AC 2011-2514: DEVELOPMENT OF GREEN TECHNOLOGY CURRICULUM

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Development of Green Technology Curriculum

Abstract

This paper will discuss the development of a training program for area professionals and a BS degree in Sustainable Energy Systems Management at Southeast Missouri State University (Southeast). The curriculum is designed to serve as a career pathway toward developing a future workforce in green energy technologies. The process involved the assessment of needs of the region, selection of advisory board members, identification of core competencies, development of course and lab curricula, development of training modules for business and industry professionals, and purchase of necessary equipment. The green technology skills that were targeted were energy efficiency and management, planning and design of sustainable facilities, sustainable and green construction, sustainable and green manufacturing, and renewable energy sources such as biomass, solar power, and wind energy technologies.

The curriculum development effort was partially funded by a grant exceeding $200,000 from the Workforce Innovation in Regional Economic Development (WIRED), a Department of Labor (DOL) agency. Per the requirements of the grant, the curriculum development also involved collaboration with two community colleges in the region. The degree program was designed in a way so that students completing a certificate and/or Associate of Applied Science (AAS) degree at the two colleges could seamlessly matriculate to the BS Technology degree.

The target audiences for the proposed program are students from the region who wish to pursue the 4-year BS degree, students who already completed the 2-year program at one of the community colleges identified as partners in this effort, and business and industrial personnel seeking training programs to immediately impact the regional economy.

All curricula were modeled around the body of knowledge for certification programs through agencies such as US Department of Energy, Society of Manufacturing Engineers, Association of Energy Engineers, National Association of Home Builder's National Green Building Program, and US Green Building Council.

Introduction

Recently, there has been an intense, global focus on the rising costs of non-renewable energy sources and the negative impacts that our societies have on the global environment. There are many reasons for this increased focus. As fuel costs rise, newer technologies are driving down the costs of many of the more expensive renewable sources. These two factors are combining to make the renewable sources economically feasible for many. Furthermore, with the current economic and military situations, there is a renewed understanding that increased use of some non-renewable fuels is increasing national trade deficits and supporting undesired entities. Finally, scientific evidence continues to accumulate that shows climate change, including sea

level rise, global temperature rise, warming oceans, shrinking ice sheets, declining arctic sea ice, glacial retreat, extreme events, and ocean acidification.[1] To many, these reasons signal that significant changes to the status quo are imminent.

While these issues present challenges to our current way of life, they also provide a new outlook on the world and opportunities for careers and product development. Where there are challenges, there are also opportunities. The goal of this project was to train the next generation of workers to address these challenges. While jobs in the green economy were once rare, that is quickly changing. Relatively few years ago there was no such thing as green building certifications, carbon cap and trading programs, and SMART grid technologies. It is becoming increasingly clear that these programs will have a significant impact on our future. In 2005, the green industry was about $265 billion and 1.6 million employees had green jobs.[2] It is expected that these numbers will grow about 5% per year. Often, these jobs are in the trades and engineering. Workers are needed who can design and build green buildings, design renewable energy systems, install and maintain solar panels and windmills, and make processes more efficient.

For these reasons, a technology department is a perfect fit for going green. In many ways, being green is synonymous with being efficient. As Kurt Kuehn (CFO of UPS) said in a recent speech, industrial technicians are charged with making processes as efficient as possible to save time and money. To be green, we expand on this principle. We expand the focus so that everything that has a harmful impact is used as efficiently as possible. In short, we do more with less. We expand the goal by also caring about our planet. Beyond that, Kuehn saw distinct advantages with sustainability from an economic perspective: it cut costs, mitigates risks, opens up new competitive and revenue opportunities, drives innovation, and improves employee development and retention.[3] While green jobs exist, formal training opportunities in green technologies are not widespread. Several universities offer classes and programs dealing with high-level design of green technologies. Moreover, an increasing number of community colleges are offering programs to train installers. The goal of this project was to fill the gap between these extremes by training technicians to use off-the-shelf tools, technologies, and methods to design green buildings, processes, and systems.

More specifically, this paper is based on developing an educational program and certification-based training modules in green energy technologies relevant to the 14-county region served by Workforce Innovation in Regional Economic Development (WIRED) – Southeast Missouri region. The green energy technology skills identified to meet the needs of the region are energy efficiency and management, sustainable facilities planning and design, sustainable green construction, sustainable and green manufacturing, and renewable energy sources such as biomass, biofuels, solar power, and wind energy technologies. In order to build and sustain a green economy in a region, training opportunities such as those presented here are required to develop a workforce skilled in these areas. This program fits nicely into our technology department because it incorporates many of same skills required of our existing industrial, mechanical, and electrical technology programs.

Literature review

Needs assessment

The first step in creating our curriculum was to determine which topics of green technology would be present. Green technology covers a large number of topics over numerous specialty areas. Covering all of these topics would be both counterproductive and infeasible. To determine the specific topics we had to determine what made the most sense for our particular geographic location, what would fit in with our particular specialties, and what would attract students into the program. A starting point for customizing the curriculum for our region was to examine the Missouri Green Jobs Report (MGJR)[4]. Included in the information found included the chart shown in Figure 1. The three industrial sectors with the largest share of green jobs in Missouri coordinated extremely well with our existing programs and expertise: green building, green energy production, and green manufacturing. Therefore, we narrowed our focus to these particular topics.

Green Industry Sector	Total Green Jobs 2008	Percent Share of Total Green Jobs
Total Green Jobs	**131,103**	**100.0%**
Green Building	68,293	52.1%
Green Energy Production	25,608	19.5%
Green Manufacturing	16,777	12.8%
Green Public Admininistration	10,010	7.6%
Green Salvage / Remediation	5,995	4.6%
Green Farming	4,419	3.4%

Source: Missouri Economic Research and Information Center

Figure 1: Percentage Share of Green Jobs in Missouri by Industrial Sector[5]

The green building aspect of our curriculum corresponded strongly with our existing construction management program. Upon consultations with professionals in the area, it was determined that our program should familiarize students with LEED (Leadership in Energy and Environmental Design) certification[6]. LEED is a third-party group that certifies a wide variety of buildings as green. Their certification focuses on "energy savings, water efficiency, CO_2 emissions reduction, improved indoor environmental quality, and stewardship of resources and sensitivity to their impacts." While the LEED certification is primarily for green building, the topics it includes also overlap with our other two areas: green energy production and green manufacturing.

For energy production, the MGJR determined that the renewable energy sources in our state with the most potential are biomass, hydroelectric, solar, and wind. Our consultations with regional experts agreed, but placed lower emphasis on hydroelectric. From our state's Division of Energy[7] and an analysis of our area, we determined that energy topics would include the growing of Biofuel sources (animal, wood, and other waste, corn, sorghum, etc.), generation of biodiesel and ethanol fuels, solar thermal systems, photovoltaic systems, wind turbines, and other

renewable electricity sources. In addition, topics on energy regulations and Smart Grid technologies were also included.

Existing curriculum review

One of the steps in developing the curriculum was to assess the availability of educational and training programs available to students in Southeast Missouri. It was found that only few institutes were offering courses and/or training programs that were related to the energy efficiency and renewable energy fields[8]. Since Southeast Missouri State University (Southeast) is the only four-year institution in Southeast Missouri, it was obvious that the students did not have too many choices while looking for a degree/certificate in energy efficiency and renewable energy technologies. In fact, none of the four-year institution in the state offered a degree in these fields. With an increasing demand of trained professionals in this field, the Industrial and Engineering Technology (IET) Department at Southeast Missouri State University developed the proposed curriculum.

Some of the other programs that were reviewed were from Vancouver Island University[9], Seneca College of Applied Arts and Technology[10], Boston University[11], Cincinnati State Technical and Community College[12], and the study presented by Crabtree et al.[13]

Curriculum development process

Project Description

This project had three primary objectives in developing the curriculum for green energy technology education:

1. Develop a BS Technology degree in Sustainable Energy Systems Management at Southeast Missouri State University. This degree shall serve as a career pathway toward developing a future workforce in green energy technologies. This degree is designed so that the students completing a certificate and/or Associate of Applied Science (AAS) degree at Three River Community College (TRCC) or Mineral Area College (MAC) could seamlessly matriculate to the BS Technology degree.
2. Develop and deliver certification based training modules to train industry and business personnel in green energy technologies relevant and applicable to the Southeast Missouri region. The training modules would offer practitioners practical concepts for implementation of energy efficient and environmentally sound green practices.
3. Provide awareness and education to all groups involved in “greening” Southeast Missouri so that they know about energy efficiency and conservation, sustainability of their systems and operations, protection of the environment and the values associated with these.

The green energy technology skills targeted to meet the above objectives are energy efficiency and management, sustainable facilities planning and design, sustainable green construction, sustainable and green manufacturing, and renewable energy sources such as biomass, biofuels, solar power, and wind energy technologies. These components were selected because they

represent the green technologies with the highest potential impact in the 14-county region served by WIRED. Development of a workforce skilled in these areas is essential toward sustaining a green economy in this region.

The first objective focused on preparing the future green workforce of Southeast Missouri. This was accomplished by creating a career pathway that would enable students to obtain a college degree related to the green energy technologies mentioned above. A BS Technology degree with specialization in Sustainable Energy Systems Management was developed at Southeast Missouri State University. This degree was designed to provide students a sound fundamental background in mathematics, basic sciences, technology, and engineering fundamentals and expertise in system analysis, design and implementation of green energy technologies. The sample plan of study is provided in Appendix A. This degree complements the green energy programs at two partner community colleges in the region. A plan was presented whereby students completing a certificate and/or an AAS degree at one of the community colleges could seamlessly matriculate to the 4-yr BS Technology degree program at Southeast.

The second objective in this project targeted individuals in business and industrial enterprises with immediate impact on the green initiatives in Southeast Missouri region. This group typically is interested in learning practical concepts of energy efficient and environmentally sound green practices. For this target audience, Southeast developed certification based training modules targeting the green energy technologies mentioned above. The development of these training modules significantly increases the accessibility to green training/workshop opportunities in the region. It significantly reduces the cost of training personnel and allows the training to be conducted locally in the 14-county region served by WIRED. Businesses and industries seeking training would not have to travel very far and be away from workplace for extended periods of time. Also, the training modules address the specific needs in the Southeast Missouri region, as opposed to training material developed to cater for a general audience.

Curriculum for both the BS Technology degree and for the training modules address the body of knowledge leading to industry recognized certifications. All curriculums related to energy efficiency/conservation for industrial and commercial systems and processes were modeled around the body of knowledge from US Department of Energy's (DOE) Qualified Specialist Certifications (Steam Tool, PHAST, and AIRMaster+), Society of Manufacturing Engineers certification (Green Specialist Certificate) and Association of Energy Engineers (AEE) Certifications (Certified Lighting Efficiency Professional (CLEP), Certified Energy Auditor (CEA), and Certified Sustainable Development Professional (CSDP)). Curriculum related to sustainable facilities and green construction practices include body of knowledge from the National Green Building Standard (ANSI-ICC-700) and National Association of Home Builder's National Green Building Program, LEED-H, Energy Star, and Energy Star-IAP. Short-term certification would include the above plus training for Building and Code Officials to gain knowledge for certification under ICC's forthcoming "Building Officials Green Certification Program." This would present a comprehensive learning opportunity in the residential & light commercial green construction process and details green building techniques. Completers of the training will have the ability to obtain Certification under NAHB's National Certified Green Professional (CGP) and have an understanding of LEED-H. Stand-alone courses based on these

training modules were developed and embedded into the proposed BS Technology degree program.

The third objective of this project was to develop a society and an industrial base that will develop an understanding of and values associated with implementing technologies to increase energy efficiency and conservation, development of systems and processes that are sustainable, reduces waste, and are friendly to the environment. For this purpose, some of the instrumentation purchased using the WIRED grant allowed the trainees to gain experience with setup, assembly, and configuration of systems related to energy and renewable systems. The success of this project will be measured in terms of number of students entering the green career pathway pipeline, employer satisfaction and preparedness of graduates to transition into the green workforce of Southeast Missouri after completion of their academic program. The other measures of success will include the number of industry/business personnel who will subscribe to and use the certification based training modules, number of workshop attendees who obtain the industry recognized certification(s) and a follow-up conducted for all attendees of the trainings to obtain green technology measures implemented within their respective organizations. Personnel involved in this project included six faculty members and two consultants who are content area experts. The role of the faculty member was to work with the two consultants to develop certification based training modules, develop courses and laboratories and work toward becoming certified in area/s of their teaching expertise.

Partnerships and Collaborators

Southeast collaborated with TRCC and MAC to establish a career pathway that will allow students to seamlessly matriculate from a certificate and/or an AAS degree to the BS Technology degree at Southeast. The transfer articulation established between Southeast and these institutions was used for the same. Students completing programs at these institutions could transfer to Southeast using one of two models that we have available. Using the first model, students completing an AAS degree at a community college will directly matriculate to the BS degree using the course-by-course transfer articulation model (Appendix B and C). Students who do not have an AAS degree but have completed a certificate and/or with documented work experience in a related or complementary field, could matriculate to the BS degree using the portfolio option (Appendix D).

Other collaborators on the project is an an experienced energy auditor who has performed well over 250 industrial energy assessments in US and China. He heads the Industrial Assessment Center for the state of West Virginia and conducts energy audits on a regular basis for US DOE's Save Energy Now (SEN) program. While he has expertise in a variety of areas, his specific expertise is in compressed air and process heating systems, which are two of the highest energy consuming processes within facilities in Missouri. The consultant for sustainable facilities design and green construction practices is an experienced builder/developer and nationally recognized consultant and author on the business of green building and development. He has been actively involved in building energy efficient and sustainable green homes including light commercial facilities using low impact, ecologically friendly materials and technologies. He has lent his expertise to Home Builders Association (HBA) in training and developing green building programs. He is also a partner in the US DOE Building America Program and its new Builder's

Challenge Program where homes demonstrate construction that is at least 30% above International Energy Conservation Codes.

Other collaborators on this project include an Industrial Advisory Group which was developed for continued sustainability and vitality of this project. Southeast established a "**Sustainable & Green Energy Advisory Group"** with focus areas in "Sustainable Facilities Design and Green Construction," "Energy Efficiency and Management," and "Sustainable Energy Systems." This group will periodically meet to assess, validate, and ensure that our program is meeting the needs of various green enterprises in the region. They will also periodically review and assess the educational objectives and outcomes of the proposed BS Technology program to ensure that graduates area prepared with skills to effectively contribute to Southeast Missouri's green economy and have the ability to evolve and adapt to changes related to the same. This would include activities such as reviewing program outcomes and formulating recommendations for improving the curriculum, laboratories, equipment, and other program resources. This group will also provide assistance in identifying learning opportunities to enhance experience of students and faculty in the program. In forming this "**Sustainable & Green Energy Advisory Group,"** IET at Southeast solicited participation from different groups including people from the Southeast Missouri Regional Training Groups, Utility companies and Electric Co-Op's, regional business and industries, community colleges, and members of the community.

Target Audience for Project

The first target audiences for our project are students from the Southeast Missouri region who wish to pursue the 4-year Bachelor of Science Technology degree with specialization in Sustainable Energy Systems Management at Southeast. This group also includes students completing an AAS degree or certificate related to Green Energy Technologies at TRCC and MAC. Students completing an AAS degree will be automatically awarded 34 credit hours for their technical coursework plus additional credits for applicable general education courses completed at these institutions. Credit also will be given for coursework at TRCC/MAC that are equivalent to course(s) offered at Southeast. Students may transfer as many as 65 credit hours (possibly more depending on coursework completed) to the BS Technology program at Southeast. Students who do not complete an AAS degree, but complete a certificate also could matriculate to the 4-year BS Technology program. Using the "portfolio" option, these students have to document two years of related work experience to obtain up to 34 hours of technical credits. Recognized national certifications are highly encouraged for these students. The IET faculty at Southeast will evaluate each student portfolio to determine if the applicant has obtained a level of technical competence equivalent to all or part of an Associate of Applied Science degree.

The next target audiences are business and industrial enterprises with immediate impact on green initiatives in the Southeast Missouri region. This group typically is interested in learning how to implement green technologies and increase energy efficiency while increasing the sustainability of their systems and operations. For this target audience, we developed certification based training modules related to energy efficiency for industrial and commercial systems and processes and the other for sustainable facilities design and green construction practices. These modules combine classroom style learning supplemented by laboratory activities using

equipment they typically will encounter in green systems and applications. Individuals targeted for energy efficiency include facility managers or energy managers of various enterprises who wish to learn how to manage energy usage and/or how to invest in energy efficiency to reduce energy costs and carbon footprint of their organizations. Individuals seeking technical skills to become industrial and/or commercial building energy auditors could benefit from these training modules. For sustainable facilities design and green construction, we will target the construction sector, including residential and commercial contractors, construction workers, construction materials suppliers, building permit and code officials, and residential and commercial building contractors.

Figure 2 shows a career pathway for Green Technology Workforce for our target audience.

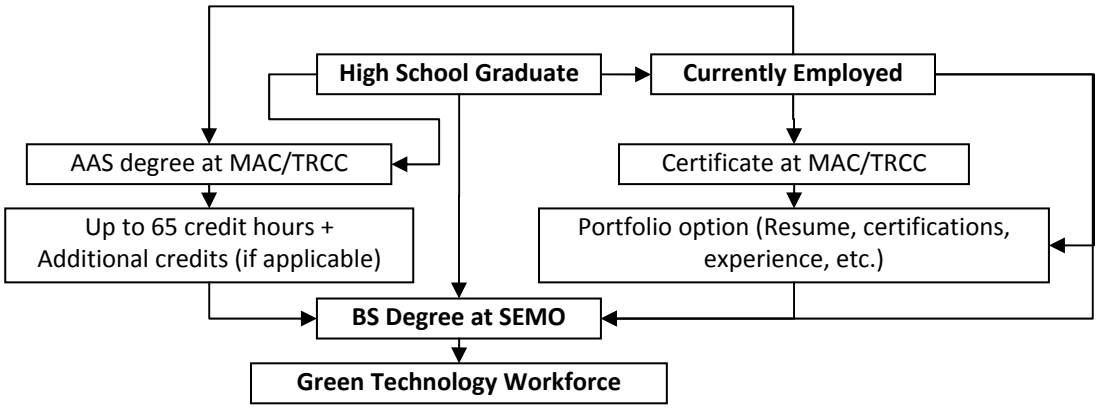

Figure 2: Sample Career Pathways

Projected Short and Long-Term Impact of Project

Besides preparing the next generation of green technology specialists, benefits of this project to the Southeast Missouri region is that it provides a framework under which industries and businesses can use resources efficiently, create efficient infrastructures, protect and enhance quality of life, and create new businesses to strengthen regional economy. Awareness, education on energy and the environment, and workforce development is critical toward achieving this goal. To put this in perspective, information obtained from US Department of Energy[14] and US Smart Communities Network[15] show that currently there are no resources available for higher education opportunities in energy, particularly those concerning energy efficiency, conservation, and renewable energy in the state of Missouri.

The latest report published by the Energy Information Administration (EIA)[16], the state of Missouri ranks 17th in terms of electricity and 25th in terms of natural gas consumption. It should also be noted that during 1980-2007, the average annual increase in the total energy consumption was 1.0% while the average annual increase in Missouri population was only 0.6%[17].

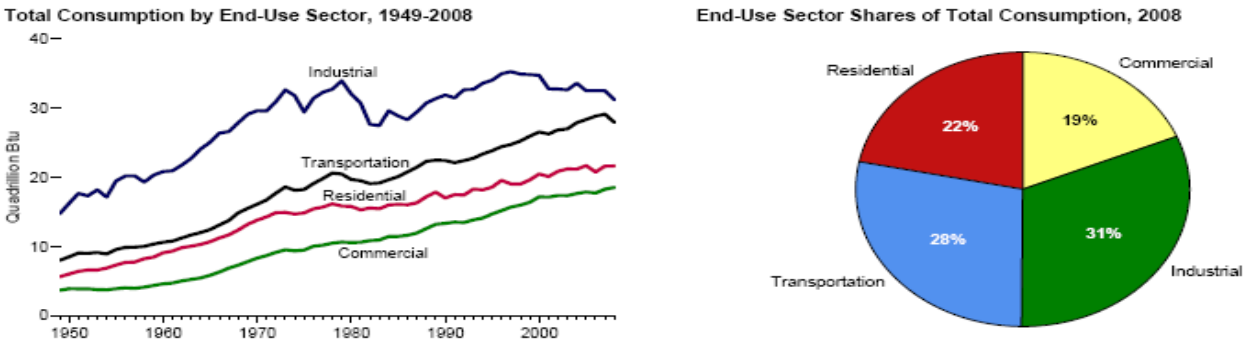

Figure 3: Summary of energy consumption in the United States[18]

Establishing a sustainable energy strategy, availability of career pathways, and developing resources in higher education on sustainability, efficiency, and conservation is essential to the economic development of the Southeast Missouri region. The proposed curriculum specifically addressed the establishment of a career pathway and development of resources required for higher education needs of the region. Towards meeting these, the projected short and long term impact of this project to the Southeast Missouri region are as follows:

Short Term Impact of Project

1. Creation of an intellectual and practice based energy systems degree program by providing theoretical knowledge in the classroom, experimental design in the laboratory, and hands-on experience in the field.
2. Establishment of a career pathway that will allow students completing "green technology" programs at area community colleges (TRCC and MAC) to seamlessly transfer to the 4-yr BS degree program at Southeast.
3. Graduate about sixty students within the next five years from the BS Technology degree with specialization in Sustainable Energy Systems Management.
4. Establish area community colleges (i.e. TRCC and MAC) and Southeast as resources for higher education opportunities in green energy technologies.
5. The certification based training modules developed through this project will make education and training more accessible and cost effective for business and industrial enterprises in the region.
6. Train approximately 100 business/industry personnel on energy efficiency, sustainable facilities design, and green construction per year.

Long Term Impact of Project

1. Create a sustainable stream of graduates through the TRCC, MAC, and Southeast career pathway pipeline and overcome green workforce shortage in the Southeast Missouri region.
2. Industries and businesses will implement technologies to increase energy efficiency and conservation awareness, reduce waste, increase sustainability of their systems and operations, and protect the environment by reducing CO_2, NO_X, and other waste.

Sustainability

The non-recurring costs associated with this project were one time equipment and software purchases (Appendix E), faculty salary for curriculum, laboratory, and training module development, certification workshop registration costs for faculty, and for consultant costs. All costs associated with continuation of this project such as maintenance of curriculum, maintenance equipment and other related infrastructure shall be assumed by annual fund of IET at Southeast, including funding professional development activities to keep faculty certifications and expertise current.

The major expense associated with the implementation of this project was in equipping the laboratories with appropriate hardware/software to supplement classroom lectures with "hands-on" activities. This was a one-time non-recurring cost and is good through the useful life of the equipment. All costs associated with equipment installation (plumbing and electric) and maintenance of equipment shall be the responsibility of IET.

We expect all certification based training modules will have at least a 3 year "shelf-life." After this time, we will utilize our faculty expertise to periodically review and update the content of the training materials and the course materials.

Activities to support student senior capstone projects will not incur any additional costs as these are activities that IET engages in during every Fall and Spring semesters. Industries do not charge a fee for sponsoring capstone projects or charge for hosting a team of students on-site for an entire semester. The University has been doing this for more than 20 years and this has been a very successful program.

Industrial Advisory Committee meetings are part of the department's regular annual activity and are funded through the departmental budget. No additional costs will be incurred to continue this activity.

Funding for the Project

Southeast Missouri State University received over $210,000 from WIRED to partially fund non-recurring costs in developing the curriculum and training modules. The funding categories include instructor salaries for curriculum development, funds for professional development for faculty members to attend workshops/training, laboratory equipment, and costs for hiring of two consultants. Part of the cost was provided as matching fund from Southeast Missouri State University, United States Department of Energy, Missouri Department of Natural Resources, and AmerenUE in terms of real funds and in-kind cost share. The total cost for the project was over $300,000.

Survey Results

Survey questions were developed to access the impact of training modules and results are shown in Table 1 and 2.

Table 1: Industrial Energy Efficiency Workshop – Day 1

Questions	Average out of possible 5 points
Overall quality of the workshop	4.43
Quality of following sessions:	N/A
Energy systems, improvement opportunities, and economics	4.57
Case studies	4.43
Missouri DNR (MODNR) – Introduction to energize Missouri industrial program	3.86
AmerenUE – Introduction and funding opportunities	4.43
I intend to apply at least one of the discussed energy efficiency principles at my workplace	4.29
The workshop was organized in a convenient location	4.43
The workshop material/handouts were relevant	5.00

Comments:

- Very value added information. Enjoyed MODNR and AmerenUE presentations
- Enjoyed hearing from an expert from outside the area. Dr. Gopala's projects were interesting. MODNR & Ameren were good ideas, will check if there are any possibilities for projects before deadline of MODNR. Would recommend having a resource like them again.
- Very well set-up & executed. Very informative. I was interested in the case studies! I liked being introduced to the equipment to use to check usage! Perhaps some actual hands on workshops – actual metering etc. would be beneficial. *Possible topic: How to do an energy audit of your site: step by step details, where to start, etc. Not as general as this class as it was an overview.
- Good workshop – would have been better if presented much earlier than the proposal deadline of MODNR. I was disappointed with the number of people in attendance – more people should have attended.
- Good workshop.
- Since I am a student, I can't apply these principles but the information will be valuable for the future.
- This workshop was very knowledgeable and very helpful in save my company money. Also I think we will be in better thought with all our employees as to upgrading our plant with the low cost.

Table 2: Industrial Energy Efficiency Workshop – Day 2

Questions	Average out of possible 5 points
Overall quality of the workshop	4.80
Quality of following sessions:	N/A
Compressed air system assessment	4.80
Motors and pumps system assessment	4.80
Lighting system assessment	4.40
Process heating and steam system assessment	4.80
Heating ventilation and air conditioning (HVAC) systems	4.40
DOE BestPractices software tools	4.80
Problem Session	4.60
I intend to apply at least one of the discussed energy efficiency principles at my workplace	4.20
The workshop was organized in a convenient location	5.00
The workshop material/handouts were relevant	5.00

Comments:

- Excellent Seminar. Thanks.
- Good program.
- Very informative, value-added info. Will definitely utilize principles @ workplace.
- Problem solving session was an excellent way to use/practice the formulas. I will use these formulas at my work place. Please let us know when the software training dates are set.
- Please continue to let us know when any of these types of workshops are taking place. Thanks & GREAT Workshop!

Conclusion

This paper outlines a model for developing green technology curriculum at a four year institution. The key activities involved in this process were need assessment, development of internal and external sources such as advisory board to provide input on the curriculum development process, laboratory development and equipment purchase, collaboration with area community colleges, and input from consultants who are content experts. Attendees in the training courses were surveyed and their responses were found to be very positive.

Some of the roadblocks that were faced during this process were equipment purchases since the university had certain requirements in terms of purchase source and requirement for bidding in several cases. The region also needed lot of education for them to realize the importance and impact of the training programs. Companies lacked awareness about the issues related to energy to commit their employees to day long training sessions. Some workshops sometimes extended

to more than a day at a time. Compounding this issue was the economic downturn in 2009 and 2010 when businesses and industries were facing financial hardships to implement energy cost saving measures within their respective institutions. Also there is lack of information and awareness to avail the opportunities available through the Missouri State Energy Program (SEP).

Acknowledgement

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Appendix A: Sample Bachelor of Science Degree Program

BACHELOR OF SCIENCE
TECHNOLOGY MANAGEMENT MAJOR
SUSTAINABLE ENERGY SYSTEMS MANAGEMENT OPTION

CURRICULUM CHECKLIST

UNIVERSITY STUDIES (53 hours)

___UI 100 First Year Seminar	3
___Artistic Expression	3
___Literary Expression	3
___Oral Expression	3
___EN 100 English Composition	3
___Written Expression	3
___Behavioral Systems	3
___Living Systems	3
___MA 134 College Algebra (Logical Systems)	3
___PH 120/020 Introductory Physics I (Physical Systems)	5
___Development of a Major Civilization	3
___MN 220 Engineering Economic Analysis (Economic Systems)	3
___Political Systems	3
___SW 207 Understanding Cult & Soc Diversity (Social Systems)	3
___UI 3xx Interdisciplinary University Studies Course	3
___UI 3xx Interdisciplinary University Studies Course	3
___UI 410 Manufacturing Research in a Global Society (Senior Seminar)	3
___WP003 Writing Proficiency Test (to be taken after completing 75 hours)	0
___MAPP Academic Proficiency & Progress Test (to be taken after completing 90 hours)	0
___CL001 ___ CL002 ___CL003 ___CL004 Career Linkages Requirements	0

TECHNOLOGY MANAGEMENT CORE
(26 Hours, not counting 17 hours included in University Studies section)

___CH 181/081/001 Basic Principles of Chemistry or PH121/021 Introductory Physics II	5
___IM 102 Technical Communication	3
___IM 301 Industrial Safety	3
___IM 311 Statistical Process Control	3
___IM 419 Industrial Supervision	3
___IM 506 Projects in IET	3
___MA 133 Plane Trigonometry	3
___MN 260 Technical Computer Programming Applications	3

IT required courses included in University Studies section above: MA134, MN220, PH120, SW207, and UI410

SUSTAINABLE ENERGY SYSTEMS MANAGEMENT OPTION (42 Hours)

___ET 160 Basic Electricity & Electronics	3
___ET 365 Industrial Electrical Power	3
___ET 426 Sustainable Energy Technology	3
___ET 435 Photovoltaic System Analysis & Design	3
___ET 470 Energy Management – Industrial Processes	3
___FM 504 Facilities Management	3
___FM 544 Sustainable Construction Materials & Technology	3
___FM 554 Facilities Operation & Supervision	3
___FM 564 Sustainable Facility Plan & Design	3
___FM 565 Building Energy Management	3
___IM 455 Sustainable & Green Manufacturing	3
___MA139 Applied Calculus	3
___UI 360 Recycling & Waste Management	3
___UI 387 Environmental Law & Public Policy	3

Appendix B: Sample Transfer Guide 1

Bachelor of Science in Technology: Technology Management
(Facilities and Sustainable Energy Systems focus)
Department of Industrial & Engineering Technology

The Technology Management option is specifically designed for students who have earned technically-oriented accredited Associate of Applied Science (AAS) degrees OR a certificate with two years of directly related work experience. Recognized national certification/s is encouraged on the latter. Students are awarded up to 34 credit hours for their technical coursework toward the BS Technology degree Technology Management with focus on Facilities and Sustainable Energy Systems.

CURRICULUM CHECKLIST

UNIVERSITY STUDIES (53 hours)

_X_UI 100 First Year Seminar	3
___Artistic Expression	3
___Literary Expression	3
___Oral Expression	3
_X_EN 100 English Composition **(ENGL 111 from TRCC)**	3
_X_Written Expression **(ENGL 112 from TRCC)**	3
___Behavioral Systems	3
___Living Systems	3
_X_MA 134 College Algebra (Logical Systems) **(MATH 163 from TRCC)**	3
___PH 120/020 Introductory Physics I (Physical Systems)	5
___Development of a Major Civilization	3
___MN 220 Engineering Economic Analysis (Economic Systems)	3
___Political Systems	3
___SW 207 Understanding Cult & Soc Diversity(Social Systems)	3
___UI 3xx Interdisciplinary University Studies Course (UI319 recommended)	3
___UI 3xx Interdisciplinary University Studies Course	3
___UI 410 Manufacturing Research in a Global Society (Senior Seminar)	3
___WP003 Writing Proficiency Test (to be taken after completing 75 hours)	0
___MAPP Academic Proficiency & Progress Test (to be taken after completing 75 hours)	0
___CL001 ___ CL002 ___CL003 ___CL004 Career Linkages Requirements (as needed)	0

For more information on Three Rivers general education courses which meet Southeast University Studies requirements visit www.semo.edu/registrar/transfer/Three_Rivers_Community_College.htm

TECHNOLOGY CORE
(26 Hours, not counting 17 hours included in University Studies section)

_X_IM 102 Technical Communication **(ENGL 105 from TRCC)**	3
___IM 301 Industrial Safety	3
___IM 311 Statistical Process Control	3
___IM 419 Industrial Supervision	3
___IM 506 Projects in IET	3
_X_MA 133 Plane Trigonometry **(MATH 164 from TRCC)**	3
___MN 260 Technical Computer Programming Applications	3
_X_ CH181/001/081 Basic Principles of Chemistry **(CHEM 111 from TRCC)**	5

IT required courses included in University Studies section above: MA134, MN220, PH120, SW207, and UI410

TRANSFER HOURS (34 hours)

_X_ From AAS Degree OR a certificate with at least two years of related work experience. Recognized national certification encouraged on the latter* 34

*Candidates may need to provide documentation, in the form of a portfolio, for their degree or certification and experience to be considered by the department faculty for credit. An interview may also be required.

_X__MA 139 Applied Calculus **(MATH 170 from TRCC)** 3

FACILITIES AND ENERGY SYSTEMS FOCUS (21 hours)
In Consultation with Academic Advisor Select 21 hours from:

ET365 Industrial Electrical Power	3
ET455 Sustainable & Green Manufacturing	3
ET460 Biomass Energy Technologies	3
ET462 Photovoltaic System Analysis and Design	3
ET465 Energy Efficiency & Management – Commercial Facilities	3
ET470 Energy Efficiency & Management – Industrial Facilities & Processes	3
FM504 Facilities Management	3
FM554 Facilities Operation & Supervision	3
FM544 Sustainable Facilities Planning & Design	3
FM564 Sustainable Construction Material & Technologies	3
UI360 Recycling and Waste Management	3
UI387 Environmental Law and Public Policy	3

Appendix C: Sample Transfer Guide 2

Bachelor of Science in Technology: Technology Management
(Facilities and Sustainable Energy Systems focus)
Department of Industrial & Engineering Technology

The Technology Management option is specifically designed for students who have earned technically-oriented accredited Associate of Applied Science (AAS) degrees OR a certificate with two years of directly related work experience. Recognized national certification/s is encouraged on the latter. Students are awarded up to 34 credit hours for their technical coursework toward the BS Technology degree Technology Management with focus on Facilities and Sustainable Energy Systems.

CURRICULUM CHECKLIST

UNIVERSITY STUDIES (53 hours)

_X_UI 100 First Year Seminar	3
___Artistic Expression	3
___Literary Expression	3
___Oral Expression	3
_X_EN 100 English Composition **(ENG-133 from MAC)**	3
_X_Written Expression **(ENG-134 from MAC)**	3
___Behavioral Systems	3
___Living Systems	3
_X_MA 134 College Algebra (Logical Systems) **(MAT123 from MAC)**	3
_X_PH 120/020 Introductory Physics I (Physical Systems) **(PHS130 from MAC)**	5
___Development of a Major Civilization	3
___MN 220 Engineering Economic Analysis (Economic Systems)	3
___Political Systems	3
___SW 207 Understanding Cult & Soc Diversity(Social Systems)	3
___UI 3xx Interdisciplinary University Studies Course (UI319 recommended)	3
___UI 3xx Interdisciplinary University Studies Course	3
___UI 410 Manufacturing Research in a Global Society (Senior Seminar)	3
___WP003 Writing Proficiency Test (to be taken after completing 75 hours)	0
___MAPP Academic Proficiency & Progress Test (to be taken after completing 75 hours)	0
___CL001 ___CL002 ___CL003 ___CL004 Career Linkages Requirements (as needed)	0

For more information on Mineral Area general education courses which meet Southeast University Studies requirements visit www.semo.edu/registrar/transfer/mineral_area_college.htm

INDUSTRIAL TECHNOLOGY CORE
(26 Hours, not counting 17 hours included in University Studies section)

_X_IM 102 Technical Communication **(TEC-104 from MAC)**	3
___IM 301 Industrial Safety	3
___IM 311 Statistical Process Control	3
___IM 419 Industrial Supervision	3
___IM 506 Projects in IET	3
_X_MA 133 Plane Trigonometry **(MAT133 or MAT134 from MAC)**	3
___MN 260 Technical Computer Programming Applications	3
_X_ CH181/001/081 Basic Principles of Chemistry **(PHS125 from MAC)**	5

IT required courses included in University Studies section above: MA134, MN220, PH120, SW207, and UI410

TRANSFER HOURS (34 hours)

_X_ From AAS Degree OR a certificate with at least two years of related work experience. Recognized national certification encouraged on the latter* 34

*Candidates may need to provide documentation, in the form of a portfolio, for their degree or certification and experience to be considered by the department faculty for credit. An interview may also be required.

_X__MA 139 Applied Calculus **(MAT 160 from MAC)** 3

FACILITIES AND ENERGY SYSTEMS FOCUS (21 hours)
In Consultation with Academic Advisor Select 21 hours from:

ET365	Industrial Electrical Power	3
ET455	Sustainable & Green Manufacturing	3
ET460	Biomass Energy Technologies	3
ET462	Photovoltaic System Analysis and Design	3
ET465	Energy Efficiency & Management – Commercial Facilities	3
ET470	Energy Efficiency & Management – Industrial Facilities & Processes	3
FM504	Facilities Management	3
FM554	Facilities Operation & Supervision	3
FM544	Sustainable Facilities Planning & Design	3
FM564	Sustainable Construction Material & Technologies	3
UI360	Recycling and Waste Management	3
UI387	Environmental Law and Public Policy	3

Appendix D: Sample Portfolio Option

Portfolio Content
Bachelor of Science - Technology Major
Technology Management Option

The portfolio serves as a way for potential students, with *(Option 1)* a certificate and two years of directly related work experience (a recognized national certification or exam encouraged), *or (Option 2)* technically-oriented associate degrees from an accredited or non-regionally accredited institutions to obtain up to 34 hours of technical credit toward the Bachelor of Science Degree, Technology major.

The purpose of the portfolio is for potential students to validate that their backgrounds and experiences equate to the technical competencies gained from a related Associate of Applied Science degree. The Department of Industrial and Engineering Technology faculty will evaluate each portfolio to determine if the applicant has obtained a level of technical competence equivalent to all or part of an Associate of Applied Science degree. *

The portfolio shall be submitted to the Department of Industrial and Engineering Technology and shall include:

Option 1

- A letter of application stating the reason(s) for interest in pursuing a Bachelor of Science Degree: Technology major. This letter will be used to evaluate written communication skills.
- A resume with three references, including previous employers
- Proof of current related certification or date and scores of exam
- Official transcripts from all schools attended
- Letters from previous employers, including employer address and telephone numbers for follow-up, which document related work experience and technical competence in detail Letters should include dates of employment, tasks performed, etc. Again, the purpose is to prove that the applicant has developed the same level of technical expertise as would come from the Associate of Applied Science degree,
- Certificates or documentation from all related formal training and workshops attended

Option 2

- A letter of application stating the reason(s) for interest in pursuing a Bachelor of Science Degree, Technology major. This letter will be used to evaluate written communication skills.
- A resume with three references, including previous employers
- Official transcripts from all schools attended
- A copy of school catalog showing completed program and course descriptions

For either option, the Department of Industrial and Engineering Technology faculty *may* request additional documentation and a personal interview with the applicant.

*Acceptance of the portfolio as meeting partial degree requirements is dependent upon a majority vote of the Department of Industrial and Engineering Technology faculty.

Appendix E: Sample List of Training Equipment

No.	Equipment
1	LabVolt Wind/Solar Trainer
2	Hampden H-ETS-1-CDL
3	Hampden H-ETS-1-A
4	Hampden H-ETS-1-B
5	Hampden H-ETS-1-C
6	Hampden H-ETS-1-D
7	Hampden H-ETS-1-F
8	Hampden H-ETS-1-G
9	Hampden H-ETS-1-H
10	Hampden Solar Heat System Trainer
11	IGBT Chopper/Inverter Module
12	Dynamometer
13	ArcGIS Desktop 9.3.1 (software)
14	F-Chart (for heating and PV)
15	Fluke 922 Meter Kit
16	Pressure gauges
17	Mini-Vane style CFM Thermo-Anemometer
18	Velocicalc Plus multifunction air velocity meter
19	Infrared thermometer
20	Indoor air quality analyzer
21	Ultrasonic corrosion thickness gauge
22	Strobe/Tach Kit
23	Extech 45160 3-in-1
24	Misc. Data loggers and other equipment
25	Combustion and emissions monitor
26	Fluke Ti10 Thermal Imaging Camera
27	Ultrasonic Leak Detector and Steam Trap Analyzer