Focus on Energy MEEA Training Program Evaluation

January 2, 2015

Public Service Commission of Wisconsin
610 North Whitney Way
P.O. Box 7854
Madison, WI 53707-7854

The Cadmus Group, Inc.

An Employee-Owned Company • www.cadmusgroup.com

This page left blank.

CADMUS

Prepared by:

Cadmus

This page left blank.

Table of Contents

List of Acronyms

Acronym	Term
CB&I	Chicago Bridge & Iron Company
CFL	Compact Fluorescent Lamp
CY	Calendar Year
EIA	Energy Information Administration
EM&V	Evaluation, Measurement, and Verification
EUL	Effective Useful Life
HID	High Intensity Discharge
HOU	Hours of Operation
HVAC	Heating, Ventilation, and Air Conditioning
KBtu/h	Thousand British Thermal Units per Hour
kW	Kilowatt
kWh	Kilowatt Hour
LED	Light-Emitting Diode
LMP	Locational Marginal Pricing
MISO	Midcontinent Independent Transmission System Operator, Inc.
MMBtu	Million British Thermal Units
MThm	Megatherm
MWh	Megawatt Hour
NTG	Net-to-Gross
PSC	Public Service Commission of Wisconsin
QA/QC	Quality Assurance/Quality Control
SEERA	Statewide Energy Efficiency and Renewable Administration
SMP	Standard Market Practice
SPECTRUM	Statewide Program for Energy Customer Tracking, Resource Utilization, and Data Management
TRC	Total Resource Cost (test)
TRM	Technical Reference Manual
VFD	Variable-Frequency Drive (also known as Variable-Speed Drive)

Executive Summary

The Midwest Energy Efficiency Alliance (MEEA) collaborated with Focus on Energy to offer certification and training programs from 2011 to 2014. These courses included Building Operator Certification (BOC) I and II and Practical Energy Management (PEM) for the commercial, industrial, and school sectors. Approximately 500 people attended the courses during this four-year period, with 10% of them taking multiple courses. The Evaluation Team (or the Team) [1] was asked to include an evaluation of training outcomes as a part of its general role as third-party evaluator for all Focus on Energy programs.

The Evaluation Team's assessment of MEEA's BOC and PEM training courses was based on self-report surveys from 125 participants who took the courses. The Team conducted process and impact evaluations based on these participants' experiences and actions. The assessment also included a review of the course materials to help better inform the survey development. However, the Evaluation Team did not assess the potential for modifying course materials, as the programs have an established curriculum that is followed in multiple states.

This report summarizes the Evaluation Team's findings and conclusions and is organized into three chapters: Process Findings, Impact Findings, and Challenges and Solutions.

In summary, the evaluation showed high participant satisfaction with the courses and presents details on factors that led participants to take the trainings. Additionally, the evaluation assessed savings for the retrofit activities using the Wisconsin TRM and other common industry sources for energy consumption data by building type and end use.

The lifecycle savings achieved through the training programs are presented in Table 1. These savings reflect the energy savings from projects training participants completed after their training course, excluding projects rebated by Focus on Energy programs,for which savings were already identified in the Focus on Energy annual evaluation reports.

Table 1. Lifecycle Savings

Participant Type	Lifecycle kWh Total Savings	Lifecycle Therm Total Savings
BOC	99,694,175	44,949
PEM	243,749,546	1,286,701
Total	343,443,721	1,331,650

---

[1] The Evaluation Team consists of Cadmus, Nexant, TecMarket Works, and St. Norbert College Strategic Research Institute.

Table 2. Overall Savings per Participant[1]

Participant type	kWh Savings per Participant	kW Savings per Participant	Therm Savings per Participant
Building Operator Certification	84,911	9	36
Practical Energy Management	42,603	5	217

[1] Participants include those who were surveyed against the savings total for that group (BOC n= 33; PEM n= 92)

The lifecycle savings were calculated using the per participant savings by project type found in Table 2. An effective useful life (EUL) figure was applied to each project category (lighting, motors, heating, and cooling) by participant using a weighted average of years based on the equipment type installed. The calculation also assumed that all participants in training programs achieved the per-participant savings identified from survey respondents. This assumption appears reasonable based on the large proportion of training participants that were surveyed, which allow the results to be presented with high levels of statistical confidence and precision.

The total first-year annual savings achieved is represented in Table 3. Additional findings, recommendations, and savings details are defined in the following report sections.

Table 3. Total Training Program First-Year Annual Savings[1]

Participant type	Annual kWh Savings	Annual kW Savings	Annual Therm Savings
Building Operator Certification	7,726,928	848	3,234
Practical Energy Management	18,148,875	2,207	92,568
Total	25,875,803	3,055	95,802

[1] Total number of training participants from January 2011- June 2014, n = 517

Based upon these evaluation findings, the Evaluation Team recommends that Focus on Energy:

- Continue to offer training courses to local customers, which can be expected to achieve continued energy savings.
- Continue to make Energy Advisors available.
- Increase follow-up with training participants, which could lead to higher savings in the future.
- Include additional impact evaluation activities to help increase the accuracy of reported energy savings, collect additional data, and create additional metrics that will assist with future planning.
- Offer a wide variety of courses to help ensure that customers’ interests and needs are met and to enable customers to execute higher quality energy efficiency projects.

Introduction

This report presents key findings from the process and impact evaluations of the BOC and PEM course trainings offered through Focus on Energy by the Midwest Energy Efficiency Alliance from 2011 to 2014. The evaluations relied upon data collected through an online survey with training participants. The survey gathered information about the participants' training processes, actions, and experiences, which the Evaluation Team leveraged to calculate energy savings attributable to the trainings, found in the Impact Findings section.

Focus on Energy offers these trainings to customers in the commercial, industrial, and school and government sectors. The training and education offerings include:

- Building Operator Certification I
- Building Operator Certification II
- Commercial Practical Energy Management
- Industrial Practical Energy Management
- Schools and Government Practical Energy Management

Online Survey

Between September 18 and October 16, 2014, the Evaluation Team completed 125 online surveys with course participants. [2] The Evaluation Team then analyzed the results from the surveys to understand program successes and areas for improvement or expansion.

The survey covered the following topics:

- How respondents learned about the training session.
- Satisfaction with components of training, including course selection, registration process, cost, course content, format, instructors, location, length of course, and overall experience.
- Reasons for participating in training courses.
- Benefits of participating in training courses for both the company and the individual.
- Project implementation as a result of training course.
- Achievement of project savings not tracked or counted by Focus on Energy.
- Barriers to energy-efficient improvements.

Survey Methodology

To initiate the survey, the Evaluation Team contacted all of the eligible participants by phone to inform them about the survey opportunity. For those reached by phone and interested in taking the survey, the

---

[2] The majority of the respondents (114) completed the survey. Eleven respondents partially completed the survey, but provided enough information that their responses were useful for the analysis.

Evaluation Team gave them the opportunity to either take the survey over the phone or receive an e-mail with a link to an online survey, which they could take at a later point in time. All except one participant chose to take the survey online.

The Evaluation Team left a message for those eligible participants they did not reach by phone, informing them of the survey opportunity, and then sent an e-mail with a link to the survey several days later. Several additional participants completed the survey through this emailed link.

The Evaluation Team made an attempt to contact all eligible participants by phone at least three times. All participants who completed the survey received a $25 Visa gift card, to reflect Focus on Energy's appreciation for their time and thoroughness on their survey responses.

Table 4 shows the population size, targets for completed surveys, and the number of completed surveys. These survey targets were designed to achieve a 90% confidence level with 10% precision. Table 21 at the end of this report contains more detailed information on the sampling process and survey sample attrition during the study.

Table 4. Survey Population and Completes

Participant Survey Groups	Population Size[1]	Target	Completed Surveys	% of Completed Surveys
Building Operator Certification Training	91	40	33	83%
Practical Energy Management[2]	426	60	92	153%

[1] Of the 517 entries listed in the database, 54 participants took multiple training courses.

[2] Practical Energy Management includes trainings for the commercial, industrial, and schools and government sectors.

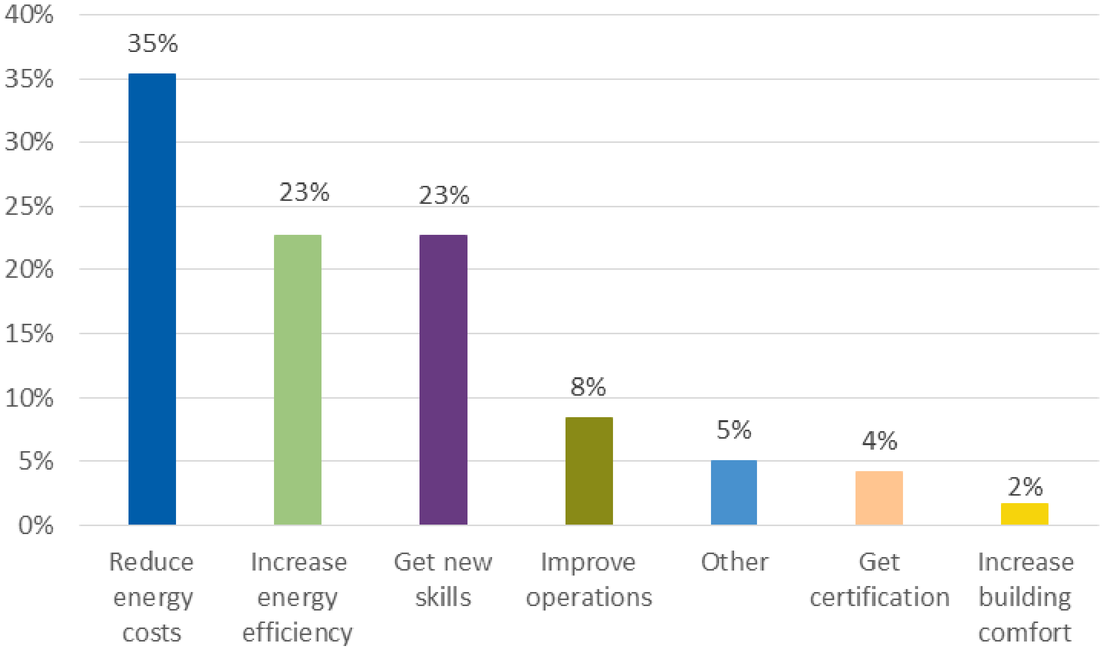
Process Findings

The Evaluation Team used survey findings to gather information about participants' experiences in the training sessions. Overall, 96% of the respondents said they were "very satisfied" or "somewhat satisfied" with their experience in the training session. The following sections explore survey feedback in more detail.

Reasons for Attending Training Course

When asked the primary reason for taking the training course, 35% of respondents said it was to reduce energy costs (Figure 1). Where, 23% said it was to increase energy efficiency and another 23% said it was to get new skills. The survey also asked respondents if there were any other reasons, in addition to their primary reason, for taking the training. Nineteen percent said it was to also increase energy efficiency, followed by 18% who said it was to reduce energy costs.

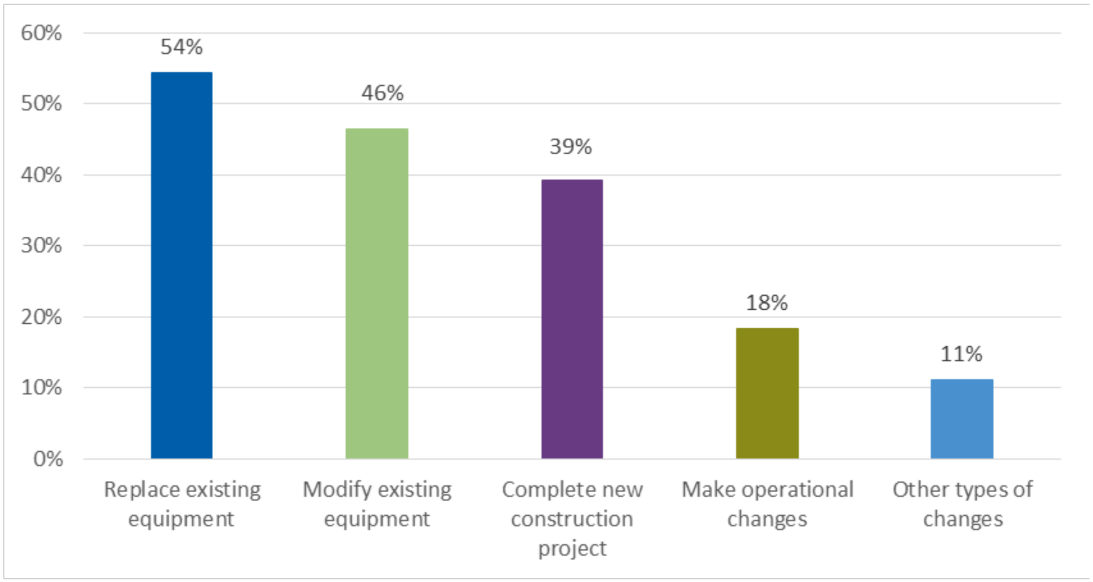
Figure 1. Primary Reason for Taking the Training



Source: Survey question D1, "What was your primary reasons for taking the training course?" (n=119)

A majority of respondents (89%) said they implemented improvements to provide energy savings for their company. More than half of respondents (54%) said they replaced existing equipment since the training that resulted in energy savings, and 46% said they modified existing equipment. Most respondents (89%) said the training was "very" or "somewhat important" in their decision to implement these projects. Figure 2 lists the types of projects survey participants implemented.

Figure 2. Types of Projects Implemented



Source: Survey question E2, "Which of the following describes the changes you made to save energy?" (n=125; multiple responses allowed)

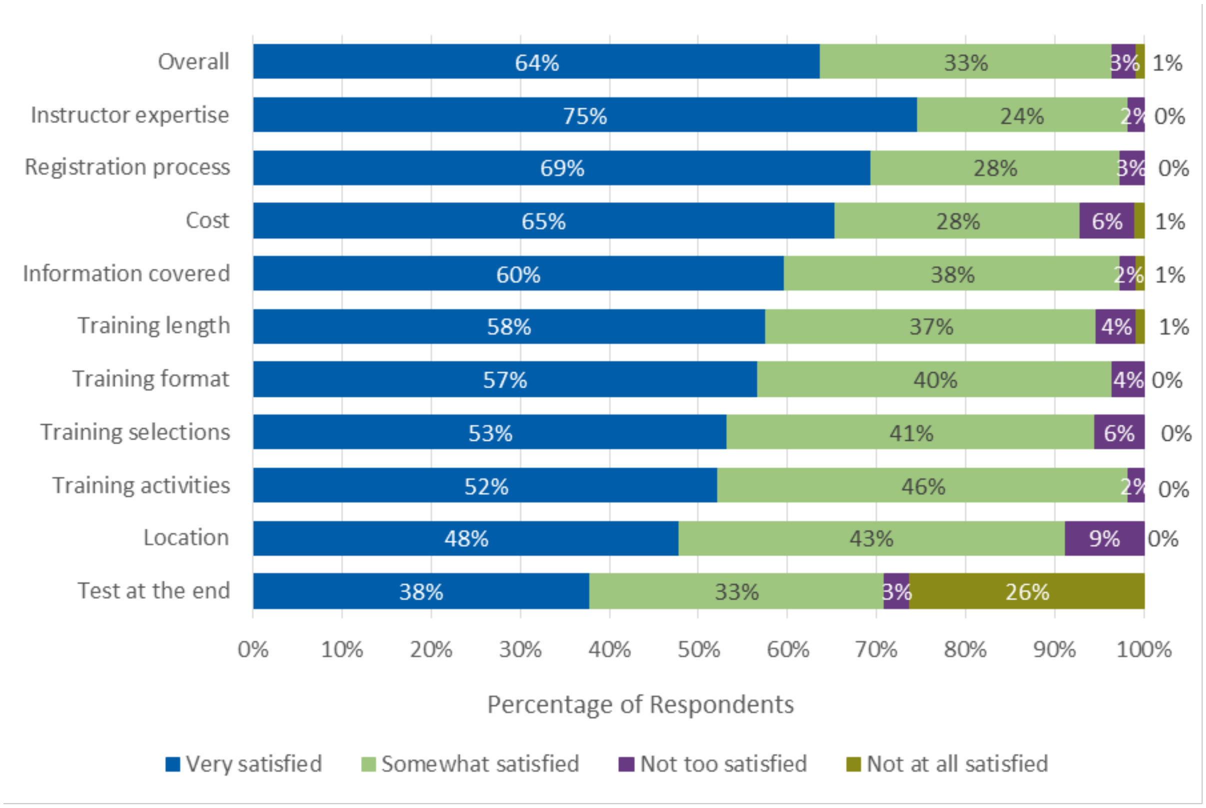
Over 70% of the respondents who implemented projects received incentives for the improvements.

Satisfaction With Training Course

Overall, 96% of respondents said they were "very" or "somewhat" satisfied with the training overall. Respondents answered questions about their satisfaction with other aspects of the training courses as well (Figure 3).

Over 90% of respondents were "very" or "somewhat" satisfied with all aspects of the training except for having to take a test at the end of the training. Over a quarter of the respondents (26%) said that they were "not at all satisfied" with the test. Unfortunately, additional feedback was not given to explain why they were dissatisfied with this aspect of the training.

Figure 3. Satisfaction with Components of Training Sessions



Source: Survey question F1, "Please indicate if you are very satisfied, somewhat satisfied, not too satisfied, or not at all satisfied with each of these areas." (n=114)

More than half of respondents (63%) said they have recommended the program to someone else and 94% plan to attend Focus on Energy sponsored trainings in the future.

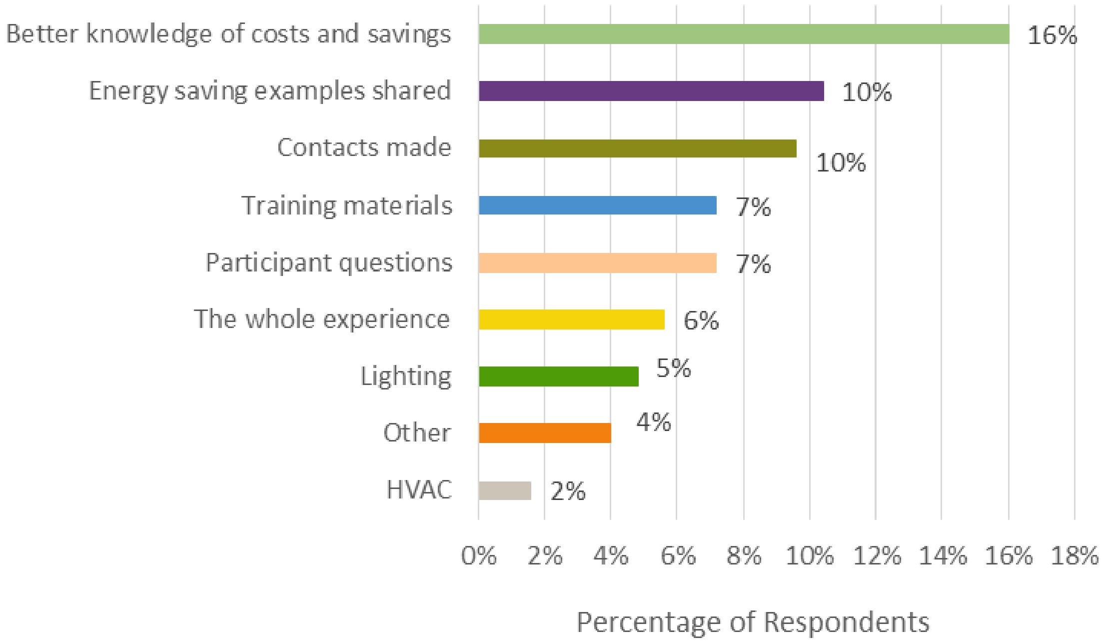
Energy Advisor

Survey respondents answered questions about whether an Energy Advisor or engineer was available during the training session and whether the information provided was useful. The majority of participants (89%) had an Energy Advisor or engineer available during the training session to help them start planning projects to save energy. Nearly all of the respondents (98%) found this "very" or "somewhat" useful in helping them identify and implement energy saving projects.

Useful Components of Training Course

The survey asked respondents to share their thoughts on what aspects of the course were particularly useful for them. Respondents most commonly cited the opportunity to better understand potential costs and savings associated with making energy-efficient upgrades (24%). Sixteen percent of the surveyed participants also appreciated the opportunity to hear from speakers and other participants about the energy-efficient projects they have undertaken, and 14% of respondents said the new contacts they made from the training.

Figure 4. Satisfaction with Components of Training Sessions



Source: Survey question F5, “Thinking about the training session, what aspect did you find particularly useful?” (n=125)

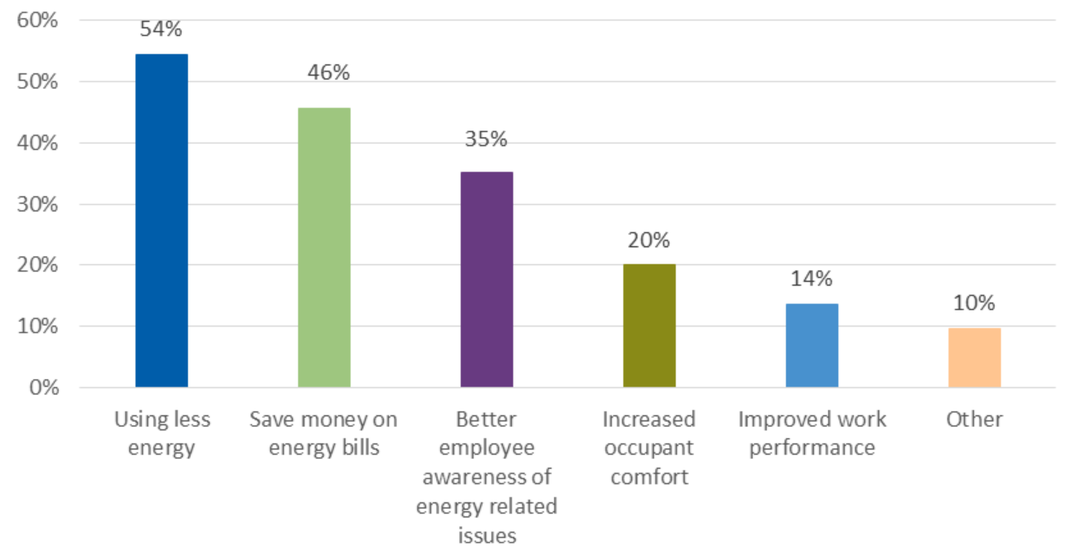
Future Interest in Training Courses

The survey asked respondents if there were any other training sessions they would like Focus on Energy to offer. Five respondents said they would like to have continued building operator certification training. Two mentioned they would like to learn more about steam traps, and two respondents wanted to learn more about lighting technologies. Another two respondents wanted to learn more about what they could do with data analytics, and one respondent wanted to learn more about how national, state, and local policy affects energy projects. Again, 94% of respondents said they plan to take additional training sessions offered by Focus on Energy in the future.

Benefits of Training Courses

Respondents most frequently said that the primary benefit to their companies for participating in the training courses were using less energy (30%), saving money on energy bills (25%), and better employee awareness of energy related issues (19%). Figure 5 shows a full breakdown of all the benefits participants thought their companies received from the training courses.

Figure 5. Company Benefits Resulting from Training



Source: Survey question D3, "What would you say are the main benefits your company has experienced as a result of your participation in the training course?" (n=125; multiple responses allowed)

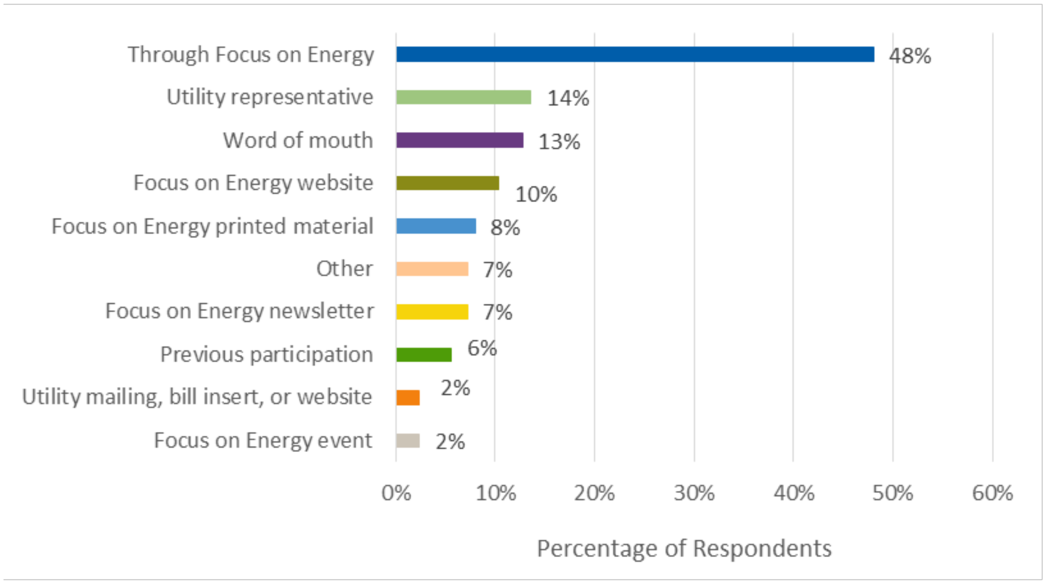
When asked what benefits the respondents experienced personally, the top answer was improved job performance (45%) followed by increased confidence (41%).

When asked if any new jobs were created as a result of the training, 33 respondents said yes. Eleven respondents estimated from one to three jobs were created, three respondents estimated from three to six jobs, and another six respondents estimated six or more jobs were created. The remaining respondents were unsure how many jobs had been created as a result of the training.

Awareness of Training Courses

Survey respondents most frequently said they learned about the training courses from Focus on Energy (41%)—either through a phone call, e-mail, or speaking with a Focus on Energy representative in person. After that, 12% of respondents reported having learned about the training courses through a utility representative, followed by 11% of respondents who heard about the courses through word of mouth. Since attending the training, 63% of the respondents have recommended the training to someone else, which could indicate a participation increase through nontraditional marketing channels.

Figure 4. Source of Awareness of Training Course

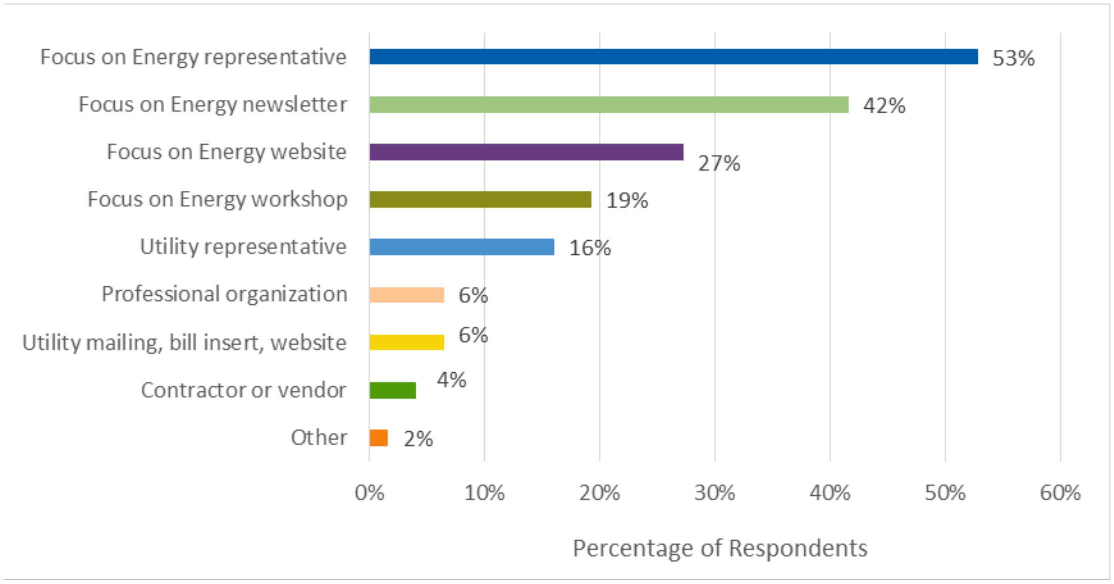


Source: Survey question C1, “How did you learn about the training course from Focus on Energy?” (n=125; multiple responses allowed)

Future Outreach

The survey asked respondents how they would like to stay informed about future training sessions and opportunities to save energy and money. Thirty percent said their primary method for staying informed would be contacts would be through a Focus on Energy representative, contacting them through phone, e-mail, or in person. Twenty-four percent of respondents mentioned the Focus on Energy monthly newsletter as a source of information. Figure 7 shows a full breakdown of all responses provided by participants.

Figure 7. Preferred Source of Information about Training Opportunities

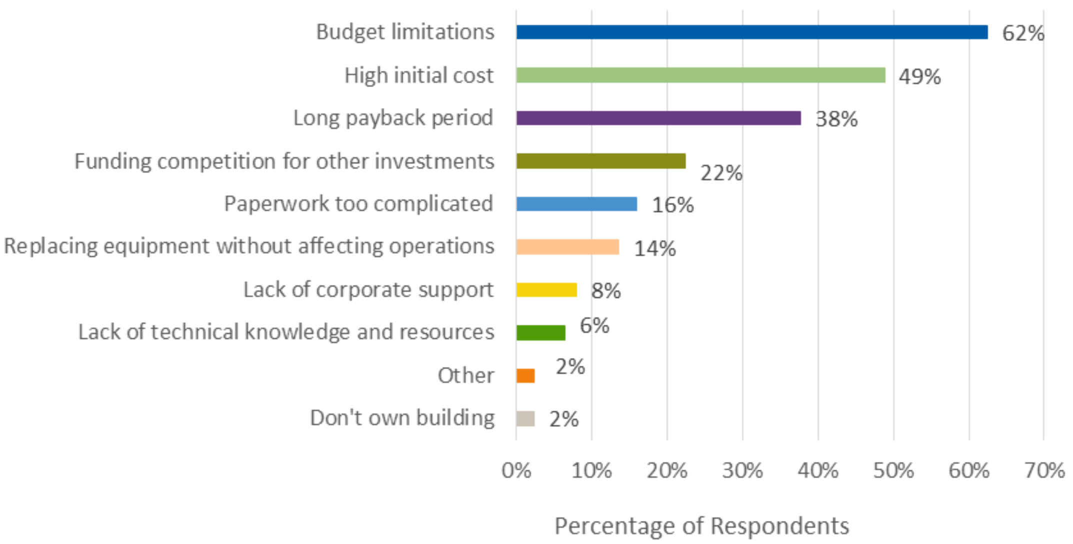


Source: Survey question I1, “In the future, how would you like to stay informed about training sessions and opportunities to save energy and money?” (n=125; multiple responses allowed)

Challenges to Energy Efficiency

When asked what the biggest challenge was to making energy-efficient improvements within one’s company, 28% of respondents said it was budget limitation, followed by 22% who said it was the high initial cost, and 17% who said it was the long payback period. Figure 8 shows a full breakdown of all the challenges participants reported facing.

Figure 8. Challenges to Energy Efficient Improvements



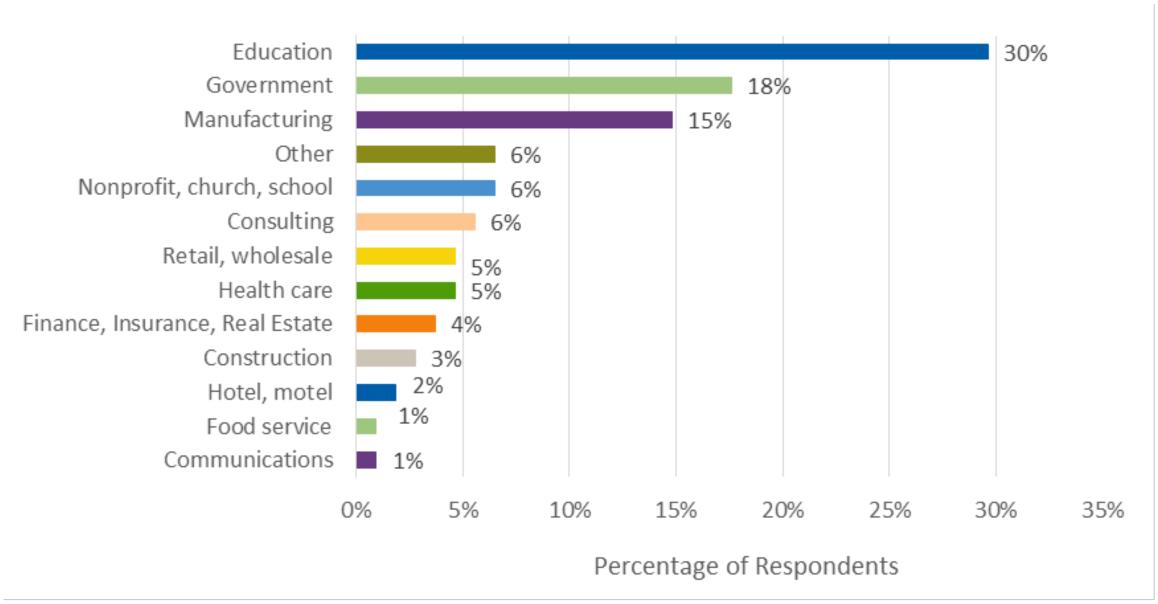
Source: Survey question G11, “What do you see as the biggest challenges to making energy efficient improvements inside your company?” (n=125; multiple responses allowed)

Filmographic

Company Profile

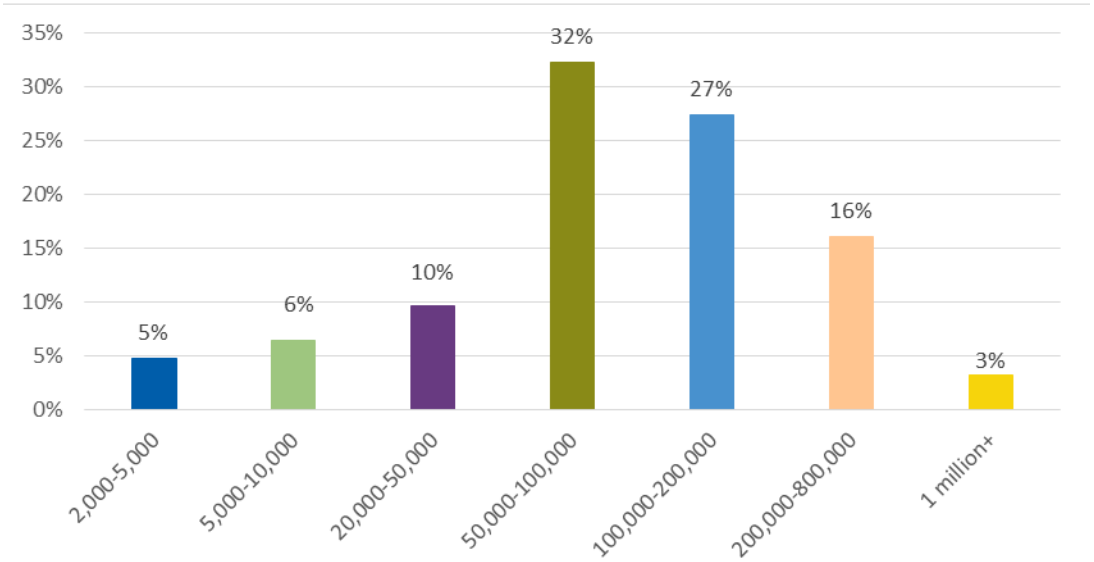
The industries most frequently represented by respondents were the education field (30%), the government (18%), and manufacturing (15%). This falls in line with the participation rates in the course categories, where 32% of all attendees took the PEM School and Government course, 28% attended PEM for Commercial Facilities and 18% took PEM for Industrial Facilities.

Figure 9. Company's Industry



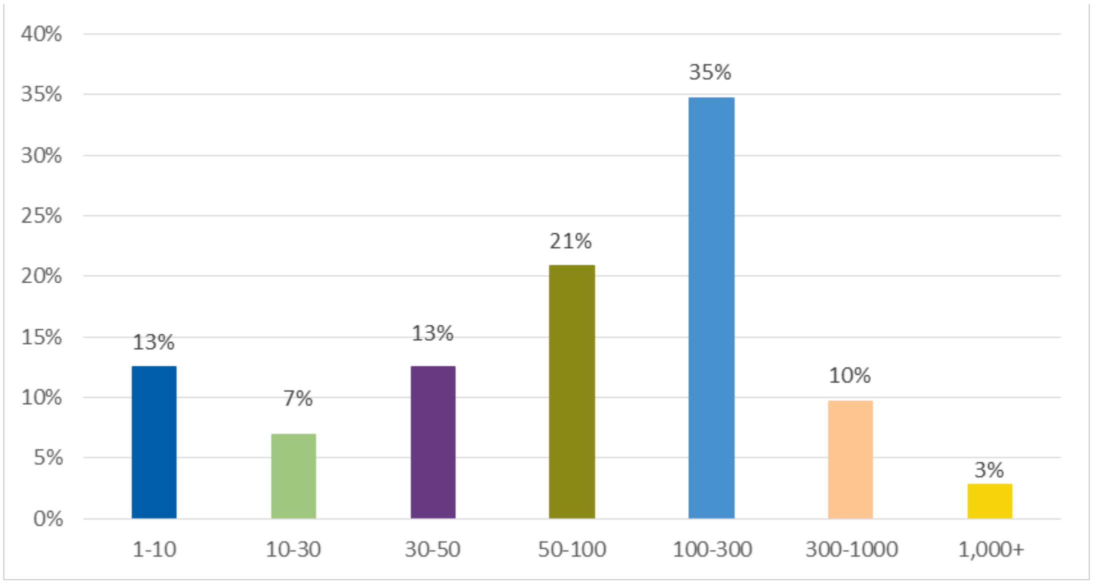
Source: Survey question H1, "What industry is your company in?" (n=108)

Figure 5. Building Square Footage



Source: Survey question H5, "What is the approximate square footage of your facility?" (n=62)

Figure 11. Number of Employees

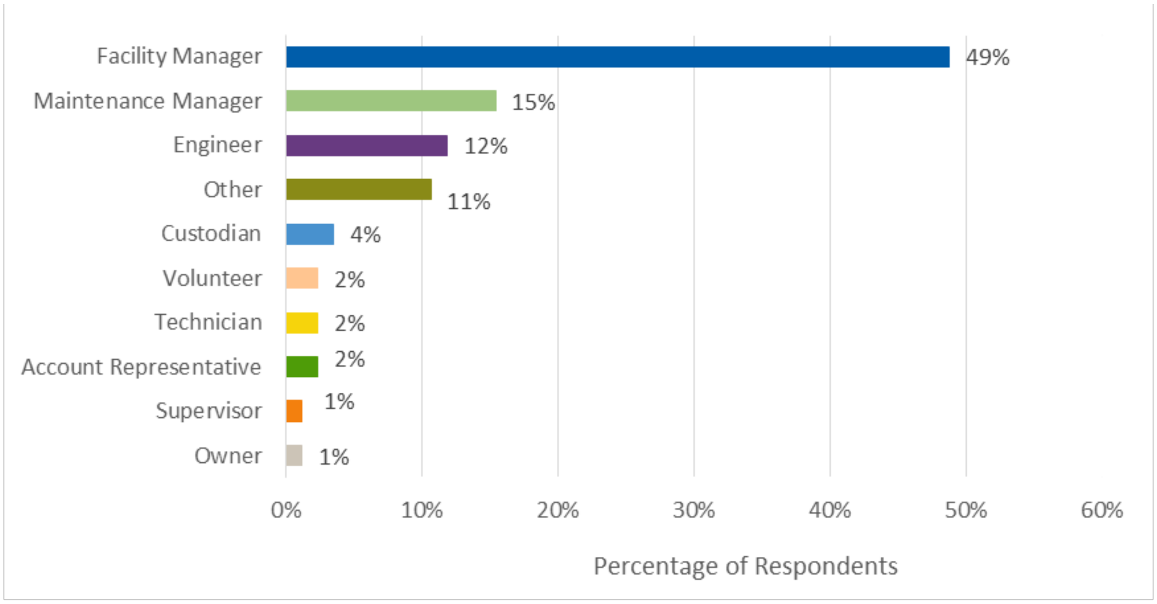


Source: Survey question H6, "How many people are employed in the facility?" (n=72)

Respondent Profile

Most commonly, respondents were facilities managers (49%), followed by maintenance managers (15%).

Figure 12. Job Title



Source: Survey question H3, "What is your title?" (n=84)

The majority of respondents (96%) considered themselves to be “very knowledgeable” or “somewhat knowledgeable” about energy efficiency. This level of awareness, however, cannot be directly linked as a result of the training.

Impact Findings

Collectively, the 125 survey respondents reported completing 374 projects after they participated in the training course. The majority of the participants completed at least three projects. This chapter describes the categorization of participants' project descriptions, the methodology used to calculate energy savings, challenges to and solutions for the survey process, and energy savings by project type.

Project Categorization

Evaluators quantify energy savings by accounting for changes in occupant behavior, replaced equipment, or improved control. Rebate programs do not typically consider behavioral changes when determining energy savings because they are difficult to prove and typically do not require financial commitment. Therefore, the Evaluation Team did not include behavioral changes in this analysis and recommends billing analysis and the use of a control group to capture this type of saving in future studies.

Replacing equipment or improving controls can be classified into the following categories: lighting, motors, heating plant replacement, and cooling plant replacement. These categories are typical to most facilities and have been proven to achieve energy savings.

Calculation Methodology

The following section describes the calculation methodology for the projects categories described above. The majority of savings algorithms, assumptions, or prescribed savings were taken from the Wisconsin technical reference manual (TRM), published August 2014. In some cases, where this information did not exist in the TRM, alternative sources were used to guide the savings methodologies.

Lighting

Fifty percent of the respondents completed a lighting project in the past four years. These lighting projects included fixture replacement, delamping of existing fixtures, installation of occupancy sensors, installation of photocell controls, and new construction projects. The general methodology for calculating energy savings with these projects includes establishing a baseline condition, proposed condition, and calculating energy savings as the difference between the two conditions. To determine the baseline and proposed conditions, the Evaluation Team established the following metrics: lamp type, quantity, and fixture/sensor location.

Survey respondents collectively reported executing a total of 245 lighting projects. Each lighting project may have multiple lamp fixture types within each lamp category as defined in the Wisconsin TRM. Because of the large volume of projects, the Evaluation Team made assumptions regarding representative fixtures for each lamp type. Table 5 list the baseline fixture and proposed fixture for each fixture type.

Table 5. Lighting Replacements

Fixture Type	Proposed	Baseline	Energy Reduction (W)
CFL	One 18W CFL Quad	One 75W Incandescent	55
LED	LED/Induction 99W	High Pressure Sodium 150W	66
Fluorescent Tube	T-8 48" Two Lamp	T-12 48" Two Lamp	24
Sensor	Occupancy	On/Off	32%
Exit Sign	Exit - LED 2W Lamp, Dual Sided	Lowest code value	4
Other	One 18W CFL Quad	One 75W Incandescent	55

The Evaluation Team calculated energy savings using the following equations:

Annual Energy Savings Algorithm

$$kWh_{SAVED} = [(Qty_{BASE} * Watts_{BASE}) – (Qty_{EE} * Watts_{EE})]/1{,}000 * HOU$$

Where:

Qty_{BASE} = quantity of standard HID fixture
$Watts_{BASE}$ = electricity consumption of standard HID fixture (baseline)
Qty_{EE} = quantity of fixture
$Watts_{EE}$ = electricity consumption of LED fixture (efficient)
1,000 = kilowatt conversion factor
HOU = average annual run hours (Table 6)

Table 6. Average Hours of Use by Sector

Sector	HOU
Agriculture	4,698
Commercial	3,730
Industrial	4,745
Schools and Government	3,239

Summer Coincident Peak Savings Algorithm

$$kW_{SAVED} = [(Qty_{BASE} * Watts_{BASE}) – (Qty_{EE} * Watts_{EE})]/1{,}000 * CF$$

Where:

CF = coincidence factor (Table 7)

Table 7. Coincidence Factors for Lighting

Sector	CF
Agriculture	0.67
Commercial	0.77
Industrial	0.77
Schools & Government	0.64

For projects with only controls changes such as installing occupancy sensors, the Evaluation Team reduced the hours of use in the proposed case by 32%.[3]

Motors, VSDs, Fans, Pumps

The motors, VSDs, fans and pumps project category includes five different project types. The majority of the projects respondents completed include installing VSDs on existing motor or replacing existing motors with high-efficiency motors. The survey asked all of the respondents with this project type to provide a brief description of the project as well as the associated horsepower (hp) or capacity of the affected equipment. The Evaluation Team calculated savings using this data. Twenty-three percent of the survey respondents replaced existing motors with high-efficiency motors. The Evaluation Team calculated energy savings for motor replacement projects using the following equations:

Annual Energy-Savings Algorithm

$$kWh_{SAVED} = [(BASE_{hp} * 0.746 / BASE_{eff}) – (EE_{hp} * 0.746 / EE_{eff})] * HOU$$

Where:

$BASE_{hp}$ = horsepower of baseline motor

$BASE_{eff}$ = efficiency of baseline motor

EE_{hp} = horsepower of proposed motor

EE_{eff} = efficiency of proposed motor

0.746 = horsepower conversion factor

HOU = average annual run hours, based on survey results

Summer Coincident Peak Savings Algorithm[4]

$$kW_{SAVED} = [(BASE_{hp} * 0.746 / BASE_{eff}) – (EE_{hp} * 0.746 / EE_{eff})]$$

---

[3] Lawrence Berkeley National Laboratory. “A Meta-Analysis of Energy Savings from Lighting Controls in Commercial Buildings” September 2011.

[4] U.S. Department of Energy, Energy Efficiency and Renewable Energy. “Advanced Manufacturing Office. Energy Tips: Motor Systems.” November 2012. Available online at: https://www1.eere.energy.gov/manufacturing/tech_assistance/pdfs/whentopurchase_nema_motor_systemts1.pdf

Table 8 lists the efficiencies assumed for the baseline and proposed motor calculations.

Table 8. Motor Efficiency

Condition	Assumed Efficiency
Baseline Efficiency	89%
Proposed Efficiency	95%

Variable speed drive installations were another category identified by respondents as an energy conservation project; VSDs, or variable frequency drives (VFDs), generate energy savings by modulating the motor speed when full-speed capacity is not required. VSDs are commonly installed on air handling unit fans, but can be applied to many other types of applications including pumps. The Evaluation Team calculated energy savings for VSD projects using the following equations:

Annual Energy-Savings Algorithm[5]

$kWh_{SAVED} = [(BASE_{hp} * 0.746 / BASE_{eff}) – (EE_{hp} * VSD_{spd} * 0.746 / EE_{eff})] * HOU$

Where:

$BASE_{hp}$ = horsepower of baseline motor
$BASE_{eff}$ = efficiency of baseline motor
EE_{hp} = horsepower of proposed motor
EE_{eff} = efficiency of proposed motor
0.746 = horsepower conversion factor
VSD_{spd} = average speed of VSD during all hours of operation
HOU = average annual run hours, based on survey results

Summer Coincident Peak Savings Algorithm[6]

$kW_{SAVED} = [(BASE_{hp} * 0.746 / BASE_{eff}) – (EE_{hp} * VSDspd * 0.746 / EE_{eff})]$

Table 9 lists the VSD speed assumed for the baseline and proposed calculations.

---

[5] U.S. Department of Energy, Energy Efficiency and Renewable Energy. “Advanced Manufacturing Office. Energy Tips: Motor Systems.” November 2012. Available online at: http://www1.eere.energy.gov/manufacturing/tech_assistance/pdfs/motor_tip_sheet11.pdf

[6] Ibid.

Table 9. Motor Speeds

Motor Speed Type	Assumed Efficiency
Baseline speed	100%
Proposed Average Speed	75%

Four respondents indicated they had impellers trimmed on pumps over the last few years. Impeller trimming saves energy by reducing the impeller's tip speed. Typically, pumps are oversized and balancing valves are installed to create additional pump head to satisfy the pumping requirements. When the pump impellers are trimmed, the balancing valve is backed out and the pump uses less energy. Energy savings typically range from 5% to 30%.[7,8] to calculate energy savings, the Evaluation Team assumed 10% hp reduction for impeller trimming.

The Evaluation Team calculated energy savings for Impeller trimming projects using the following equations:

Annual Energy-Savings Algorithm[9]

$$kWh_{SAVED} = Quantity * (BASE_{hp} * IMP_{factor} * 0.746 / BASE_{eff}) * HOU$$

Where:

Quantity = number of impellers trimmed

$BASE_{hp}$ = horsepower of baseline motor

$BASE_{eff}$ = efficiency of baseline motor

0.746 = horsepower conversion factor

IMP_{factor} = average hp reduction due to impeller trimming

HOU = average annual run hours, based on survey results

---

[7] Gil Avery, James B. Rishel. "Case Against Balancing Valves" ASHRAE Journal, July 2009.

[8] U.S. Department of Energy, Energy Efficiency and Renewable Energy. "Advanced Manufacturing Office. Energy Tips: Motor Systems." November 2012. Available online at: http://www1.eere.energy.gov/manufacturing/tech_assistance/pdfs/motor_tip_sheet11.pdf

[9] U.S. Department of Energy, Energy Efficiency and Renewable Energy. "Energy Tips – Pumping Systems." September 2006. Available online at: http://www1.eere.energy.gov/manufacturing/tech_assistance/pdfs/trim_replace_impellers7.pdf

Summer Coincident Peak Savings Algorithm[10]

$kW_{SAVED} = Quantity * (BASE_{hp} * IMPfactor * 0.746 / BASE_{eff})$

Table 10. Impellers

Impeller	Assumed Reduction in hp
Average hp reduction	10%

Three respondents said they replaced existing V-belts serving their equipment with cogged/notched or synchronous belts. V-belt drives have a new installation efficiency of 95%, which deteriorates by as much as 5% before replacement. Cogged/notched belts increase drive efficiency by an average of 2%.[11] Synchronous belts provide a consistent efficiency of 98%. To calculate energy savings, the Evaluation Team assumed a 3% efficiency improvement when survey respondents replaced V-belts with notched/cogged or synchronous belts.

Table 11. Belts

Belt Type	Assumed Efficiency
V-belt drive efficiency	95%
Cog or Synch belt efficiency	98%

The Evaluation Team calculated energy savings for V-belts projects using the following equations:

Annual Energy-Savings Algorithm[12]

$kWh_{SAVED} = Quantity * [(BASE_{hp} * 0.746 / BASE_{eff} / BASE_{belt}) – (BASE_{hp} * 0.746 / BASE_{eff} / EFF_{belt})] * HOU$

---

[10] Ibid.

[11] U.S. Department of Energy, Energy Efficiency and Renewable Energy. “Advanced Manufacturing Office. Energy Tips: Motor Systems.” November 2012. Available online at: https://www1.eere.energy.gov/manufacturing/tech_assistance/pdfs/replace_vbelts_motor_systemts5.pdf

[12] Ibid

Where:

$BASE_{hp}$ = horsepower of baseline motor

$BASE_{eff}$ = efficiency of baseline motor

$BASE_{belt}$ = belt drive efficiency due to V-belts

EFF_{belt} = belt drive efficiency due to improved belts

0.746 = horsepower conversion factor

HOU = average annual run hours, based on survey results

Summer Coincident Peak Savings Algorithm[13]

$$kW_{SAVED} = Quantity * [(BASE_{hp} * 0.746 / BASE_{eff} / BASE_{belt}) – (BASE_{hp} * 0.746 / BASE_{eff} / EFF_{belt})] * CF$$

Twenty-four respondents implemented a controls project over the past few years. The controls projects varied widely and, as such, the Evaluation Team could not perform a prescriptive calculation without significant investigation. To overcome this burden, the Evaluation Team categorized the projects as building automation system (BAS) upgrade or retrocommissioning. Retrocommissioning involves hiring a consultant to perform an energy assessment of the facility and provide energy conservation measures. Retrocommissioning projects have been proven to save from 4% to 20%. The savings depend on the number of systems in the facility, the degree of complication involved in controlling those systems, and the building space functions. To calculate energy savings, the Evaluation Team assumed a 15% improvement when the respondent performed retrocommissioning.[14] Additionally, the building information provided by the respondents was not typically enough to accurately determine a facility's annual energy consumption. When insufficient information was provided, the Evaluation Team used a 100,000 square foot office with an average energy use index (EUI) of 21.42 kWh/sq. ft.[15] to calculate savings associated with retrocommissioning or BAS controls upgrade. BAS projects typically involved replacing existing controls (pneumatic or direct digital control [DDC]) with a new DDC building automation system. Savings vary for these projects and can range from 4% to 60% savings on annual energy consumption. To calculate energy savings, the Evaluation Team assumed 4% energy savings for BAS upgrade projects.

Table 12. Controls Savings Summary

Controls Savings	Savings
RCx Savings	15%

---

[13] Ibid.

[14] U.S. Environmental Protection Agency, Energy Star Technical Reference. "U.S. Energy Use Intensity by Property Type." 2008. Available online at: http://www.energystar.gov/ia/business/EPA_BUM_Full.pdf

[15] U.S. Environmental Protection Agency, Energy Star Technical Reference. "U.S. Energy Use Intensity by Property Type." September 2014. Available online at: https://portfoliomanager.energystar.gov/pdf/reference/US%20National%20Median%20Table.pdf

BAS Upgrade savings	4%

The Evaluation Team calculated energy savings for controls projects using the following equations:

Annual Energy-Savings Algorithm

$kWh_{SAVED} = BLDGSQFT * EUI * CONTROLS$

Where:

BLDGSQFT = building area (sq. ft.) or 100,000 if insufficient information provided

EUI = Energy Use Index (kWh/Sq. ft.)

CONTROLS = percentage of savings of total annual kWh consumption

Heating

The heating project category included four project types: boiler replacement, furnace replacement, heat pump replacement, and insulation installation twenty-seven percent of the projects completed include replacing existing boilers with high-efficiency condensing boilers. The Evaluation Team calculated energy savings for boiler replacement and furnace replacement based on the prescriptive calculation from the Wisconsin TRM.

To calculate energy savings for heating projects, the Evaluation Team used the following equations:

Annual Energy-Savings Algorithm

$Therms_{SAVED} = Quantity * BC * EFLH * (1 – EFF_{baseline} / EFF_{ee}) / 100$

Where:

BC = boiler Capacity (= Actual or 373 MBh)

EFLH = 1,759 hours

$EFF_{baseline}$ = AFUE of baseline measure (=82%)

EFF_{ee} = AFUE of efficient measure (=90%)

100 = Therm conversion

Table 13 and Table 14 list the boiler and furnace efficiencies assumed for the baseline and proposed heating calculations.

Table 13. Boiler Efficiency

Condition	Assumed Efficiency
Baseline Efficiency	82%
Proposed Efficiency	90%

Table 14. Furnace Efficiency

Condition	Assumed Efficiency
Baseline Efficiency	78%
Proposed Efficiency	88%

Only one respondent completed a heat pump project. In the project description, the respondent reported installing a ground source heat pump. The Evaluation Team calculated energy savings for this project based on the prescriptive calculation from the Wisconsin TRM outlined here:

- Annual energy Savings = 4,207 kWh
- Peak Demand Reduction = 0.929 kW
- Annual Therm Savings = 0 therms

One respondent completed a steam pipe insulation project. The respondent did not provide the total length of pipe insulated; The Evaluation Team assumed 200 feet based on an engineering judgment. The Evaluation Team calculated energy savings for this project based on the prescriptive calculation from the Wisconsin TRM:

- Annual Therm Savings = 11.38 therms per linear foot pipe insulation

Cooling

The cooling project category included two types of projects: chiller replacement and air conditioner replacement. Chillers provide cooled water (typically 45°F to 55°F) to mechanical and process equipment serving the majority of large facilities across the country. Chillers come in a variety of configurations including air cooled, water cooled, reciprocation, rotary screw, scroll, and centrifugal. Each chiller type has a specific performance curve with efficiencies that vary depending on chiller load. To accurately calculate energy consumption of a chiller, the Evaluation Team required a chiller load profile and manufacturer provided performance curve. However, respondents did not provide this information in the survey. To calculate energy savings, the Evaluation Team used chiller capacity provided by the respondent and minimum code compliant chiller efficiencies. The Evaluation Team based the chiller selection for the baseline and proposed conditions survey responses and the information listed in Table 15.

Table 15. Chiller Plant Selection: Minimum Efficiencies from ASHRAE 90.1-2007

Equipment Type	Size Category	Minimum Efficiency
Air Cooled, with Condenser	All capacities	2.80 COP; 3.05 IPLV
Air Cooled, without Condenser	All capacities	3.10 COP; 3.45 IPLV
Water Cooled, Electrically Operated, Positive Displacement (Reciprocating)	All capacities	4.2 COP; 5.05 IPLV
Water Cooled, Electrically Operated, Positive Displacement (Rotary Screw and Scroll)	< 150 tons	4.45 COP; 5.20 IPLV

Water Cooled, Electrically Operated, Positive Displacement (Rotary Screw and Scroll)	≥ 150 tons and < 300 tons	4.90 COP; 5.60 IPLV
Water Cooled, Electrically Operated, Positive Displacement (Rotary Screw and Scroll)	≥ 300 tons	5.50 COP; 6.15 IPLV
Water Cooled, Electrically Operated, Centrifugal	< 150 tons	5.00 COP; 5.25 IPLV
Water Cooled, Electrically Operated, Centrifugal	≥ 150 tons and < 300 tons	5.55 COP; 5.90 IPLV
Water Cooled, Electrically Operated, Centrifugal	≥ 300 tons	6.10 COP; 6.40 IPLV

The Evaluation Team calculated demand energy savings using the following equations:

Annual Energy-Savings Algorithm

ASHRAE 2007 minimum efficiency for chillers is the proposed efficiency.

Existing Equipment as a Baseline:

$$\text{kWh}_{\text{SAVED}} = (\text{IPLV}_{\text{Baseline Existing}} - \text{IPLV}_{\text{Proposed}}) * \text{ton-hours}$$

Where:

$\text{IPLV}_{\text{Baseline Existing}}$ = integrated part load volume of baseline chiller, provided by survey participant

$\text{IPLV}_{\text{Proposed}}$ = integrated part load volume of efficient chiller, provided by survey participant

Ton-hours = determined from weather bin hours and building design cooling load, based on survey participant response

Summer Coincident Peak Savings Algorithm

Existing Equipment as a Baseline:

$$\text{kW}_{\text{SAVED}} = (\text{Full Load kW/Ton}_{\text{Baseline Existing}} - \text{Full Load kW/Ton}_{\text{Baseline Proposed}}) * \text{CF} * \text{Tons}$$

Code Minimum Efficiencies as a Baseline:

$$\text{kW}_{\text{SAVED}} = (\text{Full Load kW/Ton}_{\text{Baseline Code}} - \text{Full Load kW/Ton}_{\text{Baseline Proposed}}) * \text{CF} * \text{Tons}$$

Where:

$\text{Full Load kW/ton}_{\text{Baseline Existing}}$ = full load power draw of baseline chiller, provided by survey participant

$\text{Full Load kW/ton}_{\text{Baseline Proposed}}$ = full load power draw of efficient chiller, provided by survey participant

$\text{Full Load kW/Ton}_{\text{Baseline Code}}$ = full load power draw of baseline chiller using code standard

CF = coincidence factor (= 0.8)

Tons = full load tons of chiller, provided by survey participant

To calculate kWh savings, the Evaluation Team performed a bin analysis using the following inputs based on the Milwaukee TMY2 weather data listed in (Table 16).

Table 16. Chiller Bin Analysis

Dry Bulb Bin (°F)	System Load Output % (tons)	Bin Hours	Demand (% of chiller capacity)	Total Electric Energy (% total chiller capacity hours)
100	100%	0	100%	0
98	97%	1	97%	0.97
96	94%	2	94%	1.88
94	91%	2	91%	1.82
92	88%	5	88%	4.4
90	85%	11	85%	9.35
88	82%	15	82%	12.3
86	79%	44	79%	34.76
84	76%	32	76%	24.32
82	73%	101	73%	73.73
80	70%	92	70%	64.4
78	67%	121	67%	81.07
76	64%	82	64%	52.48
74	61%	197	61%	120.17
72	58%	230	58%	133.4
70	55%	267	55%	146.85
68	52%	402	52%	209.04
66	49%	290	49%	142.1
64	46%	338	46%	155.48
62	43%	316	43%	135.88
60	40%	282	40%	112.8
58	37%	104	37%	38.48
56	34%	220	34%	74.8
54	31%	222	31%	68.82
52	28%	267	28%	74.76
50	25%	411	25%	102.75

The Evaluation Team calculated air conditioner projects using the Wisconsin TRM methodology.

Annual Energy-Savings Algorithm

$kWh_{SAVED} = (CAP / 1,000) * (1 / SEER_{BASE} – 1 / SEER_{EE}) * EFLH_{c}$

Where:

CAP = rated cooling capacity of the energy-efficient unit (= 29,100 in BtuHcool)

1,000 = kilowatt conversion factor

$SEER_{BASE}$ = seasonal efficiency rating of the baseline unit (= 13)

$SEER_{EE}$ = seasonal efficiency rating of the energy-efficiency unit (= 14, 15, or 16)

$EFLH_{c}$ = equivalent full load hours for the cooling season (= 380)

Summer Coincident Peak Savings Algorithm

$kW_{SAVED} = (CAP / 1,000) * (1 / EER_{BASE} – 1 / EER_{EE}) * CF$

Where:

CF = 0.66 coincidence factor

EER_{ee} = 11.7 for 14 SEER, 12.2 for 15 SEER, and 12.7 for 16 SEER

Energy Savings Results

If the respondent indicated that an incentive was received for a project, the Evaluation Team crosschecked the Focus on Energy database to confirm the claimed savings. Through this process, the Team verified that a total of 7,589,816 kWh, 1,094 kW and 41,507 Therms in first-year annual savings were already claimed by Focus on Energy programs. Additional projects completed by surveyed participants, which did not receive an incentive, achieved first-year annual savings of 6,721,548 kWh, 784 kW, and 21,164 Therms.

As shown in Table 17, the largest proportion of first-year electric savings from training participants came through projects to install motors, VSDs, fans, and pumps. These findings contain total savings (both incentivized and unclaimed savings), which are consistent with the prevalence of those measures for all participants in Focus on Energy's commercial programs. While these projects are often large, complex, or require significant capital investment, they are important in order to obtain deeper savings from energy efficiency.

Table 17. First-Year Annual Savings by Project Type

Measure Category	kWh Savings	kWh % of Savings	kW Savings	kW % of Savings	Therm Savings	Therm % of Savings
Lighting	6,286,622	44%	890	47.4%	0	0
Motors, VSDs, Fans, Pumps	7,641,130	53%	777	41.4%	0	0
Cooling	383,612	3%	210	11.2%	0	0
Heating	0	0%	0	0%	62,671	100%
Total	14,311,364	100%	1,877	100%	62,671	100%

Most remaining electric savings resulted from lighting projects. As this market continues to evolve, and Federal standards influences are felt, it will continue to remain an important measure for emerging technology awareness. While cooling projects did not significantly impact the energy savings found for survey respondents, this category remains important within the context of PEM or BOC course material due to the availability of unique Focus on Energy program offerings, such as tune-ups, and can help participants better understand additional processes for improvements to their company's system.

All identified therm savings resulted from heating projects, primarily the installation of boilers and furnaces. As with motor, drive, fan and pump projects, these measures often require significant planning and capital investment. These measures are important as a training component to help enhance the decision making of the participant and to better inform them of new technologies and higher efficiency ratings.

Surveyed participants represent a significant sample of all training participants. It is reasonable to assume the per-participant savings achieved by the participants are representative of these savings achieved by all training participants, based on the high number of respondents. Therefore, Table 18 shows the total first-year annual savings from Focus on Energy training programs for all participants during the 2011-14 time period, along with those savings already claimed by Focus through other programs.

Table 18. Total First-Year Savings by Training Course for All Participants

Focus Incentive Received	Program	kWh savings	kW savings	Therm savings
Yes: Savings Already Claimed by Other Focus Programs	BOC	5,094,507	692	24,617
	PEM	26,589,613	3,899	150,860
No: New Savings Associated with Training Programs	BOC	7,726,928	848	3,234
	PEM	18,148,875	2,207	92,568

The measures installed by participants continue to realize savings through the life of the equipment therefore, lifecycle savings were also calculated for the unclaimed savings associated with the training programs. An average EUL was applied to the total savings for each type of project. For example, a weighted average EUL of 14 years was applied to savings associated with lighting, to reflect the average EULs for the individual CFL, LED, linear fluorescent, and sensor measures installed. Motors category average EUL is 12.5 years, the heating category is 13.9 years, and the cooling category is 13.4 years.

Table 19 shows the total lifecycle savings built out across the total population of training participants.

Table 19. Lifecycle Savings by Training Type

Participant Type	Lifecycle kWh Total Savings	Lifecycle Therm Total Savings
BOC	99,694,175	44,948.67
PEM	243,749,546	1,286,701
Total	343,443,721	1,331,650

Challenges and Solutions

Benchmarking these results against other evaluated training programs (Table 20) shows that the per-participant first-year annual savings being reported for this program are equivalent or lower than those of similar programs. The savings claimed in the Ameren and ComEd study, appear to be significantly higher in savings which may be due to including savings from rebated program measures or due to a different volume of project completed due to their training courses.

Table 20. Benchmarking of Training Savings

Training Type and Location	kWh Savings per Participant	kW Savings per Participant	Therm Savings per Participant
Building Operator Certification, Wisconsin	84,911	9	36
Practical Energy Management, Wisconsin	42,603	5	217
Building Operator Certification, MEEA MN[16]	42,936 - 130,746	11 - 30	2,276 - 3,219
Building Operator Certification, Ameren and ComEd[17]	417,470[1]	126.85	9,716

1. Savings appear to be significantly higher than those reported in other jurisdictions. While the contributing factors remain unknown, this source was used to show the potential range of savings that can be achieved.

Additional activities, such as billing analysis or metering, would show more information and allow the computation of savings by square footage by sector resulting greater resolution of savings. In addition, expenditures by year and per training would allow for an assessment of savings per dollar spent and a benefit cost analysis.

Process

The survey asked respondents what improvements they recommended for the courses and what they liked least about the training course. Respondents most frequently made the following four suggestions:

- Shorter sessions to help with focus and information retention;
- Post training options earlier in the year;
- Offer more sessions throughout the state; and
- Focus trainings on specific business needs/concerns (current trainings too general).

Three respondents said that the instructor was not engaging enough, two said parking in downtown Milwaukee was difficult, and two said they had to travel too far to get to the training. Another two

---

[16] Midwest Energy Efficiency Alliance and Minnesota Office of Energy Security. Prepared by Navigant. “Evaluation of MN BOC Training. March 24, 2011.

[17] Illinois Department of Commerce Economic Opportunity. Prepared by ADM Associates. “Evaluation of Illinois Energy Now Building Operator Certification Program” June 2014.

respondents said some of the information was above their level of comprehension, and one respondent wanted support in keeping up with ENEGY STAR® reporting. One respondent also wanted more time to interact with the Energy Advisor, other participants, program tools, and working through class examples.

The survey also asked respondents for feedback on what Focus on Energy could do to improve satisfaction with the training course. Three respondents said they would like more hands-on training. One respondent gave an example of having lighting samples in class to see how different light sources affect the space. Another respondent wanted to see on-site instruction looking at buildings actual mechanical and electrical systems. Respondents offered additional suggestions such as holding sessions in Madison, Kenosha, and Racine; separating sessions for buildings and manufacturing; more live, on-line courses; support in developing projects with available incentives; presentations made by end-users regarding implementation, lobbying, and realization of projects from beginning to end; and ensuring that courses are up-to-date with the latest technology advancements.

Impact

There are numerous challenges with calculating savings for energy projects based on surveys. The most common challenge is the difficulty in obtaining the data from participants and project documentation. The survey asked each respondent to provide a brief description of each project they performed. Unfortunately, respondents often entered descriptions as short as two or three words. For unique or complicated projects, this description was frequently the only source of information to calculate savings. In these instances, where no defensible savings could be calculated, the Evaluation Team did not project savings.

For this study, the Evaluation Team based energy savings projections on survey responses. Third-party verification of any projects was not available, so confidence in the energy savings results is tied to confidence in the survey responses. Unfortunately, several respondents provided conflicting information, with their brief project descriptions differing from information provided for the project-specific questions. For example, a respondent may have indicated installing VFDs on AHUs in the project description, but then on the VFD-specific question, the respondent did not report installing VFDs.

The Evaluation Team recommends further investigation on the projects completed by the surveyed participants. This would include on-site verification, metering, BAS analysis, and billing analysis using a control group.

Survey Sample Cleaning and Attrition

Table 21 lists the sample attrition for survey data collection. The evaluation achieved a standard error of 38,091 kWh and a coefficient of variation of 0.45 for the BOC training. The PEM training had a standard error of 22,826 kWh and a coefficient of variation of 0.54. The final confidence and precision levels reached are 90/11 and 90/8 respectively.

Table 21. Survey Sample Frame Attrition

Description	Sample Frame Count
Population (number of participants)	517
Selected for sample frame (unique contacts)	463
No longer works there	70
Declined	8
Link to survey sent, no response	260
Partially completed survey	11
Completed survey	114