*Realized Peak kW Reduction*
	Ex Ante	*Ex Post*	*Realization Rate*	
Prescriptive Lighting	33,385	52,603	158%	9.46
Custom Lighting	28,138	28,482	101%	5.12
Total	**61,523**	**81,085**	**132%**	**14.58**

The annual energy savings realized were 81,085 kWh, with a gross energy savings realization rate of 132%. The primary reason why ex ante savings differed from ex-post savings arose from the prescriptive ex-ante savings estimate use of a deemed value, whereas the ex-post analysis implemented the previously mentioned method. The ex-post savings analysis confirmed the hours of use at 4,978, slightly below the ex-ante savings estimate of 5,100 hours. Additionally, the verified wattages for the second, third, and fifth measures (34.1W, 46.1W, and 45.8W, respectively) varied from the ex-ante wattages (37W, 46W, and 47W, respectively).

The peak demand savings observed in the ex-post analysis, at 14.58 kW, exceeded the ex-ante estimate of 8.46 kW. The ex-ante estimate for the prescriptive measure was based on a deemed value.

2.10. Sample ID 109

Executive Summary

For the project represented by sample ID 109, a participant received prescriptive incentives from I&M for the tune-up of their existing HVAC chillers. The ex post annual energy savings are 796,928 kWh, with an ex post peak demand reduction of 228.0 kW. The project energy savings gross realization rate is 107%.

Project Description

A trade ally performed a tune up of each of the three (200 ton) chillers at an office and manufacturing site. The tune-up included evaporator and condenser tube cleaning, and temperature setpoint adjustments.

Measurement and Verification Effort

The attributes to estimate the energy and demand savings by the Indiana TRM method for "Chiller Tune-up" were collected from the site project contact and the implementation trade ally. Billing interval data was not available, but monthly billing data for the newest building owner (2023) was collected. The savings equations are:

$$kWh_{savings} = Tons\ x\ \frac{3.516}{IPLV}\ x\ EFLH\ x\ ESF$$

$$kW_{savings} = Tons\ x\ \frac{3.516}{COP}\ x\ CF\ x\ DSF$$

Where:

$kWh_{savings}$	= *Delta savings from existing chiller to chiller after tune up*
$kW_{savings}$	= *Peak demand savings*
Tons	= *Total tonnage of chillers receiving tune up*
IPLV	=*Assumed efficiency prior to tune up, IN TRM*
COP	= *Assumed efficiency prior to tune up, IN TRM*
EFLH	=*Effective full load hours, IN TRM*
CF	= *Coincidence Factor for Peak Demand hour, IN TRM*
ESF	=*Energy savings factor, IN TRM*
DSF	=*Demand savings factor, IN TRM*

The chilled water handles the load for various air makeup units, air handlers with both VAV and CAV boxes, primarily in the office space. The EFLH referenced those attributes for a large office building with South Bend weather.

Chiller Tune-up Savings Algorithm Inputs

Variable	Input
Tons	2,000
Chillers	3
IPLV	5.9
EFLH	2786

Type	Centrifugal
ESF	0.08
Systems	Makeup air, AHU's CAV & VAV
Energy savings, kWh	796,928
Demand savings, kW	228.00

To complement the prescriptive savings analysis, the pre- and post-project periods were examined, as shown in the subsequent figure for monthly billing data. The project took place from September 29, 2023, to October 5, 2023, resulting in a decrease in energy usage for the billing period ending October 19, 2023. However, an econometric analysis to estimate the savings was not conducted, given that the owner was initiating manufacturing production, and the production data was not disclosed and could not be accounted for in the analysis.

Monthly Energy Usage, kWh

Results

Gross Energy Impacts Summary

Measure Category	*kWh Savings*			*Ex Post Gross kW Savings*
	Ex Ante	*Ex Post*	*Realization Rate*	
Prescriptive Chiller Tune-up	744,000	796,928	107%	228.00
Total	**744,000**	**796,928**	**107%**	**228.00**

The ex post annual energy savings are 796,928 kWh and the ex post peak demand reduction is 228.00 kW. The energy gross realization rate is 107%.

2.11. Sample ID 114

Executive Summary

Under a project represented by sample ID 114, a program participant received prescriptive incentives from I&M for installing more efficient lighting in the interior and exterior of their building.

The ex post energy savings are 230,546 kWh and peak demand savings are 30.38 kW resulting in an energy savings realization rate of 55%.

Project Description

The participant installed (370) LED high bay fixtures, (160) LED 4' lamps, (17) LED wall packs, and (35) LED area lights.

Measurement and Verification Effort

To verify the project savings, ADM staff reviewed project documentation, existing lighting types, new lighting, methods of controlling the lighting and the HVAC types for each area. Interval electric billing data for one year was aggregated in one-hour periods, binned to the day of the week, to estimate the working schedule.

The following algorithms for energy and coincident peak demand savings were sourced from the measure: *Lighting Systems, (Indiana TRM version 2.2)*.

$$kWh_{savings} = \sum_{Area} \left[Hours\ x\ (Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed}) x\ Whf_{kWh} / 1000 \frac{W}{kW} \right]$$

$$kW_{savings} = \sum_{Area} \left[(Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed})\ x\ Whf_{kW}\ xCF / 1000 \frac{W}{kW} \right]$$

Where:

$kWh_{savings}$	= *Annual energy savings*
$kW_{savings}$	= *Annual coincident peak demand savings*
Qty	= *Quantity of fixtures or lamps*
W	= *Wattage of each fixture or lamp*
$Hours$	= *Lighting annual operating hours*
Whf	= *Waste heat factor for kW or kWh, IN TRM 2.2 by city & HVAC type*
CF	=*Coincident peak demand factor, IN TRM 2.2, by building type*

The variables for the energy savings algorithm are summarized in the following table.

Lighting Energy Savings Calculations

Measure	*Quantity*		*Wattage*		*Annual Hours*	*Waste Heat Factor*	*Ex Ante Annual kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
	Base	*Efficient*	*Base*	*Efficient*					
HID to LED High Bay	304	304	216	170	4,460	0.10	249,523	68,664	28%
4’ T8 to LED 4’ lamp	160	160	32	18.00	4,460	0.10	13,133	10,999	84%
HID to LED High Bay	18	18	250	148.20	4,460	0.10	14,774	8,997	61%
HID to LED High Bay	48	48	400	148.20	4,460	0.10	62,208	59,346	95%
HID to LED Wall Pack	17	17	250	80.10	4,303	0.00	10,649	12,428	117%
HID to LED Area Light	18	18	400	149.01	4,303	0.00	19,440	19,440	100%
HID to LED Area Light	17	17	1,000	307.30	4,303	0.00	51,408	50,672	99%
Total							**421,135**	**230,546**	**55%**

Results

Realized Gross Savings

Measure Category	*kWh Savings*			*Realized Peak kW Reduction*
	Ex Ante	*Ex Post*	*Realization Rate*	
Prescriptive Lighting	421,135	230,546	55%	30.38
Total	**421,135**	**230,546**	**55%**	**30.38**

The annual energy savings achieved were 230,546 kWh, with a gross energy savings realization rate of 16%. The significant variance between anticipated and actual savings stems from the prescriptive ex-ante savings estimate relying on a deemed value, whereas the ex-post analysis employed the previously mentioned method. The hours of operation confirmed for interior measures (4,460) and exterior measures (4,303) varied from the ex-ante estimate of 4,368 hours. Furthermore, the efficient wattages confirmed for the third to seventh measures (148.2W, 148.2W, 80.1W, 149.01W, and 307.3W, respectively) were distinct from the ex-ante projected wattages (150W, 150W, 80W, 150W, and 300W, respectively).

The peak demand ex-post savings of 30.38 kW was fewer than the ex-ante savings of 67.39 kW. The ex-ante savings estimate was a deemed value which was greater than the realized savings.

2.12. Sample ID 115

Executive Summary

Under project(s) represented by sample ID 115, a program participant received prescriptive incentives from I&M for installing more efficient lighting in their building.

The ex post energy savings are 88,561 kWh and peak demand savings are 12.03 kW resulting in an energy savings realization rate of 162%.

Project Description

The participant installed (652) LED 4’ lamps and (4) occupancy sensors.

Measurement and Verification Effort

To verify the project savings, ADM staff reviewed project documentation, existing lighting types, new lighting, methods of controlling the lighting and the HVAC types for each area. Interval electric billing data for one year was aggregated in one hour periods, binned to the day of the week, to estimate the working schedule.

The following algorithms for energy and coincident peak demand savings were sourced from the measure: *Lighting Systems, (Indiana TRM version 2.2).*

$$kWh_{savings} = \sum_{Area} \left[Hours\ x\ (Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed}) x\ Whf_{kWh} / 1000 \frac{W}{kW} \right]$$

$$kW_{savings} = \sum_{Area} \left[(Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed})\ x\ Whf_{kW}\ xCF / 1000 \frac{W}{kW} \right]$$

Where:

$kWh_{savings}$ = *Annual energy savings*
$kW_{savings}$ = *Annual coincident peak demand savings*
Qty = *Quantity of fixtures or lamps*
W = *Wattage of each fixture or lamp*
Hours = *Lighting annual operating hours*
Whf = *Waste heat factor for kW or kWh, IN TRM 2.2 by city & HVAC type*
CF = *Coincident peak demand factor, IN TRM 2.2, by building type*

The variables for the energy savings algorithm are summarized in the following table.

Lighting Energy Savings Calculations

Measure	*Quantity*		*Wattage*		*Annual Hours*	*Waste Heat Factor*	*Ex Ante Annual kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
	Base	*Efficient*	*Base*	*Efficient*					
4’ T12 to LED 4’ lamp	652	652	32	14	6,604	0.12	53,516	87,115	163%

Measure	*Quantity*		*Wattage*		*Annual Hours*	*Waste Heat Factor*	*Ex Ante Annual kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
	Base	*Efficient*	*Base*	*Efficient*					
Occupancy Sensor	0	4	0	163	6,604	0.12	1,220	1,445	119%
Total							**54,736**	**88,561**	**162%**

Results

Realized Gross Savings

Measure Category	*kWh Savings*			*Realized Peak kW Reduction*
	Ex Ante	*Ex Post*	*Realization Rate*	
Prescriptive Lighting	54,736	88,561	162%	12.03
Total	**54,736**	**88,561**	**162%**	**12.03**

The annual energy savings realized were 88,561 kWh, with a gross energy savings realization rate of 162%. The variance between anticipated and actual savings arose because the ex-ante savings estimate used a deemed value per unit, whereas the ex-post analysis employed the previously described method. This analysis confirmed the hours of use at 6,604, which exceeds the deemed hours for a retail facility of 4,984. The analysis of occupancy sensor savings considered the connected watts and hours of use, while the ex-ante savings estimate relied on a deemed value per unit.

The peak demand ex-post savings of 12.03 kW was greater than the deemed ex-ante savings of 8.67 kW.

2.13. Sample ID 116

Executive Summary

Under a project represented by sample ID 116, a program participant received prescriptive incentives from I&M for installing more efficient lighting in their building.

The ex post energy savings are 89,352 kWh and peak demand savings are 12.95 kW resulting in an energy savings realization rate of 152%.

Project Description

The participant replaced fluorescent linear tube lighting with (702) LED 4' lamps and also added (4) occupancy sensors.

Measurement and Verification Effort

To verify the project savings, ADM staff reviewed available project documentation, collected the existing lighting type, new lighting manufacturer model and specification data, the lighting control methods and the type of HVAC for each area. Interval electric billing data for one year was aggregated in one hour periods, binned to the day of the week, to estimate the working schedule.

The following algorithms for energy and coincident peak demand savings were sourced from the measure: *Lighting Systems, (Indiana TRM version 2.2)*.

$$kWh_{savings} = \sum_{Area} \left[Hours\ x\ (Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed}) x\ Whf_{kWh} / 1000 \frac{W}{kW} \right]$$

$$kW_{savings} = \sum_{Area} \left[(Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed})\ x\ Whf_{kW}\ xCF / 1000 \frac{W}{kW} \right]$$

Where:

$kWh_{savings}$	= *Annual energy savings*
$kW_{savings}$	= *Annual coincident peak demand savings*
Qty	= *Quantity of fixtures or lamps*
W	= *Wattage of each fixture or lamp*
Hours	= *Lighting annual operating hours*
Whf	= *Waste heat factor for kW or kWh, IN TRM 2.2 by city & HVAC type*
CF	=*Coincident peak demand factor, IN TRM 2.2, by building type*

The variables for the energy savings algorithm are summarized in the following table.

Lighting Energy Savings Calculations

Measure	*Quantity*		*Wattage*		*Annual Hours*	*Waste Heat Factor*	*Ex Ante Annual kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
	Base	*Efficient*	*Base*	*Efficient*					
4' T12 to LED 4' lamp	702	702	32	14	6,188	0.12	57,620	87,888	153%
Occupancy Sensor	0	4		176	6,188	0.12	1,220	1,465	120%
Total							**58,840**	**89,352**	**152%**

Results

Realized Gross Savings

Measure Category	*kWh Savings*			*Realized Peak kW Reduction*
	Ex Ante	*Ex Post*	*Realization Rate*	
Prescriptive Lighting	58,840	89,352	152%	12.95
Total	**58,840**	**89,352**	**152%**	**12.95**

The annual energy savings realized amounted to 89,352 kWh, with a gross energy savings realization rate of 152%. The discrepancy between expected and actual savings stems from the ex-ante savings estimate using a deemed value per unit, in contrast to the ex-post analysis, which applied the method outlined above. This analysis confirmed the hours of use at 6,188, greater than the deemed hours for a retail facility of 4,984. The analysis for occupancy sensor savings took into account the connected watts and the hours of use, while the ex-ante savings estimate was based on a deemed value per unit as well.

The peak demand ex-post savings of 12.95 kW was greater than the deemed ex-ante savings of 8.05 kW.

2.14. Sample ID 117

Executive Summary

Under a project represented by sample ID 117, a program participant received prescriptive incentives from I&M for installing more efficient lighting in their building.

The ex post energy savings are 26,516 kWh and peak demand savings are 4.06 kW resulting in an energy savings realization rate of 16%.

Project Description

The participant replaced fluorescent linear lamps with (206) LED 4’ retrofit kits and (11) LED 3’ retrofit kits.

Measurement and Verification Effort

To verify the project savings, ADM staff reviewed project documentation, existing lighting types, new lighting, methods of controlling the lighting and the HVAC types for each area. Interval electric billing data for one year was aggregated in one hour periods, binned to the day of the week, to estimate the working schedule.

The following algorithms for energy and coincident peak demand savings were sourced from the measure: *Lighting Systems, (Indiana TRM version 2.2)*.

$$kWh_{savings} = \sum_{Area}\left[Hours\ x\ (Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed}) x\ Whf_{kWh}/1000\frac{W}{kW}\right]$$

$$kW_{savings} = \sum_{Area}\left[(Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed})\ x\ Whf_{kW}\ xCF/1000\frac{W}{kW}\right]$$

Where:

$kWh_{savings}$	= *Annual energy savings*
$kW_{savings}$	= *Annual coincident peak demand savings*
Qty	= *Quantity of fixtures or lamps*
W	= *Wattage of each fixture or lamp*
Hours	= *Lighting annual operating hours*
Whf	= *Waste heat factor for kW or kWh, IN TRM 2.2 by city & HVAC type*
CF	=*Coincident peak demand factor, IN TRM 2.2, by building type*

The variables for the energy savings algorithm are summarized in the following table.

Lighting Energy Savings Calculations

Measure	*Quantity*		*Wattage*		*Annual Hours*	*Waste Heat Factor*	*Ex Ante Annual kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
	Base	*Efficient*	*Base*	*Efficient*					
4’ 1L T8 to LED 66W Retrofit Kit	28	28	107.40	66.1	5,814	0.13	22,982	7,618	33%
4’ 2L T8 to LED 33W Retrofit Kit	16	16	53.75	33.0	5,814	0.13	1,935	2,187	113%
8’ 2L T8 to LED 37W Retrofit Kit	133	133	53.90	37.2	5,814	0.13	109,166	14,632	13%
4’ 1L T8 to LED 20W Retrofit Kit	29	29	27.18	19.9	5,814	0.13	23,803	1,391	6%
3’ 1L T8 to LED 16W Retrofit Kit	11	11	25.00	15.5	5,814	0.13	9,029	688	8%
Total							**166,916**	**26,516**	**16%**

Results

Realized Gross Savings

Measure Category	*kWh Savings*			*Realized Peak kW Reduction*
	Ex Ante	*Ex Post*	*Realization Rate*	
Prescriptive Lighting	166,916	26,516	16%	4.06
Total	**166,916**	**26,516**	**16%**	**4.06**

The ex post energy savings are 26,516 kWh with a gross energy savings realization rate of 16%. The difference between the expected and realized savings is due to the following:

- The ex-ante savings estimate used deemed savings values. The first, third, fourth, and fifth measures ex ante estimate were based on those for a high bay fixture, with an 820.9 deemed savings per unit. However, the actual installed product was a retrofit kit, which would have had a significantly lower deemed savings of 155.2 per unit. The second measure savings estimate was based on the value for a light fixture intended to replace a 2L T8/T12, with a deemed savings of 120.8 per unit. The installed product, in this case, was also a retrofit kit.
- The base wattages verified (107.4W, 53.75W, 53.9W, 27.18W, and 25W, respectively) were different from the ex-ante base wattages (114W, 57W, 57W, 23W, and 22W, respectively).
- The efficient wattages verified for the first, third, fourth, and fifth measures (66.1W, 37.2W, 19.9W, 15.5W, respectively) were slightly different from the ex-ante efficient wattages (66W, 37W, 20W, and 15W, respectively).
- The verified hours of operation, totaling 5,814, exceeded the ex-ante Technical Reference Manual (TRM) hours for retail, which were 4,984.

The peak demand ex-post savings of 4.06 kW was less than the ex-ante savings of 36.55 kW that was based on a deemed value.

2.15. Sample ID 118

Executive Summary

Under a project represented by sample ID 118, a program participant received prescriptive incentives from I&M for installing more efficient lighting in the interior and exterior of their building.

The ex post energy savings are 189,233 kWh and the realization rate was 32%. The peak demand savings are 39.55 kW.

Project Description

The participant installed (164) LED high bay fixtures, (288) LED 4' lamps, (16) LED exit signs, and (164) occupancy sensors.

Measurement and Verification Effort

To verify the project savings, ADM staff reviewed available project documentation, collected the existing lighting type, new lighting manufacturer model and specification data, the lighting control methods and the type of HVAC for each area. Interval electric billing data for one year was aggregated in one hour periods, binned to the day of the week, to estimate the working schedule.

The following algorithms for energy and coincident peak demand savings were sourced from the measure: *Lighting Systems, (Indiana TRM version 2.2).*

$$kWh_{savings} = \sum_{Area} \left[Hours\ x\ (Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed}) x\ Whf_{kWh} / 1000 \frac{W}{kW} \right]$$

$$kW_{savings} = \sum_{Area} \left[(Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed})\ x\ Whf_{kW}\ x CF / 1000 \frac{W}{kW} \right]$$

Where:

$kWh_{savings}$	= *Annual energy savings*
$kW_{savings}$	= *Annual coincident peak demand savings*
Qty	= *Quantity of fixtures or lamps*
W	= *Wattage of each fixture or lamp*
$Hours$	= *Lighting annual operating hours*
Whf	= *Waste heat factor for kW or kWh, IN TRM 2.2 by city & HVAC type*
CF	=*Coincident peak demand factor, IN TRM 2.2, by building type*

The variables for the energy savings algorithm are summarized in the following table.

Lighting Energy Savings Calculations

Measure	*Quantity*		*Wattage*		*Annual Hours*	*Waste Heat Factor*	*Ex Ante Annual kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
	Base	*Efficient*	*Base*	*Efficient*					
HID to LED High Bay	164	164	400	185	3,734	0.00	134,611	131,651	98%
4’ T8 to LED 4’ lamp	288	288	32	13.8	3,734	0.00	23,639	19,571	83%
None to Occupancy Sensor	0	164		185	3,734	0.00	433,452	33,984	8%
Exit Sign to LED Exit Sign	16	16	30	1.3	8,760	0.00	3,216	4,027	125%
Total							**594,918**	**189,233**	**32%**

Results

Realized Gross Savings

Measure Category	*kWh Savings*			*Realized Peak kW Reduction*
	Ex Ante	*Ex Post*	*Realization Rate*	
Prescriptive Lighting	594,918	189,233	32%	39.55
Total	**594,918**	**189,233**	**32%**	**39.55**

The annual energy savings realized amounted to 189,233 kWh, with a gross energy savings realization rate of 32%. The discrepancy between anticipated and actual savings primarily resulted from the ex-ante savings estimate using a deemed value, while the ex-post analysis employed the method previously mentioned. Specifically, the ex-ante savings estimate incorrectly applied the deemed savings for daylighting controls (2,643 per quantity), despite the absence of daylighting in the facility. Therefore, the deemed value for occupancy sensors (457 per quantity) would have been the appropriate choice. Additionally, the efficient wattages verified for the second measure (13.8W) exceeded the ex-ante estimated wattages (13W).

The peak demand ex-post savings of 39.55 kW was less than the ex-ante savings of 126.21 kW based on a deemed value.

2.16. Sample ID 119

Executive Summary

Under a project represented by sample ID 119, a program participant received prescriptive incentives from I&M for installing barrel insulation on process equipment. The ex post annual energy savings are 211,405 kWh, with a peak demand reduction of 46.61 kW, resulting in a kWh realization rate of 103%.

Project Description

The project added insulation to the barrel of uninsulated injection molding machines to reduce the heat loss from the barrel generated by the electric band heaters with 1.5" of fiberglass insulation, totaling 169 square feet of area.

Measurement and Verification Effort

ADM staff reviewed the application documents, invoices, and product specifications. The site contact verified the installed insulation and hours of operation.

The table shown below summarizes the collected data, with the energy and demand savings.

$$kWh_{savings} = Hours\ x\ BandHeater\%\ x \sum_{Temp} \frac{kW}{SF}\ x\ SF$$

Barrel Wrap Savings Inputs

Measure Category	*Input Values*	
	Insulation contractor	*Indiana TRM*
Hours	4,536	Actual
Band Heater Cycle	60%	Not specified
kW/SF no insul @450F, W//SF	0.3987	0.387
kW/SF insul @450F, W/SF	0.0310	0.0229
kW/SF savings @450F, W/SF	0.3677	0.3641
Square feet insulated	484.63	484.63

The ex-post analysis determined the band heater cycling percentage to be 75%, taking into account the insulation contractor's value of 60% and the assumed Indiana TRM value of 100%. The savings are detailed in the table below.

Barrel Insulation Savings

Measure	*Square Feet*	*Hours*		*Temperature*	*Ex Post Gross kWh*	*Ex Post Gross kW*
		Operating	*Band Heater %*			
Insulate Barrel: 169SF	169	4,536	75	450	211,404	46.61

Results

Gross Energy Impacts Summary

Measure Category	*kWh Savings*			*Ex Post Gross kW Savings*
	Ex Ante	*Ex Post*	*Realization Rate*	
Custom – Barrel Wrap Insulation	204,490	211,404	103%	46.61
Total	**204,490**	**211,404**	**103%**	**46.61**

The ex-post annual barrel insulation savings 211,404 kWh with a peak demand reduction of 46.61 kW, resulting in a kWh realization rate of 103%.

Both the ex-ante and ex-post reference heat transfer calculations derived from the 3E Plus Software tool. The resulting savings are similar.

2.17. Sample ID 120, 207

Executive Summary

Under project(s) represented by sample ID 120, 207, a program participant received prescriptive and custom incentives from I&M for installing more efficient lighting, lighting controls and exit signs, over the building code prescribed lighting power density requirement, in a new construction warehouse building.

The ex post annual energy savings are 1,009,355 kWh and the realization rate is 80%. The ex post peak demand savings are 154.65 kW.

Project Description

The participant installed energy efficient lighting and lighting controls that exceeded the minimum building code required lighting power density, by building type, as specified within the standard: *Energy Standard for Buildings Except Low-Rise Residential Buildings (ASHRAE 90.1-2007).* The participant also installed exterior energy efficient lighting, exceeding the code-based lighting power allowance.

The participant installed LED exit signs (13), occupancy sensors (172), LED high bay fixtures (172) and exterior LED wall wash fixtures (9).

Measurement and Verification Effort

To verify the project savings, ADM staff visited the site and installed temporary light metering devices. During the visit, staff collected the existing lighting type, new lighting manufacturer model and specification data, the lighting control methods and the type of HVAC for each area. Interval electric billing data for one year was aggregated in one-hour periods, binned to the day of the week, to estimate the working schedule.

The following algorithms for energy and coincident peak demand savings were sourced from the measure: *Lighting Systems, (Indiana TRM version 2.2).*

$$kWh_{savings} = \sum_{Area} \left[Hours \ x \ (Qty_{base} x \ W_{base} - Qty_{installed} x W_{installed}) x \ Whf_{kWh} / 1000 \frac{W}{kW} \right]$$

$$kW_{savings} = \sum_{Area} \left[(Qty_{base} x \ W_{base} - Qty_{installed} x W_{installed}) \ x \ Whf_{kW} \ xCF / 1000 \frac{W}{kW} \right]$$

Where:

$kWh_{savings}$	= *Annual energy savings*
$kW_{savings}$	= *Annual coincident peak demand savings*
Qty	= *Quantity of fixtures or lamps*
W	= *Wattage of each fixture or lamp*
Hours	= *Lighting annual operating hours*
Whf	= *Waste heat factor for kW or kWh, IN TRM 2.2 by city & HVAC type*
CF	=*Coincident peak demand factor, IN TRM 2.2, by building type*

The light metering performed in January resulted in the "Metered" values displayed in the following table. The site contact provided the annual working schedule and indicated that the warehouse operates nearly 24/7 during the harvest period. Interval billing data for another location was reviewed, providing the additional data for "Harvest Period" in the table. The two periods were weighted and combined to estimate the total hours show in the "Weighted Hours" column and used for the energy savings analysis.

On Site Light Metering with Similar Building Interval Usage Data

Measure Category	*Annual Hours of Use*		
	Metered	*Harvest Period Interval Data*	*Weighted Hours*
Loading dock	4,109	8,760	5,272
Main aisle	2,388	8,760	5,272
Warehouse1	100	8,760	2,265
Warehouse2	90	8,760	2,257
Warehouse3	90	8,760	2,257

The variables for the energy savings algorithm are summarized in the following table.

Lighting Energy Savings Calculations

Measure	*Quantity*		*Wattage*		*Annual Hours*	*Waste Heat Factor*	*Ex Ante Annual kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
	Base	*Efficient*	*Base*	*Efficient*					
LED Exit Sign	13	13	30	7	-	1.00	2,613	2,619	100%
Occupancy Sensors	172	172	-	333	4,087	1.00	78,604	90,953	116%
LED high bay fixture	48	48	821	105	5,812	1.00	257,333	199,734	78%
LED high bay fixture	124	124	1,126	144	5,812	1.00	911,693	707,629	78%
LED high bay fixture	4	4	393	50	5,812	1.00	10,261	7,964	78%
LED exterior	9	9	278	266	4,303	1.00	456	456	100%
Total							**1,260,960**	**1,009,355**	**80%**

Results

Realized Gross Savings

Measure Category	*kWh Savings*			*Realized Peak kW Reduction*
	Ex Ante	*Ex Post*	*Realization Rate*	
Prescriptive Lighting	81,217	93,573	115%	10.19
Custom Lighting	1,179,743	915,783	78%	144.46

Measure Category	*kWh Savings*			*Realized Peak kW Reduction*
	Ex Ante	*Ex Post*	*Realization Rate*	
Total	**1,260,960**	**1,009,355**	**80%**	**154.65**

The ex post energy savings are 1,009,355 kWh with a gross energy savings realization rate of 80%. The difference between the ex-ante and ex post savings estimates is due to the following factors:

- The ex-ante savings for the custom measure were estimated using an annual operation hour of 7,488, which exceeds the range of metered hours (100 to 4,109) and surpasses the range of weighted hours (2,257 to 5,272).
- The ex-post savings for the prescriptive lighting occupancy sensors in the warehouse were calculated using an energy savings factor of 68%, significantly higher than the deemed Indiana TRM2 savings factor of 0.24.

The peak demand ex-post savings of 154.65 kW was more than the ex-ante savings of 127.81 kW.

2.18. Sample ID 121

Executive Summary

Under project(s) represented by sample ID 121, a program participant received prescriptive incentives from I&M for installing more efficient lighting in their building.

The ex post energy savings are 54,836 kWh and peak demand savings are 8.64 kW resulting in an energy savings realization rate of 141%.

Project Description

The participant installed (472) LED 4' lamps.

Measurement and Verification Effort

To verify the project savings, ADM staff reviewed project documentation, existing lighting types, new lighting, methods of controlling the lighting and the HVAC types for each area. Interval electric billing data for one year was aggregated in one hour periods, binned to the day of the week, to estimate the working schedule.

The following algorithms for energy and coincident peak demand savings were sourced from the measure: *Lighting Systems, (Indiana TRM version 2.2).*

$$kWh_{savings} = \sum_{Area} \left[Hours\ x\ (Qty_{base} x\ W_{base} - Qty_{installed} x W_{install}\ )x\ Whf_{kWh}/1000 \frac{W}{kW} \right]$$

$$kW_{savings} = \sum_{Area} \left[(Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed})\ x\ Whf_{kW}\ xCF/1000 \frac{W}{kW} \right]$$

Where:

$kWh_{savings}$	= *Annual energy savings*
$kW_{savings}$	= *Annual coincident peak demand savings*
Qty	= *Quantity of fixtures or lamps*
W	= *Wattage of each fixture or lamp*
Hours	= *Lighting annual operating hours*
Whf	= *Waste heat factor for kW or kWh, IN TRM 2.2 by city & HVAC type*
CF	=*Coincident peak demand factor, IN TRM 2.2, by building type*

The variables for the energy savings algorithm are summarized in the following table.

Lighting Energy Savings Calculations

Measure	*Quantity*		*Wattage*		*Annual Hours*	*Waste Heat Factor*	*Ex Ante Annual kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
	Base	*Efficient*	*Base*	*Efficient*					
4’ 3L T12 to LED 4’ 3L	10	10	96	42	6,188	0.12	3,024	3,756	124%
4’ 4L T12 to LED 4’ 4L	2	2	128	56	6,188	0.12	881	1,002	114%
4’ 2L T12 to LED 4’ 2L	150	150	64	28	6,188	0.12	26,585	37,559	141%
4’ 1 L T12 to LED 4’ 1L	138	138	32	14	6,188	0.12	11,327	17,277	153%
Total							**37,912**	**54,836**	**144%**

Results

Realized Gross Savings

Measure Category	*kWh Savings*			*Realized Peak kW Reduction*
	Ex Ante	*Ex Post*	*Realization Rate*	
Prescriptive Lighting	37,912	54,836	144%	8.64
Total	**37,912**	**54,836**	**144%**	**8.64**

The ex post energy savings are 54,836 kWh with a gross energy savings realization rate of 144%. The discrepancy between anticipated and actual savings stems from the ex-ante savings estimate using a deemed value per unit, whereas the ex-post analysis employed the previously mentioned method. This analysis confirmed the hours of use at 6,188, exceeding the deemed hours for a retail facility of 4,984.

The peak demand ex-post savings of 8.64 kW were similar to the ex-ante savings of 8.67 kW.

2.19. Sample ID 122

Executive Summary

Under a project represented by sample ID 122, a program participant received prescriptive incentives from I&M for installing more efficient lighting in their building.

The ex post energy savings are 101,807 kWh and peak demand savings are 13.93 kW resulting in an energy savings realization rate of 160%.

Project Description

The participant installed (755) LED 4' lamps and (5) occupancy sensors.

Measurement and Verification Effort

To verify the project savings, ADM staff reviewed available project documentation, collected the existing lighting type, new lighting manufacturer model and specification data, the lighting control methods and the type of HVAC for each area. Interval electric billing data for one year was aggregated in one-hour periods, binned to the day of the week, to estimate the working schedule.

The following algorithms for energy and coincident peak demand savings were sourced from the measure: *Lighting Systems, (Indiana TRM version 2.2).*

$$kWh_{savings} = \sum_{Area} \left[Hours\ x\ (Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed}) x\ Whf_{kWh} / 1000 \frac{W}{kW} \right]$$

$$kW_{savings} = \sum_{Area} \left[(Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed})\ x\ Whf_{kW}\ xCF / 1000 \frac{W}{kW} \right]$$

Where:

$kWh_{savings}$ = *Annual energy savings*
$kW_{savings}$ = *Annual coincident peak demand savings*
Qty = *Quantity of fixtures or lamps*
W = *Wattage of each fixture or lamp*
$Hours$ = *Lighting annual operating hours*
Whf = *Waste heat factor for kW or kWh, IN TRM 2.2 by city & HVAC type*
CF =*Coincident peak demand factor, IN TRM 2.2, by building type*

The variables for the energy savings algorithm are summarized in the following table.

Lighting Energy Savings Calculations

Measure	*Quantity*		*Wattage*		*Annual Hours*	*Waste Heat Factor*	*Ex Ante Annual kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
	Base	*Efficient*	*Base*	*Efficient*					
4' T12 to LED 4' lamp	755	755	32	14	6,556	0.12	61,970	100,138	162%

Measure	*Quantity*		*Wattage*		*Annual Hours*	*Waste Heat Factor*	*Ex Ante Annual kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
	Base	*Efficient*	*Base*	*Efficient*					
Occupancy Sensor	0	5	0	151	6,556	0.12	1,525	1,669	109%
Total							**63,495**	**101,807**	**160%**

Results

Realized Gross Savings

Measure Category	*kWh Savings*			*Realized Peak kW Reduction*
	Ex Ante	*Ex Post*	*Realization Rate*	
Prescriptive Lighting	63,495	101,807	160%	13.93
Total	**63,495**	**101,807**	**160%**	**13.93**

The ex post energy savings are 101,807 kWh with a gross energy savings realization rate of 160%. The discrepancy between expected and realized savings arises from the ex-ante savings estimate relying on a deemed value per unit, in contrast to the ex-post analysis, which implemented the previously described method. This analysis confirmed the hours of use at 6,656, which exceeds the deemed hours for a retail facility of 4,984. The analysis for occupancy sensors took into account the connected watts and hours of use, while the ex-ante savings estimate was based on a deemed value per unit.

The peak demand ex-post savings of 13.93 kW was greater than the ex-ante savings of 8.67 kW, based on a deemed value.

2.20. Sample ID 123

Executive Summary

Under a project represented by sample ID 123, a program participant received prescriptive incentives from I&M for installing more efficient lighting in their building.

The ex post energy savings are 14,718 kWh and peak demand savings are 0.00 kW resulting in an energy savings realization rate of 96%.

Project Description

The participant installed (10) LED Wall Packs and (11) LED Area Lights.

Measurement and Verification Effort

To verify the project savings, ADM staff reviewed project documentation, existing lighting types, new lighting, methods of controlling the lighting and the HVAC types for each area. Interval electric billing data for one year was aggregated in one hour periods, binned to the day of the week, to estimate the working schedule.

The following algorithms for energy and coincident peak demand savings were sourced from the measure: *Lighting Systems, (Indiana TRM version 2.2).*

$$kWh_{savings} = \sum_{Area} \left[Hours\ x\ (Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed}) x\ Whf_{kWh} / 1000 \frac{W}{kW} \right]$$

$$kW_{savings} = \sum_{Area} \left[(Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed})\ x\ Whf_{kW}\ xCF / 1000 \frac{W}{kW} \right]$$

Where:

$kWh_{savings}$ = *Annual energy savings*
$kW_{savings}$ = *Annual coincident peak demand savings*
Qty = *Quantity of fixtures or lamps*
W = *Wattage of each fixture or lamp*
$Hours$ = *Lighting annual operating hours*
Whf = *Waste heat factor for kW or kWh, IN TRM 2.2 by city & HVAC type*
CF = *Coincident peak demand factor, IN TRM 2.2, by building type*

The variables for the energy savings algorithm are summarized in the following table.

Lighting Energy Savings Calculations

Measure	*Quantity*		*Wattage*		*Annual Hours*	*Waste Heat Factor*	*Ex Ante Annual kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
	Base	*Efficient*	*Base*	*Efficient*					
HID to LED Wall Pack	10	10	100	28.9	4,303	0.00	3,456	3,059	89%

Measure	*Quantity*		*Wattage*		*Annual Hours*	*Waste Heat Factor*	*Ex Ante Annual kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
	Base	*Efficient*	*Base*	*Efficient*					
MH to LED Area Light	11	11	400	153.7	4,303	0.00	11,880	11,658	98%
Total							**15,336**	**14,718**	**96%**

Results

Realized Gross Savings

Measure Category	*kWh Savings*			*Realized Peak kW Reduction*
	Ex Ante	*Ex Post*	*Realization Rate*	
Prescriptive Lighting	15,336	14,718	96%	0.00
Total	**15,336**	**14,718**	**96%**	**0.00**

The ex post energy savings are 14,718 kWh with a gross energy savings realization rate of 96%. The difference between the expected and realized savings is due to a difference in the verified efficient wattages (28.9W and 153.7W) used in the ex post analysis from the wattages used in the ex-ante savings estimate (30W and 150W).

2.21. Sample ID 124,125

Executive Summary

Under Project(s) represented by sample ID 124 & 125, a program participant received prescriptive incentives from I&M for installing more efficient lighting in their building.

The ex post energy savings are 7,675 kWh and peak demand savings are 2.23 kW resulting in an energy savings realization rate of 58%.

Project Description

The participant installed (160) LED 4' 17W lamps.

Measurement and Verification Effort

To verify the project savings, ADM staff reviewed project documentation, existing lighting types, new lighting, methods of controlling the lighting and the HVAC types for each area. Interval electric billing data for one year was aggregated in one-hour periods, binned to the day of the week, to estimate the working schedule.

The following algorithms for energy and coincident peak demand savings were sourced from the measure: *Lighting Systems, (Indiana TRM version 2.2).*

$$kWh_{savings} = \sum_{Area}\left[Hours\ x\ (Qty_{base} x\ W_{base} - Qty_{installed} x W_{installe}\ )x\ Whf_{kWh}/1000\frac{W}{kW}\right]$$

$$kW_{savings} = \sum_{Area}\left[(Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed})\ x\ Whf_{kW}\ xCF/1000\frac{W}{kW}\right]$$

Where:

$kWh_{savings}$	= *Annual energy savings*
$kW_{savings}$	= *Annual coincident peak demand savings*
Qty	= *Quantity of fixtures or lamps*
W	= *Wattage of each fixture or lamp*
$Hours$	= *Lighting annual operating hours*
Whf	= *Waste heat factor for kW or kWh, IN TRM 2.2 by city & HVAC type*
CF	=*Coincident peak demand factor, IN TRM 2.2, by building type*

The variables for the energy savings algorithm are summarized in the following table.

Lighting Energy Savings Calculations

Measure	*Quantity*		*Wattage*		*Annual Hours*	*Waste Heat Factor*	*Ex Ante Annual kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
	Base	*Efficient*	*Base*	*Efficient*					
4' T8 to LED 4' lamp	32	32	32	17	2,920	1.00	2,627	1,402	53%

Measure	*Quantity*		*Wattage*		*Annual Hours*	*Waste Heat Factor*	*Ex Ante Annual kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
	Base	*Efficient*	*Base*	*Efficient*					
4’ T8 to LED 4’ lamp	128	128	32	17	2,920	1.12	10.506	6,274	60%
Total							**13,133**	**7,675**	**58%**

Results

Realized Gross Savings

Measure Category	*kWh Savings*			*Realized Peak kW Reduction*
	Ex Ante	*Ex Post*	*Realization Rate*	
Prescriptive Lighting 124	13,133	7,675	58%	2.23
Total	**13,133**	**7,675**	**58%**	**2.23**

The ex post energy savings are 7,675 kWh with a gross energy savings realization rate of 58%. The difference between the expected and realized savings is due to the ex-ante savings estimate using deemed values in the savings calculations.

The peak demand ex-post savings of 2.23kW was more than the ex-ante savings of 1.824kW which had also been deemed.

2.22. Sample ID 126

Executive Summary

Under a project represented by sample ID 126, received prescriptive incentives from I&M for installing more efficient lighting in their building during a renovation, lighting controls, and packaged rooftop heat pumps.

The ex post energy savings are 430,747 kWh and peak demand savings are 72.87 kW resulting in an energy savings realization rate of 72%.

Project Description

The participant installed (24) LED 2x2 fixtures, (712) LED 2x4 fixtures, (29) LED exit signs, (190) occupancy sensors, and (4) VFD's.

Measurement and Verification Effort

To verify the project savings, ADM staff reviewed available project documentation, collected the existing lighting type, new lighting manufacturer model and specification data, the lighting control methods and the type of HVAC for each area. Interval electric billing data for one year was aggregated in one hour periods, binned to the day of the week, to estimate the working schedule.

The following algorithms for energy and coincident peak demand savings were sourced from the measure: *Lighting Systems, (Indiana TRM version 2.2)*.

$$kWh_{savings} = \sum_{Area} \left[Hours\ x\ (Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed}) x\ Whf_{kWh} / 1000 \frac{W}{kW} \right]$$

$$kW_{savings} = \sum_{Area} \left[(Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed})\ x\ Whf_{kW}\ xCF / 1000 \frac{W}{kW} \right]$$

Where:

$kWh_{savings}$	= *Annual energy savings*
$kW_{savings}$	= *Annual coincident peak demand savings*
Qty	= *Quantity of fixtures or lamps*
W	= *Wattage of each fixture or lamp*
$Hours$	= *Lighting annual operating hours*
Whf	= *Waste heat factor for kW or kWh, IN TRM 2.2 by city & HVAC type*
CF	=*Coincident peak demand factor, IN TRM 2.2, by building type*

The variables for the energy savings algorithm are summarized in the following table.

Lighting Energy Savings Calculations

Measure	*Quantity*		*Wattage*		*Annual Hours*	*Waste Heat Factor*	*Ex Ante Annual kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
	Base	*Efficient*	*Base*	*Efficient*					
U-tube fixture to LED 2x2 fixture	24	24	59	56.80	3,054	0.07	2,903	173	6%
T8 to LED 2x4 fixture	712	712	112	29.84	3,054	0.07	313,736	191,668	61%
Inc Exit Sign to LED	29	29	25	1	8,760	0.07	2,407	6,542	272%
Occupancy controls	0	190	-	112	3,054	0.07	57,935	20,884	36%
Total							**376,981**	**219,267**	**58%**

Variable Speed Drive Energy Savings

VSD	*Load*	*HP*	*VFD Quantity*	*ESF kWh/hp*	*ESF kW/hp*	*Ex Ante Annual kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
VSD1,2	Hot water	15	2	4,139	0.88	93,600	124,170	133%
VSD 3,4	CHW	10	2	4,016	0.42	82,000	80,320	98%
VSD 5	AHU fan	5	1	1,689	0.23	31,200	8,445	27%
VSD 7	Return fan	3	1	1,415	0.28	4,680	4,245	91%
Total						**217,180**	**211,480**	**97%**

Results

Realized Gross Savings

Measure Category	*kWh Savings*			*Realized Peak kW Reduction*
	Ex Ante	*Ex Post*	*Realization Rate*	
Prescriptive Lighting	376,981	219,267	58%	36.19
Prescriptive VFD	217,180	211,480	97%	36.68
Total	**594,161**	**430,747**	**72%**	**72.87**

The ex post energy savings are 430,747 kWh with a gross energy savings realization rate of 72%. The difference between the expected and realized savings is due to the following:

- The verified wattage of the first measure (56.80) is greater than the wattage used to calculate ex-ante savings (55).
- There were multiple verified wattages for the second measure (23.2W, 28.8W, 30W, 34.3W, and 65.1W). The ex-ante savings estimate combined all the fixtures into one

measure. The ex-post analysis average wattage (29.84W) in general was less than the wattage used for the savings estimate (36W).

- The confirmed hours of use for the facility (3,053) are greater than the deemed hours (2,379) used in the ex ante savings analysis.
- The savings for the occupancy sensors is based on the connected load per sensor (112) and hours of use, where the ex-ante savings was calculated using a deemed savings per sensor (304 kwh).

The peak demand ex-post savings of 72.87 kW was less than the ex-ante savings of 80.23 kW.

2.23. Sample ID 127, 215

Executive Summary

Under project(s) represented by sample ID 127, 215, a program participant received prescriptive and custom incentives from I&M for installing more efficient lighting in their building.

The ex post energy savings are 182,372 kWh and peak demand savings are 43.34 kW resulting in an energy savings realization rate of 102%.

Project Description

The participant installed (106) LED high bay fixtures and (222) LED retrofit kits.

Measurement and Verification Effort

To verify the project savings, ADM staff reviewed project documentation, existing lighting types, new lighting, methods of controlling the lighting and the HVAC types for each area. Interval electric billing data for one year was aggregated in one hour periods, binned to the day of the week, to estimate the working schedule.

The following algorithms for energy and coincident peak demand savings were sourced from the measure: *Lighting Systems, (Indiana TRM version 2.2).*

$$kWh_{savings} = \sum_{Area} \left[Hours\ x\ (Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed})x\ Whf_{kWh}/1000 \frac{W}{kW} \right]$$

$$kW_{savings} = \sum_{Area} \left[(Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed})\ x\ Whf_{kW}\ xCF/1000 \frac{W}{kW} \right]$$

Where:

$kWh_{savings}$	= *Annual energy savings*
$kW_{savings}$	= *Annual coincident peak demand savings*
Qty	= *Quantity of fixtures or lamps*
W	= *Wattage of each fixture or lamp*
$Hours$	= *Lighting annual operating hours*
Whf	= *Waste heat factor for kW or kWh, IN TRM 2.2 by city & HVAC type*
CF	=*Coincident peak demand factor, IN TRM 2.2, by building type*

The variables for the energy savings algorithm are summarized in the following table.

Lighting Energy Savings Calculations

Measure	Quantity		Wattage		Annual Hours	Waste Heat Factor	Ex Ante Annual kWh Savings	Ex Post Gross kWh Savings	Gross Realization Rate
	Base	Efficient	Base	Efficient					
HID to LED High Bay	6	6	400	157	3,215	0.13	7,588	5,281	70%
HID to LED High Bay	100	100	400	157	3,215	0.13	82,080	88,009	107%
Prescriptive Total							**89,668**	**93,289**	**104%**
8’ 2L T8 to LED Retrofit Kit	111	222	257	26	3,900	0.00	88,745	89,083	100%
Custom Total							**178,413**	**182,372**	**102%**

Results

Realized Gross Savings

Measure Category	kWh Savings			Realized Peak kW Reduction
	Ex Ante	Ex Post	Realization Rate	
Prescriptive Lighting	89,668	93,289	104%	25.97
Custom Lighting	88,745	89,083	100%	17.36
Total	**178,413**	**182,372**	**102%**	**43.34**

The ex post energy savings are 182,372 kWh with a gross energy savings realization rate of 102%. The main difference between the expected and realized savings is due to the Prescriptive ex-ante savings estimate being based on a deemed value while the ex-post analysis used the method stated above. The first measure had a deemed savings per unit (1,265) that is much greater than the second measure deemed savings (821). Both measures have the same base wattage and the same efficient fixture installed. In addition, the first, second, and third measures had verified wattages (156.9W, 156.9W, and 25.6W, respectively) that differ from the wattages the ex-ante used (155W, 155W, and 26W, respectively).

The primary difference between expected and realized savings stems from the prescriptive ex-ante savings estimate relying on a deemed value, in contrast to the ex-post analysis, which applied the specified method. The deemed per unit savings for the first measure (1,265) was significantly greater than for the second measure (821), despite both measures having identical base wattage and the same efficient fixture installed. Furthermore, the verified wattages for the first, second, and third measures (156.9W, 156.9W, and 25.6W, respectively) varied from the ex-ante wattages (155W, 155W, and 26W, respectively).

The peak demand ex-post savings of 43.34 kW was greater than the ex-ante savings of 19.12 kW. Ex post savings were greater because the ex-ante savings estimate for the prescriptive measure relied on a deemed value that was lower than the savings realized. For the custom measure, the ex-ante savings estimate was 0.00, whereas the ex-post analysis utilized the appropriate CF (capacity factor) value associated with the building type.

2.24. Sample ID 129

Executive Summary

Under a project represented by sample ID 129, a program participant received prescriptive incentives from I&M for installing more efficient lighting in their building.

The ex post energy savings are 1,386 kWh and peak demand savings are 0.61 kW resulting in an energy savings realization rate of 44%.

Project Description

The participant installed (38) LED 4' lamps.

Measurement and Verification Effort

To verify the project savings, ADM staff reviewed project documentation, existing lighting types, new lighting, methods of controlling the lighting and the HVAC types for each area. Interval electric billing data for one year was aggregated in one hour periods, binned to the day of the week, to estimate the working schedule.

The following algorithms for energy and coincident peak demand savings were sourced from the measure: *Lighting Systems, (Indiana TRM version 2.2).*

$$kWh_{savings} = \sum_{Area}\left[Hours\ x\ (Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed}) x\ Whf_{kWh}/1000\frac{W}{kW}\right]$$

$$kW_{savings} = \sum_{Area}\left[(Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed})\ x\ Whf_{kW}\ xCF/1000\frac{W}{kW}\right]$$

Where:

$kWh_{savings}$	= *Annual energy savings*
$kW_{savings}$	= *Annual coincident peak demand savings*
Qty	= *Quantity of fixtures or lamps*
W	= *Wattage of each fixture or lamp*
Hours	= *Lighting annual operating hours*
Whf	= *Waste heat factor for kW or kWh, IN TRM 2.2 by city & HVAC type*
CF	=*Coincident peak demand factor, IN TRM 2.2, by building type*

The variables for the energy savings algorithm are summarized in the following table.

Lighting Energy Savings Calculations

Measure	*Quantity*		*Wattage*		*Annual Hours*	*Waste Heat Factor*	*Ex Ante Annual kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
	Base	*Efficient*	*Base*	*Efficient*					
4' T12 to LED 4' lamp 4000K	14	14	32	16	2,028	0.12	1,149	511	44%

Measure	*Quantity*		*Wattage*		*Annual Hours*	*Waste Heat Factor*	*Ex Ante Annual kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
	Base	*Efficient*	*Base*	*Efficient*					
4’ T12 to LED 4’ lamp 5000K	24	24	32	16	2,028	0.12	1,970	875	44%
Total							3,119	1,386	44%

Results

Realized Gross Savings

Measure Category	*kWh Savings*			*Realized Peak kW Reduction*
	Ex Ante	*Ex Post*	*Realization Rate*	
Prescriptive Lighting	3,119	1,386	44%	0.61
Total	**3,119**	**1,386**	**44%**	**0.61**

The ex-post energy savings are 1,386 kWh with a gross energy savings realization rate of 44%. The discrepancy between ex ante and ex-post savings arises because the ex-ante savings estimate was based on a deemed value per unit, in contrast to the ex-post analysis, which applied the specified method. This analysis confirmed the hours of use at 2,028, which are fewer than the deemed hours for a retail facility of 4,984.

The peak demand ex-post savings of 0.61 kW exceeded the ex-ante savings of 0.43 kW, based on a deemed savings value.

2.25. Sample ID 131

Executive Summary

Under project represented by sample ID 131, a program participant received prescriptive incentives from I&M for installing more efficient lighting in their building.

The ex post energy savings are 11,690 kWh and peak demand savings are 2.27 kW resulting in an energy savings realization rate of 95%.

Project Description

The participant installed (34) LED 2x4 panel fixtures and (35) LED 4' lamps.

Measurement and Verification Effort

To verify the project savings, ADM staff reviewed project documentation, existing lighting types, new lighting, methods of controlling the lighting and the HVAC types for each area. Interval electric billing data for one year was aggregated in one hour periods, binned to the day of the week, to estimate the working schedule.

The following algorithms for energy and coincident peak demand savings were sourced from the measure: *Lighting Systems, (Indiana TRM version 2.2).*

$$kWh_{savings} = \sum_{Area} \left[Hours\ x\ (Qty_{base} x\ W_{base} - Qty_{installed} x W_{installe}\ )x\ Whf_{kWh}/1000 \frac{W}{kW} \right]$$

$$kW_{savings} = \sum_{Area} \left[(Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed})\ x\ Whf_{kW}\ xCF/1000 \frac{W}{kW} \right]$$

Where:

$kWh_{savings}$	= *Annual energy savings*
$kW_{savings}$	= *Annual coincident peak demand savings*
Qty	= *Quantity of fixtures or lamps*
W	= *Wattage of each fixture or lamp*
Hours	= *Lighting annual operating hours*
Whf	= *Waste heat factor for kW or kWh, IN TRM 2.2 by city & HVAC type*
CF	=*Coincident peak demand factor, IN TRM 2.2, by building type*

The variables for the energy savings algorithm are summarized in the following table.

Lighting Energy Savings Calculations

Measure	*Quantity*		*Wattage*		*Annual Hours*	*Waste Heat Factor*	*Ex Ante Annual kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
	Base	*Efficient*	*Base*	*Efficient*					
4' 3L T8 to LED 2x4 fixture	34	34	96	45	4,719	0.10	10,282	9,027	88%

Measure	*Quantity*		*Wattage*		*Annual Hours*	*Waste Heat Factor*	*Ex Ante Annual kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
	Base	*Efficient*	*Base*	*Efficient*					
T8 lamp to LED 4' lamp	25	25	32	12	4,719	0.10	2,052	2,663	130%
Total							12,334	11,690	95%

Results

Realized Gross Savings

Measure Category	*kWh Savings*			*Realized Peak kW Reduction*
	Ex Ante	*Ex Post*	*Realization Rate*	
Prescriptive Lighting	12,334	11,690	95%	2.27
Total	**12,334**	**11,690**	**95%**	**2.27**

The ex post energy savings are 11,690 kWh with a gross energy savings realization rate of 95%. The primary difference between ex ante and ex post savings stems from the ex-ante savings estimate relying on a deemed value, in contrast to the ex-post analysis, which employed the method described above.

The peak demand ex-post savings of 2.27 kW was greater than the ex-ante savings of 1.71 kW.

2.26. Sample ID 132

Executive Summary

Under a project represented by sample ID 132, a program participant received prescriptive incentives from I&M for replacing their existing LED linear lighting lamps with a more efficient LED linear lamp.

The ex post energy savings are 8,974 kWh and peak demand savings are 1.69 kW resulting in an energy savings realization rate of 56%.

Project Description

The participant installed (197) LED 8.5W linear lamps.

Measurement and Verification Effort

To verify the project savings, ADM staff reviewed project documentation, existing lighting types, new lighting, methods of controlling the lighting and the HVAC types for each area. Interval electric billing data for one year was aggregated in one hour periods, binned to the day of the week, to estimate the working schedule.

The following algorithms for energy and coincident peak demand savings were sourced from the measure: *Lighting Systems, (Indiana TRM version 2.2)*.

$$kWh_{savings} = \sum_{Area}\left[Hours\ x\ (Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed}) x\ Whf_{kWh} / 1000 \frac{W}{kW}\right]$$

$$kW_{savings} = \sum_{Area}\left[(Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed})\ x\ Whf_{kW}\ xCF / 1000 \frac{W}{kW}\right]$$

Where:

$kWh_{savings}$ = *Annual energy savings*
$kW_{savings}$ = *Annual coincident peak demand savings*
Qty = *Quantity of fixtures or lamps*
W = *Wattage of each fixture or lamp*
$Hours$ = *Lighting annual operating hours*
Whf = *Waste heat factor for kW or kWh, IN TRM 2.2 by city & HVAC type*
CF =*Coincident peak demand factor, IN TRM 2.2, by building type*

The variables for the energy savings algorithm are summarized in the following table.

Lighting Energy Savings Calculations

Measure	*Quantity*		*Wattage*		*Annual Hours*	*Waste Heat Factor*	*Ex Ante Annual kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
	Base	*Efficient*	*Base*	*Efficient*					
T8 LED to T8 LED	197	197	15	8.5	5,840	1.2	16,154	8,974	56%
Total							16,154	8,974	56%

Results

Realized Gross Savings

Measure Category	*kWh Savings*			*Realized Peak kW Reduction*
	Ex Ante	*Ex Post*	*Realization Rate*	
Prescriptive Lighting	16,154	8,974	56%	1.69
Total	**16,154**	**8,974**	**56%**	**1.69**

The ex post energy savings are 8,974 kWh with a gross energy savings realization rate of 65%. The primary difference between ex ante and ex post savings stems from the ex-ante savings estimate relying on a deemed value, in contrast to the ex-post analysis, which employed the method described above.

The peak demand ex-post savings of 1.69 kW was less than the ex-ante savings of 1.97 kW, which was also based on a deemed value.

2.27. Sample ID 133

Executive Summary

Under a project represented by sample ID 133, a program participant received prescriptive incentives from I&M for installing more efficient lighting in the interior and exterior of their building.

The ex post energy savings are 22,531 kWh and peak demand savings are 5.9 kW resulting in an energy savings realization rate of 77%.

Project Description

The participant installed (136) LED 1x4 panel fixtures, (7) LED 8’ downlights, (10) LED 6” downlights, (12) LED exit signs, and (6) LED wall packs.

Measurement and Verification Effort

To verify the project savings, ADM staff reviewed project documentation, existing lighting types, new lighting, methods of controlling the lighting and the HVAC types for each area. Interval electric billing data for one year was aggregated in one hour periods, binned to the day of the week, to estimate the working schedule.

The following algorithms for energy and coincident peak demand savings were sourced from the measure: *Lighting Systems, (Indiana TRM version 2.2).*

$$kWh_{savings} = \sum_{Area}\left[Hours\ x\ (Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed}) x\ Whf_{kWh} / 1000 \frac{W}{kW}\right]$$

$$kW_{savings} = \sum_{Area}\left[(Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed})\ x\ Whf_{kW}\ xCF / 1000 \frac{W}{kW}\right]$$

Where:

$kWh_{savings}$	= *Annual energy savings*
$kW_{savings}$	= *Annual coincident peak demand savings*
Qty	= *Quantity of fixtures or lamps*
W	= *Wattage of each fixture or lamp*
$Hours$	= *Lighting annual operating hours*
Whf	= *Waste heat factor for kW or kWh, IN TRM 2.2 by city & HVAC type*
CF	=*Coincident peak demand factor, IN TRM 2.2, by building type*

The variables for the energy savings algorithm are summarized in the following table.

Lighting Energy Savings Calculations

Measure	*Quantity*		*Wattage*		*Annual Hours*	*Waste Heat Factor*	*Ex Ante Annual kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
	Base	*Efficient*	*Base*	*Efficient*					
1x4 Surface (Flat Panel)	136	136	64	45	3443	1.2	16,451	10,676	65%
8" Downlight	7	7	180	18	3443	1.2	4,022	4,685	116%
6" Downlight	10	10	75	15	3443	1.2	5,746	2,479	43%
Exit Sign	12	12	25	5.2	8760	1.2	2,412	2,498	97%
Building Mounted Wall Pack	6	6	100	15	4300	1	2,074	2,193	106%
Total							**30,703**	**22,531**	**73%**

Results

Realized Gross Savings

Measure Category	*kWh Savings*			*Realized Peak kW Reduction*
	Ex Ante	*Ex Post*	*Realization Rate*	
Prescriptive Lighting	29,288	22,531	77%	5.90
Total	**29,288**	**22,531**	**77%**	**5.90**

The ex post energy savings are 22,531 kWh with a gross energy savings realization rate of 73%. The primary difference between ex ante and ex post savings stems from the ex-ante savings estimate relying on a deemed value, in contrast to the ex-post analysis, which employed the method described above.

The peak demand ex-post savings of 5.9 kW was greater than the ex-ante savings of 3.92 kW, which was based on a deemed savings value.

2.28. Sample ID 134

Executive Summary

Under a project represented by sample ID 134, the participant received prescriptive incentives from I&M while renovating their existing school building with new LED lighting, occupancy controls, LED exit signs and efficient heat pump variable refrigerant flow condensing units.

The ex post energy savings are 159,647 kWh with ex post peak demand reduction of 51.67 kW and the gross energy savings realization rate is 10%.

Project Description

The participant replaced fluorescent lighting fixtures with LED troffers (382), LED exit signs (26), wall mounted occupancy sensors (91) and networked ceiling occupancy sensors (28). They also replaced air conditioning units and a gas boiler with (8) heat pump variable refrigerant flow units.

Measurement and Verification Effort

To verify the project savings, ADM staff reviewed project documentation, existing lighting types, new lighting, methods of controlling the lighting and the HVAC types for each area. Interval electric billing data for one year was aggregated in one-hour periods, binned to the day of the week, to estimate the working schedule.

The following algorithms for energy and coincident peak demand savings were sourced from the measure: *Lighting Systems, (Indiana TRM version 2.2).*

$$kWh_{savings} = \sum_{Area} \left[Hours\ x\ (Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed}) x\ Whf_{kWh} / 1000 \frac{W}{kW} \right]$$

$$kW_{savings} = \sum_{Area} \left[(Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed})\ x\ Whf_{kW}\ xCF / 1000 \frac{W}{kW} \right]$$

Where:

$kWh_{savings}$	= *Annual energy savings*
$kW_{savings}$	= *Annual coincident peak demand savings*
Qty	= *Quantity of fixtures or lamps*
W	= *Wattage of each fixture or lamp*
$Hours$	= *Lighting annual operating hours*
Whf	= *Waste heat factor for kW or kWh, IN TRM 2.2 by city & HVAC type*
CF	=*Coincident peak demand factor, IN TRM 2.2, by building type*

The lighting prescriptive measure savings inputs are summarized in the following table.

Prescriptive Lighting Energy Savings Calculations

Measure	Quantity		Wattage		Hours	Heating Cooling Interaction Factor	Ex Ante Annual kWh Savings	Ex Post Gross kWh Savings	Gross Realization Rate
	Base	Efficient	Base	Efficient					
2L U-Tube T12 to LED troffer	41	41	48	18	3,744	0.00	4,959	3,776	76%
3L 4' T12 to LED troffer	196	196	120	30	3,744	0.00	59,270	54,156	91%
4L 4' T12 to LED Troffer	145	145	160	30	3,744	0.00	63,893	57,871	91%
Inc Exit Signs to LED	26	26	30	4	3,744	0.00	2,158	2,075	96%
Wall occupancy sensor	-	91	-	50	3,744	0.00	27,748	5,463	20%
Ceiling occupancy sensor	-	28	-	158	3,744	0.00	17,076	5,346	31%
Total							**175,104**	**128,688**	**73%**

The following algorithms for energy and coincident peak demand savings were sourced from the measure: *Heat Pump System, (Indiana TRM version 2.2).*

$$kWh_{savings} = \sum_{88\ units} \begin{matrix} CAP_{cool} x EFLHcool\left(\frac{1}{IEER_{base}} - \frac{1}{IEER_{eff}}\right) + \\ CAP_{heat} x EFLHheat\left(\frac{1}{HSPF_{base}} - \frac{1}{HSPF_{eff}}\right) \end{matrix}$$

Where:

$kWh_{savings}$	= *Annual energy savings*
$IEER_{base}$	= *Code efficiency, 12 to 13 EER, by capacity*
$IEER_{eff}$	= *Installed efficiency, 12.8 to 17 EER, by capacity*
COP_{base}	= *Code efficiency, 14.3 HSPF*
COP_{eff}	= *Installed efficiency, 12.8 to 22.5 HSPF by capacity*
Capacity	=*Installed heating or cooling capacity, MBH*
$EFLH_{cool}$	= *Effective full load cooling hours, IN TRM*
$EFLH_{heat}$	= *Effective full load heating hours, IN TRM TRM*

Baseline and New Equipment Specifications

Equipment	*Quantity*	*Cooling Capacity*	*Heating Capacity*	*Cooling Efficiency, IEER*		*Heating Efficiency, COP, 47F*	
		MBH	*MBH*	*Pre*	*Post*	*Pre*	*Post*
VRF Heat Pump	2	115	129	11.2	24.1	3.3	3.74
	2	72	77	11.2	25.4	3.3	4.29
	2	72	77	11.2	25.4	3.3	4.29
	1	72	77	11.2	25.4	3.3	4.29
	Ex Ante	Ex Post					
Total Tons	64	49 cool; 54 heat					
Air Makeup Unit	1	180	Gas	11.0	20.4		

The air makeup unit, identified in the equipment list, uses gas as its heating fuel source. This setup exists alongside a combination of gas heating and electric heat pump heating within the same spaces. Given that the school was undergoing renovations, a new construction baseline was applied to accommodate the mix of heating methods and the integration of updated equipment.

HVAC Energy Savings

Equipment	*Quantity*	*Cooling Capacity*	*Heating Capacity*	*EFLH*		*kWh savings*
		MBH	*MBH*	*Cool*	*Heat*	*Ex Post*
VRF Heat Pump	2	115	129	454	1,359	8,654
	2	72	77	454	1,359	7,553
	2	72	77	454	1,359	7,553
	1	72	77	454	1,359	3,776
Air Makeup Unit(VFD fan)	1	180		454	1,359	3,423

Results

Realized Gross Savings

Measure Category	*kWh Savings*			*Realized Peak kW Reduction*
	Ex Ante	*Ex Post*	*Realization Rate*	
Prescriptive Lighting	175,104	128,688	73%	24.66
Prescriptive HVAC	1,476,374	30,959	2%	27.01
Total	**1,651,478**	**159,647**	**10%**	**51.67**

The ex post energy savings are 159,647 kWh with a gross energy savings realization rate of 10%. The difference between the ex-ante and ex post savings estimates is due to the following factors:

The waste heat factor has a significant effect on the lighting savings. The site installed new heat pumps, which have a negative waste heat factor. The total heat pump capacity is 53 tons, but the project also installed 70 tons of gas fired makeup air units. The waste heat factor was set to zero for the ex post analysis, as there is not a predominate heating source.

During the site visit, images of the new heat pumps and makeup air units were collected. The installed capacity aligned with the invoice provided with the project documentation of 54 tons, and not the 64 tons listed in the application. The site contact was not aware of the difference but mentioned the efficient cooling capacity of the makeup units. One makeup unit was included for the prescriptive measure with an additional 15 tons of cooling only.

Still with the 69 tons of cooling and 54 tons of heat pump heating, the savings (30,959) were much less than the ex-ante value (1,476,374). The effective full load hours for heating and cooling from the IN TRM for a school building in Ft Wayne were applied to the equipment attributes.

The peak demand ex-post savings of 51.67 kW was less than the ex-ante value of 275.90 kW, as it followed the low energy savings.

Results – common to all Heat Pump Measures

The deemed savings per unit for prescriptive HVAC measures that were applied to the capacity in tons overestimates the energy savings, for capacities of 65 KBTUh. The deemed savings values for three heat pump capacities (5-ton, 10 ton and 20 ton) with four SEER efficiency levels (SEER 16,17,18,21) align with the table in the workbook, *"2021 2022 IN MI Approved CI Pgm Targets Measures"*. These savings for the models then appear in the workbook, *"2023 Indiana Pres Measure Workbook"*, but now have units of per ton, instead of per unit. For example, a 20-ton heat pump overestimates the savings by a factor of 20 from the original modeling. Also, there is a discrepancy in some of models for the usage of heating efficiency expressed by a "COP" (coefficient of performance) value instead of a HSPF value (3.412 x COP). The IN TRM measure for air sourced heat pumps includes the conversion of 3.412 kBTU to kWh, when using efficiency units expressed by the COP.

2.29. Sample ID 135

Executive Summary

Under a project represented by sample ID 135 a program participant received prescriptive incentives from I&M for installing more efficient lighting on the exterior of their building.

The ex post energy savings are 1,080 kWh and peak demand savings are 0.0 kW resulting in an energy savings realization rate of 100%.

Project Description

The participant installed (1) LED wall pack.

Measurement and Verification Effort

To verify the project savings, ADM staff reviewed available project documentation, collected the existing lighting type, new lighting manufacturer model and specification data, the lighting control methods and the type of HVAC for each area. Interval electric billing data for one year was aggregated in one hour periods, binned to the day of the week, to estimate the working schedule.

The following algorithms for energy and coincident peak demand savings were sourced from the measure: *Lighting Systems, (Indiana TRM version 2.2).*

$$kWh_{savings} = \sum_{Area} \left[Hours\ x\ (Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed}) x\ Whf_{kWh} / 1000 \frac{W}{kW} \right]$$

$$kW_{savings} = \sum_{Area} \left[(Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed})\ x\ Whf_{kW}\ xCF / 1000 \frac{W}{kW} \right]$$

Where:

$kWh_{savings}$	= *Annual energy savings*
$kW_{savings}$	= *Annual coincident peak demand savings*
Qty	= *Quantity of fixtures or lamps*
W	= *Wattage of each fixture or lamp*
Hours	= *Lighting annual operating hours*
Whf	= *Waste heat factor for kW or kWh, IN TRM 2.2 by city & HVAC type*
CF	=*Coincident peak demand factor, IN TRM 2.2, by building type*

The variables for the energy savings algorithm are summarized in the following table.

Lighting Energy Savings Calculations

Measure	*Quantity*		*Wattage*		*Annual Hours*	*Waste Heat Factor*	*Ex Ante Annual kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
	Base	*Efficient*	*Base*	*Efficient*					
HID to LED Wall Pack	1	1	275	24	4,303	0.00	1,080	1,080	100%

Measure	*Quantity*		*Wattage*		*Annual Hours*	*Waste Heat Factor*	*Ex Ante Annual kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
	Base	*Efficient*	*Base*	*Efficient*					
Total							**1,080**	**1,080**	**100%**

Results

Realized Gross Savings

Measure Category	*kWh Savings*			*Realized Peak kW Reduction*
	Ex Ante	*Ex Post*	*Realization Rate*	
Prescriptive Lighting	1,080	1,080	100%	0.00
Total	**1,080**	**1,080**	**100%**	**0.00**

The ex post energy savings are 1,080 kWh with a gross energy savings realization rate of 100%.

2.30. Sample ID 201

Executive Summary

Under a project represented by sample ID 201, a participant received custom incentives from I&M for replacing fluorescent tube lighting fixtures with LED high bay fixtures.

The ex post energy savings are 2,279,931 kWh, peak demand savings are 257.11 kW, with an energy savings realization rate of 99%.

Project Description

The participant replaced 6L-T5HO linear fluorescent fixtures (412) and 10L-T5HO fixtures (627) with LED high bay fixtures (1,039) in a 24/7 manufacturing facility.

Measurement and Verification Effort

To verify the project savings, ADM staff reviewed project documentation, existing lighting types, new lighting, methods of controlling the lighting and the HVAC types for each area. Interval electric billing data for one year was aggregated in one hour periods, binned to the day of the week, to estimate the working schedule.

The following algorithms for energy and coincident peak demand savings were sourced from the measure: *Lighting Systems, (Indiana TRM version 2.2).*

$$kWh_{savings} = \sum_{Area}\left[Hours\ x\ (Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed}) x\ Whf_{kWh}/1000\frac{W}{kW}\right]$$

$$kW_{savings} = \sum_{Area}\left[(Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed})\ x\ Whf_{kW}\ xCF/1000\frac{W}{kW}\right]$$

Where:

$kWh_{savings}$	*= Annual energy savings*
$kW_{savings}$	*= Annual coincident peak demand savings*
Qty	*= Quantity of fixtures or lamps*
W	*= Wattage of each fixture or lamp*
Hours	*= Lighting annual operating hours*
Whf	*= Waste heat factor for kW or kWh, IN TRM 2.2 by city & HVAC type*
CF	*=Coincident peak demand factor, IN TRM 2.2, by building type*

The variables for the energy savings algorithm are summarized in the following table.

Lighting Energy Savings Calculations

Measure	*Quantity*		*Wattage*		*Annual Hours*	*Waste Heat Factor*	*Ex Ante Annual kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
	Base	*Efficient*	*Base*	*Efficient*					
6L T5HO to LED high bay	412	412	351	155	7,488	1.08	2,313,707	993.833	99%
10L T5HO to LED high bay	627	627	596	210	7,488	1.08		1,286,098	
Total							2,313,707	2,279,931	99%

Results

Realized Gross Savings

Measure Category	*kWh Savings*			*Realized Peak kW Reduction*
	Ex Ante	*Ex Post*	*Realization Rate*	
Custom lighting	2,313,707	2,279,931	99%	257.11
Total	**2,313,707**	**2,279,931**	**99%**	**257.11**

The ex-post energy savings are 2,279,931 kWh with a gross energy savings realization rate of 99%. The discrepancy between ex ante and ex-post savings estimates arose because the ex-post savings method applied the waste heat factor for the nearest city listed in the IN TRM, whereas the ex-ante used an averaged value. This difference in approaches also accounts for the difference in peak demand (257.11 kW vs 267.26 kW).

2.31. Sample ID 202

Executive Summary

Under a project represented by sample ID 202, a participant received custom incentives from I&M for installing variable speed air compressor and variable speed refrigerated air dryers during the construction of their new manufacturing facility. The ex post energy savings are 2,141,508 kWh, peak demand savings are 168.10 kW, with an energy savings realization rate of 100%.

Project Description

The new construction manufacturing site installed a total of six air compressors, of which two are variable speed (500 kW, 700 kW), receiving an incentive for the efficiency level exceeding a modulating air compressor with a blowdown cycle. Incentives were also received for installing five variable speed cycling refrigerated air dryers, for the savings achieved over a non-cycling refrigerated air dryer.

Measurement and Verification Effort

To verify the project savings, ADM staff visited the site to verify the air compressor model plates, and to collect data from the air compressor optimizer. The optimizer graphics display historical usage by air compressor and air dryer for each hour since the startup of the facility.

The following algorithms for energy and coincident peak demand savings were sourced from the measure: *Efficient Air Compressors, (Indiana TRM version 2.2).*

$$kWh_{savings} = Bhp\ x\ \frac{0.746}{n_{motor}}\ x\ Hours\ x\ ESF$$

$$kW_{savings} = \frac{kWh_{savings}}{Hours}\ x\ CF$$

Where:

$kWh_{savings}$	= *Energy savings, kWh, over a modulating air compressor with blowdown*
$kW_{savings}$	= *Demand savings, kW, over a modulating air compressor with blowdown*
Bhp	= *Compressor motor full load brake horsepower*
n_{motor}	= *Efficiency rating of compressor motor*
HOURS	= *Annual hours compressor operating*
ESF	=*Energy savings factor for VSD compressor; IN TRM Efficient Compressor*
CF	= *Peak coincidence factor, IN TRM Efficient Compressor*

During the site visit, data was collected to determine the actual operating hours. Data was aggregated from the run time from the control unit of each unit in the compressor plant, along with information from the compressor optimizer control system. During this period, the plant air flow setpoint varied from 1,000 to 3,500 CFM for the high-pressure system and 500 to 1,000 CFM for the low-pressure system, as the new plant had been going through startup.

Air Compressor Savings Inputs

Type	*Unit*	*HP*	*Run Hours*	*Loaded Hours*	*Average Pressure*
Single speed	LP1	611	801	561	57
Single speed	LP2	611	1132	842	56
Single speed	LP3	611	896	833	59
Variable Speed	HPLP	1160	4,456		56
Single Speed	HP1	611	4029	3956	109
Variable Speed	HP2	611	1,583		125

Due to the variability in the dependent variable CFM, a correlation was not identified to predict the annual run time of the two variable speed air compressors for the incentivized measures.

From a visual observation of the trend data, the HPLP variable speed air compressor will exceed the estimate of 4,500 hours per year, and the HP2 variable speed air compressor will reach the 4,500 hours estimate.

Air Compressor Analysis

Variable	*Bhp*	n_{motor}	*HOURS*	*ESF*	*CF*	*Ex Post kWh*
Compressor 1	1160	0.968	4,500	0.26	0.38	1,045,941
Compressor 2	611	0.968	4,500	0.26	0.38	554,358
Total	1,771					1,600,299

The high- and low-pressure air compressor plants installed variable speed refrigerated air dryers to remove the moisture from the air. The savings were determined with the method listed in the *Michigan MEMD FES-I19 Cycling Compressed Air Dryers*. Savings are based on the operating characteristics of a standard non-cycling refrigerated air dryer.

$$kW_{Demand\ reduction} = SP\ x\ (EC_{nc} - EC_{VSD})$$

$$kW_{savings} = kW_{Demand\ reduction}\ x\ CF$$

$$kWh_{savings} = kW_{savings}\ x\ HOURS$$

Where:

$kWh_{Demand\_reduction}$	= *Demand reduction for new dryer, kW*
$kW_{savings}$	= *Demand savings, kW, over non-cycling dryer*
$kWh_{savings}$	= *Energy savings over a non-cycling air dryer*
SP	= *Energy usage fully loaded non-cycling air dryer*
EC_{nc}	= *Part load percent energy of non-cycling dryer*
EC_{VSD}	= *Part load percent energy of variable speed drive dryer*
HOURS	= *Annual hours compressor operating*
CF	= *Peak coincidence factor, IN TRM Efficient Compressor*

The ex-ante savings for the variable HOURS, utilized the default MEMD value of 6,240 hours, which the measure sourced from a 3 shift, 5-day work week. During the site visit, the run times of the 5 refrigerated air dryers were collected. The design documents for the air compressor plant identify the design as N+1 for the low-pressure plant and also N+1 for the high-pressure plant.

There is currently more dryer capacity online (5 x 6000 CFM) that the plan is currently producing air (low pressure plant 3,000 CFM, high pressure 3,000 CFM). A good scheduling strategy for variable speed units is running all units at the lowest speed for the heat rejection required, but the plant may eventually set one or more units to standby to regain a N+1 status. As units x run hours for 5 units x 6,420 is similar to unit x run hours for 3.5 units, the ex-post savings analysis did not adjust the hours of use, as the plant is still accelerating their production schedules.

Results

Gross Energy Impacts Summary

Measure Category	*kWh Savings*			*Ex Post Gross kW Savings*
	Ex Ante	*Ex Post*	*Realization Rate*	
Custom – VSD Air Compressors	1,600,300	1,600,300	100%	135.13
Custom – VSD Air Dryers	541,433	541,208	100%	32.97
Total	**2,141,733**	**2,141,508**	**100%**	**168.10**

The ex post annual energy savings are 2,141,508 kWh and the ex post peak demand reduction is 168.10 kW. The energy gross realization rate is 100%.

The ex-post-peak demand savings for the VSD air dryer (32.97 kW) is less than the ex-ante savings (86.77). The demand reduction calculated with the MEMD measure must be factored by the CF value to estimate the peak demand savings.

2.32. Sample ID 203

Executive Summary

Under project represented by sample ID 203, a participant received custom incentives from I&M for installing more efficient lighting, lighting controls and exit signs, over the building code prescribed lighting power density requirement, in a new construction warehouse building. The ex post energy savings are 1,986,581 kWh and the realization rate is 94%. The peak demand savings are 329.20 kW.

Project Description

The participant installed energy efficient lighting and lighting controls that exceeded the minimum building code required lighting power density, by building type, as specified within the standard: *Energy Standard for Buildings Except Low-Rise Residential Buildings (ASHRAE 90.1-2007).* The participant also installed exterior energy efficient lighting, exceeding the code-based lighting power allowance.

Measurement and Verification Effort

To verify the project savings, ADM staff reviewed available project documentation, collected the existing lighting type, new lighting manufacturer model and specification data, the lighting control methods and the type of HVAC for each area. Interval electric billing data for one year was aggregated in one-hour periods, binned to the day of the week, to estimate the working schedule.

The following algorithms for energy and coincident peak demand savings were sourced from the measure: *Lighting Systems, (Indiana TRM version 2.2).*

$$kWh_{savings} = \sum_{Area}\left[Hours\ x\ (Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed}) x\ Whf_{kWh}/1000\frac{W}{kW}\right]$$

$$kW_{savings} = \sum_{Area}\left[(Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed})\ x\ Whf_{kW}\ xCF/1000\frac{W}{kW}\right]$$

Where:

$kWh_{savings}$	= *Annual energy savings*
$kW_{savings}$	= *Annual coincident peak demand savings*
Qty	= *Quantity of fixtures or lamps*
W	= *Wattage of each fixture or lamp*
$Hours$	= *Lighting annual operating hours*
Whf	= *Waste heat factor for kW or kWh, IN TRM 2.2 by city & HVAC type*
CF	=*Coincident peak demand factor, IN TRM 2.2, by building type*

The variables for the energy savings algorithm are summarized in the following table.

Lighting Energy Savings Calculations

Measure	*Quantity*		*Wattage*		*Annual Hours*	*Waste Heat Factor*	*Ex Ante Annual kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
	Base	*Efficient*	*Base*	*Efficient*					
LED High Bay	1659	1659	414	174	4380	1.00	1,881,958	1,744,005	100%
LED Panel	31	31	67	28	4380	1.00		5,263	
LED Panel	16	16	85	36	4380	1.00		3,436	
LED Panel	1	1	65	28	4380	1.00		166	
LED Panel	42	42	115	49	4380	1.00		12,314	
LED Pendant	13	13	17	7	4380	1.00		550	
LED Track	24	24	218	92	4380	1.00		13,311	
LED Track	9	9	146	61	4380	1.00		3,328	
LED Downlight	1	1	42	18	4380	1.00		106	
LED Track	8	8	174	73	4380	1.00		3,528	
LED pendant	3	3	24	10	4380	1.00		181	
LED Panel	14	14	67	28	4380	1.10		2,614	
LED Panel	84	84	85	36	4380	1.10		19,846	
LED Panel	99	99	65	28	4380	1.10		18,093	
LED Wall pack	33	33	330	108	4300	1.00		31,441	
LED Pole	14	14	745	244	4300	1.00		30,135	
LED Pole	3	3	1,588	244	4300	1.00	220,814	17,341	45%
LED Pole	9	9	1,588	244	4300	1.00		52,022	
LED Pole	5	5	1,588	244	4300	1.00		28,901	
Total							2,102,772	1,986,581	94%

Although there is not an actual baseline fixture for calculating lighting power density (LPD) savings, the implied base watts for each fixture are presented in the previous table to facilitate a visual comparison between lighting pairs. The three measures exhibiting low realization rates in the above table are associated with parking lot lighting. The ex-ante savings implied a base watts of 3,264 watts for each fixture, where a 244 LED pole fixture was installed. However, an examination of the exterior lighting plan and the photometric distribution for the pole lamps revealed that a significant portion of the area does not achieve the illumination level indicative of the expected parking lot lighting power density. Consequently, the ex-post savings analysis adjusted the area from 370,000 to 180,000 square feet, suggesting a baseline pole lamp wattage of 1,500 watts. This adjustment more accurately reflects the product description for the LED

244 Pole lamps (R3, R4, R5), which are marketed as replacements for up to a 1,000 W metal halide lamp.

Parking Lot Lighting 0.15 Watts/square feet of illuminated area

	Measure	*Area*	*Quantity*		*Wattage*	
			Base	*Efficient*	*Implied Base Watts*	*Efficient*
Ex ante	LED 244W Pole R3	**370,000**	3	3	*3,264*	244
	LED 244W Pole R4		9	9	*3,264*	244
	LED 244W Pole R5		5	5	*3,264*	244
Ex post	LED 244W Pole R3	**180,000**	3	3	*1,500*	244
	LED 244W Pole R4		9	9	*1,500*	244
	LED 244W Pole R5		5	5	*1,500*	244

Results

Realized Gross Savings

Measure Category	*kWh Savings*			*Realized Peak kW Reduction*
	Ex Ante	*Ex Post*	*Realization Rate*	
Custom	2,102,771	1,986,581	94%	329.20
Total	**2,102,771**	**1,986,581**	**94%**	**329.20**

The ex post energy savings are 1,986,581 kWh with a gross energy savings realization rate of 94%. The difference between the ex-ante and ex-post savings estimates is due to the following factors:

- The ex-ante savings estimate for the exterior pole lamps indicated that the illuminated parking lot area was 340,000 square feet. However, the ex-post analysis found that the baseline fixture wattage of 3,264 W was not realistic, and consequently, ADM consulted the lamp photometric specifications to determine the actual lighting coverage when the target lumen levels are met.

The peak demand ex post savings of 329.20 kW was similar to the ex-ante savings of 328.00 kW.

2.33. Sample ID 204

Executive Summary

Under a project represented by sample ID 204, a program participant received custom incentives from I&M for replacing air compressors in a manufacturing plant. The ex post energy savings are 1,892,294 kWh, peak demand savings are 40.19 kW, with an energy savings realization rate of 100%.

Project Description

The project added a variable speed air compressor (268 hp) and a load/no load air compressor (100 hp) to their existing plant containing a large load/no load air compressor (450 hp). Between the original air study and as-installed air study, the plant experienced an increase in production with a higher compressed air demand.

Measurement and Verification Effort

To verify the project savings, ADM staff reviewed available project documentation, collected the pre and post period air compressor power metering completed by the trade ally. Interval electric billing data for one year was aggregated in one hour periods, binned to the day of the week, to estimate the working schedule. As there was metered pre and post data, the following algorithm, also used for the ex ante savings analysis was applied to the other input variables.

$$kWh_{savings} = \sum (kW_{comp1} + kW_{comp2}) - (kW_{comp1} + kW_{comp3} + kW_{comp4})_{week} x52weeks$$

$$kW_{savings} = kWh_{savings}\ x\ CF/\ Hours$$

Where:

kWh_{leaks} = *Energy savings, kWh*
kW_1 = *Power at flow for450hp, modulating air compressor*
kW_2 = *Power at flow assumed load/no load air compressor*
kW_3 = *Power at flow for new 100hp, modulating air compressor*
kW_4 = *Power at flow new VSD 268 hp air compressor*
$\sum$ = *10 second interval, pre air flow equals post air flow*
$kW_{savings}$ = *Annual energy savings/8760*

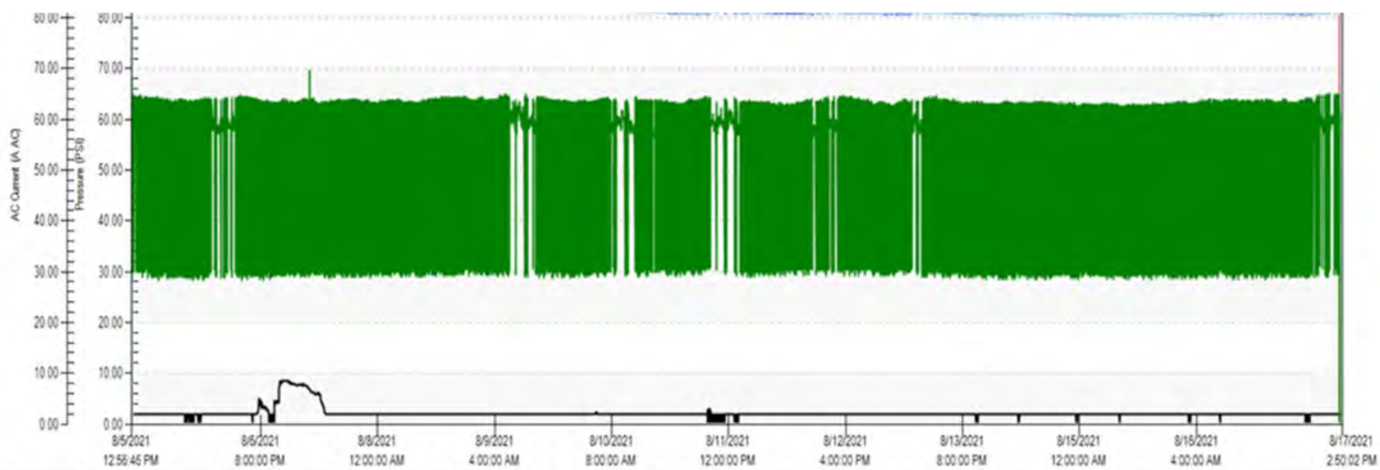
The air compressor data in the table below, is also expressed in the following two figures.

Air Compressor Analysis

Variable	*Comp 1*	*Comp 2*	*Comp 3*	*Comp 4*
Hp, rated	450	200	100	268
CFM, rated	2310	1405	690	715
Control method	Modulation,wo BD	Load/NoLoad	Load/NoLoad	No Load
kW100CFM	16.7	18.0	18.68	18.94
Energy Used pre	2,376,687	2,111548		
Energy post	700,082	0	15,036	1,414,503

Post Period Compressor Current Metering

Pre Period Compressor Current Metering



In addition to the decrease in the maximum current reach during the metering, the pre and post metered data have a significant difference with the compressor able to reach zero power at zero air flow.

Results

Gross Energy Impacts Summary

Measure Category	*kWh Savings*			*Ex Post Gross kW Savings*
	Ex Ante	*Ex Post*	*Realization Rate*	
Air Compressor - Custom	1,892,294	1,892,294	100%	40.19
Total	**1,892,294**	**1,892,294**	**100%**	**40.19**

The ex post annual energy savings are 1,892,294 kWh and the ex post peak demand reduction is 105.77 kW. The energy gross realization rate is 100%.

The ex-post coincident peak demand savings value of 40.19 is less than the ex-ante demand savings value of 105.77, as the ex-post savings method followed the IN TRM 2.2 Efficient Air Compressor method of factoring the demand savings by the CF factor 0.38.

2.34. Sample ID 205

Executive Summary

Under a project represented by sample ID 205, a participant received custom incentives from I&M for replacing fluorescent tube lighting fixtures with LED high bay fixtures.

The ex post energy savings are 1,632,384 kWh, peak demand savings are 165.68 kW, with an energy savings realization rate of 98%.

Project Description

The participant replaced 6L T5HO linear fluorescent fixtures (500) and 10L T5HO fixtures (500) with LED high bay fixtures (1,000) in a 24/7 manufacturing facility.

Measurement and Verification Effort

To verify the project savings, ADM staff reviewed available project documentation, collected the existing lighting type, new lighting manufacturer model and specification data, the lighting control methods and the type of HVAC for each area. Interval electric billing data for one year was aggregated in one-hour periods, binned to the day of the week, to estimate the working schedule.

The following algorithms for energy and coincident peak demand savings were sourced from the measure: *Lighting Systems, (Indiana TRM version 2.2).*

$$kWh_{savings} = \sum_{Area}\left[Hours\ x\ (Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed}) x\ Whf_{kWh}/1000\frac{W}{kW}\right]$$

$$kW_{savings} = \sum_{Area}\left[(Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed})\ x\ Whf_{kW}\ xCF/1000\frac{W}{kW}\right]$$

Where:

$kWh_{savings}$	= *Annual energy savings*
$kW_{savings}$	= *Annual coincident peak demand savings*
Qty	= *Quantity of fixtures or lamps*
W	= *Wattage of each fixture or lamp*
Hours	= *Lighting annual operating hours*
Whf	= *Waste heat factor for kW or kWh, IN TRM 2.2 by city & HVAC type*
CF	=*Coincident peak demand factor, IN TRM 2.2, by building type*

The variables for the energy savings algorithm are summarized in the following table.

Lighting Energy Savings Calculations

Measure	Quantity		Wattage		Annual Hours	Waste Heat Factor	Ex Ante Annual kWh Savings	Ex Post Gross kWh Savings	Gross Realization Rate
	Base	Efficient	Base	Efficient					
6L T5HO to LED high bay	500	500	358	265	7,488	1.0	1,668,649	1,134,432	98%
10L T5HO to LED high bay	500	500	468	225	7,488	1.0		497,952	
Total							1,668,649	1,632,384	98%

Results

Realized Gross Savings

Measure Category	kWh Savings			Realized Peak kW Reduction
	Ex Ante	Ex Post	Realization Rate	
Custom lighting	1,668,649	1,632,384	98%	165.68
Total	**1,668,649**	**1,632,384**	**98%**	**165.68**

The ex post energy savings are 1,632,384 kWh with a gross energy savings realization rate of 98%.

The peak demand ex-post savings of 165.68 kW are less than the ex-ante savings of 193 kW.

2.35. Sample ID 208

Executive Summary

Under a project represented by sample ID 208, a program participant received custom incentives from I&M for the detection and repair of compressed air leak in their industrial facility. The ex post annual energy savings are 672,841 kWh, with an ex post peak demand reduction of 77.75 kW. The project energy savings gross realization rate is 100%.

Project Description

The ultrasonic leak detection audit identified and subsequently repaired 512 CFM of compressed air leaks. The reduced air load eliminated the usage of one trim air compressor and impacted the base load air compressor.

Measurement and Verification Effort

Through remote data collection, ADM staff verified the completion of the leak repair project, the hours of operation, and the energy profile and operation of the on-site air compressor. ADM then used the *UE Systems Compressed Gas Flow Rate Curves* to calculate the air loss rate at each leak based on the ultrasonic decibel (dB) reading at each leak. To calculate the annual energy consumption reduction, this air loss calculation was used, along with compressor-specific power and annual hours of operation. The following equations were used to calculate the annual energy savings from the leak repairs:

$$SCFM_{leaks} = \sum 0.014 \times \mathrm{dB}^{1.4004}$$

$$kWh_{savings} = SCFM_{leaks}\ x\ R_{air\ leaks}\ x\ \eta_{air\ comp}\ x\ F_{adjustment}\ x\ Hours\ x\ SCFM$$

$$kW_{savings} = kWh_{savings}\ x\ CF/\ Hours$$

Where:

$SCFM_{leaks}$	= *Cubic feet per minute in reduced leaks at atmospheric pressure*
dB	= *Decibel reading at each leak*
$kWh_{savings}$	= *Annual energy savings*
R_{leaks}	= *Repair rate of leaks*
$Hours$	= *Indicated hours of usage for the compressors*
$N_{air\ compressor}$	= *Sum of Nameplate compressor kW adjusted to discharge pressure divided by sum of nameplate compressor CFM*
FP_0	=*Fraction of full load power at zero air flow (FLP, FP_0 from CAGI sheet)*
$F_{adjustment}$	=*Adjusts full load power to weighted part load power by controls type*
CF	= *Coincidence Factor for Peak Demand h*

The Fraction Power (FP) on the air compressor demand curve, where the reduction in load occurs from repairing the air leaks, was determined by the method adapted from *Modeling and Simulation of Air Compressor Use, ACEEE.org.* Applying the FP to the product of the reduced air flow and power is summarized in the following equation:

$$kWh_{savings} = CFM_{repai}\quad x\ {}^{1}\Big/\frac{SCFM}{kW}\ x\ (FP_o + (1 - FP_o)xFC)$$

The peak demand equation:

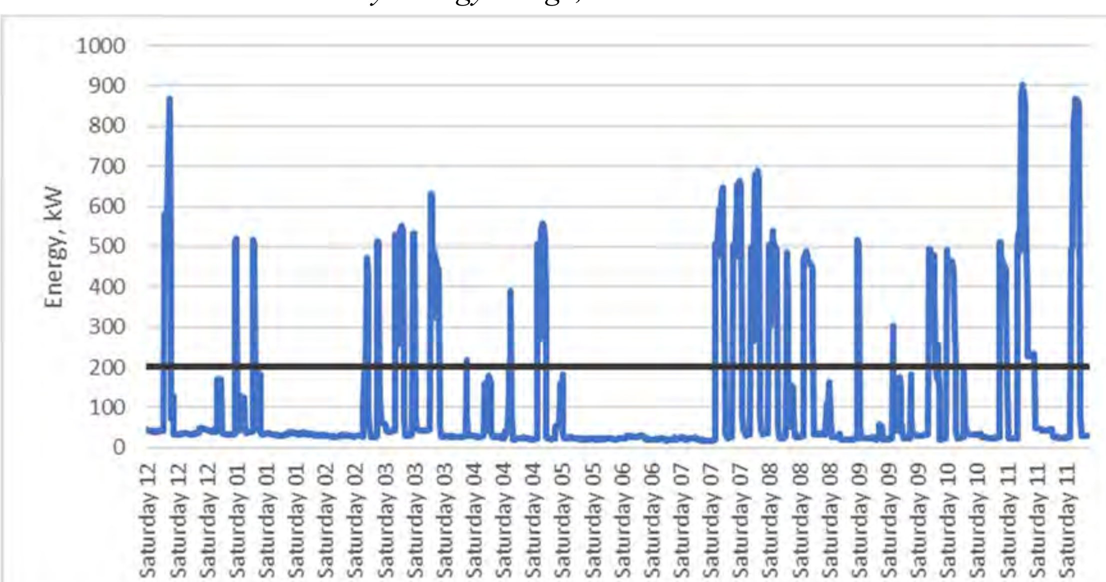
$$kW_{Peak} = \frac{kWh_{savings}}{HOU}$$

Where:

kWhsavings	*= Annual energy savings*
CFM	*= Air leaks; CFM*
db	*= ultrasonic air leak intensity; decibels*
kW	*=Full load air compressor power, kw*
SCFM	*= Full load air compressor flow, cfm*
FP_o	*= No Production factor*
FC	*= Fraction of operating range;*
kW_{peak}	*= peak demand savings*
HOU	*= Annual compressor hours of*

The interval billing data was summarized in a trend chart to validate the ex ante savings analysis usage of 7,200 hours in the calculation of energy savings. A 5-day, 24-hour schedule was confirmed, with additional periodic usage on Saturdays. A criterion of a minimum of 200 kW usage, corresponding to the usage of at least one of the three compressors, was applied to estimate Saturday usage. This analysis indicated that the compressors operated for 20% of Saturday hours and these hours were added to the 24/5 hours, resulting in an annual usage of 6,490 hours.

Saturday Energy Usage, One Year Period



The table below presents ex ante and ex post energy savings, verified hours of operation, CFM of the repaired leak, and the compressor flow per kW.

Air Leak Savings Algorithm Inputs with Savings

Variable	*Ex Ante Values*	*Ex Post Values*	*Realization Rate*
Leaks Repaired; CFM	279/233	279/233	equal
Power/flow source	HPx.745/plate	CAGI/CAGI	Not equal
Annual Hours	7,200	6,490	Not equal
Sequencing	75 hp to 150 hp	75 hp to 150 hp	equal
Control method	VFD	VFD	equal
75 hp Compressor Savings kwh	402,840	356,171	88%
150 hp Compressor Savings	272,483	316,670	116%
CF	1.0	0.75	Not equal
Energy savings, 75hp	55.95	41.16	73%
Energy savings, 150 hp	37.84	36.60	97%

Results

Gross Energy Impacts Summary

Measure Category	*kWh Savings*			*Ex Post Gross kW Savings*
	Ex Ante	*Ex Post*	*Realization Rate*	
Custom Air Compressor Leaks	675,323	672,841	100%	77.75
Total	**675,323**	**672,841**	**100%**	**77.75**

The ex post annual energy savings are 672,841 kWh and the ex post peak demand reduction is 77.75. The energy gross realization rate is 100%.

The project achieved a realization rate of 100% for the total energy savings, although there was some variance in the inputs to the air leak savings algorithm. The reduced ex-post hours of use affected the savings for the 75 hp trim air compressor, as the other inputs remained relatively similar. The 150 hp base load compressor saw higher ex-post savings compared to the ex-ante estimates. This difference is attributed to the ex-ante savings being calculated without the typically used air leak calculator, which either accounts for the total package power or adds an additional 25% kW when power is estimated through a hp to kW conversion, rather than being derived from the relevant CAGI data sheet.

2.36. Sample ID 210

Executive Summary

Under a project represented by sample ID 210, a program participant received new construction custom incentives from I&M for installing more efficient lighting in the interior of their building.

The ex-post energy savings are 708,812 kWh and the realization rate is 158%. The peak demand savings are 114.57 kW.

Project Description

The participant installed energy efficient lighting and lighting controls that exceeded the minimum building code required lighting power density, by building type, as specified within the standard: *Energy Standard for Buildings Except Low-Rise Residential Buildings (ASHRAE 90.1-2007).* The participant also installed exterior energy efficient lighting, exceeding the code-based lighting power allowance.

The participant designed and installed lighting in the warehouse space requiring less power per square foot than a minimum code compliant building, based on space-by-space lighting allowances. The site installed (448) LED 212W High Bay fixtures.

Measurement and Verification Effort

To verify the project savings, ADM staff reviewed available project documentation, collected the existing lighting type, new lighting manufacturer model and specification data, the lighting control methods and the type of HVAC for each area. In addition, interval billing data was reviewed to verify the annual hours of use.

The following algorithms for energy and coincident peak demand savings were sourced from the measure: *Lighting Systems, (Indiana TRM version 2.2).*

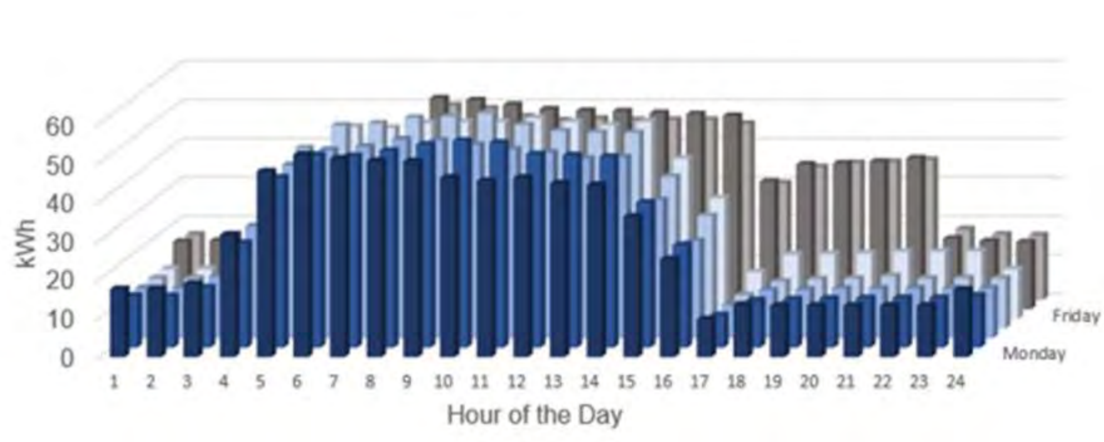
$$kWh_{savings} = \sum_{Area} \left[Hours\ x\ (Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed}) x\ Whf_{kWh} / 1000 \frac{W}{kW} \right]$$

$$kW_{savings} = \sum_{Area} \left[(Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed})\ x\ Whf_{kW}\ xCF / 1000 \frac{W}{kW} \right]$$

Where:

$kWh_{savings}$	= *Annual energy savings*
$kW_{savings}$	= *Annual coincident peak demand savings*
Qty	= *Quantity of fixtures or lamps*
W	= *Wattage of each fixture or lamp*
$Hours$	= *Lighting annual operating hours*
Whf	= *Waste heat factor for kW or kWh, IN TRM 2.2 by city & HVAC type*
CF	=*Coincident peak demand factor, IN TRM 2.2, by building type*

Site Interval Lighting Hours:



The variables for the energy savings algorithm are summarized in the following table.

Lighting Energy Savings Calculations

Measure	*Quantity*		*Wattage*		*Annual Hours*	*Waste Heat Factor*	*Ex Ante Annual kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
	Base	*Efficient*	*Base*	*Efficient*					
4’ T8 to LED 4’ lamp	448	448	536	212	4,888	0.00	449,679	708,812	158%
Total							449,679	708,812	158%

Results

Realized Gross Savings

Measure Category	*kWh Savings*			*Realized Peak kW Reduction*
	Ex Ante	*Ex Post*	*Realization Rate*	
NC Custom Lighting	449,679	708,812	158%	114.57
Total	**449,679**	**708,812**	**158%**	**114.57**

The ex post energy savings are 708,812 kWh with a gross energy savings realization rate of 158%. The primary discrepancy between the ex post and ex ante energy savings stems from the hours of operation. The verified hours of use, as determined through interval data, totaled 4,888, which exceeds the ex-ante estimate of 3,110 hours. Additionally, the verified efficient wattage of 212W is lower than the ex-ante estimated wattage of 214W.

The peak demand ex-post savings of 114.57 kW was slightly greater than the ex-ante savings of 113.86 kW.

2.37. Sample ID 211

Executive Summary

Under a project represented by sample ID 211, a program participant received custom incentives from I&M for the detection and repair of compressed air leak in their industrial facility. The ex post annual energy savings are 296,444 kWh, with an ex post peak demand reduction of 25.78 kW. The project energy savings gross realization rate is 100%.

Project Description

The ultrasonic leak testing identified leaks throughout the facility, with 467 CFM reduced by the repair of air hoses, quick disconnects, fittings and regulators.

Measurement and Verification Effort

Through remote data collection, ADM staff verified the completion of the leak repair project, the hours of operation, and the energy profile and operation of the on-site air compressor. ADM then used the *UE Systems Compressed Gas Flow Rate Curves* to calculate the air loss rate at each leak based on the ultrasonic decibel (dB) reading at each leak. To calculate the annual energy consumption reduction, this air loss calculation was used, along with compressor-specific power and annual hours of operation. The following equations were used to calculate the annual energy savings from the leak repairs:

$$SCFM_{leaks} = \sum 0.014 \times \mathrm{dB}^{1.4004}$$

$$kWh_{savings} = SCFM_{leaks}\ x\ R_{air\ leaks}\ x\ \eta_{air\ comp}\ x\ F_{adjustment}\ x\ Hours\ x\ SCFM$$

$$kW_{savings} = kWh_{savings}\ x\ CF/\ Hours$$

Where:

$SCFM_{leaks}$	= *Cubic feet per minute in reduced leaks at atmospheric pressure*
dB	= *Decibel reading at each leak*
$kWh_{savings}$	= *Annual energy savings*
R_{leaks}	= *Repair rate of leaks*
$Hours$	= *Indicated hours of usage for the compressors*
$N_{air\ compressor}$	= *Sum of Nameplate compressor kW adjusted to discharge pressure divided by sum of nameplate compressor CFM*
$F_{adjustment}$	=*Adjusts full load power to weighted part load power by controls type*
CF	= *Coincidence Factor for Peak Demand hours (0.865)*

The Fraction Power (FP) on the air compressor demand curve, where the reduction in load occurs from repairing the air leaks, was determined by the method adapted from *Modeling and Simulation of Air Compressor Use, ACEEE.org.* Applying the FP to the product of the reduced air flow and power is summarized in the following equation:

$$kWh_{savings} = CFM_{repairs}\ x\ {}^{1}\!\Big/\!\frac{SCFM}{kW}\ x\ (FP_o + (1 - FP_o)xFC)$$

The peak demand equation:

$$kW_{Peak} = \frac{kWh_{savings}}{HOU} x\ CF$$

Where:

kWhsavings	= *Annual energy savings*
CFM	= *Air leaks; CFM*
db	= *ultrasonic air leak intensity; decibels*
kW	=*Full load air compressor power, kw*
SCFM	= Full load air compressor flow, cfm
FP_o	= No Flow Production factor
FC	= Fraction of operating range; assume savings occur mostly idle
kW_{peak}	= peak demand savings
CF	=Peak demand coincident factor, 0.38, IN TRM 2.2
HOU	= Annual compressor hours

The table below presents ex ante and ex post energy savings, verified hours of operation, CFM of the repaired leak, and the compressor flow per kW.

Air Leak Savings Algorithm Inputs

Variable	*Ex Ante*	*Ex Post*	*Ex Post Source*
Leaks Found; CFM	500	500	Leak repair log
Leaks Repaired; CFM	467	467	Leak repair log
scfm/kW	6.0	6.0	Full airflow/packaged power
Control method	Load/unload	Load/unload	Site photo; Narrative
Operating Hours	4,368	4,368	Billing interval data
kWh	296,444	296,444	Calculated
CF	1	0.38	IN TRM 2.2; Air Compressors
kW	67.87	25.78	Calculated

Results

Gross Energy Impacts Summary

Measure Category	*kWh Savings*			*Ex Post Gross kW Savings*
	Ex Ante	*Ex Post*	*Realization Rate*	
Air Compressor	296,444	296,444	100%	25.78
Total	**296,444**	**296,444**	**100%**	**25.78**

The ex post annual energy savings are 296,444 kWh and the ex post peak demand reduction is 25.78 kW. The energy gross realization rate is 100%.

The ex-ante and ex post savings were based on the same inputs for the savings algorithm.

The ex-post peak demand savings (25.78) is less than the ex-ante (67.87), as the ex-post method applied the coincidence factor for the air compressor measures, to the reduction in power demand with the reduced air leaks.

2.38. Sample ID 212

Executive Summary

Under a project represented by sample ID 212, a program participant received custom incentives from I&M for the detection and repair of compressed air leaks in their industrial facility. The ex post annual energy savings are 289,245 kWh, with an ex post peak demand reduction of 24.77 kW. The project energy savings gross realization rate is 100%.

Project Description

Ultrasonic compressed air leak reduction was performed at the facility, with 248 CFM of air leaks reduced from the repair of air hoses, quick disconnect fittings, air tools and connections.

Measurement and Verification Effort

Through remote data collection, ADM staff verified the completion of the leak repair project, the hours of operation, and the energy profile and operation of the on-site air compressor. ADM then used the *UE Systems Compressed Gas Flow Rate Curves* to calculate the air loss rate at each leak based on the ultrasonic decibel (dB) reading at each leak. To calculate the annual energy consumption reduction, this air loss calculation was used, along with compressor-specific power and annual hours of operation. The following equations were used to calculate the annual energy savings from the leak repairs:

$$SCFM_{leaks} = \sum 0.014 \times \mathrm{dB}^{1.4004}$$

$$kWh_{savings} = SCFM_{leaks}\ x\ R_{air\ leaks}\ x\ \eta_{air\ comp}\ x\ F_{adjustment}\ x\ Hours\ x\ SCFM$$

$$kW_{savings} = kWh_{savings}\ x\ CF/\ Hours$$

Where:

$SCFM_{leaks}$	= *Cubic feet per minute in reduced leaks at atmospheric pressure*
dB	= *Decibel reading at each leak*
$kWh_{savings}$	= *Annual energy savings*
R_{leaks}	= *Repair rate of leaks*
$Hours$	= *Indicated hours of usage for the compressors*
$N_{air\ compressor}$	= *Sum of Nameplate compressor kW adjusted to discharge pressure divided by sum of nameplate compressor CFM*
$F_{adjustment}$	=*Adjusts full load power to weighted part load power by controls type*
CF	= *Coincidence Factor for Peak Demand hours*

The Fraction Power (FP) on the air compressor demand curve, where the reduction in load occurs from repairing the air leaks, was determined by the method adapted from *Modeling and Simulation of Air Compressor Use, ACEEE.org.* Applying the FP to the product of the reduced air flow and power is summarized in the following equation:

$$kWh_{savings} = CFM_{repairs}\ x\ {}^{1}\Big/\frac{SCFM}{kW}\ x\ (FP_o + (1 - FP_o)xFC)$$

The peak demand equation:

$$kW_{Peak} = \frac{kWh_{savings}}{HOU}$$

Where:

kWhsavings = *Annual energy savings*

CFM = *Air leaks; CFM*

db = *ultrasonic air leak intensity; decibels*

kW =*Full load air compressor power, kw*

SCFM = Full load air compressor flow, cfm

FP_o = No Flow Production factor

FC = Fraction of operating range; assume savings occur mostly idle

kW_{peak} = peak demand savings

HOU = Annual compressor hours of

The table below presents ex ante and ex post energy savings, verified hours of operation, CFM of the repaired leak, and the compressor flow per k

Air Leak Savings Algorithm Inputs

Variable	*Ex Ante Value*	*Ex Post Value*
Leaks Found; CFM	247.9	247.9
Leaks Repaired; CFM	221.1	221.1
SCFM/kW	6.1	6.1
Operating Hours	8,760	8,760
kWh savings	289,245	289.245
kW reduced	33.02	33.02

Results

Gross Energy Impacts Summary

Measure Category	*kWh Savings*			*Ex Post Gross kW Savings*
	Ex Ante	*Ex Post*	*Realization Rate*	
Custom Air Compressor	289,245	289,245	100%	33.02
Total	**289,245**	**289,245**	**100%**	**24.77**

The ex post annual energy savings are 289,245 kWh and the ex post peak demand reduction is 33.02kW. The energy gross realization rate is 100%. The ex-post savings for peak coincident demand (24.77 kW) is less than the ex-ante (33.02) as the ex post estimate applied the IN TRM coincident peak factor for air savings to the demand reduction.

2.39. Sample ID 213

Executive Summary

Under a project represented by sample ID 213, a program participant received custom incentives from I&M for replacing hydraulic injection molding machines with hybrid electric machines.

The ex post energy savings are 150,234 kWh with ex post peak demand reduction of 19.56 kW and the gross energy savings realization rate is 73%.

Project Description

The manufacturing facility replaced two hydraulic injection molding machines with two hybrid electric machines, to reduce the energy required to manufacture various weights of parts.

Measurement and Verification Effort

To verify the project savings, ADM staff reviewed available project documentation, collected the machine specifications and obtained the data from the comparison test trials of the two machines. Interval electric billing data for one year was aggregated in one hour periods, binned to the day of the week, to estimate the working schedule.

$$kWh_{savings} = \sum_{Area} [Hours \times (kW_{base} - kW)/1000]$$

Where:

$kWh_{savings}$ = *Annual energy savings*

kW = *Machine kW for comparison test runs with same produce*

$Hours$ = *Annual machine uptime run hours*

The data from the test runs are summarized in the following table. The supporting data had two methods of analyzing the data already completed. Both methods were reviewed in the following two tables.

Plastic Injection Press Savings (Method 2)

Press Tested	*Baseline*	*Hybrid Electric*
Test Date	3/21/2023	3/22/2023
Shot Cycles	50	50
Parts/Cycle	6	6
Total Parts Produced	300	300
Weight/Cycle (pounds)	0.248	0.248
Cycle Time	45.6 Seconds	45.6 Seconds
Total Test Time	40 Minutes, 39 Seconds	41 Minutes, 44 Seconds
Total Energy Consumed (kWh)	12.7851	3.5751

Average Power (kW)	18.8592	5.1316
Annual Operating Hours	5,760	5,760
Machine Uptime %	95%	95%
Total Predicted Energy Usage (kWh)	103,197.38	28,080.25
Annual Energy Savings (kWh)	75,117	

Plastic Injection Press Savings (Method 1)

Press Tested	*Baseline*	*Hybrid Electric*
Test Date	3/21/2023	3/22/2023
Total Parts Produced	886	213,852
Total Test Time	40 Minutes, 39 Seconds	41 Minutes, 44 Seconds
lbs/year	310204	310204
kWh/k-lb	349.116	0.4045
Total Predicted Energy Usage (kWh)	108,297.32	125.46
Machine Uptime %	95%	95%
Annual Energy Savings (kWh)	102,763.26	

The following observations were made regarding method 1, which was subsequently not used for the ex post savings method.

Method 1 Uncertainties

Variable	*Quantity*	*Sourced*	*Comments*
Baseline	886	Value is sum of field, “Counts, LGR)	Not a production count, but a factor of kWh from the power metering logger
Hybrid Electric	213,852	Value is the sum of field, “ # “	A sequential number generated from the power metering logger

Results

Realized Gross Savings

Measure Category	*kWh Savings*			*Realized Peak kW Reduction*
	Ex Ante	*Ex Post*	*Realization Rate*	
Custom	205,526	150,234	73%	19.56
Total	**205,526**	**150,234**	**73%**	**19.56**

The ex post energy savings are 150,234 kWh with a gross energy savings realization rate of 73%. The difference between the ex-ante and ex post savings estimates is due to the following factors.

There were two methods for estimating savings in the project documentation, both were referencing the same testing in March 2023 for two hydraulic injection molding machines. Method 1 referenced erroneous data for production information. Method 2 referenced accurate data fields to estimate the savings based on hourly usage. Annual grams of material through the machine may provide another estimate, but the two machines produced the same product with the same cycle time, so hourly power usage provides a good estimate of the annual savings.

The peak demand ex-post savings of 19.56 kW was less than the ex-ante value of 29.34, as the ex-ante utilized a 1.0 CF to factor by the demand reduction. The ex-post applied the CF from the IN TRM 2.2 for Injection Molding Machine Barrel Wrap.

2.40. Sample ID 214

Executive Summary

Under a project represented by sample ID 214, a program participant received custom incentives from I&M for the detection and repair of compressed air leaks in their industrial facility. The ex post annual energy savings are 96,078 kWh, with an ex post peak demand reduction of 10.14 kW. The project energy savings gross realization rate is 103%.

Project Description

Ultrasonic compressed air leak detection performed at the facility identified 168 CFM of air leaks that were repaired to reduce the load on the air compressors.

Measurement and Verification Effort

Through remote data collection, ADM staff verified the completion of the leak repair project, the hours of operation, and the energy profile and operation of the on-site air compressor. ADM then used the *UE Systems Compressed Gas Flow Rate Curves* to calculate the air loss rate at each leak based on the ultrasonic decibel (dB) reading at each leak. To calculate the annual energy consumption reduction, this air loss calculation was used, along with compressor-specific power and annual hours of operation. The following equations were used to calculate the annual energy savings from the leak repairs:

$$SCFM_{leaks} = \sum 0.014 \times \text{dB}^{1.4004}$$

$$kWh_{savings} = SCFM_{leaks} \ x \ R_{air\ leaks} \ x \ \eta_{air\ comp} \ x \ F_{adjustment} \ x \ Hours \ x \ SCFM$$

$$kW_{savings} = kWh_{savings} \ x \ CF / \ Hours$$

Where:

$SCFM_{leaks}$	= *Cubic feet per minute in reduced leaks at atmospheric pressure*
dB	= *Decibel reading at each leak*
$kWh_{savings}$	= *Annual energy savings*
R_{leaks}	= *Repair rate of leaks*
$Hours$	= *Indicated hours of usage for the compressors*
$N_{air\ compressor}$	= *Sum of Nameplate compressor kW adjusted to discharge pressure divided by sum of nameplate compressor CFM*
$F_{adjustment}$	=*Adjusts full load power to weighted part load power by controls type*
CF	= *Coincidence Factor for Peak Demand hours*

The Fraction Power (FP) on the air compressor demand curve, where the reduction in load occurs from repairing the air leaks, was determined by the method adapted from *Modeling and Simulation of Air Compressor Use, ACEEE.org.* Applying the FP to the product of the reduced air flow and power is summarized in the following equation:

$$kWh_{savings} = CFM_{repairs} \ x \ {}^{1}\Big/_{\frac{SCFM}{kW}} \ x \ (FP_o + (1 - \ FP_o\ ) x FC)$$

The peak demand equation:

$$kW_{Peak} = \frac{kWh_{savings}}{HOU} x\ CF$$

Where:

kWhsavings	= *Annual energy savings*
CFM	= *Air leaks; CFM*
db	= *ultrasonic air leak intensity; decibels*
kW	= *Full load air compressor power, kw*
SCFM	= Full load air compressor flow, cfm
FP_o	= No Production factor
FC	= Fraction of operating range; assume savings occur mostly idle
kW_{peak}	= peak demand savings
CF	=Peak demand coincident factor, 0.38, IN TRM 2.2
HOU	= Annual compressor hours

The table below presents ex ante and ex post energy savings, verified hours of operation, CFM of the repaired leak, and the compressor efficiency.

Air Leak Savings Algorithm Inputs

Variable	*Ex Ante*	*Ex Post*	*Ex Post Source*
Leaks Found; CFM	178	178	Leak repair log
Leaks Repaired; CFM	168	168	Leak repair log
scfm/kW	7.3	7.4	Full airflow/packaged power
Control method	VSD	VSD	Site photo; Narrative
Package power; power zero flow	NA	54.0; 1.1	CAGI Data Sheets, GA45VSD
Operating Hours	3,600	3,600	Billing interval data
kWh savings	92,796	92,796	Calculated
CF	1	0.38	IN TRM 2.2; Air Compressors
kW reduced	25.78	10.14	Calculated

Results

Gross Energy Impacts Summary

Measure Category	*kWh Savings*			*Ex Post Gross kW Savings*
	Ex Ante	*Ex Post*	*Realization Rate*	
Custom Air Compressor	92,796	96,078	103%	10.14
Total	**92,796**	**96,078**	**103%**	**10.14**

The ex post annual energy savings are 96,078 kWh and the ex post peak demand reduction is 10.14 kW. The energy gross realization rate is 103%.

The ex-ante and ex-post savings were based on the same method, except the ex-ante method utilized the default conversion from motor hp to packaged power, whereas the ex-post method sourced the CAGI data sheet for the variable speed air compressor, model GA45VSD.

The ex-post peak demand savings (10.14) is less than the ex-ante (26.69), as the ex-post method applied the coincidence factor for the air compressor measures, to the reduction in power demand with the reduced air leaks.

2.41. Sample ID 216

Executive Summary

Under a project represented by sample ID 216, a program participant received custom incentives from I&M for the detection and repair of compressed air leaks in their industrial facility. The ex post annual energy savings are 83,265 kWh, with an ex post peak demand reduction of 5.63 kW. The project energy savings gross realization rate is 100%.

Project Description

Ultrasonic compressed air leak detection performed at the facility identified 77 CFM of air leaks that were repaired to reduce the load on the air compressors.

Measurement and Verification Effort

Through remote data collection, ADM staff verified the completion of the leak repair project, the hours of operation, and the energy profile and operation of the on-site air compressor. ADM then used the *UE Systems Compressed Gas Flow Rate Curves* to calculate the air loss rate at each leak based on the ultrasonic decibel (dB) reading at each leak. To calculate the annual energy consumption reduction, this air loss calculation was used, along with compressor-specific power and annual hours of operation. The following equations were used to calculate the annual energy savings from the leak repairs:

$$SCFM_{leaks} = \sum 0.014 \times \mathrm{dB}^{1.4004}$$

$$kWh_{savings} = SCFM_{leaks}\ x\ R_{air\ leaks}\ x\ \eta_{air\ comp}\ x\ F_{adjustment}\ x\ Hours\ x\ SCFM$$

$$kW_{savings} = kWh_{savings}\ x\ CF/\ Hours$$

Where:

$SCFM_{leaks}$	*= Cubic feet per minute in reduced leaks at atmospheric pressure*
dB	*= Decibel reading at each leak*
$kWh_{savings}$	*= Annual energy savings*
R_{leaks}	*= Repair rate of leaks*
$Hours$	*= Indicated hours of usage for the compressors*
$N_{air\ compressor}$	*= Sum of Nameplate compressor kW adjusted to discharge pressure divided by sum of nameplate compressor CFM*
$F_{adjustment}$	*=Adjusts full load power to weighted part load power by controls type*
CF	*= Coincidence Factor for Peak Demand hours*

The Fraction Power (FP) on the air compressor demand curve, where the reduction in load occurs from repairing the air leaks, was determined by the method adapted from *Modeling and Simulation of Air Compressor Use, ACEEE.org.* Applying the FP to the product of the reduced air flow and power is summarized in the following equation:

$$kWh_{savings} = CFM_{repairs}\ x\ {}^{1}\!\Big/\!\frac{SCFM}{kW}\ x\ (FP_o + (1 - FP_o)xFC)$$

The peak demand equation:

$$kW_{Peak} = \frac{kWh_{savings}}{HOU} \, x \, CF$$

Where:

kWhsavings	*= Annual energy savings*
CFM	*= Air leaks; CFM*
db	*= ultrasonic air leak intensity; decibels*
kW	*=Full load air compressor power, kw*
SCFM	*= Full load air compressor flow, cfm*
FP_o	*= No flow Production factor*
FC	*= Fraction of operating range; assume savings occur mostly idle*
kW_{peak}	*= peak demand savings*
CF	*=Peak demand coincident factor, 0.38, IN TRM 2.2*
HOU	*= Annual compressor hours of*

The table below presents ex ante and ex post energy savings, verified hours of operation, CFM of the repaired leak, and the compressor efficiency.

Air Leak Savings Algorithm Inputs

Variable	*Ex Ante*	*Ex Post*	*Ex Post Source*
Leaks Found; CFM	97	97	Leak repair log
Leaks Repaired; CFM	76.7	76.7	Leak repair log
scfm/kW	6.3	6.3	Full airflow/packaged power
Control method	VSD	VSD	Site photo; Narrative
Package power; power zero flow	135.7; 0.0	135.7; 0.0	CAGI Data Sheets, LS11009V
Operating Hours	5,616	5,616	Billing interval data
kWh savings	83,265	83,265	Calculated
CF	1	0.38	IN TRM 2.2; Air Compressors
kW reduced	14.83	5.63	Calculated

Results

Gross Energy Impacts Summary

Measure Category	*kWh Savings*			*Ex Post Gross kW Savings*
	Ex Ante	*Ex Post*	*Realization Rate*	
Custom Compressed Air Leaks	83,265	83,265	100%	5.63
Total	**83,265**	**83,265**	**100%**	**5.63**

The ex post annual energy savings are 83,265 kWh and the ex post peak demand reduction is 5.63 kW. The energy gross realization rate is 100%.

The ex-ante and ex-post savings were based on the same method, with the same verified equation inputs.

The ex-post peak demand savings (5.63) is less than the ex-ante (14.83), as the ex-post method applied the coincidence factor for the air compressor measures, to the reduction in power demand with the reduced air leaks.

2.42. Sample ID 217

Executive Summary

Under a project represented by sample ID 217, a participant had the direct install program replace the door opening weatherstrips in a hotel to reduce air infiltration.

The ex post energy savings are 64,257 kWh with ex post peak demand reduction of 1.2 kW and the gross energy savings realization rate is 100%.

Project Description

The direct install program identified the opportunity for weatherization at a hotel by first measuring the gaps from the door frame to the door that permit excess infiltration. Then installed weatherstripping around fifty exterior doors.

Measurement and Verification Effort

ADM staff visited the site to verify the new weatherstrips installed on the door, the perimeter sealed, quantity of doors, and to note the PTAC type. The same method for *Commercial Weather Stripping from the Illinois TRM* was applied for both the ex ante and ex post savings method.

$$kW_{savings} = \sum_{Area} \left[\frac{(\Delta kWh_{cool} x\ Length)}{EFLH_{cool}} \quad X\ CF \right]$$

Where:

$kWh_{savings}$ = *Annual energy savings*
$kW_{savings}$ = *Annual peak demand savings*
ΔkWh_{cool} = *Energy savings per foot, Illinois TRM Commercial Weatherstripping*
ΔkWh_{heat} = *Energy savings per foot, Illinois TRM Commercial Weatherstripping*
$Length$ = *Door perimeter sealed*
$EFLH_{cool}$ =*Effective full load cooling hours, Illinois TRM Commercial Weatherstripping*
CF =*Coincident peak demand factor,*

Results

Gross Energy Impacts Summary

Measure Category	*kWh Savings*			*Ex Post Gross kW Savings*
	Ex Ante	*Ex Post*	*Realization Rate*	
Custom Weatherization	64,257	64,257	100%	1.20
Total	**64,257**	**64,257**	**100%**	**1.20**

The ex post annual energy savings are 64,257 and the ex post peak demand reduction is 1.20 kW. The energy gross realization rate is 100%, as both methods utilized the same TRM energy savings factors for the cities with the nearest weather data.

2.43. Sample ID 218

Executive Summary

Under a project represented by sample ID 218, a participant received new construction custom incentives from I&M for installing more efficient lighting over the building code prescribed lighting power density requirement, in a new construction retail building.

The ex post energy savings are 59,797 kWh and the realization rate is 100% The peak demand savings are 12.13 kW.

Project Description

The participant installed energy efficient lighting and lighting controls that exceeded the minimum building code required lighting power density, by building type, as specified within the standard: *Energy Standard for Buildings Except Low-Rise Residential Buildings (ASHRAE 90.1-2007).* The participant also installed exterior energy efficient lighting, exceeding the code-based lighting power allowance.

The participant designed and installed lighting in the retail space requiring less power per square foot than a minimum code compliant building, based on space-by-space lighting allowances. The participant installed (189) LED 8' Strip fixtures and (2) LED 4' Strip fixtures.

Measurement and Verification Effort

To verify the project savings, ADM staff reviewed project documentation, existing lighting types, new lighting, methods of controlling the lighting and the HVAC types for each area. Interval electric billing data for one year was aggregated in one hour periods, binned to the day of the week, to estimate the working schedule.

The following algorithms for energy and coincident peak demand savings were sourced from the measure: *Lighting Systems, (Indiana TRM version 2.2).*

$$kWh_{savings} = \sum_{Area} \left[Hours\ x\ (Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed}) x\ Whf_{kWh} / 1000 \frac{W}{kW} \right]$$

$$kW_{savings} = \sum_{Area} \left[(Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed})\ x\ Whf_{kW}\ xCF / 1000 \frac{W}{kW} \right]$$

Where:

$kWh_{savings}$	= *Annual energy savings*
$kW_{savings}$	= *Annual coincident peak demand savings*
Qty	= *Quantity of fixtures or lamps*
W	= *Wattage of each fixture or lamp*
$Hours$	= *Lighting annual operating hours*
Whf	= *Waste heat factor for kW or kWh, IN TRM 2.2 by city & HVAC type*
CF	=*Coincident peak demand factor, IN TRM 2.2, by building type*

The variables for the energy savings algorithm are summarized in the following table.

Lighting Energy Savings Calculations

Measure	*Quantity*		*Wattage*		*Annual Hours*	*Waste Heat Factor*	*Ex Ante Annual kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
	Base	*Efficient*	*Base*	*Efficient*					
LED Strip fixture w/ LED 4' 2L	189	189	99	36	4,434	0.12	58,756	59,482	101%
LED Strip fixture w/ LED 4' L	2	2	50	18	4,434	0.12	933	315	34%
Total							59,689	59,797	100%

Results

Realized Gross Savings

Measure Category	*kWh Savings*			*Realized Peak kW Reduction*
	Ex Ante	*Ex Post*	*Realization Rate*	
Custom Lighting	59,689	59,797	100%	12.13
Total	**59,689**	**59,797**	**100%**	**12.13**

The ex post energy savings are 59,797 kWh with a gross energy savings realization rate of 100%. The ex-post saving analysis found a few differences from the ex-ante savings analysis. The verified hours (4,434) are greater than the ex-ante savings hours estimate (4,368). The verified efficient quantity for the second measure is 2, which is fewer than the ex-ante estimated quantity of 6.

The peak demand ex-post savings of 12.13 kW is similar to the ex-ante savings of 12.25 kW.

2.44. Sample ID 221

Executive Summary

Under a project represented by sample ID 221, a program participant received custom incentives from I&M for the detection and repair of compressed air leak in their industrial facility. The ex post annual energy savings are 544,812 kWh, with an ex post peak demand reduction of 62.87 kW. The project energy savings gross realization rate is 113%.

Project Description

The ultrasonic leak detection audit identified and subsequently repaired 641 CFM of compressed air leaks. The reduced air load eliminated the usage of one trim air compressor and impacted the base load air compressor.

Measurement and Verification Effort

Through remote data collection, ADM staff verified the completion of the leak repair project, the hours of operation, and the energy profile and operation of the on-site air compressor. ADM then used the *UE Systems Compressed Gas Flow Rate Curves* to calculate the air loss rate at each leak based on the ultrasonic decibel (dB) reading at each leak. To calculate the annual energy consumption reduction, this air loss calculation was used, along with compressor-specific power and annual hours of operation. The following equations were used to calculate the annual energy savings from the leak repairs:

$$SCFM_{leaks} = \sum 0.014 \times \mathrm{dB}^{1.4004}$$

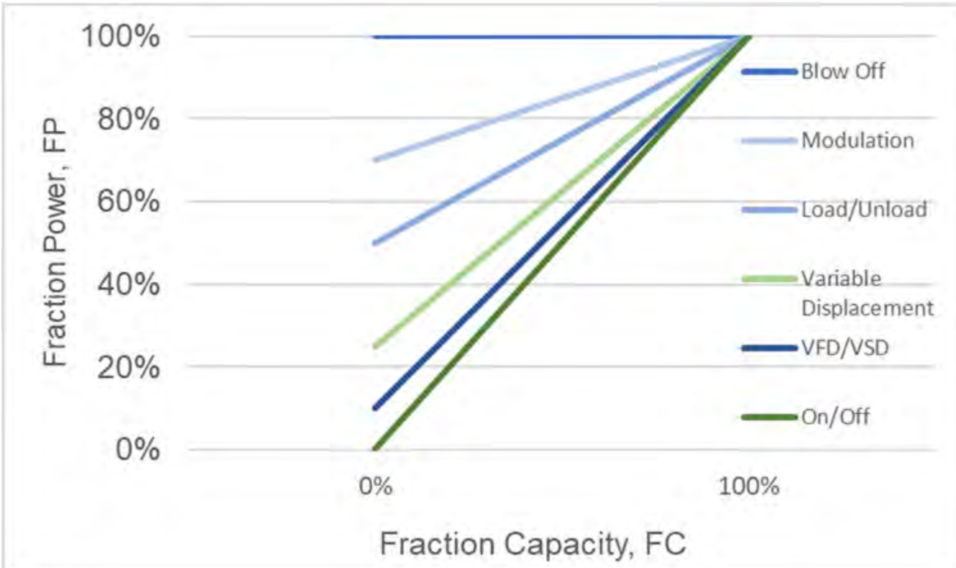
$$kWh_{savings} = SCFM_{leaks}\ x\ R_{air\ leaks}\ x\ \eta_{air\ comp}\ x\ F_{adjustment}\ x\ Hours\ x\ SCFM$$

$$kW_{savings} = kWh_{savings}\ x\ CF/\ Hours$$

Where:

$SCFM_{leaks}$	= *Cubic feet per minute in reduced leaks at atmospheric pressure*
dB	= *Decibel reading at each leak*
$kWh_{savings}$	= *Annual energy savings*
R_{leaks}	= *Repair rate of leaks*
$Hours$	= *Indicated hours of usage for the compressors*
$N_{air\ compressor}$	= *Sum of Nameplate compressor kW adjusted to discharge pressure divided by sum of nameplate compressor CFM*
$F_{adjustment}$	=*Adjusts full load power to weighted part load power by controls type*
CF	= *Coincidence Factor for Peak Demand hours*

The ex-ante air leak reduction calculator sourced the fractional power to fractional capacity curves from the same source as the ex-post savings, "Modeling and Simulation of Air compressor Energy Usage", Chris Schmidt, Kelly Kissock. The version used for the ex-ante calculator omits the air compressor control type of variable displacement or binned it to the VFD/VSD control type. The control type has a slightly higher fraction power at zero flow compared to the VSD. The CAGI sheets for the air compressor list the zero-flow power at 44 kW, which is 24% of the packaged power, so the Variable Displacement curve in the following figure is a good fit with an FP_0 of 25%.



The Fraction Power (FP) on the air compressor demand curve, where the reduction in load occurs from repairing the air leaks, was determined by the method adapted from *Modeling and Simulation of Air Compressor Use, ACEEE.org.* Applying the FP to the product of the reduced air flow and power is summarized in the following equation:

$$kWh_{savings} = CFM_{repairs}\ x\ {}^{1}\!\Big/\frac{SCFM}{kW}\ x\ (FP_o + (1 - FP_o)xFC)$$

The peak demand equation:

$$kW_{Peak} = \frac{kWh_{savings}}{HOU} x\ CF$$

Where:

kWhsavings	= *Annual energy savings*
CFM	= *Air leaks; CFM*
db	= *ultrasonic air leak intensity; decibels*
kW	=*Full load air compressor power, kw*
SCFM	= Full load air compressor flow, cfm
FP_o	= No flow Production factor
FC	= Fraction of operating range; assume savings occur mostly idle
kW_{peak}	= peak demand savings

HOU = Annual compressor hours

CF =Coincident peak demand factor

The table below presents ex ante and ex post energy savings, verified hours of operation, CFM of the repaired leak, and the compressor efficiency.

Air Leak Savings Algorithm Inputs

Variable	*Ex Ante*	*Ex Post*	*Ex Post Source*
Leaks Found; CFM	641	641	Leak log
Leaks Repaired; CFM	540	540	Leak log
Scfm/kw	7.6	6.5	Full capacity/Packaged power
Control type	VSD	Variable Displacement	Site pictures
P_o, power at zero flow	0.0	44.0	CAGI Sheets(similar model)
Operating Hours	5600	6,700	Interval billing data
kWh	479,087	544,812	
kW	83.17	83.82	

Results

Gross Energy Impacts Summary

Measure Category	*kWh Savings*			*Ex Post Gross kW Savings*
	Ex Ante	*Ex Post*	*Realization Rate*	
Air Compressor	479,087	544,812	113%	83.82
Total	**479,087**	**544,812**	**113%**	**62.87**

The ex-post annual energy savings are 544,812 kWh and the ex post peak demand reduction is 83.82 kW. The energy gross realization rate is 113%.

The ex post coincident peak demand savings of 62.87 kW is less than the ex-ante value of 83.82, after applying the CF factor from the IN TRM value of 0.75 for air flow reduction.

2.45. Sample ID 222

Executive Summary

Under a project represented by sample ID 222, a program participant received custom incentives from I&M for the detection and repair of compressed air leaks in their industrial facility. The ex post annual energy savings are 190,737 kWh, with an ex post peak demand reduction of 22.00 kW. The project energy savings gross realization rate is 74%.

Project Description

The ultrasonic leak detection audit identified and subsequently repaired 169 CFM of compressed air leaks. The reduced air load eliminated the usage of one trim air compressor and impacted the base load air compressor.

Measurement and Verification Effort

Through remote data collection, ADM staff verified the completion of the leak repair project, the hours of operation, and the energy profile and operation of the on-site air compressor. ADM then used the *UE Systems Compressed Gas Flow Rate Curves* to calculate the air loss rate at each leak based on the ultrasonic decibel (dB) reading at each leak. To calculate the annual energy consumption reduction, this air loss calculation was used, along with compressor-specific power and annual hours of operation. The following equations were used to calculate the annual energy savings from the leak repairs:

$$SCFM_{leaks} = \sum 0.014 \times \text{dB}^{1.4004}$$

$$kWh_{savings} = SCFM_{leaks}\ x\ R_{air\ leaks}\ x\ \eta_{air\ comp}\ x\ F_{adjustment}\ x\ Hours\ x\ SCFM$$

$$kW_{savings} = kWh_{savings}\ x\ CF/\ Hours$$

Where:

$SCFM_{leaks}$	= *Cubic feet per minute in reduced leaks at atmospheric pressure*
dB	= *Decibel reading at each leak*
$kWh_{savings}$	= *Annual energy savings*
R_{leaks}	= *Repair rate of leaks*
$Hours$	= *Indicated hours of usage for the compressors*
$N_{air\ compressor}$	= *Sum of Nameplate compressor kW adjusted to discharge pressure divided by sum of nameplate compressor CFM*
FP_0	=*Fraction of full load power at zero air flow (FLP, FP_0 from CAGI sheet)*
$F_{adjustment}$	=*Adjusts full load power to weighted part load power by controls type*
CF	= *Coincidence Factor for Peak Demand hours*

The Fraction Power (FP) on the air compressor demand curve, where the reduction in load occurs from repairing the air leaks, was determined by the method adapted from *Modeling and Simulation of Air Compressor Use, ACEEE.org.* Applying the FP to the product of the reduced air flow and power is summarized in the following equation:

$$kWh_{savings} = CFM_{repairs}\ x\ {}^{1}\!\Big/\frac{SCFM}{kW}\ x\ (FP_o + (1 - FP_o)xFC)$$

The peak demand equation:

$$kW_{Peak} = \frac{kWh_{savings}}{HOU} \, x \, CF$$

Where:

kWhsavings = *Annual energy savings*

CFM = *Air leaks; CFM*

db = *ultrasonic air leak intensity; decibels*

kW =*Full load air compressor power, kw*

SCFM = Full load air compressor flow, cfm

FP_o = No Production factor

FC = Fraction of operating range;

kW_{peak} = peak demand savings

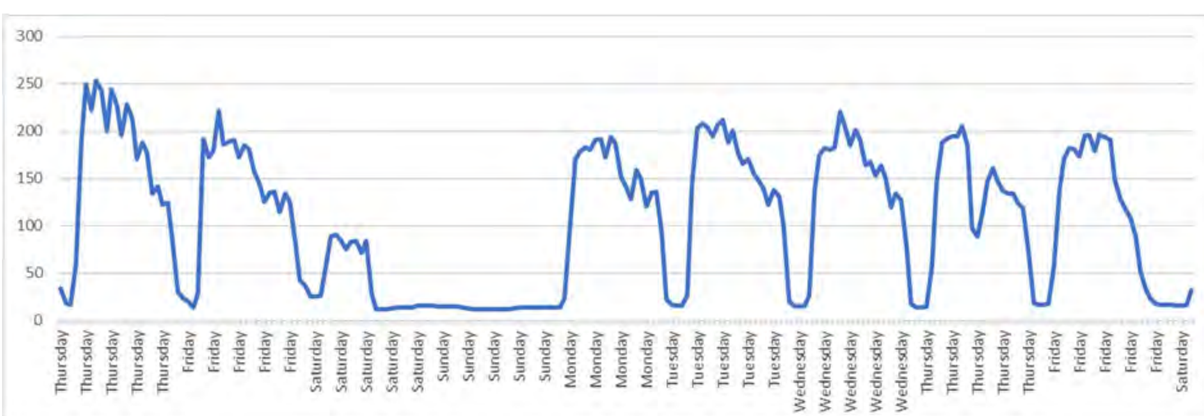
HOU = Annual compressor hours of use

The table below presents ex ante and ex post energy savings, verified hours of operation, CFM of the repaired leak, and the compressor flow per kW.

Air Leak Savings Algorithm Inputs

Variable	*Ex Ante*	*Ex Post*
Leaks Found; CFM	168.9	168.9
Leaks Repaired; CFM	145.4	145.4
Scfm/kW	6.4	6.4
Hours at rated capacity	7,352	6,500
kWh savings	257,055	190,737
CF	1	0.75
kW reduced	29.34	22.00

The interval billing data was aggregated over one year to estimate the operating hours for the air compressors. This data shows a significant drop in the total plant load between shifts, and



operations on some Saturdays occur at reduced capacity. By setting a threshold at 50 kW to account for both weekdays and weekends, the annual operating hours are closer to 6,500, compared to the ex-ante estimate of 7,352.

Results

Gross Energy Impacts Summary

Measure Category	*kWh Savings*			*Ex Post Gross kW Savings*
	Ex Ante	*Ex Post*	*Realization Rate*	
Air Compressor	257,055	190,737	74%	22.00
Total	**257,055**	**190,737**	**74%**	**22.00**

The ex post energy savings are 190,737 kWh and the ex post peak demand reduction is 22.00. The energy gross realization rate is 74%.

The main contributor is the difference in ex ante and ex post savings estimates is the annual hours of use in the manufacturing facility. The ex-ante hours assumed a 24/6 operating schedule, which is an overestimate of the working hours for this facility. The load between shifts, Sundays and some Saturdays, is less than the input power of a single air compressor operating.

2.46. Sample ID 300

Executive Summary

Under a project represented by sample ID 300, a program participant received work direct install incentives from I&M for installing efficient lighting in the interior and exterior of their building.

The ex post energy savings are 19,933 kWh and peak demand savings are 0.69 kW resulting in an energy savings realization rate of 59%.

Project Description

The participant installed (68) LED 4' lamps, (22) LED 4' panel fixtures, (2) LED wall packs, (18) LED canopy fixtures, and (9) occupancy sensors on refrigerated cases.

Measurement and Verification Effort

To verify the project savings, ADM staff reviewed project documentation, existing lighting types, new lighting, methods of controlling the lighting and the HVAC types for each area. Interval electric billing data for one year was aggregated in one hour periods, binned to the day of the week, to estimate the working schedule.

The following algorithms for energy and coincident peak demand savings were sourced from the measure: *Lighting Systems, (Indiana TRM version 2.2).*

$$kWh_{savings} = \sum_{Area} \left[Hours\ x\ (Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed}) x\ Whf_{kWh} / 1000 \frac{W}{kW} \right]$$

$$kW_{savings} = \sum_{Area} \left[(Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed})\ x\ Whf_{kW}\ xCF / 1000 \frac{W}{kW} \right]$$

Where:

$kWh_{savings}$	= *Annual energy savings*
$kW_{savings}$	= *Annual coincident peak demand savings*
Qty	= *Quantity of fixtures or lamps*
W	= *Wattage of each fixture or lamp*
Hours	= *Lighting annual operating hours*
Whf	= *Waste heat factor for kW or kWh, IN TRM 2.2 by city & HVAC type*
CF	=*Coincident peak demand factor, IN TRM 2.2, by building type*

The variables for the energy savings algorithm are summarized in the following table.

Lighting Energy Savings Calculations

Measure	*Quantity*		*Wattage*		*Annual Hours*	*Waste Heat Factor*	*Ex Ante Annual kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
	Base	*Efficient*	*Base*	*Efficient*					
T8 to LED 4' lamp	68	68	28	22	8,760	0.13	5,576	4,024	72%

Measure	*Quantity*		*Wattage*		*Annual Hours*	*Waste Heat Factor*	*Ex Ante Annual kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
	Base	*Efficient*	*Base*	*Efficient*					
2 x 4 fixture to LED Panel fixture	22	22	70	60	8,760	0.13	2,453	2,170	88%
HID to LED Wall Pack fixture	2	2	250	80	4,303	0.00	1,376	1,463	106%
HID to LED Canopy fixture	18	18	300	150	4,303	0.00	19,795	11,645	59%
None to Occupancy Sensor	0	9	-	27	8,760	0.00	4,575	631	14%
Total							33,774	19,933	59%

Results

Realized Gross Savings

Measure Category	*kWh Savings*			*Realized Peak kW Reduction*
	Ex Ante	*Ex Post*	*Realization Rate*	
Work Direct Install Lighting	33,774	19,933	59%	0.69
Total	**33,774**	**19,933**	**59%**	**0.69**

The ex post energy savings are 19,933 kWh with a gross energy savings realization rate of 59%. The primary difference between ex ante and ex post savings stems from the ex ante savings estimate relying on a deemed value, whereas the ex-post analysis employed the method previously described. The three interior measures had verified hours of operation at 8,760, while the hours for the exterior measures, excluding daylighting, were 4,403.

The peak demand ex-post savings of 0.69 kW was less than the ex-ante savings of 1.19 kW. The ex-ante savings estimate used a deemed value.

2.47. Sample ID 301

Executive Summary

Under a project represented by sample ID 301, a program participant received work direct install incentives from I&M for installing efficient lighting in the interior of their building.

The ex post energy savings are 2,803 kWh and peak demand savings are 0.32 kW resulting in an energy savings realization rate of 112%.

Project Description

The participant installed (15) LED Panel fixtures, (5) LED 5' lamps, and (2) LED 4' lamps.

Measurement and Verification Effort

To verify the project savings, ADM staff reviewed available project documentation, collected the existing lighting type, new lighting manufacturer model and specification data, the lighting control methods and the type of HVAC for each area. Interval electric billing data for one year was aggregated in one hour periods, binned to the day of the week, to estimate the working schedule.

The following algorithms for energy and coincident peak demand savings were sourced from the measure: *Lighting Systems, (Indiana TRM version 2.2).*

$$kWh_{savings} = \sum_{Area} \left[Hours\ x\ (Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed}) x\ Whf_{kWh} / 1000 \frac{W}{kW} \right]$$

$$kW_{savings} = \sum_{Area} \left[(Qty_{base} x\ W_{base} - Qty_{installe}\ \ xW_{installed})\ x\ Whf_{kW}\ xCF / 1000 \frac{W}{kW} \right]$$

Where:

$kWh_{savings}$ = *Annual energy savings*
$kW_{savings}$ = *Annual coincident peak demand savings*
Qty = *Quantity of fixtures or lamps*
W = *Wattage of each fixture or lamp*
Hours = *Lighting annual operating hours*
Whf = *Waste heat factor for kW or kWh, IN TRM 2.2 by city & HVAC type*
CF =*Coincident peak demand factor, IN TRM 2.2, by building type*

The variables for the energy savings algorithm are summarized in the following table.

Lighting Energy Savings Calculations

Measure	*Quantity*		*Wattage*		*Annual Hours*	*Waste Heat Factor*	*Ex Ante Annual kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
	Base	*Efficient*	*Base*	*Efficient*					
Troffer to LED Panel fixture	15	15	75	60	7,378	0.13	1,673	1,869	112%

Measure	*Quantity*		*Wattage*		*Annual Hours*	*Waste Heat Factor*	*Ex Ante Annual kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
	Base	*Efficient*	*Base*	*Efficient*					
5’ T8 to LED 5’ lamp	5	5	40	24	8,760	0.00	645	701	109%
4’ T8 to LED 4’ lamp	2	2	32	18	7,378	0.13	184	233	126%
Total							2,501	2,803	112%

Results

Realized Gross Savings

Measure Category	*kWh Savings*			*Realized Peak kW Reduction*
	Ex Ante	*Ex Post*	*Realization Rate*	
Work Direct Install Lighting	2,501	2,803	112%	0.32
Total	**2,501**	**2,803**	**112%**	**0.32**

The ex post energy savings are 2,803 kWh with a gross energy savings realization rate of 112%. The discrepancy between expected and realized savings arises because the ex-ante savings estimate was based on a deemed value, in contrast to the ex-post analysis, which applied the specified method. The ex-post analysis confirmed the hours of operation for interior measures at 7,378 and for refrigeration measures at 8,760.

The peak demand ex-post savings of 0.32 kW was less than the ex-ante savings of 0.43 kW. The ex-ante savings estimate was a deemed value which was greater than the realized savings.

2.48. Sample ID 302

Executive Summary

Under a project represented by sample ID 302, a program participant received work direct install incentives from I&M for installing more efficient lighting in the interior of their building.

The ex post energy savings are 8,502 kWh and peak demand savings are 1.88 kW resulting in an energy savings realization rate of 79%.

Project Description

The participant installed (132) LED 4' lamps.

Measurement and Verification Effort

To verify the project savings, ADM staff reviewed available project documentation, collected the existing lighting type, new lighting manufacturer model and specification data, the lighting control methods and the type of HVAC for each area. Interval electric billing data for one year was aggregated in one hour periods, binned to the day of the week, to estimate the working schedule.

The following algorithms for energy and coincident peak demand savings were sourced from the measure: *Lighting Systems, (Indiana TRM version 2.2)*.

$$kWh_{savings} = \sum_{Area}\left[Hours\ x\ (Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed}) x\ Whf_{kWh}/1000\frac{W}{kW}\right]$$

$$kW_{savings} = \sum_{Area}\left[(Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed})\ x\ Whf_{kW}\ xCF/1000\frac{W}{kW}\right]$$

Where:

$kWh_{savings}$	= *Annual energy savings*
$kW_{savings}$	= *Annual coincident peak demand savings*
Qty	= *Quantity of fixtures or lamps*
W	= *Wattage of each fixture or lamp*
$Hours$	= *Lighting annual operating hours*
Whf	= *Waste heat factor for kW or kWh, IN TRM 2.2 by city & HVAC type*
CF	=*Coincident peak demand factor, IN TRM 2.2, by building type*

The variables for the energy savings algorithm are summarized in the following table.

Lighting Energy Savings Calculations

Measure	*Quantity*		*Wattage*		*Annual Hours*	*Waste Heat Factor*	*Ex Ante Annual kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
	Base	*Efficient*	*Base*	*Efficient*					
4' T8 to LED 4' lamp	132	132	32	14	3,578	0.00	10,824	8,502	79%
Total							10,824	8,502	79%

Results

Realized Gross Savings

Measure Category	*kWh Savings*			*Realized Peak kW Reduction*
	Ex Ante	*Ex Post*	*Realization Rate*	
Work Direct Install Lighting	10,824	8,502	79%	1.88
Total	**10,824**	**8,502**	**79%**	**1.88**

The ex post energy savings are 8,502 kWh with a gross energy savings realization rate of 79%. The primary difference between expected and realized savings stems from the ex-ante savings estimate relying on a deemed value, whereas the ex-post analysis employed the method described earlier. The verified efficient wattage of 14W is higher than the ex-ante estimated wattage of 12W.

The peak demand ex-post savings of 1.88 kW was greater than the ex-ante savings of 1.32 kW. The ex-ante savings estimate was a deemed value which was less than the realized savings.

2.49. Sample ID 303

Executive Summary

Under a project represented by sample ID 303, a program participant received work direct install incentives from I&M for installing more efficient lighting in the interior of their building.

The ex post energy savings are 28,015 kWh and peak demand savings are 7.11 kW resulting in an energy savings realization rate of 95%.

Project Description

The participant installed (36) LED UFO high bay fixtures.

Measurement and Verification Effort

To verify the project savings, ADM staff reviewed available project documentation, collected the existing lighting type, new lighting manufacturer model and specification data, the lighting control methods and the type of HVAC for each area.

Lighting Energy Savings Calculations

Measure	*Quantity*		*Wattage*		*Annual Hours*	*Waste Heat Factor*	*Ex Ante Annual kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
	Base	*Efficient*	*Base*	*Efficient*					
HID to LED UFO High Bay	36	36	400	149.9	3,111	0.00	29,549	28,015	95%
Total							29,549	28,015	95%

Results

Realized Gross Savings

Measure Category	*kWh Savings*			*Realized Peak kW Reduction*
	Ex Ante	*Ex Post*	*Realization Rate*	
Work Direct Install Lighting	29,549	28,015	95%	7.11
Total	**29,549**	**28,015**	**95%**	**7.11**

The ex post energy savings are 28,015 kWh with a gross energy savings realization rate of 95%. The primary discrepancy between expected and realized savings arises because the ex-ante savings estimate was based on a deemed value of 820.8 per unit, in contrast to the ex-post analysis, which applied the previously described method. The verified efficient wattages for the second measure at 149.9W are lower than the ex-ante estimated wattages of 150W.

The peak demand ex-post savings of 7.11 kW was greater than the ex-ante savings of 6.5 kW. The ex-ante savings estimate was a deemed value which was less than the ex-post savings.

2.50. Sample ID 304

Executive Summary

Under a project represented by sample ID 304, a program participant received work direct install incentives from I&M for installing more efficient lighting in the interior of their building.

The ex post energy savings are 6,845 kWh and peak demand savings are 2.01 kW resulting in an energy savings realization rate of 83%.

Project Description

The participant installed (100) LED 4' lamps.

Measurement and Verification Effort

To verify the project savings, ADM staff reviewed available project documentation, collected the existing lighting type, new lighting manufacturer model and specification data, the lighting control methods and the type of HVAC for each area.

Lighting Energy Savings Calculations

Measure	*Quantity*		*Wattage*		*Annual Hours*	*Waste Heat Factor*	*Ex Ante Annual kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
	Base	*Efficient*	*Base*	*Efficient*					
4' T8 to LED 4' lamp	100	100	42	18	2,852	0.00	8,200	6,845	83%
Total							8,200	6,845	83%

Results

Realized Gross Savings

Measure Category	*kWh Savings*			*Realized Peak kW Reduction*
	Ex Ante	*Ex Post*	*Realization Rate*	
Work Direct Install Lighting	8,200	6,845	83%	2.01
Total	**8,200**	**6,845**	**83%**	**2.01**

The ex post energy savings are 6,845 kWh with a gross energy savings realization rate of 83%. The main difference between expected and realized savings stems from the ex-ante savings estimate relying on a deemed value, whereas the ex-post analysis employed the previously outlined method.

The peak demand ex-post savings of 2.01 kW was greater than the ex-ante savings of 1.00 kW. The ex-ante savings estimate was a deemed value which was less than the ex post savings.

2.51. Sample ID 305

Executive Summary

Under a project represented by sample ID 305, a program participant received work direct install incentives from I&M for installing more efficient lighting in the interior of their building.

The ex post energy savings are 25,681 kWh and peak demand savings are 6.52 kW resulting in an energy savings realization rate of 97%.

Project Description

The participant installed (33) LED UFO high bay fixtures.

Measurement and Verification Effort

To verify the project savings, ADM staff reviewed available project documentation, collected the existing lighting type, new lighting manufacturer model and specification data, the lighting control methods and the type of HVAC for each area. Interval electric billing data for one year was aggregated in one hour periods, binned to the day of the week, to estimate the working schedule.

The following algorithms for energy and coincident peak demand savings were sourced from the measure: *Lighting Systems, (Indiana TRM version 2.2).*

$$kWh_{savings} = \sum_{Area} \left[Hours\ x\ (Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed}) x\ Whf_{kWh} / 1000 \frac{W}{kW} \right]$$

$$kW_{savings} = \sum_{Area} \left[(Qty_{base} x\ W_{base} - Qty_{installed} x W_{installed})\ x\ Whf_{kW}\ xCF / 1000 \frac{W}{kW} \right]$$

Where:

$kWh_{savings}$	= *Annual energy savings*
$kW_{savings}$	= *Annual coincident peak demand savings*
Qty	= *Quantity of fixtures or lamps*
W	= *Wattage of each fixture or lamp*
Hours	= *Lighting annual operating hours*
Whf	= *Waste heat factor for kW or kWh, IN TRM 2.2 by city & HVAC type*
CF	=*Coincident peak demand factor, IN TRM 2.2, by building type*

The variables for the energy savings algorithm are summarized in the following table.

Lighting Energy Savings Calculations

Measure	*Quantity*		*Wattage*		*Annual Hours*	*Waste Heat Factor*	*Ex Ante Annual kWh Savings*	*Ex Post Gross kWh Savings*	*Gross Realization Rate*
	Base	*Efficient*	*Base*	*Efficient*					
HID to LED UFO High Bay	33	33	400	149.89	3,111	0.00	26,426	25,681	97%
Total							26,426	25,681	97%

Results

Realized Gross Savings

Measure Category	*kWh Savings*			*Realized Peak kW Reduction*
	Ex Ante	*Ex Post*	*Realization Rate*	
Work Direct Install Lighting	26,426	25,681	97%	6.52
Total	**26,426**	**25,681**	**97%**	**6.52**

The ex post energy savings are 25,681 kWh with a gross energy savings realization rate of 97%. The main difference between ex ante and ex post savings stems from the ex-ante savings estimate relying on a deemed value, in contrast to the ex-post analysis, which employed the method described above. Additionally, the verified efficient wattages for the second measure are 149.89W, slightly less than the ex-ante estimated wattages of 150W.

The peak demand ex-post savings of 6.53 kW was less than the ex-ante savings of 10.16 kW. The ex-ante savings estimate was a deemed value which was greater than the realized savings.

2.52. Sample ID 400

Executive Summary

Under the Strategic Energy Management (SEM) program, a participant implemented low-cost measures. The ex post annual energy savings are 394,137 kWh, with an ex post peak demand reduction of 35.63 kW. The project energy savings gross realization rate is nearly 100%.

Project Description

The strategic energy management participant identified low cost opportunities for energy reduction in their facility. The project repaired three solenoid values leaking 26 CFM. They also identified the need to control air handler fan speed and installed four VFD's.

Measurement and Verification Effort

Projects documents were reviewed for the air leaks, air compressor model data. CAGI data sheets were sourced for the air compressor operating efficiency at full load and no/low load. The participant provided trended data for the VFDs, to analyze the hourly bin energy savings.

$$kWh_{savings} = CFM_{repairs}\ x\ {}^{1}\Big/\tfrac{SCFM}{kW}\ x\ (FP_o + (1 - FP_o)xFC)$$

The peak demand equation:

$$kW_{Peak} = \frac{kWh_{savings}}{HOU}$$

Where:

kWhsavings	= *Annual energy savings*
CFM	= *Air leaks; CFM*
kW	=*Full load air compressor power, kw*
SCFM	= Full load air compressor flow, cfm
FP_o	= No flow Production factor
FC	= Fraction of operating range;
kW_{peak}	= peak demand savings
HOU	= Annual compressor hours

The table below presents ex ante and ex post energy savings, verified hours of operation, CFM of the repaired leak, and the compressor efficiency.

Air Leak Savings Algorithm Inputs

Variable	*Ex Ante*	*Ex Post*
Air leaks per valve	26	26
Valves repaired	3	3
Rated flow, cfm	NA	1075

Rated package power	NA	221.2
Package power zero flow	NA	55.3
kW/100 CFM, rated cap	20.6	17.3
Annual hours	8400	8400
Energy savings, kWh	134,971	113,669
CF	NA	0.75
Demand reduction, kW	0	10.15

Pre Period Fan Motor Power Monitoring

Hour	*Fan 2 Energy, kWh*	*Fan 3 Energy, kWh*	*Fan 4 Energy, kWh*	*Fan 1 Energy, kWh (fan 4 data)*
12 AM	9.3	15.1	14.7	14.7
1 AM	9.5	15.6	15.4	15.4
2 AM	9.5	16.0	15.8	15.8
3 AM	9.7	15.8	15.6	15.6
4 AM	9.9	16.0	16.2	16.2
5 AM	10.5	16.8	17.5	17.5
6 AM	10.9	17.2	18.2	18.2
7 AM	10.8	17.1	17.9	17.9
8 AM	10.3	16.3	16.7	16.7
9 AM	9.9	15.5	15.9	15.9
10 AM	9.6	15.1	15.1	15.1
11 AM	9.5	15.3	15.8	15.8
12 PM	9.2	15.0	15.5	15.5
1 PM	8.8	14.5	14.6	14.6
2 PM	9.1	15.0	14.9	14.9
3 PM	9.6	15.7	15.6	15.6
4 PM	9.9	16.3	16.2	16.2
5 PM	9.9	16.2	16.2	16.2
6 PM	9.9	16.3	16.2	16.2
7 PM	10.4	17.0	17.5	17.5
8 PM	11.2	18.3	18.6	18.6
9 PM	11.0	17.9	18.2	18.2
10 PM	10.7	17.5	17.5	17.5
11 PM	9.3	15.0	14.6	14.6
Day	238.5	386.8	390.5	390.5
Annual hours	8520	8520	8520	8520
Annual kWh	84,657	137,312	138,629	138,6289

VFD Summary by Fraction Air Flow

Flow %	Power, kW	Schedule %	4 x VFD Annual kWh
70	13.2	15%	67,532
60	9.0	15%	45,935
50	5.7	40%	77,653
40	3.3	20%	22,226
40	1.6	10%	5,413
Total Post Period		100%	218,760

Results

Gross Energy Impacts Summary

Measure Category	*kWh Savings*			*Ex Post Gross kW Savings*
	Ex Ante	*Ex Post*	*Realization Rate*	
SEM- VFD Fan Motor	259,647	280,467	108%	25.68
SEM- Air Leak Repair	134,971	113,670	84%	10.15
Total	**394,618**	**394,137**	**100%**	**35.63**

The ex post energy savings are 394,137 kWh and the ex post peak demand reduction is 35.63 kW. The overall project energy gross realization rate is 100%, although ex post VFD savings exceeded the ex ante savings and the ex post savings for the air leak repair were less than the ex ante savings.

The increased savings achieved with the VFDs installed on the fan motors can be attributed to data cleaning conducted during the ex-post savings analysis. Specifically, the first 27 hours of metered data showed zero values across all logged channels, with no subsequent zero values noted in the remaining 13 days of data logging. This period was identified as the interval between the programming and installation of the logging equipment, leading to a higher calculated baseline energy usage.

Conversely, the lesser savings realized from the air leak repair are due to the application of the same savings analysis method used across all air leak reduction projects. This method accounts for the air compressor control method by incorporating the fraction power value at zero flow and the total package input power. As a result, an air compressor efficiency of 17.3 kW/100CFM was determined, compared to the ex-ante calculated efficiency of 20.6 kW/100CFM for the same air compressor.

[Section Break (Next Page) Below, Don't Delete, add page breaks above this comment if needed to add site reports]

3. C&I Participant Survey Instrument

Screening / background

1. Our records indicate that you are the main contact for the [FR_MEAS1] project completed at [LOCATION].
2. Were you involved in the decision to complete this project?

   1. Yes
   2. No

3. Could you provide the name and contact information of the person most knowledgeable about the decision to complete this project?

[Terminate if Q2 = 2]

4. Does your company have any of the following policies or procedures in place at [LOCATION]?

[FOR EACH, 1 = Yes, 2 = No, 98 = Don't know]

a) A person or persons responsible for monitoring or managing energy usage
b) Defined energy savings goals
c) A specific policy requiring that energy efficiency be considered when purchasing equipment
d) Carbon reduction goals

Program Awareness

5. How did you FIRST learn about Indiana Michigan Power's incentives for efficient equipment upgrades?

[RANDOMIZE 1 – 10, FIX 11 and 98]

1. From a Trade Ally/contractor/equipment vendor/ energy consultant
2. From an Indiana Michigan Power Account Representative
3. From a program representative / CLEAResult
4. From an internet search
5. At an event/trade show
6. Received an email blast or electronic newsletter
7. Received an informational brochure
8. From a program sponsored webinar
9. From *Indiana Michigan*'s website
10. Friends or colleagues
11. Some other way (please explain) [OPEN]
98. Don't know

Program Delivery Efficiency

Onsite Energy Assessment

6. Did [PROGRAM TA/REPRESENTATIVE] complete an onsite energy evaluation or survey of your facility?

1. Yes
2. No

[Display IF Q6= 1]

7. Upon completion of your initial assessment, were there any energy efficiency measures recommended that you did not implement?

1. No, we implemented all of the recommended measures
2. Yes, there were some recommended measures that we did not install
98. Don't recall

[Display if Q7=2]

8. Which recommended measures did you **not** install? [Multiple response]

1. Lighting replacements
2. Lighting controls
3. HVAC measures
4. Refrigeration measures
5. Food service measures
6. Compressed air measures
7. Other measures not listed above (Please describe)
98. Don't recall

[Display if Q7=2]

9. Why did you not install those recommended measures? [Multiple response]

1. High initial cost
2. Identifying potential areas for improvement/lack of technical knowledge
3. Other investments/improvements have higher funding priority
4. Long payback period/return on investment
5. Unaware of available incentives for energy efficient equipment
6. Lack of corporate support for energy efficiency investments
7. Lack of staff time to pursue energy efficiency upgrades
8. Finding a contractor/vendor with which to work
9. Confusion about who to contact for information or navigating the energy efficiency program offerings
10. Completing the required paperwork to receive the incentive
11. Don't own building
12. Other, please specify [Anchor]

SBDI Trade Ally Experience

[Display Q10 IF SBDI = 1]

10. Using the scale below, please indicate how much you agree or disagree with the following statements regarding your experience with your SBDI Trade Ally:

[SCALE: 1 = 1 (Completely disagree), 2 = 2, 3 =3, 4 = 4, 5 = 5 (Completely agree), 98 = Not applicable]

[RANDOMIZE A – D]

a) My SBDI Trade Ally's recommendations made sense for my business.
b) My SBDI Trade Ally could answer my questions about the program.
c) My SBDI Trade Ally could answer my questions about my project.
d) I would recommend my SBDI Trade Ally as a contractor to consider.

[Display Q11 IF Q10a, Q10b, Q10c, or Q10d < 3]

11. What could your SBDI Trade Ally have done differently that would have improved your opinion of the service they provided?

Application Process and Project Completion

[Display Q12 IF SBDI = 0]

12. Which of the following people worked on completing your application for program incentives (including gathering required documentation)?

[MULTI SELECT]

1. Yourself
2. Another member of your company
3. A contractor
4. An equipment vendor
5. A designer or architect

[Display Q13 IF Q12 = 1]

13. Using a 5-point scale, where 1 means "completely unacceptable" and 5 means "completely acceptable," how would you rate . . .

[SCALE: 1 = 1 (Completely unacceptable), 2 = 2, 3 =3, 4 = 4, 5 = 5 (Completely acceptable agree), 99 = Not applicable]

a) the ease of finding the application on Indiana Michigan Power's website
b) the ease of completing the application
c) the time it took to approve the application
d) the clarity of information on how to complete the application
e) the effort required to provide required invoices or other supporting documentation
f) the overall application process

[Display Q14 IF Q13a)-f) < 3]

14. How could the application process be improved?

[Display Q15 IF Q12 = 1]

15. Did you have a clear sense of whom you could go to for assistance with the application process?

1. Yes
2. No
98. Don't know

[Display Q16 IF SBDI = 1]

16. How long did you have to wait for the equipment to be installed after the onsite assessment was performed? Would you say…

    1. Less than 1 week
    2. 1-2 weeks
    3. 3-4 weeks
    4. 5-6 weeks
    5. More than 6 weeks
    6. All equipment was installed the same day
    98. Don't know

[Display Q17 IF SBDI = 0]

17. Who installed your program-qualified equipment or efficiency upgrades? Was it…

    1. Your own staff
    2. A contractor you've worked with before
    3. A contractor recommended by the Indiana Michigan program (registered trade ally)
    4. A new contractor that someone else recommended
    5. Someone else (Please specify)
    98. Don't know

Energy Efficiency as a Service – Non-Participants

[Display section if EEaaS = 0 and STATE = IN]

18. I&M now offers a new program called Energy Efficiency-as-a-Service that provides efficiency improvements to commercial and industrial customers with zero upfront costs and immediate savings. I&M's partner, Allumia funds, installs, and maintains a complete upgrade and meters the actual savings achieved on a monthly basis. During the fixed contract term, the customer shares a percentage of the metered savings achieved to cover the cost of the program.

    Before taking this survey, did you know that I&M offers this program?

    1. Yes
    2. No
    98. Not sure

[Display if Q18 = 1]

19. Did you consider this service when you were planning your project?

    1. Yes
    2. No

98. Not sure

[Display if Q19 = 1 or 2]

20. Why did you choose not to participate in Energy Efficiency-as-a-Service?

[Multiselect]

1. Concerns about sharing a percentage of savings with the program provider.
2. I prefer to handle energy efficiency improvements in-house.
3. Skepticism about the program's promised immediate savings.
4. Lack of trust in the program provider (Allumia funds).
5. Not interested in committing to a fixed-term contract.
6. I have financial constraints that prevent me from participating.
7. I find the zero upfront cost aspect too good to be true.
8. I had another financing option available
9. Other (please specify)

Energy Efficiency as a Service - Participants

[Display section if EEaaS = 1]

21. Our records say that you worked with I&M's Energy Efficiency as a Service Program. Through this program, Allumia provides design, financing, and implementation assistance.

Did your organization work with the Energy Efficiency as a Service Program?

1. Yes
2. No
98. Not sure

[Display if Q21 = 1]

22. Which aspect of the Energy Efficiency as a Service were the most important benefits to you when you were considering the service? Please select up to two options.

[Multiselect]

1. Project financing
2. Project management
3. The system maintenance provided
4. System design services
5. Installation services
6. Something else

[Display if Q23 = 6]

23. What was other benefit of the service that was important to you?

[Display if Q21 = 1]

24. How satisfied are you with the following aspects of the Energy Efficiency as a Service Program?

[SCALE: 1 = 1 (Very dissatisfied), 2 = 2, 3 =3, 4 = 4, 5 = 5 (Very satisfied), 99 = Not applicable]

a) The information you received on how the service works.
b) The financing provided through the program.
c) The process of installing the energy-saving equipment.
d) The process of installing the metering system.
e) The information you receive about the performance of the project.
f) The impact on your electricity bill.

[Display if any in Q24 < 3]

25. What would have made you more satisfied with the Energy Efficiency as a Service Program?

Decision Making and Equipment Selection

26. Has your organization purchased any significant energy efficient equipment in the last three years without applying for a financial incentive through an energy efficiency program at the [LOCATION] location?

1. Yes. Our organization purchased energy efficient equipment but did not apply for incentive.
2. No. Our organization purchased significant energy efficient equipment and applied for an incentive.
3. No significant energy efficient equipment was purchased by our organization.
98. Don't know

[Display Q27 IF Q26 = 1 or 2]

27. Which of the following financial methods, if any, does your organization typically use to evaluate energy efficiency improvements?

[Multiselect]

1. Initial Cost
2. Simple payback
3. Internal rate of return
4. Life cycle cost
5. We don't use any of these
98. Don't know

[Display Q28 IF Q27= 2]

28. What payback period do you typically require to approve an efficiency project?

[Display Q29 IF Q27= 3]

29. What internal rate of return do you typically use to approve an efficiency project?

30. Before participating in the I&M program had you implemented any equipment or measure similar to the [FR_MEAS1] [INSTALLED_FR1] at the [LOCATION] location?

    1. Yes
    2. No
    98. Don't know

31. When did you first learn about I&M's energy efficiency program? Was it BEFORE or AFTER you finalized the specifications of your [FR_MEAS1] project, including the efficiency level and the scope of the project?

    1. Before
    2. After
    98. Don't know

32. Did you have plans to [INSTALL_FR1] the [FR_MEAS1] at the [LOCATION] location before participating in the program?

    1. Yes
    2. No
    98. Don't know

[Display Q33 IF Q32 = 1]

33. Prior to hearing about the program [FINANCING_INCENTIVE], was the purchase of the [FR_MEAS1] included in your organization's capital budget?

    1. Yes
    2. No
    98. Don't know / Not applicable

[Display Q34 IF Q32 = 1]

34. Had your organization ALREADY ordered or purchased the [FR_MEAS1] BEFORE you heard about the program?

    1. Yes
    2. No
    98. Don't know

35. Did the program [FINANCING_INCENTIVE] help the [FR_MEAS1] project receive implementation approval from your organization?

    1. Yes
    2. No

98. Don't know / Not applicable

36. Would you have completed the [FR_MEAS1] project even if you had not participated in the program?

1. Yes
2. No
98. Don't know

37. Did you have experience with I&M's energy efficiency programs before completing the [FR_MEAS1] project?

1. Yes
2. No
98. Don't know

[Display Q38 if Q37 = 1]

38. How important was your previous experience with Indiana-Michigan-offered programs in making your decision to [INSTALL_FR1] the [FR_MEAS1] at the [LOCATION] location?

1. Very important
2. Somewhat important
3. Only slightly important
4. Not at all important
98. Don't know

[Display Q39 if Q6= 1]

39. Earlier you mentioned that [PROGRAM TA/REPRESENTATIVE] completed an onsite energy evaluation. Was the [FR_MEAS1] recommended through that onsite energy evaluation?

1. Yes
2. No
98. Don't know

[Display Q40 if Q39 = 1]

40. If the [FR_MEAS1] was not recommended as part of the onsite energy evaluation, how likely is it that you would have [INSTALLED_FR1] it anyway?

1. Definitely would have
2. Probably would have
3. Probably would not have
4. Definitely would not have
98. Don't know

41. Would your organization have been financially able to [INSTALL_FR1] the [FR_MEAS1] at the [LOCATION] without the [FINANCING_INCENTIVE] from the program?

1. Yes
2. No
98. Don't know

[Display Q42 if Q41 = 2]

42. To confirm, your organization would NOT have allocated the funds to complete a similar energy saving project if the program [FINANCING_INCENTIVE] was not available. Is that correct?

    1. Yes
    2. No
    98. Don't know

43. If the [FINANCING_INCENTIVE] from the program had not been available, how likely is it that you would have [INSTALLED_FR1] the [FR_MEAS1] at the [LOCATION] location anyway?

    1. Definitely would have [INSTALLED_FR1]
    2. Probably would have [INSTALLED_FR1]
    3. Probably would not have [INSTALLED_FR1]
    4. Definitely would not have [INSTALLED_FR1]
    98. Don't know

[Display if Q21 = 1]

44. How likely is it that you would have [INSTALLED_FR1] the [FR_MEAS1] if your organization had not received assistance with project design and implementation from Allumia through I&M's Energy Efficiency as a Service Program?

    1. Definitely would have [INSTALLED_FR1]
    2. Probably would have [INSTALLED_FR1]
    3. Probably would not have [INSTALLED_FR1]
    4. Definitely would not have [INSTALLED_FR1]
    98. Don't know

[Display Q45 if Q41 = 2 and Q42 = 1 and Q32 = 1and Q33 = 1]

45. Previously you said that your organization had plans to complete the project and would have completed it if you had not participated in the program. You also said that your organization would not have been financially able to install the equipment without the program [FINANCING_INCENTIVE].

    In your own words, can you explain the role that the financial incentive played in your decision to complete this project?

[Display Q46 IF MEASURE_QUANT > 1]

46. Did you install more [FR_MEAS1] because of the program?

1. Yes
2. No, the program did not affect quantity purchased and installed.
98. Don't know

[Display Q46 IF ENERGY_EQUIP = YES]

47. Did you install equipment that was more energy efficient because of the program?
    1. Yes
    2. No, the program did not affect level of efficiency chosen for equipment.
    98. Don't know

[Display Q48 IF Q47 = 1]

48. What kind of equipment, if any, would you have installed if the program was not available?
    1. [OPEN]
    98. Don't know

49. Did you [INSTALL_FR1] the [FR_MEAS1] earlier than you otherwise would have because of program?
    1. Yes
    2. No, the program did not affect timing of project.
    98. Don't know

[Display Q50 IF Q49= 1]

50. When would you otherwise have completed the project?
    1. Less than 6 months later
    2. 6-12 months later
    3. 1-2 years later
    4. 3-5 years later
    5. More than 5 years later
    98. Don't know

[Display Q51 IF MULTIPLE_MEASURE =1]

51. Our records indicate you [INSTALLED_FR2] [FR_MEAS2] at the [FR_LOC2] location in addition to [FR_MEAS1] at the [FR__LOC1] location. Did both of these projects go through the same decision making process or was a separate decision made for each?
    1. The same decision making process applies to both projects.
    2. A different decision making process applies to each project.
    3. We did not [INSTALL_FR2] [FR_MEAS2] at the [FR_LOC2] location.
    98. Don't know

[IF MULTIPLE_MEASURE =1 Q51 = 2, REPEAT Q30 THROUGH Q50 WITH FR_MEAS2]

Spillover

[NOTE: THESE QUESTIONS SERVE TO COLLECT DATA TO QUANTIFY SPILLOVER EFFECTS FROM the INCENTIVE PROGRAMS AND DIRECT IMPACTS OF THE ENERGY ASSESSMENT TOOL]

52. Since you completed the incentive project, have you installed any energy efficient equipment at a facility that receives electrical service from I&M and that you DID NOT get a rebate or discount for from I&M?

    1. Yes
    2. No
    98. Don't know

[Display Q53 if Q52 = 1]

53. What additional energy efficient equipment have you installed?

[MULTI SELECT]

    1. Lighting
    2. Lighting controls or occupancy sensors
    3. LED exit signs
    4. Unitary or split air conditioning system or chiller
    5. ENERGY STAR Room air conditioners
    6. Efficient motors
    7. Refrigeration equipment (including LED case lighting)
    8. Kitchen equipment
    9. Something else [OPEN ENDED]
    96. Didn't implement any measures [SKIP TO Customer satisfaction]
    98. Don't know

[Display Q54 if Q52= 1]

54. Why didn't you receive incentives for those items?

[MULTI SELECT RANDOMIZE ORDER, BUT FIX OTHER AND DON'T KNOW]

    1. Didn't know whether equipment qualified for financial incentives
    2. Equipment did not qualify for financial incentives
    3. Too much paperwork for the financial incentive application
    4. Financial incentive was insufficient
    5. Didn't have time to complete paperwork for financial incentive application
    6. Didn't know about financial incentives until after equipment was purchased
    7. We did receive an incentive [SKIP TO SATISFACTION]]
    8. Other (Please specify) [OPEN ENDED]
    98. Don't know

[Display Q55 if Q52= 1]

55. Did you work with a contractor to install that efficient equipment or did your company's staff install the equipment?

1. Worked with a contractor
2. Company self-installed the equipment
3. Both
98. Don't know

Lighting

[Display Q56 IF Q52 = 1]

56. What type of lighting did you install? [MULTI-SELECT]

1. T8 Fluorescent linear lamps – Single (1) lamps
2. T8 Fluorescent linear lamps – 2 lamp fixtures
3. T8 Fluorescent linear lamps – 4 lamp fixtures
4. T8 Fluorescent linear lamps – 6 lamp fixtures
5. T5 Fluorescent linear lamps – Single (1) lamps
6. T5 Fluorescent linear lamps – 2 lamp fixtures
7. T5 Fluorescent linear lamps – 4 lamp fixtures
8. T5 Fluorescent linear lamps – 6 lamp fixtures
9. LED Screw-in BAR/R/ER bulbs
10. LED Screw-in Interior PAR/MR bulbs
11. LED Screw-in omnidirectional A-line bulbs
12. LED 2-foot linear replacement lamps
13. LED 4-foot linear replacement lamps
14. LED exterior flood or spot luminaires
15. LED 1x4 panel or troffer
16. LED 2x2 panel or troffer
17. LED 2x4 panel or troffer
18. LED high-bay lighting
19. Another type
98. Don't know

[Display Q57 IF Q56 = 19]

57. What other type of lighting equipment did you install?

[TEXT BOX] Lamps/Bulbs

[REPEAT Q58 - Q61 FOR EACH TYPE SELECTED IN Q56]

58. How many [Q56 RESPONSE] did you install?

[TEXT BOX] Watts

59. What was the average wattage of the [Q56 RESPONSE]?

60. Were the [Q56 RESPONSE] installed inside or outside?

1. Inside
2. Outside
3. Parking garage
98. Don't know

[Display Q61 IF Q60 = 1]

61. What type of building did you install the [Q56 RESPONSE] in?

1. Food Sales
2. Food Service
3. Health Care
4. Hotel/Motel
5. Office
6. Public Assembly
7. Public Services (non-food)
8. Retail
9. Warehouse
10. School
11. College
12. Industrial – 1 Shift
13. Industrial – 2 Shift
14. Industrial – 3 Shift
15. Other (Please describe)
98. Don't know

[Display Q62 IF Q60 = 1]

62. Is the inside space heated, cooled, or both?

1. Heated
2. Cooled
3. Both
98. Don't know

63. What type of lighting did the [Q56 RESPONSE] replace?

1. T12s (linear fluorescents)
2. T8s (linear fluorescents)
3. Metal-halide / High-intensity discharge
4. Incandescent
5. Compact fluorescent (CFL)
5. Something else [OPEN]
98. Don't know

64. What was the average wattage of the old lamps or bulbs?
65. How many of the old lamps or bulbs did you remove?

[Display Q66 if **Q53** =1]

66. How important was your experience with the program in your decision to install this lighting equipment?

[SCALE 0 "Not at all important" - 10 "Very important"]

98. Don't know

[Display Q67 if **Q53** =1]

67. If you had NOT participated in the program, how likely is it that your organization would still have installed this lighting equipment?

[SCALE 0 "Definitely would not have installed" - 10 "Definitely would have installed"]

98. Don't know

[Display Q68 if [Q66=0,1,2,3 AND Q67=0,1,2,3]

OR IF [Q66=8,9,10 AND Q67=8,9,10]

68. You scored the importance of your program experience to your decision to implement additional lighting measures with [Q66 RESPONSE] out of 10 possible points. You ALSO scored the likelihood of implementing additional lighting measures if your organization had not participated in the program with [Q67 RESPONSE] out of 10 possible points.
69. Can you please explain the role the program made in your decision to implement this measure?

Lighting Controls

[Display Q70 IF Q53 = 2]

70. How many fixtures are being controlled by the lighting controls?

[Display Q71 IF Q53 = 2]

71. On average, how many lamps or bulbs does each fixture contain?

[Display Q72 IF Q53 = 2]

72. What is the average wattage of these lamps?

[Display Q73 IF Q53 = 2]

73. Are any of the lighting controls that you installed central time clock controls?

1. Yes
2. No
98. Don't know

[Display Q74 IF Q73 = 1]

74. How many of the fixtures are controlled by the central time clock?

[Display Q75 IF Q53 = 2]

75. What type of building did you install the lighting controls in?

1. Food Sales
2. Food Service
3. Health Care
4. Hotel/Motel
5. Office
6. Public Assembly
7. Public Services (non-food)
8. Retail
9. Warehouse
10. School
11. College
12. Industrial – 1 Shift
13. Industrial – 2 Shift
14. Industrial – 3 Shift
16. Other (Please specify)
98. Don't know

[Display Q76 IF Q53 = 2]

76. How important was your experience with the program in your decision to install lighting controls?

[SCALE 0 "Not at all important" - 10 "Very important"]

98. Don't know

[Display Q77 if Q53 = 2]

77. If you had NOT participated in the program, how likely is it that your organization would still have installed lighting controls?

[SCALE 0 "Definitely would not have installed" - 10 "Definitely would have installed"]

98. Don't know

[Display Q78 if [Q76=0,1,2,3 AND Q77=0,1,2,3]

OR [Q76=8,9,10 AND Q77=8,9,10]]

78. You scored the importance of your program experience to your decision to implement lighting controls with [Q76 RESPONSE] out of 10 possible points. You ALSO scored the likelihood of implementing lighting controls if your organization had not participated in the program with [Q77 RESPONSE] out of 10 possible points. Can you please explain the role the program made in your decision to implement this measure?

LED Exit Signs

[Display Q79 IF Q53 = 2]

79. Did you install single-sided or double-sided exit signs?
   1. Single-sided
   2. Double-sided
   98. Don't know

[Display Q80 IF Q79 = 2]

80. How many double-sided LED exit signs did you install?

81. How many LED exit signs did you install?

82. Which of the following best describes the type of exit sign the new LED exit signs replaced?
   1. Incandescent
   2. CFL (Dual sided)
   3. CFL (Single Sided)
   98. Don't know

83. How important was your experience with the program in your decision to install LED exit signs?

[SCALE 0 "Not at all important" - 10 "Very important"]
   98. Don't know

[Display Q84 if Q53 = 2]

84. If you had NOT participated in the program, how likely is it that your organization would still have installed LED exit signs?

[SCALE 0 "Definitely would not have installed" - 10 "Definitely would have installed"]
   98. Don't know

[Display Q85 if [Q83=0,1,2,3 AND Q84=0,1,2,3]

OR [Q83=8,9,10 AND Q84=8,9,10]]

85. You scored the importance of your program experience to your decision to implement lighting controls with [Q76 RESPONSE] out of 10 possible points. You ALSO scored the likelihood of implementing LED exit signs if your organization had not participated in the program with [Q77 RESPONSE] out of 10 possible points. Can you please explain the role the program made in your decision to implement this measure?

HVAC Measures

[Display Q86 IF Q53 = 4]

86. What types of energy efficient equipment did you install as part of the HVAC project? [MULTI SELECT]

1. Split air conditioning system (An A/C system that has an evaporator indoors and the compressor and condenser outdoors.)
2. Packaged air conditioning system (A type of central air conditioning that contains both the air handler fan, compressor and condenser in a single unit. These are typically mounted on the roof.)
3. Heat pump (An electric heating and cooling system)
4. Air cooled chiller (A system that produces cold liquid sent around to individual spaces used for cooling air usually found in larger facilities)
5. Water cooled chiller (A system that produces cold liquid sent around to individual spaces used for cooling air usually found in larger facilities)
6. Another type
98. Don't know

[Display Q87 IF Q86 = 6]

87. What other type of HVAC equipment did you install?

[REPEAT Q88 – Q91 for each selected in Q86]

88. We would like to know more about the rated efficiency and number of units of the [Q86 RESPONSE](s) that you installed.
89. For each level of efficiency of the equipment you installed, please provide the rated efficiency and the number of units.
90. What type of building did you install the heating/cooling equipment in?

1. Grocery
2. High School
3. Hospital
4. Light Industrial
5. Office - Large
6. Office - Small
7. Primary School
8. Religious Worship
9. Restaurant - Fast Food

10. Restaurant - Full Service
11. Retail - Big Box
12. Retail - Large
13. Retail - Small
14. University
15. Warehouse
16. Other (Please specify)
98. Don't know

91. What city is the building where you installed the heating/cooling equipment located in?

[Display Q92 IF Q86 = 1-7]

92. How important was your experience with the program in your decision to install the energy efficient HVAC equipment?

[SCALE 0 "Not at all important" - 10 "Very important"]

98. Don't know

[Display Q93 IF Q86 = 1-7]

93. If you had NOT participated in the program, how likely is it that your organization would still have installed the energy efficient HVAC equipment?

[SCALE 0 "Definitely would not have installed" - 10 "Definitely would have installed"]

98. Don't know

[Display Q94 if [Q92=0,1,2,3 AND Q93=0,1,2,3] OR [Q92=8,9,10 AND Q93=8,9,10]]

94. You scored the importance of your program experience to your decision to implement energy efficient HVAC equipment with [Q92 RESPONSE] out of 10 possible points. You ALSO scored the likelihood of implementing the energy efficient HVAC equipment if your organization had not participated in the program with [Q93 RESPONSE] out of 10 possible points. Can you please explain the role the program made in your decision to implement this measure?

[Display Q95 IF Q53 = 4]

95. How many ENERGY STAR room air conditioners did you install?

[Display Q96 IF Q53 = 4]

96. What type of building did you install the heating/cooling equipment in?

1. Grocery
2. High School
3. Hospital
4. Light Industrial
5. Office - Large
6. Office - Small

7. Primary School
8. Religious Worship
9. Restaurant - Fast Food
10. Restaurant - Full Service
11. Retail - Big Box
12. Retail - Large
13. Retail - Small
14. University
15. Warehouse
16. Other
98. Don't know

[Display Q97 IF Q53 = 4]

97. What city is the building where you installed the room air conditioners located in?

[Display Q98 IF Q53 = 4]

98. How important was your experience with the program in your decision to install the heating/cooling equipment?

[SCALE 0 "Not at all important" - 10 "Very important"]

98. Don't know

[Display Q99 IF Q53 = 4]

99. If you had NOT participated in the program, how likely is it that your organization would still have installed the heating/cooling equipment?

[SCALE 0 "Definitely would not have installed" - 10 "Definitely would have installed"]

98. Don't know

[Display Q100 if [Q98=0,1,2,3 AND Q99=0,1,2,3] OR [Q98=8,9,10 AND Q99=8,9,10]]

100. You scored the importance of your program experience to your decision to install the energy efficient air conditioners with [Q98 RESPONSE] out of 10 possible points. You ALSO scored the likelihood of installing the energy efficient air conditioners if your organization had not participated in the program with [Q99 RESPONSE] out of 10 possible points. Can you please explain the role the program made in your decision to implement this measure?

Efficient Motors

[Display Q101 IF Q53 = 5]

101. How many efficient motors did you install?

[Display Q102 IF Q53 = 5]

102. What is the approximate average horsepower of the new motors? That is, what is the average across all of the motors you installed without an incentive?

[TEXT BOX]

[Display Q103 IF Q53 = 5]

103. What is the approximate average efficiency of the new motors? That is, what is the average efficiency across all of the new motors?

[TEXT BOX] Rated efficiency (%)

[Display Q104 IF Q53 = 5]

104. On average, how many hours per day do the motors operate? That is, what the average number of hours the motors you installed operate?

[TEXT BOX] hours per day

[Display Q105 IF Q53 = 5]

105. How important was your experience with the program in your decision to install efficient motors?

[SCALE 0 "Not at all important" - 10 "Very important"]

98. Don't know

[Display Q106 IF Q53 = 5]

106. If you had NOT participated in the program, how likely is it that your organization would still have installed the efficient motors?

[SCALE 0 "Definitely would not have installed" - 10 "Definitely would have installed"]

98. Don't know

[Display Q107 if [Q105=0,1,2,3 AND Q106=0,1,2,3] OR [Q105=8,9,10 AND Q106=8,9,10]]

107. You scored the importance of your program experience to your decision to implement efficient motors with [Q105 RESPONSE] out of 10 possible points. You ALSO scored the likelihood of implementing the efficient motors if your organization had not participated in the program with [Q106 RESPONSE] out of 10 possible points. Can you please explain the role the program made in your decision to implement this measure?

Commercial Refrigeration Equipment

[Display Q108 IF Q53 = 6]

108. What types of energy efficient refrigeration equipment did you install?

1. ENERGY STAR Commercial freezer
2. ENERGY STAR Commercial refrigerator
3. Anti-sweat heater controls

4. LED refrigerated case lighting
5. Refrigerated case covers
6. Some other type of refrigeration equipment
98. Don't know

[Display Q109 IF Q108 = 6]

109. What other type of energy efficient refrigeration equipment did you install?

[Display Q110 IF Q108 = 1]

110. How many ENERGY STAR commercial freezers did you install?

[Display Q111 IF Q110 = 1, REPEAT FOR EACH UP TO THREE TIMES]

111. What is the volume in cubic feet of the first freezer?

[Display Q112 IF Q110 = 1, REPEAT FOR EACH UP TO THREE TIMES]

112. Does this freezer have a solid door or a glass door?

1. Solid door
2. Glass door
98. Don't know

[Display Q113 IF Q110 = 1, REPEAT FOR EACH UP TO THREE TIMES]

113. Is this a vertical freezer or a chest type freezer?

1. Vertical
2. Chest
98. Don't know

[Display Q114 IF Q108 = 2]

114. How many ENERGY STAR commercial refrigerators did you install?

[TEXT BOX] refrigerators

[Display Q115 IF Q114 = 2, REPEAT FOR EACH UP TO THREE TIMES]

115. What is the volume in cubic feet of the first refrigerator?

[TEXT BOX] cubic feet

[Display Q116 IF Q114 = 2, REPEAT FOR EACH UP TO THREE TIMES]

116. Does this refrigerator have a solid door or a glass door?

1. Solid door
2. Glass door

98. Don't know

[Display Q117 IF Q114 = 2, REPEAT FOR EACH UP TO THREE TIMES]

117. Is this a vertical refrigerator or a chest type refrigerator?

1. Vertical
2. Chest
98. Don't know

[Display Q118 IF Q108 = 3]

118. Did you install humidity-based controls or conductivity-based controls, or both types?

1. Humidity-based controls
2. Conductivity-based controls
3. Both types
98. Don't know

[Display Q119 IF Q118= 1 OR 3]

119. How many humidity-based controls did you install?

[Display Q120 IF Q118= 1 OR 3]

120. What is the total number of freezer or refrigerator doors controlled by the humidity-based controls?

[Display Q121 IF Q118= 2 OR 3]

121. How many conductivity-based controls did you install?

[Display Q122 IF Q118= 2 OR 3]

122. What is the total number of freezer or refrigerator doors controlled by the conductivity-based controls?

[Display Q123 IF Q118 = 98]

123. How many anti-sweat heater controls did you install?

[Display Q124 IF Q118 = 98]

124. What is the total number of freezer or refrigerator doors controlled by the anti-sweat heater controls?

[Display Q125 IF Q108 = 4]

125. How many linear feet in total of LED case lighting did you install?

[Display Q126 IF Q108 = 5]

126. How many linear feet of refrigerated case covers did you install?

[Display Q127 if Q53=6]

127. How important was your experience with the program in your decision to install the energy efficient refrigeration equipment?

[SCALE 0 "Not at all important" - 10 "Very important"]

98. Don't know

[Display Q128 if Q53=6]

128. If you had NOT participated in the program, how likely is it that your organization would still have installed this energy efficient refrigeration equipment?

[SCALE 0 "Definitely would not have installed" - 10 "Definitely would have installed"]

98. Don't know

[Display Q129 if [Q127=0,1,2,3 AND Q128=0,1,2,3] AND [Q127=8,9,10 AND Q128=8,9,10]]

129. You scored the importance of your program experience to your decision to implement energy efficient refrigeration equipment with [Q127 RESPONSE] out of 10 possible points. You ALSO scored the likelihood of implementing energy efficient refrigeration equipment if your organization had not participated in the program with [Q128 RESPONSE] out of 10 possible points. Can you please explain the role the program made in your decision to implement this measure?

Commercial Kitchen Equipment

[Display Q130 IF Q53 = 7]

130. What type of kitchen equipment did you install?

1. Low flow pre-rinse spray valves
2. ENERGY STAR Commercial fryers
3. ENERGY STAR Commercial steam cookers
4. ENERGY STAR hot food holding cabinets
5. ENERGY STAR commercial griddles
6. ENERGY STAR commercial convection ovens
7. ENERGY STAR commercial combination ovens
8. Some other type of kitchen equipment
98. Don't know

[Display Q131 IF Q130 = 8]

131. What other type of kitchen equipment did you install?

[Display Q132 IF Q130 = 1]

132. Is the flow rate for any of the spray valves you installed equal to or less than 1.6 gallons per minute?

1. Yes
2. No
98. Don't know

[Display Q133 IF Q130 = 1]

133. How many pre-rinse spray valves with a flow rate equal to or less than 1.6 gallons per minute did you install?

[Display Q134 IF Q130 = 1]

134. Did you install the pre-rinse spray valves that the [LOCATION] location?

1. Yes
2. No
98. Don't know

[Display Q135 IF Q134= 2]

135. In what city is the building where you installed the pre-rinse spray valves located in?

[Display Q136 IF Q130 = 2]

136. How many ENERGY STAR commercial fryers did you install?

[Display Q137 IF Q130 = 3]

137. How many ENERGY STAR commercial steam cookers did you install?

1. Number of 3 pan steam cookers [NUMERIC]
2. Number of 4 pan steam cookers [NUMERIC]
3. Number of 5 pan steam cookers [NUMERIC]
4. Number of 6 pan steam cookers [NUMERIC]
98. Don't know

[Display Q138 IF Q130 = 4]

138. How many ENERGY STAR hot food holding cabinets did you install?

[Display Q139 IF Q130 = 5]

139. How many ENERGY STAR commercial griddles did you install?

[Display Q140 IF Q130 = 6]

140. How many ENERGY STAR commercial convection ovens did you install?

[Display Q141 IF Q130 = 7]

141. How many ENERGY STAR commercial combination ovens did you install?

[Display Q142 if Q53= 1 and Q130=1-8]

142. How important was your experience with the program in your decision to install this kitchen equipment?

[SCALE 0 "Not at all important" - 10 "Very important"]

98. Don't know

[Display Q143 if Q53= 1 and Q130=1-8]

143. If you had NOT participated in the program, how likely is it that your organization would still have installed this kitchen equipment?

[SCALE 0 "Definitely would not have installed" – 10 "Definitely would have installed"]

98. Don't know

[Display Q144 if [Q142=0,1,2,3 AND Q143=0,1,2,3] OR [Q142=8,9,10 AND Q143=8,9,10]]

144. You scored the importance of your program experience to your decision to implement energy efficient kitchen equipment with [Q142 RESPONSE] out of 10 possible points. You ALSO scored the likelihood of implementing energy efficient kitchen equipment if your organization had not participated in the program with [Q143 RESPONSE] out of 10 possible points.

145. Can you please explain the role the program made in your decision to implement this measure?

Customer Satisfaction

146. Not including any contractors that you hired, in the course of doing this project did you have any interactions with program staff about questions or concerns that you had?

1. Yes
2. No
98. (Don't know)

147. Using the scale below, please rate how dissatisfied or satisfied you are with each of the following ....

[SCALE: 1 = 1 (Very dissatisfied), 2 = 2, 3 =3, 4 = 4, 5 = 5 (Very satisfied)]

[A AND B FIRST, RANDOMIZE C - M, ASK N LAST]

a) [Display IF Q146 = 1] How long it took program staff to address your questions or concerns
b) [Display IF Q146 = 1] How thoroughly they addressed your questions or concerns
c) [Display IF SBDI = 1] The amount of time between the onsite energy assessment and the installation of the equipment
d) [Display IF SBDI = 1] The equipment that was installed
e) [Display IF SBDI = 1 OR Q17 = 2,3,4] The quality of the installation
f) [Display IF SBDI = 0] The steps you had to take to get through the program
g) [Display IF SBDI = 0 and EEaaS = 0] The amount of time it took to get your rebate or incentive
h) The range of equipment that qualifies for the program
i) [Display IF SBDI = 1] How well your SBDI Trade Ally explained the program rules and processes
j) The program overall

[Display Q148 IF ANY IN Q146 < 3]

148. Why were you dissatisfied with those parts of the program you mentioned?
149. If you could change one thing about the program, what would it be?
150. Using the same scale, how dissatisfied or satisfied are you with I&M as your electricity service provider?

[SCALE: 1 = 1 (Very dissatisfied), 2 = 2, 3 =3, 4 = 4, 5 = 5 (Very satisfied)]

Firmographic

151. Does your organization own or occupy, own and rent to someone else, or rent the facility where the project(s) took place?

1. Own and occupy
2. Own and rent to someone else
3. Rent
98. Don't know
99. Prefer not to state

152. Which best describes your facility located at [LOCATION]? Would you say this facility is…

1. Your company's only location
2. One of several locations owned by your company
3. The headquarters location of a company with several locations
98. Not sure
99. Prefer not to state

153. About how many people work at this location?

1. Less than 10
2. 10 – 25
3. 26 – 50
4. 51 – 100
5. 101- 250
6. More than 250
98. Not sure
99. Prefer not to state

154. What is the total square footage of the interior space building located at [LOCATION]? If you are not sure of the total square footage, please provide your best guess.

155. Do you have any other comments that you would like to relay to I&M about energy efficiency in the commercial and industrial sector or about their programs?

4. SEM Participant Interview Guide

Introduction

Objective: Establish rapport and gathering contextual information about the participant and their business.

1. Can you tell me about your business and your role?
    a. What kind of work do you do at the sites that have participated in SEM?
    b. What are your primary responsibilities in your current role?

[Probe for if energy management is a part of their job]

Awareness

Objective: Gather information on how they found out about the program and what piqued their interest.

2. How did your company first become involved with I&M's SEM program?
    a. Were you approached by program representatives, contractor, other source?
3. How would you describe how much effort your business had made in reducing energy at your facility before you began participating in SEM? Was energy efficiency a priority for your organization?
4. Had you participated in other programs offered by I&M before (or at the same time as) as participating in the SEM service?
5. How was the SEM service described to you?

Motivation

Objective: Understand customer motivations in participating in the program, their decision process and their overall feelings about the program processes and opportunities for improvement.

6. Does your company have formal goals related to reducing energy consumption? What benefits are important to you?

[If not the respondents role, does your business have someone who is focused on managing energy use?]

7. Was there anything in particular about the SEM option that drew your interest?
    a. What were the most important factors leading to your company's decision to participate in I&M's SEM option (i.e., why SEM versus other measures)?

Program Influence

8. I have a few questions about the energy saving changes that you completed in 2023. To begin with can you tell me about the types of energy-saving changes your organization has made through the program in the past year?

[Briefly review each action/change]

9. Could you briefly tell me how the program contributed, if it contributed at all, to your identifying and implementing those changes?
   a. Were there particular activities or forms of support that were particularly helpful?
   b. Were there activities or support that was not very helpful?
10. Had your organization identified any of those changes before you began working with the Strategic Energy Management Program?

[Ask for those changes that they were previously considering:]

   a. Which ones had you identified previously?
   b. Did the support from the program change how you approached the energy savings changes you made or their scope? How so?
   c. Did participating in the program change the timing of when you made those changes? That is were you able to do them sooner because of your involvement in the SEM program?
11. How likely is it that you would identified and implemented the same energy saving opportunities without the support from the Strategic Energy Management program?
12. Were there recommended changes that your company decided against? If so, why? What would it take for you to decide to do those as well?

Program Experience

Objective: Gather information on customer experience going through the SEM process and any changes they made due to their SEM.

13. Please describe your experience working on SEM with CLEAResult I&M from the point the idea was presented to now.

[POSSIBLE PROBES]

   a. What services, tools, or activities have been of the most use to your business?
   b. Was there anything that stands out as not really being of value to you?
   c. Do you have any feedback on the cohort sessions?
   d. Do you have any feedback on the onsite sessions?
   e. Other than yourself, how many employees of your company have participated in the SEM activities?
14. Was the process and outcome what you expected or were there surprises? What was different than you expected?
15. Has your company seen any benefits from SEM activities so far?
   a. Facility-wide assessment?

b. Ongoing energy use monitoring?
c. Employee energy conservation training?
d. Have you experienced any non-energy benefits from SEM?

16. Have there been any drawbacks or complications related to your participation in SEM?

Barriers

Objective: Gather information on factors that might discourage participation or adoption of recommended energy-saving actions.

17. Are there any barriers preventing or delaying your taking energy-saving actions identified through the SEM program?

    a. What could I&M/CLEAResult do to help remove or minimize those barriers so you can take those actions?

18. Can you think of reasons why companies like yours might be reluctant to work with a program offering like this?

    a. Are there things I&M could do to encourage more companies to try SEM?
    b. What messaging would be most effective in convincing other customers to try SEM?

Program Satisfaction

Objective: Gather information on customer satisfaction with SEM, the process, and I&M/CLEAResult

19. How satisfied are you with SEM overall on a scale from 1 (very unsatisfied) to 5 (very satisfied? Explore reasons for rating.

    a. How does your satisfaction with SEM compare with other programs you participate in?

20. From your perspective, what is the biggest thing I&M and CLEAResult could do to improve customer satisfaction with SEM as an energy saving option?

Emerging Technology

Objective: To identify any emerging technologies I&M should be aware of and any additional comments about SEM.

21. I have just a few more questions. Are there any new technologies or energy-saving strategies you know of that I&M should include in their program offerings?
22. Do you think I&M is missing any services or offerings?
23. Do you have anything else you would like to tell I&M about your experience with SEM?

Conclusion

24. Thank you for speaking with us today, is there anything else you would like to add that we haven't talked about yet?