ADDRESSING THE ALTERNATIVE ENERGY WORKFORCE NEEDS

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SUMMARY

Reliable and alternative energy sources are essential for the economic well being and national security of the United States of America. Recent spikes in energy prices have brought to public attention the need for a comprehensive energy strategy to ensure a sustainable supply of energy for our nation. Alternative energy sources to support our infrastructure are becoming more and more significant as we look towards the future. Establishment of the NextEnergy Center in Michigan is an important step in that direction; and to prepare technical workforce for alternative energy area would be an important milestone in taking forward our nation towards the future.

In this paper, the necessary curriculum, courses, and degree program were explored to address the alternative energy technology workforce needs. Also, various avenues with the pros and cons were explored, identified, and recommended. The project work done dealt with the design, developments, field testing, and demonstrations leading to various alternatives. A curriculum was proposed with specialization in energy technology. It would provide an educational avenue to the 2 year associate degree graduates of technical programs from community colleges. The program would capture the attention of students, faculty, and staff interested in technical education. A model syllabus is specifically suggested in collaboration with community college.

Specific goals and objectives the project were to include opinions and views of subject area experts from industry and academic institutions; identifying the over all curriculum needs of the program(s); designing and developing appropriate courses to be offered traditionally and in distance learning modes; revising existing curriculum and courses; developing laboratory experiences as an integral part of learning pedagogy; and exploring job placement and co-op work experience opportunities.

INTRODUCTION

The national security and economic well being of the United States of America very much depends on the reliable energy sources and supplies [14,16,24,30,37,41,46]. Alternative energy sources, although not economically competitive at this time with the traditional forms of energy, do continue to provide a promise of the bright future [1,2,4,5,9-13,15,20,23,25-33,41-48,50]. The 1973 oil embargo of the west by the OPEC (Oil Producing and Exporting Countries) cartel did serve as a wake up call to many nations and brought to forefront the need to achieve energy independence in the USA. Today, we are more dependent on the oil cartel than ever before because of lack of energy policy as well as the simple laws of economics.

Recent spikes in energy prices have brought to public attention the need for a comprehensive energy strategy to ensure a sustainable supply of energy for our nation. Alternative energy sources to support our infrastructure are becoming more and more significant as we look towards the future. The state government in Michigan has been pro-active in establishing the NextEnergy Center in Detroit [38]. It was organized to support research, design, manufacturing, commercialization, and education of alternative energy technologies for automotive, stationary and portable use. It is an important step to promote renewable and alternative energy and a visible forum for business, industry, and professionals.

A well prepared technical workforce in the alternative energy area should be a very significant and necessary component of our future energy agenda. It is the responsibility of universities offering professional programs to offer courses and programs to address that need [3,6,7,17-19,21,22,34-36]. At the same time, one very important challenge for the engineering and technical degree graduates is finding employment up on graduation in the field of their studies. The US Bureau of Labor Statistics data and our alumni surveys indicate practically no or very limited job growth opportunities in energy in the near future [8,39]. On top of that, there are future projections of a decline in the workforce of the utility industry, one of the primary employer in energy and power distribution arena [39]. As educators in the discipline, we have to recognize these issues and take the challenge to maintain a balance in our curricula to prepare our graduates for present as well as future trends.

The academic community should not postpone the implementation of the professional programs in alternative energy until industry would create significant number of jobs in the field. Preparation of the technical professionals requires a significant amount of lead time and delaying to launch new curricula pending existence of substantial number of jobs in industry would be too late. Practicing professionals in the area under consideration would be needed to develop new technologies and devices to implement alternative energy in the industry. This, in turn, would create jobs in the alternative energy field. As such, the curricula should be designed in such a way that they would prepare our graduates to work in industries with current technological processes as well as specific equipment closely associates with various sources of energy.

COMMUNITY COLLEGE PARTNERSHIP

The Division of Engineering Technology at WSU was established in 1973 in collaboration with local industries and community colleges to offer the upper division (junior and senior years) programs in engineering technology for the community college associate degree graduates [49]. As a result, WSU offers all six degree curricula in engineering technology as the last two years of the baccalaureate completion programs. It is a very good example of true partnership where duplication of courses is minimized and at the same time, limited financial resources of the tax-base are put to optimum utilization. In the same spirit, the alternative energy curriculum was discussed and developed.

Henry Ford Community College, an important partner, located in Dearborn convened a team of experts from DTE Energy, Utility Workers Union of America Local 223, other industries, and WSU and decided to address the technical workforce needs dealing with stationary but distributed power plant units using the fuel cells to generate electricity. At the same time, Macomb Community College, a large sister institution, organized a group of alternative energy leaders from General Motors, universities, and automotive supplier industries and made a decision to explore fuel cell applications for motor vehicles.

As both community college teams pursued their respective agendas, the issue of employment opportunities for the associate and bachelor's degree graduates became a significant stumbling block. A very important characteristic of any technical program is the ability of its graduates to find jobs. That issue provided one of the most alarming situation for all involved since there was no reliable data from any source giving the future job projections in alternative energy [38,39]. Even though both the teams pursued federal funding to develop curricula, fully developing the certificate or associate degree programs were put on hold for the future.

UNDERGRADUATE PROGRAM

In 2003, the NextEnergy Center solicited proposals for offering curricula in alternative energy discipline [38]. In response, an upper division energy technology (EGT) concentration leading to the bachelor of science in engineering technology (BSET) degree for the community college associate of applied science (AAS) graduates was developed. The same issue of job opportunities for the BS degree graduates provided warning to the WSU team developing the upper division program in energy technology (EGT). As a result, the energy technology proposed program contains very limited and slow development of energy related courses [8,33-36]. Also, the university with its restricted resources could not afford to sustain faculty diversion from the traditional courses.

Since the economic and business base of Michigan is primarily automotive and related industries, early development of courses dealing with motor vehicles were given priority. One bright moment in all the negative thinking that was taking place, the WSU Division of Engineering Technology was selected by the DTE Energy as one of the three exhibition sites for an alternative energy unit at the same time. A fuel cell miniature operating power plant was installed next to the ET building for faculty and student use in teaching and demonstration.

Specifically, following items and issues were addressed in designing the curriculum: (i) A team of experts from academia and industry was assembled to identify important components of the EGT curriculum and its impact on industry needs in the area of energy technology. In particular, the implications of alternative energy and the workforce needs of the future were addressed. (ii) Defined the BSET degree curriculum for energy technology based on the expert advice and the accreditation guidelines of the Technology Accreditation Commission of the Accreditation Board for Engineering and Technology [40]. (iii) Designed collaborative curriculum with community college partners (Henry Ford Community College and Macomb Community College) and an ideal articulation plan was devised where up to half the degree credits (freshman and sophomore years) would transfer. An example of possible transfer program with Henry Ford Community College is shown in Table 1. (iv) Created upper division courses and related laboratories for the EGT curriculum. (v) Program launch of the model BSET-EGT degree was delayed pending funding from external sources.

ENERGY TECHNOLOGY BS DEGREE CURRICULUM

It was important to design the BSET-EGT curriculum to satisfy the accreditation requirements of the Technology Accreditation Commission of the Accreditation Board for Engineering and Technology for energy technology and related programs [40]. This was a necessary step to grant credibility to the program as well as to allow students the flexibility of possible transfer to similar programs in the country. Courses contents and sequences were created to follow the rigor and pre-requisite/co-requisite based foundation blocks.

The curriculum leading to the BSET degree with energy technology (EGT) concentration is summarized as follows:

(a)	Mathematics & Science		29 credit hours
(b)	Upper Division EGT Technical Courses		42 credit hours
(c)	Lower Division Technical Courses		30 credit hours
(d)	Communication		9 credit hours
(e)	General Education		18 credit hours
		Total	128 credit hours

The total credits shown to earn the BSET degree includes up to 64 credits that students would be permitted to transfer from our collaborative community college partners. Table 1 shows an example of such a transfer plan. The upper division curriculum and courses collectively were designed to address the education needed for complex regional industrial infrastructure where electrical/electronics and mechanical/manufacturing disciplines are integral and necessary parts of a system. A more detail information about the courses (required and technical electives) for the degree program is given in the Table 2 and on the Division of Engineering Technology web site [49].

GENERAL PHILOSOPHY AND CONCERNS

Even though the emerging issue of preparing the workforce for alternative energy discipline continues to hold promise, the short term future of employing those graduates poses a difficult challenge to higher education. That is the primary reason community colleges and universities are cautious about offering such programs. Based on this philosophy, a limited number of courses focusing on the local business needs were included in this proposed specialized program. New courses proposed included the following with the aim of developing two courses every year (see Table 2):

MCT 5150	Energy Sources and Conversion
EET 6200	Control Systems for Vehicles
MCT 5210	Fuel Cell Technology
MCT 6150	Hybrid Vehicle Technology
MCT 6410	Applied Vehicle Dynamics
MIT 6510	Advanced Manufacturing Processes

For all of these areas, there exists no textbooks specifically addressing various curricula levels. For faculty willing to teach, course materials and readily available textbook remain a main challenge in the near future. The proposed curriculum was designed such that all of the courses developed for the EGT program could also serve students from six other programs wanting to broaden their knowledge base. This was necessary to sustain the new curriculum with a minimum number of new students in the EGT program during the early and formative years. Once the technical job opportunities would begin to open up in the region, the institution would have to increase efforts to serve those needs.

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CONCLUSIONS/RECOMMENDATIONS

For the energy independence of the USA, there exists a definite need for a comprehensive energy policy and the infrastructure necessary to support the energy initiatives. Opportunities do exist to write textbooks and teaching materials at associate and baccalaureate levels in the same area. Since professional schools are required to serve the business and industry needs, the lack of job opportunities in alternative energy technology discipline would continue to provide challenges for the academic community. The diehard alternative energy advocates would have to continue to remain optimistic to push the agenda and the envelope.

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Table 1. An Example of BSET Transfer Plan for Henry Ford Community College

Category (Credits)/Courses	Req Cr	Earned Credit	Transfer Cr	HFCC Course	Remaining Credit
Math/Science (29 Credits)					8 cr
CSC 1050 Intro to C & Unix	2		2	CIS 170	
MAT 1800 Elementary Functions	4		4	MAT 175	
MAT 3430 Applied Diff & Integral Calculus	4				
MAT 3450 Appl Calc & Diff Equations	4				
CHM 1020 General Chemistry	4		4	CHM 131	
PHY 2130,1 General Physics I	4		4	PHY 120/131	
PHY 2140,1 General Physics II	4		4	PHY 121/132	
Life Science	3		3	BIO/PSY 131	
EGT Technical Core (42 Credits)					39 cr
E T 3030 Statics	3				
E T 3850 Reliability & Engg Statistics	3				
E T 3870 Engg Economic Analysis	3				
EET 3010 Instrumentation	3				
EET 3500 Electrical Machines & Power	3				
EET 3720 Micro & Programmable Controllers	3				
MIT 3510 Manufacturing Processes	3		3	MET 100/110	
MCT 5150 Energy Sources and Conversion	3				
MCT 5210 Fuel Cell Technology	4				
EET/MCT Upper Division EGT Tech Elective	3				
EET/MCT Upper Division EGT Tech Elective	4				
EET/MCT Upper Division EGT Tech Elective	4				
E T 4999 Senior Project	3				
Lower Division Tech Courses (30 Credits)					0 cr
E T 2140 Computer Graphics	3			DRAF 120	
E T 2200 Engineering Materials	3			ENGR 201	
EET 2000 Electrical Principles	3			ELEC 103/195	
EET 2720 Microprocessor Fundamentals	3			ELEC 295	
Other Lower Div Tech Courses	18		30	Other LDT Courses	
Communication (9 Credits)					6 cr
Basic Composition	3		3	ENG 131	
ENG 3050 Intermediate Writing	3			ENG 132	
ENG 3060 Oral Communication	3			SPC 131	
English Proficiency Exam	0				
General Education (18 Credits)					12 cr
Critical Thinking Exam	0				
Historical Studies	3		3	HIST 111/112/113	
American Society & Institutions	3		3	POLS 131	
Social Science	3			SOC 131/BEC 133	
Foreign Culture	3			ANTH 152/SPN 231	
Visual & Performing Arts	3			ART 121/122/123	
Philosophy & Letters	3			PHIL 133/139	
Total Credits Required for BSET Degree	128		63		65 cr
Remarks: (1) Maximum 64 semester credits can be transferred from Community Colleges (2) Transfer credits are subject to WSU Transfer Student Statute and may be revised (3) Minimum 30 credits MUST be earned from WSU and 24 credits in the Div of E T courses					

Table 2. EGT Courses Descriptions

(a) Required Courses:

Course descriptions for the existing courses are available on the website [49]. Following is a list of proposed new courses:

MCT 5150 Energy Sources and Conversion Cr. 3. Prereq: ET 3450, PHY 2140. Energy sources and conversion; terrestrial limitations; fuel cells, solar energy, geothermal and hydropower, wind energy, and fusion; microturbines.

MCT 5210 Fuel Cell Technology Cr. 4. Prereq: ET 3450, PHY 2140. Fundamentals of fuel cell; thermodynamic process; types of fuel cell; stationary and automotive power applications; economic and technical considerations.

(b) Elective Courses:

Students would select up to 18 credits of technical elective courses to satisfy the BSET-EGT degree requirements. Following is a list existing courses [49] and proposed new courses (with descriptions):

EET 4200 Control Systems

EET 4600 Power Electronics

MCT 3100 Mechanics of Materials

MCT 3150 Applied Thermodynamics

MCT 3180 Fluid Mechanics

MCT 4210 Heat Transfer

MIT 4800 Quality Control

EET 6200 Control Systems for Vehicles (New Course) Cr. 4 Prereq: EET 4200. Control systems applied to traditional and hybrid automotive applications. Open and closed loops, and electronic controls; sensors and transducers; hybrid and electric vehicles; engine control fundamentals; power train controls, vehicle control in intelligent vehicle highway systems.

MCT 6150 Hybrid Vehicle Technology (New Course) Credits 4 Prereq: E T 3450, PHY 2140. Fundamentals of hybrid vehicles; technical concepts and design, energy analysis, unified modeling approach, optimization and control. Conventional power generation: IC engine overview, concepts of hybridization, on-board energy storage. Overview of motors, transmissions, fuel cells, future applications.

MCT 6410 Applied Vehicle Dynamics (New Course) Credits 4, Prereq: ET 3450, ET 3050/EET 4200. Dynamic performance balance of vehicle subsystems: powertrains, brakes, steering, suspension, and tire; steady and transient motion conditions; Role of structure and structural parameters related to vehicle dynamics.

MIT 6510 Advanced Manufacturing Processes (New Course) Cr.4 Prereq: MIT 3510. Advanced manufacturing processes, especially those related to alternative energy technologies. Nontraditional processes based on mechanical, chemical, electrical and thermal principles. Processing polymers, ceramics, composites and other advanced materials.