A.S. DEGREE PROGRAM

MILWAUKEE AREA TECHNICAL COLLEGE

OAK CREEK CAMPUS – ENERGY CONSERVATION & ADVANCED MANUFACTURING (ECAM)

Sustainable Facilities Operations - Program Development

National Science Foundation - National Center for Building Technician Education

Center for Energy Conservation & Advanced Manufacturing

ECAM

Milwaukee Area Technical College

BEST

Building Efficiency for a Sustainable Tomorrow

NSF

10/2/2013, revised 2025

SUSTAINABLE FACILITIES OPERATIONS

Program Documentation

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Table of Contents

Catalog description

Program code: 10-481-1

Overview — Sustainable Facilities Operations is designed to help prepare students to efficiently and effectively manage the total facility. The material covered will benefit students who are practicing as or wanting to become an energy manager, facilities manager, operations and maintenance manager, energy auditor, maintenance supervisor, superintendent of buildings and grounds, building manager, plant manager, maintenance manager, maintenance director, operations manager or energy technician. Emphasis is placed on cost-effective energy options, direct digital controls, energy management systems, sustainable operations management, maintenance management, commissioning and project management. Additional attention is placed on saving operations and maintenance dollars by introducing developments in the energy industry, contracting options for services and best practices in efficient and effective operations and maintenance. Monitoring, control, reporting and presenting sustainability performance is given full treatment. Supervision, management and training of building service employees are also covered.

About MATC
MATC is the largest of the 16 Wisconsin Technical Colleges and with a student headcount of around 50,000, MATC has the power to change the local economy. According to a 2007 analysis of investment effectiveness and economic growth report, MATC creates a $1.2 billion economic contribution to the greater Milwaukee region. MATC offers hundreds of traditional pathways to gainful employment and universities that comprise this economic benefit to the community.

MATC Environmental Studies Cluster
The Environmental Studies Cluster is about pathways that are adaptable to a variety of backgrounds where the end result is a career that pays a family supporting wage or salary while sustaining the natural environment. The new areas of study at MATC are Sustainable Facilities Operations, Energy Engineering Technology, Renewable Energy, Environmental Health and Water Quality Technology. MATC is the only college in the region to offer such a wide variety of green courses, certificates and programs.

- Environmental Health and Water Quality Technology AAS Degree
- Sustainable Operations Certificate
- Energy Engineering Technology Certificate
- Renewable Energy Certificate – under development
- **Sustainable Facilities Operations AAS Degree – Documented here**

The first course ended on March 9, 2009 with 32 students with excellent evaluations. Their backgrounds ranged from little experience and education to graduate degrees in engineering and architecture with over 10 years of experience. The second course is the LEED for Green Buildings and it started on March 30, 2009 with great success.

The proposed Sustainable Facilities degree is an interdisciplinary program that presents the opportunity to initiate students in green collar industries and help to develop a sustainable green economy in the district. Through this program students will be exposed to sustainable commercial and industrial operations, energy technologies and engineering and renewable energy systems while taking a set of at least three core courses in one of three concentrations. Other courses in natural and applied science, mathematics, technical and industrial areas and energy systems are part of the degree program. The program has been developed to attract incumbent workers, high school graduates, new entrants and displaced workers interested in developing their future in the new green economy.

Program design rationale and key elements

The Sustainable Facilities Operations program has a **2-year** Associates (AS) degree structure as deemed by the Wisconsin Technical College System.

Year 1 teaches the fundamentals of buildings and building systems from the perspective of environmental impact and emphasizes efficiency. Students are introduced to buildings as an organic, living structure as well as a systems thinking point of view. In coordination with this perspective the second half of year one looks at interior and exterior design and introduces technical proficiencies in energy auditing, a holistic approach to buildings.

Year 2 broadens and deepens the first-year fundamental curriculum by introducing more complex occupations such as commissioning, measurement and verification as well as energy technician.

Goal

Sustainable Facilities Operations is designed to help prepare students to efficiently and effectively manage the total facility.

Program-level learning outcomes (PLO's)

Energy: Measure, evaluate and propose prioritized specific measures to improve energy efficiency in buildings through operations improvements.

Sustainability: Integrate a global perspective of the impacts of buildings into operations plans for facilities.

Communications: Engage staff and stakeholders by reporting and evaluating inputs to effectively operate facilities.

Building Science: Define and explain building science, systems and all aspects of operations.

Business and budgeting: Evaluate operations and proposed changes with respect to sustainable business practices and sound economic analysis.

Exit skills

After successfully completing the Sustainable Facilities Operations program, the graduating student shall be able to:

- Operate & optimize a variety of complex building systems
- Develop operating and capital budgets
- Measure and verify systems performance
- Train and develop internal building services staff
- Register and implement a LEED project
- Compose and evaluate building service contracts
- Develop computerized maintenance management and an asset management system
- Commission projects and systems
- Engage a staff in a systematic continuous improvement program
- Develop and program a sequence of operations for various building systems
- Reduce energy use in facilities
- Perform energy audits
- Demonstrate skills in basic business mathematics and communications
- Demonstrate energy & facilities management computer skills
- Report and present data from performance measures

Embedded course sequence including lab and lecture hours

Preparation for Admission — The following are required for admission to the program:

- A high school diploma or GED
- Demonstration of proficiency in basic skills through a course placement assessment

In addition, potential for success in the program will be enhanced if you have some work experience and/or a strong interest in sustainability and facilities management. You should also possess conceptual abilities, problem-solving skills, computer skills and organizational skills.

TECHNICAL STUDIES			**Credits**
( ) = Semester Order for Full-Time Students			
(1)	SUSTN-100	Sustainable Facilities Operations	3
(1)	SUSTN-105	The LEED Rating System	3
(1)	NATSCI-169	Energy in Nature, Technology and Society	3
(2)	SUSTN-104	Energy Auditing & Managing Energy Use	3
(2)	RBUS-111	Business Communications	3
(2)	INDESGN-100	Introduction to Interior Design	3
(3)	HVAC2-132	Architectural and Mechanical Fundamentals	3
(3)	SUSTN-102	Reporting and Presenting Systems Performance	3
(3)	SUSTN-106	Measurement and Verification	3
(4)	SUSTN-101	Environmental Control Technician	3
(4)	SUSTN-103	The Commissioning Process	3
(4)	HVAC2-146	Digital Energy Management Systems - METASYS	3

GENERAL STUDIES		
ECON-195	Economics	3
OR	*Any 200-series ECON course*	
ENG-151	Communication Skills 1 ǂ	3
and ENG-152	Communication Skills 2 ǂ	3
OR	*ENG-201 **and** any 200-series ENG or SPEECH course*	
MATH-113	Technical Math 1A	3
OR	*Any 200-series MATH course*	
NATSCI-167	Science of Technology	3
OR	*Any 200-series NATSCI course*	
PSYCH-199	Psychology of Human Relations	3
OR	*Any 200-series PSYCH course*	
SOCSCI-197	Contemporary American Society	3
OR	*Any 200-series SOCSCI or HIST course*	

Suggested Electives: Six Credits Needed 6
It is strongly suggested that students take 200-level math and science courses as electives if they are considering a four-year college or university transfer.
TOTAL CREDITS: 63

Core courses & descriptions

SUSTN 100 - SUSTAINABLE FACILITIES OPERATIONS
This is an accelerated course that covers the overall aspects of operating a building in an ecologically and economically sustainable fashion in today's complex world. Sustainability as it relates to social and environmental responsibility is discussed. The triple bottom line, LEAN, Six Sigma, CMMS, LEED and overall sustainable operations are covered and are part of a class project. Students are encouraged to use a project from their work or of personal interest to them.

SUSTN 101 – ENVIRONMENTAL CONTROL TECHNICIAN
This 8-week accelerated course prepares the student to upgrade, operate and maintain energy management systems and related software and components. The controls used in this course are the latest technologies on the market. While the course focuses on the technological aspects of an energy controls technician, it also addresses customer service and proposal writing.

SUSTN 102 - REPORTING & PRESENTING SUSTAINABLE SYSTEMS PERFORMANCE
This course is designed to help the learner to measure and report quantitative operational performance. Basic mathematical calculations and spreadsheet management are covered. Topics include spreadsheets, descriptive statistics, EMS data mining, standardized methods of data collection, methods of displaying data, reporting results and presenting information. Energy, water, materials, waste streams and other sustainability measures are all covered within the context of commercial and industrial operational performance measures. A survey of continuous improvement, time series analysis and an introduction to Big Data are final topics of discussion.

SUSTN 103 – THE COMMISSIONING PROCESS
This course examines commissioning (Cx) of existing and new buildings. The course covers the different forms of building Cx, selecting buildings that are good candidates for Cx, project goals, establishing client operating requirements, investigating systems and performance, Cx report, systems manuals, functional performance testing, along with hands on advanced techniques such as DDC trend logging of systems, measuring system performance, data logging/system monitoring, and Cx persistence methods. An understanding of construction or engineering basics is desired.

SUSTN 104 - ENERGY AUDITING & MANAGING ENERGY USE
This course considers residential, commercial and industrial energy audits. The course illustrates how to both understand and analyze utility billing data, how to conduct an energy audit and what information to obtain during a walk through energy audit, how to determine energy use of specific equipment, how to stratify where energy in a building is being used, identify opportunities to calculate savings and reduce facility energy use, how to prioritize energy saving projects, and how to structure the information into a comprehensive report. Spreadsheets and reporting formats will be provided. Students will be required to use Energy Star Portfolio Manager to rate a building for Energy Star Certification.

SUSTN 105 – THE LEED RATING SYSTEM
This course is an overview of projects that follow a new standard of green buildings such as the LEED© rating system. The USGBC has divided LEED buildings into a series of categories and they are evolving so changes to their system are likely at regular intervals as the science of building technology advances. This course covers the LEED rating system and the evolution in building sciences as reflected in updates to the LEED rating system.

SUSTN 106 - MEASUREMENT AND VERIFICATION
This course covers different methods of measuring and verifying energy savings. Emphasis is on the International Performance Measurement & Verification Protocols (IPMVP) and includes hands on M&V using kWh meters, energy management systems, and data loggers. Information covered will prepare the learner to take the national certification exam for measurement and verification. All energy managers know the importance of verifying that projects are working, including promoting success within and outside organizations. This course covers the simple to complex methodologies for measuring success so that systems and projects are documented and managed. Special emphasis is placed on energy performance contracts.

Rationale for course sequences, pre-requisites, and co-requisites

Year 1 teaches the fundamentals of buildings and building systems from the perspective of environmental impact and emphasizes efficiency. Students are introduced to buildings as an organic, living structure as well as a systems thinking point of view. In coordination with this perspective the second half of year one looks at interior and exterior design and introduces technical proficiencies in energy auditing, a holistic approach to buildings.

Year 2 broadens and deepens the first-year fundamental curriculum by introducing more complex occupations such as commissioning, measurement and verification as well as energy technician.

Sequences of topically related courses:

- Energy auditing, energy management and commissioning
- Architecture and function of buildings
- LEED and sustainability
- Communications

Inputs for program design and development

Scope and Methods Proposal: Sustainable Facilities Operations

Program Code: 10-481-1

Participants

Names, addresses, E-mail addresses and phone numbers were taken from the directories of: 1) International Facilities Managers Association, 2) Builders, Owners and Managers Association, 3) Building Engineers Group and 4) Energy Engineers Association, 4) government directories 5) major hospitals 6) insurance companies, 7) energy services providers and 8) real estate management businesses. Bias is existent to the extent that only individuals who belong to these associations or organizations are represented in the sample. Job titles will be used to differentiate between facilities related jobs and other occupations found in these directories. The hiring authority for

occupational titles such as: facilities manager, plant manager, operations manager, director of physical plant, energy manager and plant operations manager, sustainability coordinator or manager, energy manager, energy auditor, energy technician, renewable energy coordinator or manager and similar titles are our target respondents. These are the individuals who are involved with hiring the people who do the selection, installation, operations and maintenance of energy systems in various types of plants and facilities and are directly involved with sustainable practices and technologies as well as energy purchase and use.

Job Descriptions

An inspection of facilities and plant managers' job descriptions (JDs) from the member organizations referenced above, City and County of Milwaukee, South Eastern Wisconsin Human Resource web sites and web postings reveal strong energy systems accountability. Specifically, these JDs explain that a facilities/plant operators, technicians and managers' essential function is to plan and coordinate activities that contribute to the overall physical plant's performance.

Respondents' job titles included words such as manager, director and supervisor. Virtually all facilities-plant managers' JDs indicate some level of human supervision while many JDs specify training and development, hiring, firing, corrective action, evaluation, promotion and other supervisory and leadership responsibilities. JDs show that the facilities/plant manager has direct control over training programs as well.

Most JDs show financial responsibilities for both capital and operations and maintenance (O&M) budget development. Energy utility budgets (electric, natural gas, water, steam, chilled water, coal, propane, oil and other utilities) are part of the O&M budget while energy innovation feasibility, design, installation and demonstration are most often part of the capital budget. Alternatively, some organizations separate O&M from capital by a specific dollar amount. For example, if a project has a total cost exceeding $25,000.00 it would be considered a capital investment and may be subject to a cost benefit analysis while a project with a total cost under $25,000.00 may be considered an O&M project. In each instance, however, energy innovation implementation (capital) and performance (O&M) is managed directly by the facilities/plant manager. Our survey targets the hiring authority as the respondent.

Every JD in the sample will specify that energy systems knowledge is required and that the facilities and plant manager would make decisions and suggestions about energy system improvements and the organizations sustainability initiatives. Overall, facilities and plant managers are responsible for: 1) energy innovation procurement and turnkey installation, 2) commissioning, operations and maintenance of such innovations during their service life, 3) training and development programs associated with energy innovation equipment and systems, 4) energy systems budget development, 5) utility budgeting, 6) keeping abreast of the latest development in the energy industries to continually upgrade equipment, systems and people along with green practices and technologies.

Survey Procedures

The U.S. postal service or electronic email were send out with 10 letters of introduction in advance of the actual survey. Following Dillmann's (1978) procedure, this cover letter emphasized a reasonable explanation of the study, its benefits to the group and the importance of the respondent's response to the programs' success. The letter was reproduced on MATC letterhead stationery with the recipient's name and address on the envelope. Each letter was personally signed by me.

The first round of survey mailings or e-mailings took place three business days after the introductory letter. A survey instrument was composed of items and constructs. Cover letter, survey and a self-addressed stamped envelope were carefully folded in an official MATC envelope. All documents carried the MATC letterhead.

Exactly one week after the survey mailing an e-mail follow-up was sent to all recipients of the first mailing. The first round of e-mails was individually typed with the respondent's name, e-mail address and my e-signature. The text on this e-mail was written as a thank you for those who have already returned their questionnaires and a reminder to those who have not. A second follow-up e-mail was sent to respondents exactly three weeks after the original mail-out. This three-week follow-up e-mail informed them that their questionnaire has not been received and included a restatement of the basic appeals from the original cover letter and an attachment questionnaire that the respondent could easily navigate and return. The third and final follow-up e-mail was dispatched seven weeks after the original mailing. It consisted of the cover letter statement and still another attached questionnaire (Dillman, 1978).

A final effort was made with telephone survey interviews where I personally asked the questions on the survey while filling in the survey instrument for respondents in order to attain a final return rate.

Analysis

Areas of emphasis have been identified: 1) facilities manager/operator, 2) energy technician, and 3) energy/sustainability professional. Frequency distributions will be in table format where the number of jobs projected in these areas will have a total and grand total. Provisions will be made for split files, demographics and modeling for future research.

Facilities managers/operators are individuals who are responsible for the physical plant and its performance relative to energy, maintenance and operations. These positions have further responsibility for recycling, waste disposal, housekeeping, energy management, maintenance management, new system installation and upgrades, HVAC, grounds keeping, fire, life & safety systems, and a host of other systems such as telephone, data, and at times, transportation.

Energy technicians are responsible for scheduling, trouble shooting, programming and integration of controllers and equipment found in and around buildings in

industrial and commercial settings. Energy technicians may work in-house for an organization or with an energy services provider. These individuals may be commissioning agents, energy auditors, measurement and verification specialists as well.

The last emphasis is the *sustainability professional* concentration. This has an obvious direct link to sustainability and is also linked to facilities personnel and energy technicians. However, this area may be separated into two divisions: 1) manufacturer, installer, maintainer and operator of a renewable technology such as photovoltaic system, wind turbines, geothermal or solar thermal systems and 2) the sustainability professional. Sustainability professionals are members of a relatively new industry. These individuals are responsible for keeping track of energy performance, recycling programs, marketing the sustainability agenda inside and outside of the organization, LEED projects, legal issues surrounding government regulation and general sustainable practices and technologies at a higher level and spend considerable time composing reports and presentations. Admittedly, this is aspect of the program is under exploration and success depends on energy pricing structures, materials availability and demand for sustainable practices and technologies. Therefore, I am suggesting that the survey include several items and demographics that investigate further. First time interval starts Monday, February 1, 2009.

Survey Structure Reference

Mail And Telephone Surveys: The Total Design Method, Dillman, D. A. (1978), Wiley, New York

Survey Results (see appendix A for the survey)

1 & 2. Facilities related existing positions that respondents listed: direct installers, energy advisors, energy project coordinators, assistant energy advisor, energy service engineer, grant application analyst, performance assurance specialist, measurement and verification specialist, energy auditor, energy controls technician, project development engineer and commissioning agent.

3. The total number of entry level energy-related positions are 214 (through an interview it was revealed that Johnson Controls was actually higher than this total). All respondents require a 2- or 4-year degree.

4 & 5. 10 respondents experienced maximum growth (7+) in the number of facilities/energy positions over the past (2008) year due to business growth.

6 & 7. 10 respondents see an increase in facilities/energy related positions over the next three years due to business growth.

8. Over the next three years, 2009, 2010 & 2011, the respondents expect to replace

120, 113 & 111 energy/facilities related people, respectively. None of the respondents hired part-time employees.

9. The average starting wage was +19.00 per hour.

10. 60% of the respondents felt they had adequate training, 10% felt that they did not have adequate training while 30% were unsure.

11. All respondents would be willing to hire students who successfully completed the program.

12. All respondents would be willing to hire a graduate of sustainable facilities operations who had related work experience.

13. 30% were unsure while 70% said they would send employees through the sustainable facilities operations program. 20% have already started to send their employees through the new courses that are part of this program.

14. Comments were positive about current employees who have already taken courses that are part of the program. Suggestions were made about addressing communications, data analysis and problem solving skills as part of the program. Johnson Controls said if we provide a LEED AP course on-line, they could enroll up to 50 people right away.

15. 100% of the respondents were in the energy services industries.

16. There are +1200 employees in the responding organizations (Johnson Controls maxed out the top of the scale).

17. Respondents suggested we consider geothermal, solar-thermal, photovoltaic, wind, maintenance, commissioning systems, energy conservation and management, mentoring and field experiences.

18. All respondents are willing to serve on advisory committees and some already serve on the ECAM steering committee.

Survey instrument was emailed as an attachment to prospective employers within the facilities/energy industries with response rates of 80%. Five responses were based upon telephone interviews.

Results were mixed. While we had found openings in a variety of the occupations stated above, there were not many of them across the survey respondents. There were less than expected job possibilities in total, excluding Johnson Controls and Franklyn Energy. However, when I followed up with investigation, I found that there were two places of employment that were hiring and planning to hire over the next three years. Franklin Energy planned to hire 150 people in three years and Johnson Controls would

not commit to hiring but indicated that they will need thousands of new hires. While Johnson Controls was rightfully guarded with their statements, their own estimates from their highest ranking managers ranged from 10,000 to 50, 000 world wide.

Franklyn Energy proved to be less guarded and provided a signed document that indicated their intention to hire 150 energy services providers such as residential and commercial energy auditors, commissioning agents, LEED professionals and measurement and verification specialists. This result alone was enough evidence to gain approval from the Wisconsin Technical College System.

Sustainable Facilities DACUM Results:

General Knowledge	Worker Behaviors/ Attributes

❑ Ecology\
❑ Chemistry
❑ Horticulture
❑ Computers
❑ Control systems
❑ Building codes
❑ Mathematics
❑ Human behavior
❑ Quality standards
❑ Sustain "resources"
  ❑ Materials
  ❑ Operation
  ❑ Environment
❑ Business accounting
❑ Economics
	❑ Value resources and environment
	❑ Leadership
	❑ Professional development
	❑ Currency
	❑ Organizational Skills

General Skills	**Tools/ Equipment**
❑ Change belts ❑ Change filters ❑ Clean strainers ❑ Clean humidifiers ❑ Lubricate bearings ❑ Clean air intakes ❑ Test dampers ❑ Test valves ❑ Measure airflow ❑ Measure temperature ❑ Measure sequences ❑ Public speaking ❑ Writing ❑ Cost benefit analysis ❑ Data mining ❑ Interpersonal skills	❑ Computers ❑ Software ❑ Internet access ❑ Meters ❑ Current and Historical Utility Data
Future trends	
❑ Current vs. Future occupations ❑ Technology	

Documentation of team involvement in the planning process
(June, 2008)

The external ECAM Steering Committee, consisting of the top business partners of MATC, supported this degree through the entire process. Progress reports were made to the committee and feedback was received throughout.

The internal ECAM Steering Committee played an active role in the development of the degree and supported the degree during the entire process. Names are as follows:

Karen Coy-Romano
Caryn Doring
Al Evinrude
Jim Gribble
Lori Hains
Bill Hodgkinson
Greg Holther
Joe Jacobsen
Ken Johnson
Sandra McClary
Tom Olson
Mitch Sheuttke
John Stilp
Nick Triscari
Dave Turner
Jen Turner
Dorothy Walker

Johnson Controls helped to create a sub-committee consisting of their most important technical energy experts and MATC representatives to examine the current state of the industry. During this meeting specific competencies were discussed, job requirements and prospects for employment in the area of sustainable facilities. This session was in addition to the DACUM.

AS degree option: general education requirements

This program is an AS degree only as listed.

Transfer institutions, programs, and credits

Collaborations, partnerships and articulation initiatives include:

UW Milwaukee: We are collaborating with UW Milwaukee on an introduction to wind and a renewable energy finance course as part of a $320,000 grant that will also be tied to a second grant associated with Lakeshore Community College program in wind.

High School: We are partnering with the Inland Seas High School to develop laddering into our environmental cluster. Inland Seas is a "water" focused high school on the near south side of Milwaukee that has great potential to ladder through MATC to UWM and other 4-year institutions and into green jobs.

Milwaukee Public Schools: We are working with Milwaukee Public Schools to develop a green middle school and a green high school. This initiative ensures that young people in our community are not only exposed to green technologies and practices but, they are prepared to meet the challenges of science and mathematics due to the content. Meetings are underway with the president of the MPS board and show great promise.

Industry involvement

Samples of industry involvement:

The President, Provost and virtually all the Deans have approved and are anticipating the successful completion of this program. I have presented the degree to the counselors and admissions advisors. Financial aid is processing applicants in this program.

This program has not only been formally presented to the MATC community and the MATC Board but also the City of Milwaukee, the Green Manufacturing Summit, the Renewable Energy Summit, the Water Council, Engineers Without Borders, Engineers and Scientists of Milwaukee, several schools at the University of Wisconsin, Marquette University, Milwaukee School of Engineering, Milwaukee County, Keep Greater Milwaukee Beautiful, Milwaukee Public Schools, Inland Seas School, International Facilities Managers Association, Building and Owners and Operators Association, The Energy Engineers Association among others.

Labor market needs analysis

Career Outlook — The projected employment outlook in the field of sustainable facilities operations and management is very strong. First-line supervisors/managers of maintenance mechanics, installers, building service workers and repair technicians are in demand. It is projected that over 100,000 (Johnson Controls) new employees will be added to the energy systems and sustainability industry over the next decade. In addition, the area of greening facilities operations provides many new and existing exciting career options such as sustainability technician or coordinator with promotional opportunities leading up to manager and director. Opportunities abound for those who are interested in sustainable technologies and practices in energy and materials. In addition, the program includes training and information on how to become a certified LEED professional, commissioning agent, certified energy auditor, certified energy engineer, certified energy manager and a certified facilities manager. A strong Energy Management System component is found within the Energy Systems Emphasis.

Green Pathways
The transformation of existing industries and the emergence of new industries that contribute to protecting the environment and reducing our ecological footprint is essentially the new green economy. MATC is aggressively developing sustainable pathways to green collar jobs and green careers in the new green economy by introducing a set of green certificates and programs. Several areas of study are underway and several others are under development

The Green Economy

The green economy is projected to be the most important development of the 21st century. Current (2008/09) annual salaries range from the high $40,000's to over $70,000. Franklin Energy of Milwaukee expects to hire at least 150 energy measurement and verification specialists who can perform energy audits, set up energy performance contracts and give advice about financial incentives to install, replace, repair and upgrade traditional energy systems and install and upgrade to renewable energy systems. Johnson Controls Inc. is expecting to hire hundreds of energy technicians due to a demographic of energy technicians who are close to retirement age. This same demographic projection applies to dozens of other energy service providers in the Milwaukee area. The new administration in Washington DC is determined to create 5 million new green jobs comprised largely of energy efficiency technicians and renewable energy assessors/installers. Estimates range from 700,000 to 5 million skilled technicians will be needed nationwide. Milwaukee Area Technical College is situated within the economic nucleus of Wisconsin. Milwaukee uses more energy, water and other resources, has more buildings, has the largest infrastructure, has the largest population, has the highest rates of unemployment and poverty, has the largest transportation systems, has the most industrial facilities, and therefore has the greatest need for training and education in sustainable operations, energy efficiency and clean energy.

Typical job titles and pay ranges for program graduates

Triple Bottom Line: This program will produce real jobs that pay above average wages while cleaning up the environment. The motivation of students is tremendous. This is a career that students get excited about, it is cool, it is wholesome, and it addresses the most important issues of the 21st century, our children's future, global warming and energy independence, thus addressing the triple bottom line.

- Commercial and Industrial Plant Operator and Manager
- Building Manager
- Energy Technician
- Facilities or Facility Operator
- Municipal Operations and Maintenance
- Renewable energy installer, site assessor, service provider and designer
- Manufacture of green parts, equipment and systems
- Utility Operator, Supervisor, Manager
- Power Engineer
- Stationary Engineer
- Sustainability Coordinator, Manager and Director
- HVAC Technician
- Operations and Maintenance Technician
- Building Services Worker, Supervisor, Manager and Director

Links to employment data

Research.com: Sustainability Careers: 2025 Guide to Career Paths, Options & Salary - https://research.com/careers/sustainability-careers#2

IREC Clean Energy Careers Map - https://irecusa.org/career-maps/

EDF Green Jobs Hub - https://www.edf.org/degrees/green-jobs-hub

Alignment with industry certifications

Students completing the program will be ready for the following certification exams with individual specific study and practice:

Association of Energy Engineers

Certified Energy Auditor
Certified Energy Manager
Commissioning Authority
Measurement and Verification Specialist

International Facility Management Association

Sustainability Facility Professional

United States Green Buildings Council

LEED Accredited Professional
LEED Green Associate

Framework of Career Pathways, Career Clusters, and Programs of Study:

The program organizes educational preparation and occupational choices into a unified concept of applied environmental studies in an energy cluster. By combining academics with career and technical education, students have a clear path to their future. The applied energy cluster:

- Is for all learners interested in solving environmental problems
- Offers a distinct educational plan of study learners can follow from pre-college to post-secondary education to the workplace to advanced degrees
- Offers a sequence of complexity that learners can understand and accomplish
- Is connected to nationally recognized certification
- Helps to create smooth transitions in the educational pipeline and reduce duplication
- Empower learners through information and experiences they need to make informed decisions about their future in a sustainable economy
- Helps counselors, teachers, parents, and learners design individual plans of study with dignity

- Offers a key element in enhancing sustainable economic development by connecting environmental responsibility with schools, business and industry

Affiliations with industry organizations

Johnson Controls, Inc., MATC Operations, University of Wisconsin-Milwaukee Facility Services, Wilinski Associates

Additional industry organizations

ASHRAE, Wisconsin Chapter of Association of Energy Engineers

Recruitment

A recruitment strategy is both formal and informal. On the formal side, we have ads in buses, billboards and newspapers throughout the Greater Milwaukee area. We also have a trade show booth style system that is used at several major events throughout the year. The Green Energy Summit, Green Cities, the Machine Tool Show, the Solar America and the Green Manufacturers Show. Informally, we make a consistent effort to bring up our offerings at meetings, seminars, conferences and with friends throughout the sustainability community in the region. We also have relationships with engineering and business schools like the University of Wisconsin, Concordia University, the Milwaukee School of Engineering and Marquette University. MATC provides printed literature about the program as well as placement in the catalog.

Program entry standards:

Our experience has been that the following characteristics lead to success:

- previously acquired aptitudes
- academic preparation
- computer skills
- industry experience
- technical skills
- study skills
- focus
- hands-on proficiency
- self-directed researcher
- ability to think critically to solve problems

Sources of potential students:

Buildings, Energy & Technology (BET)

MATC is developing this transitional course to prepare new entrants, displaced workers and high school students for a wide variety of technical programs. BET is a transitional component leading to technical studies when the learner has little to no experience, training and education. Specifically, BET addresses hand and

power tools, basic units of measure, reading meters and understanding utility bills. The second part of the course is an introduction to electricity and heat along with standards in workplace behavior. Along with lecture/lab work, the course ends with simple conversion and several commercial and industrial site visits to provide the experience needed to enter a variety of skilled professions. This coursework will be applicable as an elective to a variety of technical certificates, diplomas and degrees at MATC.

Program infrastructure

In August of 2007, MATC was handed the keys to the Energy Conservation and Advanced Manufacturing Center (ECAM) where we have already provided the best attended LEED technical review session in the United States, a testament to the need for sustainable training and education in the Milwaukee area. ECAM has two labs associated with energy.

The first is the **Energy Solutions Lab** which is the primary hands-on instructional space for the Sustainable Facilities Operations program. It not only has the usual inventory of HVAC pumps, compressors, air handlers, chillers, boilers and associated piping and ducting systems (figure 1 & 2), but also a thermal storage system and in 2010 a ground source geothermal system was installed. This lab is also dedicated to renewable energy production, distribution, control and monitoring, and students will have real life experiences with important technologies. The water source geothermal system will be monitored and controlled in this lab along with two 17 kW photovoltaic (PV) rooftop arrays, two tracking pole-mounted PV units, and two stationary PV pole-mounted systems. The 90 kW wind turbine in Mequon will be monitored from this lab where the students will be trained in wind technology through our web based real-time energy monitoring and control systems.

ECAM has a Digital Controls Lab that houses a complete classroom of operator workstations, controllers, actuators and sensors. Students learn how to write sequences of operations for the usual equipment but also geothermal, solar thermal, thermal storage and more innovative equipment operating instruction through energy management software.

In 2016 a new building automation lab was added with 5 air handlers and 10 VAV boxes fitted with digital controls to support a new diploma program. The lab also has a lighting control system that is used to train students.

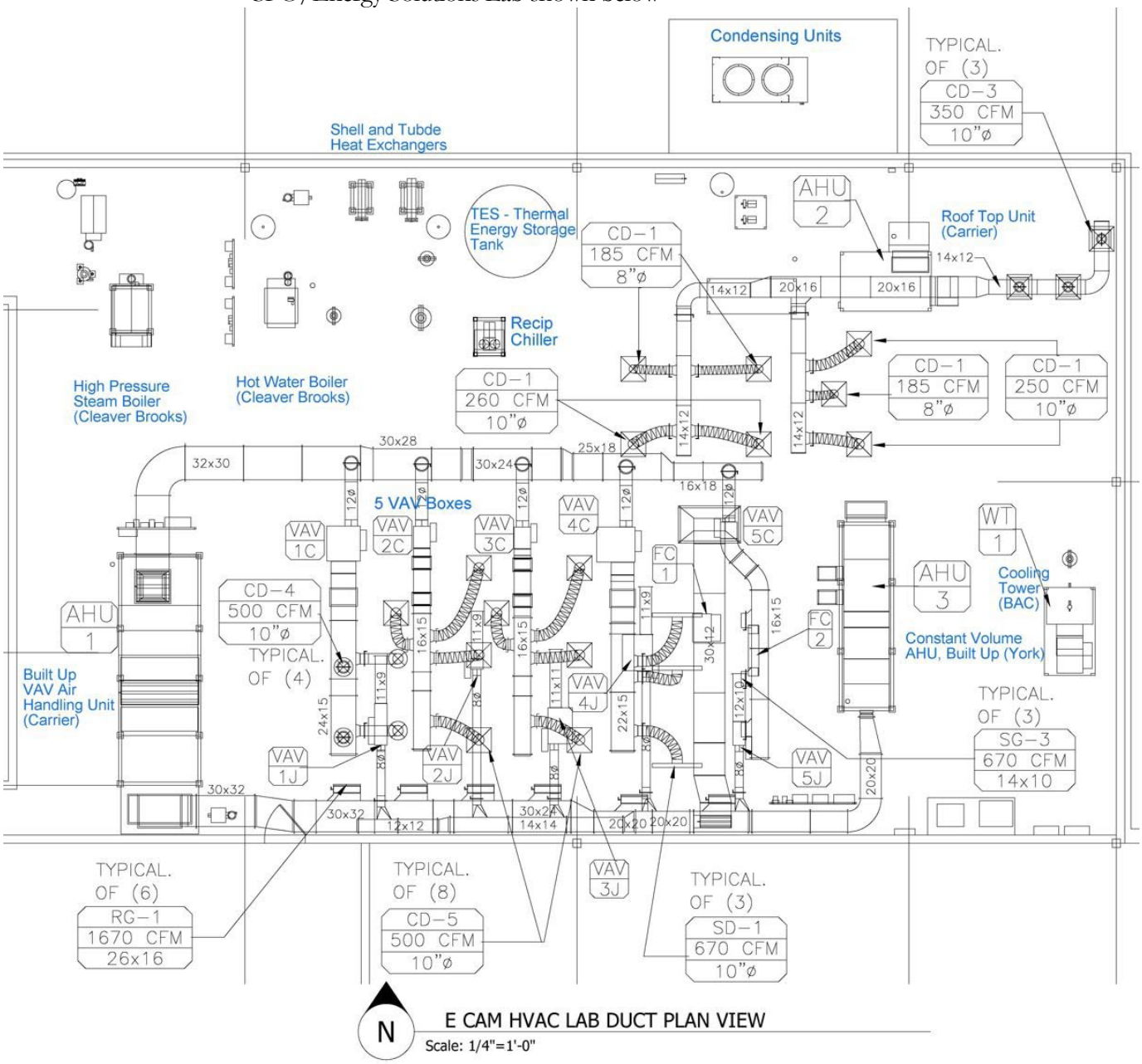
The manufacturing portion of ECAM is the largest portion of the center. It houses a large CNC lab with over a dozen CNC machines, water cutter, and other equipment. Adjacent to the CNC lab is a welding lab.

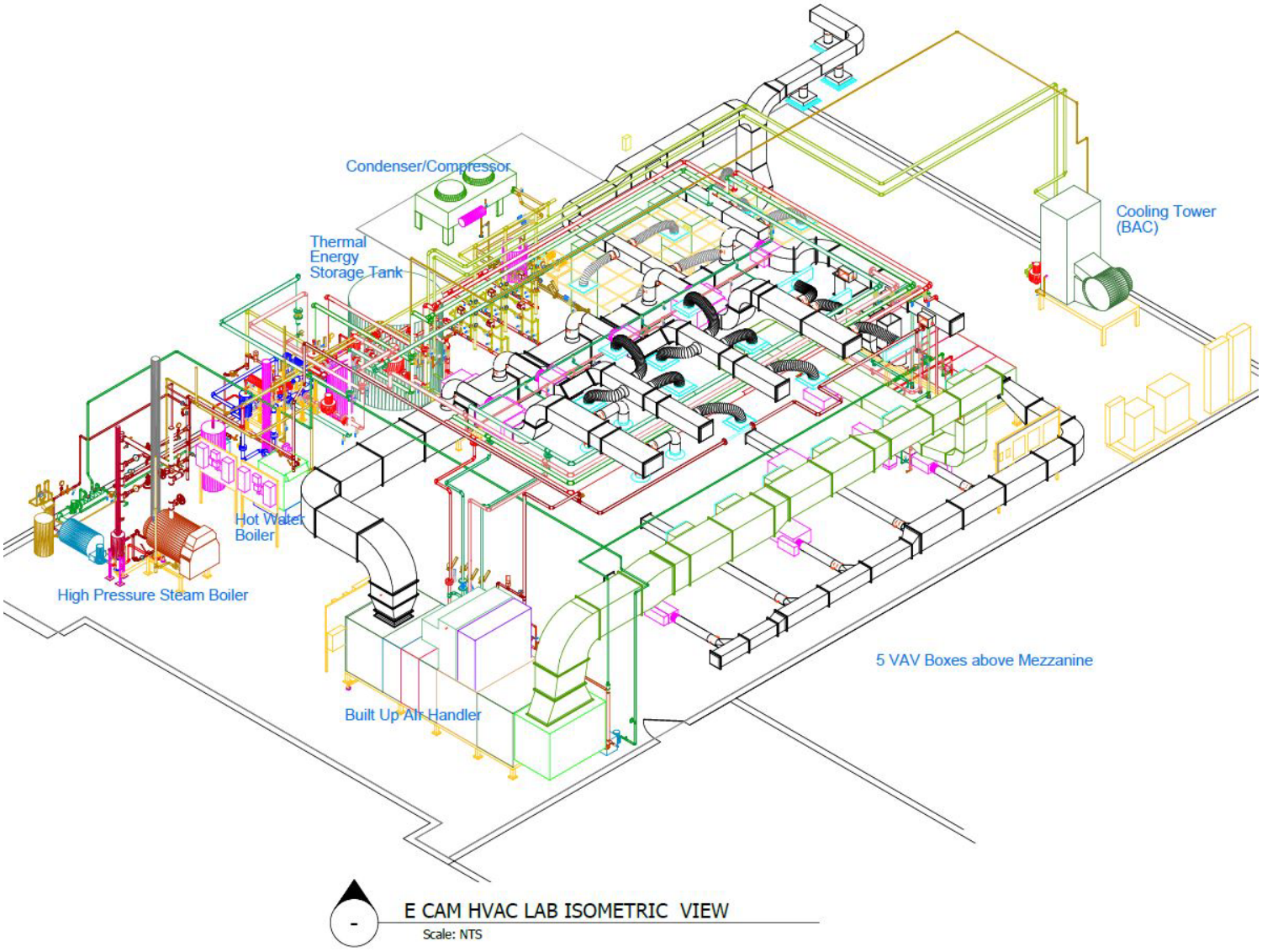
Accessibility of equipment

Student access to equipment is critical and includes safety measures to protect students as well as equipment, space for viewing and working, adjacent classroom area, computer lab area, instrumentation storage area, set-up and maintenance facilities, and accommodation for nighttime classes with year-round simulation of all weather conditions. A high-bay industrial type space with access for installing and operating equipment and accommodating ongoing modifications is key.

Lab layout & elements

SFO/Energy Solutions Lab shown below





E CAM HVAC LAB ISOMETRIC VIEW
Scale: NTS

Photographs of SFO/Energy Solutions Lab

Figure 1 - View of boiler, thermal energy storage in the Energy Solutions Lab at MATC's ECAM

Figure 2 - View of air handling unit & instructional mezzanine

SFO/Energy Solutions lab equipment and application in classes

The Energy Solutions Lab includes:

- Built-up air handling unit (AHU) with variable air volume (VAV) boxes
- Constant volume AHU
- BAC cooling tower
- High pressure steam boiler
- Hot water boiler
- Reciprocating chiller
- Shell and tube heat exchangers
- Rooftop unit
- Ground source geothermal system
- Thermal energy storage tank
- Controls for monitoring geothermal & photovoltaic systems

Various campus buildings might also lend themselves to Living Lab learning opportunities to offset the need to construct or improve instructional labs; however, you should expect to negotiate with your facilities department regarding levels of access to equipment rooms.

Refer to individual course documents for application of equipment to specific courses.

Tools, instruments & software

- On-site utility meters
- Light meter (e.g., Extech)
- Kill A Watt plug load meter
- HOBO TRH dataloggers
- Energy Star Portfolio Manager

See individual course documents for application of instruments to courses.

Pedagogy

Problem-based learning

Problem-based learning (PBL) is a learner-centered pedagogy in which students explore a subject in the context of complex, multifaceted, and realistic problems. The goals of PBL are to help the students develop flexible knowledge, effective problem-solving skills, self-directed learning, effective collaboration skills and intrinsic motivation.

Through PBL, students:

- Become immersed in open-ended scenarios simulating real-life work situations
- Work in groups, identify what they already know, what they need to know, and how and where to access new information that may lead to resolution of the problem
- Explore a problem or scenario that is presented with missing information and is open-ended allowing for critical thinking and analysis, thus generating a range of solutions that have not been suggested before
- Determine if the problem suggested is the real problem or whether there is a different problem that needs to be solved

Many PBL scenarios used in Sustainable Facilities Operations courses were performed outside of the classroom to enhance real-world learning opportunities. However, the Commissioning class completed functional performance testing on the geothermal system and the rooftop of the ECAM labs.

PBL-Living Lab learning strategies beyond the classroom

- The Energy Auditing class did 2-6 energy audits in the community each year. A sample of buildings includes:
    - Two office buildings occupied by engineering firms
    - Truck terminal
    - Restoration contractor headquarters
    - 4 or 5 churches, most with schools and other buildings
    - MATC South Campus ECAM addition
    - A Milwaukee high school and a K-12 school
    - A firehouse
- The Energy Modeling course created some ASSET Score models of buildings that were part of the Better Buildings Challenge for the City of Milwaukee.

Appendix A – Industry Survey Instrument

SURVEY conducted by Milwaukee Area Technical College for a Sustainable Facilities Operations Associate Degree program

Milwaukee Area Technical College is exploring community interest for an **associate degree program in Sustainable Facilities Operations.** Please help us by completing this questionnaire regarding your organization's hiring practices and future hiring needs. The course offerings will be determined by your suggestions along with research on similar programs offered elsewhere. If you would like to speak with a representative from MATC regarding this survey, please contact Prof. Ted Wilinski at 414-571-4570 or by e-mail wilinskt@matc.edu.

Overview — Sustainable Facilities Operations is designed to help prepare students to efficiently and effectively manage and operate the total facility. The material covered will benefit students who are practicing as or wanting to become an energy manager, facilities manager, operations and maintenance manager, energy auditor, maintenance supervisor, superintendent of buildings and grounds, building manager, plant manager, maintenance manager, maintenance director, operations manager, LEED AP, commissioning authority, or energy technician. Emphasis is placed on cost-effective energy options, direct digital controls, energy management systems, sustainable operations management, maintenance management, commissioning, LEED certification and project management. Additional attention is placed on saving operations and maintenance dollars by introducing developments in the energy industry, contracting options for services and best practices in efficient and effective operations and maintenance. Monitoring, control, reporting and presenting sustainability performance is given full treatment. Supervision, management and training of building service employees are also covered. Traditional aspects of operations management will be covered as well such as Six Sigma and Lean.

Please select the most appropriate response and fax back to MATC at 414-571-4746

1) Do you currently employ individuals to perform facilities/energy related duties?
   _____ No, but we plan to add this position in the future. (If "No", go to Question 3)
   _____ No, and we have no plans to create such positions. (If "No", go to Question 3)
   _____ Yes. (Go to Question 2.)

2) Please list the job titles your organization uses for individuals employed in entry-level facilities/energy related positions.

3) a. How many entry-level facilities or energy related positions exist in your company? Check one box in each row or enter N/A.

1	2-3	4-6	7+	
				Full-time (35 or more hrs/wk)
				Part-time (under 35 hrs/wk)

   b. What training has your typical entry-level facilities or energy related personnel attained?
   _____ No post high school training
   _____ 1-year technical diploma
   _____ 2-year associate degree
   _____ 4-year bachelor's degree

4) During the ***past three years***, how has the number of facilities or energy related positions changed at your company? Check box as appropriate.

Full-time positions:	0	1	2-3	4-6	7+		**Part-time positions:**	0	1	2-3	4-6	7+
Increased by							Increased by					
Decreased by							Decreased by					

5) **Employment change**:

If you experienced a change in the number of positions, please indicate the reasons.

Technological changes	_____	Labor costs	_____
Licensing/certification	_____	Business growth	_____
Decrease in business	_____	Staff retirements	_____
Economic environment	_____	Staff turnover	_____

Other reasons:

6) During the ***next three years***, how do you expect the number of facilities or energy related positions will change at your company?

Full-time positions:			**Part-time positions:**	
No change			No change	
Increase			Increase	
Decrease			Decrease	

7) If you expect a change **during the next three years**, what factors will most influence this change?

Technological changes	_____	Labor costs	_____
Licensing/certification	_____	Business growth	_____
Decrease in business	_____	Staff retirements	_____
Economic environment	_____	Staff turnover	_____

Other reasons:

8) **During the next three years**, how many entry-level facilities or energy related positions do you expect to **hire**?

	2006			2007			2008		
Replacements of existing positions	1-2	3-4	5+	1-2	3-4	5+	1-2	3-4	5+
Full-time (35 or more hrs/wk)									
Part-time (under 35 hrs/wk)									
New positions	1-2	3-4	5+	1-2	3-4	5+	1-2	3-4	5+
Full-time (35 or more hrs/wk)									
Part-time (under 35 hrs/wk)									

9) Please indicate the typical starting hourly wage for an entry level facilities/energy operations technician at your place of work?

	Less than $14.00	$14.00	$15.00	$16.00	$17.00	$18.00	$19.00 +
Full-time:							
Part-time							

10) Do you think that entry-level facilities/energy related positions currently employed in your establishment have adequate educational preparation for the duties they are performing?

_____ Yes

_____ No
_____ Unsure

11) Hire Graduates:
Would you be willing to hire a graduate who has successfully completed an associate degree in Sustainable Facilities Operations? _____ Yes _____ No

Comment:

12) No Related Experience:
Would you hire a graduate of a Sustainable Facilities Operations program who had no related paid work experience? _____ Yes _____ No

Why or why not?

13) Do you have employees that would be interested in completing an associate degree in Sustainable Facilities Operations if it were available part- time?

_____ yes _____ no _____ unsure

If **yes**, check all choices that they would be most interested in

evenings	weekends	Internet (online)

14) Please make any <u>additional</u> <u>comments</u> to assist us in determining whether there is a need for an associate degree in Sustainable Facilities Operations.

15) Please select the category that best describes your organization.

	Retail & Services		Insurance
	Automotive		Real Estate
	Manufacturing		Health care
	Transportation		Residential Property Management
	Energy Services Provider		Non profit/public
	Government		Education
	Financial/banking		Other

16) Please indicate the number of permanent full- and part-time employees in your organization located in the Milwaukee region.

_____ Less than 50 employees

_____
_____ 51 to 200 employees
_____ 201 – 999 employees
_____ 1000+ employees

17) MATC is considering a unique associate degree design which offers core courses in Sustainable Facilities Management followed by field energy courses which prepare graduates to work in a certain kind of business or have a specialized area of study such as photovoltaic, geothermal, solar thermal and wind installation, maintenance and operations. What specialized area(s) would you suggest?

Comments/suggestions:	

18) Would you or someone in your organization be willing to assist MATC in keeping current in your field by serving on a program advisory committee or ad hoc program design committee?

_____ Yes (please enter contact information below)
_____ No
_____ Not sure

Name: _____
Title: _____
Company: _____
Address: _____
Email: _____
Phone: _____

Thank you for taking the time to complete this survey. Please submit in the enclosed envelope.

Appendix B – Industry DACUM participants

Attendees

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Appendix C – DACUM for Sustainable Facilities Operations

Sustainable Facilities Operations

DUTIES	TASKS												
A. Manage Personnel	Recruit Staff	Hire staff	Review Pay scales	Provide Training and education	Mentor staff	Motivate staff	Assign task to staff	Build Teams	Evaluate staff	Discipline Personnel			
B. Manage Resources	Monitor energy usage	Track energy usage	Measure Waste streams	Record Waste Streams	Promote advanced recycling	Conduct Energy Audits	Conduct Sustainability Audits	Transform waste to products	Implement sustainability practices				
C. Implement Sustainable Maintenance	Create equipment inventory	Establish service intervals	Create procedures manuals	Analyze building performance data	Analyze equipment vibrations	Analyze fluids	Scan systems (thermography infra red)	Perform scheduled service	Schedule preventive maintenance for all mechanical equipment	Establish service request protocols	Perform Demand maintenance	Maintain grounds	Establish effective cleaning system
D. Analyze Systems	Evaluate current and future space needs	Measure energy use	Track energy use	Plan building upgrades and replacements	Measure performance against goals	Establish sustainability goals							
E. Develop Information Flow	Write reports (summary of work)	Communicate with staff	Develop programming and informational materials	Document activities	Write Measurement &Verification reports	Deliver information orally	Solicit feed back	Write sustainability articles					
F. Administer Budgets	Seek funding sources	Provide cost estimates	Determine return on investment	Determine payback periods	Determine internal rate of return	Determine net present value	Balance funds	Apply triple bottom line concepts Energy Environment Financial					
G. Process Logistics	Establish daily task priorities	Schedule personnel	Schedule activities	Schedule materials	Select vendors	Negotiate contracts	Review proposals	Adhere to purchasing protocols					

BEST Center Curricula, Resources & Recordings

Academic Programs
Georgia Piedmont Technical College - Building Automation Systems
Milwaukee Area Technical College - Sustainable Facilities Operations
Laney College - Commercial HVAC Systems
City College San Francisco - Commercial Building Energy Analysis & Audits

Professional Development Materials, Presentations & Videos
National Institutes
Building Automation Systems Instructor Workshops
Webinars (e.g., BEST Talks)

Faculty Profile Videos
Reports & Case Studies
Marketing Resources

BEST
Building Efficiency for a Sustainable Tomorrow

NSF National Science Foundation